Elias G. Carayannis
Editor

Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship

Springer Reference

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With 376 Figures and 97 Tables

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Editor
Elias G. Carayannis
Department of Information Systems & Technology
Management, School of Business
George Washington University
Washington, DC, USA

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Preface

I am pleased to share with you perhaps the first in its nature, scale and scope, publishing project trying to bring together theories, practices and policies related to the nature and dynamics of creativity, invention, innovation and entrepreneurship. In collaboration with Springer Publishers, the four Associate Editors of the **Springer Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship** and I have brought to completion this precedent-setting and intellectual footprint-defining Work of Reference. The aim has been to help define the intellectual scaffolds for the four related emerging thematic areas of research and practice.

The CI2E Encyclopedia has a total of 274 entries including *definitions / entries* of approximately *2,000-4,000 words* apiece plus longer (up to 6000 words) essays. The presentation style of the entries is informational / educational; the entries describe, define, synthesize, and review a topic, whereas there are several entries that showcase original theoretical or empirical research findings (see for instance the piece on the Epidemiology of Innovation). We have included qualified input from *Government, University, Industry and Civil Society researchers, policy makers and practitioners*. All contributions were reviewed on the basis of peer review as well as editorial review.

The CI2E Encyclopedia will consist of both print and on-line versions and will remain a living conceptual platform that will incorporate new entries on an ongoing basis in its online version and will have follow up print editions on a periodic basis.

May 2013

Elias G. Carayannis
PhD, MBA, BScEE, CPMMA
Washington, DC, USA

About the Editor

Elias G. Carayannis

Title: Professor of Science, Technology, Innovation and Entrepreneurship
Department: Information Systems & Technology Management, School of Business
Address: Funger Hall, Suite 515C
Phone: (202) 994-4062
Email: caraye@gwu.edu

Degrees:
Ph.D., Rensselaer Polytechnic Institute, 1994
M.B.A., Rensselaer Polytechnic Institute, 1990
B.Sc.E.E., National Technical University of Athens, Greece, 1985

Area of Expertise
Dr. Elias G. Carayannis is full professor of Science, Technology, Innovation and Entrepreneurship, as well as co-founder and co-director of the Global and Entrepreneurial Finance Research Institute (GEFRI) and director of Research on Science, Technology, Innovation and Entrepreneurship, European Union Research Center, (EURC) at the School of Business of the George Washington University in Washington, DC. Dr. Carayannis' teaching and research activities focus on the areas of strategic Government-University-Industry R&D

partnerships, technology road-mapping, technology transfer and commercialization, international science and technology policy, technological entrepreneurship, and regional economic development.

Publications

Dr. Carayannis has several publications in both academic and practitioner journals, including the following:

- IEEE Transactions in Engineering Management
- Research Policy
- Journal of R&D Management
- Journal of Engineering and Technology Management
- International Journal of Technology Management
- International Journal of Entrepreneurship and Innovation Management
- International Journal of Technovation
- Journal of Technology Transfer
- Engineering Management Journal
- Journal of Growth and Change
- Review of Regional Studies
- International Journal of Global Energy Issues
- International Journal of Environment and Pollution
- Le Progres Technique
- Focus on Change Management

He has also published 16 books to date on science, technology, innovation and entrepreneurship with Springer Publishers, CRC Press, Praeger/Greenwood, Palgrave/MacMillan, and Edward Elgar, and has several more projects under contract.

He has also published working papers with the World Bank and given invited lectures on a number of occasions at the World Bank, the IADB, the European Union, and several universities.

Professional Activities

Dr. Carayannis has the following professional roles and affiliations:

- Editor in chief of the Springer Journal of the Knowledge Economy
- Editor in chief of the Springer Journal of Innovation and Entrepreneurship: A Systems View Across Time and Space
- Editor in chief of the IGI International Journal of Social Ecology and Sustainable Development
- Editor in chief of the Edward Elgar Book Series on Science, Technology, Innovation and Entrepreneurship
- Editor in chief of the Springer Book Series on Innovation, Technology, and Knowledge Management
- Associate editor of the International Journal of Innovation and Regional Development
- Visiting professor at the Jönköping School of Entrepreneurship, Sweden
- Visiting professor at Grenoble Ecole de Management, France
- Visiting senior research fellow at Southeastern European Research Center, Greece
- Visiting senior research fellow at NIFU-STEP, Norway

He has consulted for a wide variety of technology-driven organizations in both government and the private sector, including the World Bank, the European Commission, the Inter-American Development Bank, the US Agency for International Development, IKED, the National Science Foundation Small Business Innovation Research Program, the National Institute of Standards and Technology Advanced Technology Program, the National Coalition for Advanced Manufacturing (NACFAM), the USN CNO Office, Sandia National Laboratories' New Technological Ventures Initiative, the General Electric Corporate Training & Development Center, Cowen & Co, First Albany International, and others.

Current Research

Dr. Carayannis is engaged with doctoral students and colleagues from around the world in the following areas of research:

- Technology Innovation and Entrepreneurship
- New Technology Ventures Formation and Financing
- Technology Innovation Metrics and Measurement
- International Science & Technology Policies and Practices
- International Development and Technology Entrepreneurship
- Technology Transfer and Commercialization
- Strategic Government – University-Industry R&D Partnerships
- Regional Economic Development
- Innovation Networks and Knowledge Clusters
- ICT-Enabled Technology Innovation and Entrepreneurship

Other

Dr. Carayannis is the co-founder and co-director of the Global and Entrepreneurial Finance Research Institute (GEFRI) and director of Research on Science, Technology, Innovation and Entrepreneurship of the European Union Research Center (EURC) at the GW School of Business.

He is fluent in English, French, German, Greek, and has a working knowledge of Spanish.

Associate Editors

Igor N. Dubina, Ph.D. in Social Philosophy, Dr.Sc.h. in Mathematical Economics, Vice-Rector for Strategic Programs and International Cooperation, Altai State University.

Igor N. Dubina has a Ph.D. in social sciences and a Dr.Sc. in mathematical economics. Recently, he is a vice-rector for Strategic Programs and International Cooperation and professor of Mathematical Economics at Altai State University, Barnaul, Russia. His educational background is in the fields of economics and statistical analysis, his Ph.D. dissertation (1999) was on the topic "Creativity as a Phenomenon of Social Communications," and his habilitation Dr.Sc. dissertation (2012) was on the topic "Game Theory Models for the Organization of Creative and Innovative Activities in Firms." His research interests are concentrated in interdisciplinary approaches to creativity and innovation studies, mathematical and computer simulation of innovation, survey design and statistical methods for empirical social and economic research.

Dr. Dubina has published 11 monographs and textbooks on creativity and innovation management, and mathematical methods and models for social and economic research, including *Creativity Management in the Innovation Economy* (Moscow, 2009); *Statistical Methods for Social and Economic Research* (Moscow, 2010); *Game Theory Fundamentals* (Moscow, 2010); *Managing Creative and Innovative People: The Art,* *Science and Craft of Fostering Creativity, Triggering Invention and Catalyzing Innovation* (London/Westport, 2007); *Creative Approaches in Business and Management* (Barnaul, 2007); and over 80 papers in Russian and English.

During 2010–2011 academic year, Dr. Dubina was a Fulbright visiting scholar at the George Washington University (GWU) School of Business (Washington, DC). From August 2004 to July 2005, he worked in the Department of Management Science at GWU and in the International Center for Studies in Creativity (Buffalo, NY) as a visiting research scholar. During the 2009 fall semester, he was in a position of a visiting research fellow at the Central European University (Budapest, Hungary). He presented conference papers in over 20 countries and gave guest lectures in George Washington University, Texas A&M University, Drake University, Buffalo State College, Waubonsee College (USA), Central European University (Hungary), Japan Institute of Applied Technologies, Kindai University (Japan), and other universities over the world.

Norbert M. Seel, Dr. phil. Dr. habil, Professor emeritus of Education, University of Freiburg, Germany.

Dr. Norbert M. Seel was chair and distinguished professor for research on learning and instruction as well as the head of the Department of Educational Science at the Albert-Ludwigs-University at Freiburg, Germany, until September 2012. From 1992 to 1998, he was a professor at the Technical University of Dresden where he also was the dean of the School of Education. He graduated from Saarland University in 1979.

His research interests include model-based learning and thinking, inductive reasoning and complex problem solving, the investigation of exploratory learning within technology-enhanced environments, creativity and processes of decision making in instructional settings.

Dr. Seel has published or edited more than 20 books, among them the textbook *Psychology of Learning* (2nd ed.), as well as more than 200 refereed journal articles and book chapters in the area of cognitive psychology, learning research and instruction. He is the editor in chief of the *Encyclopedia of the Sciences of Learning*.

David F. J. Campbell, The Alpen-Adria-University Klagenfurt, Faculty for Interdisciplinary Studies (iff), Institute of Science Communication and Higher Education Research (WIHO), Vienna, Austria.

The University of Applied Arts Vienna, Unit for Quality Enhancement, Vienna, Austria.

The University of Vienna, Lecturer in Political Science, Department of Political Science, Vienna, Austria.

David F. J. Campbell is a research fellow (senior scientist) at the Institute of Science Communication and Higher Education Research (WIHO), Faculty for Interdisciplinary Studies (iff), Alpen-Adria-University of Klagenfurt (http://uni-klu.ac.at/wiho/inhalt/876.htm); lecturer in Political Science at the University of Vienna (http://politikwissenschaft.univie.ac.at/institut/personen/lektorinnen/); and quality enhancement manager and quality researcher at the University of Applied Arts in Vienna (http://www.dieangewandte.at/jart/prj3/angewandte/main.jart?rel=de&content-id=1268829109404&reserve-mode=active). He studied political science at the University of Vienna and finished with a doctoral degree in 1996.

Campbell lead-authored *Epistemic Governance in Higher Education: Quality Enhancement of Universities for Development* (Springer, 2013) and *Democracy Ranking (Edition 2012): The Quality of Democracy in the World* (Books on Demand, 2012); coauthored *Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: 21st-Century Democracy, Innovation, and Entrepreneurship for Development* (Springer, 2012); coedited *Encyclopedia of Creativity, Invention, Innovation and Entrepreneurship* (Springer, 2013, forthcoming); *Knowledge Creation, Diffusion, and Use in Innovation Networks and Knowledge Clusters* (Praeger, 2006); and *Demokratiequalität in Österreich: Zustand und Entwicklungsperspektiven* (Leske+Budrich, 2002) ("Democracy Quality in Austria"). His articles on knowledge, innovation, knowledge economy and democracy, knowledge democracy, and quality of democracy have been published in several international journals. Campbell teaches (taught) at the University of Klagenfurt, University of Vienna, and George Washington University in Washington D.C. (Elliott School of International Affairs).

David Campbell is academic director of the global **Democracy Ranking** of the quality of democracy (http://www.democracyranking.org), and senior associate editor of two new journals, launched in 2010 and 2012:

1. **Journal of the Knowledge Economy (JKEC) (SPRINGER)**, http://www.springer.com/economics/policy/journal/13132
2. **Journal of Innovation and Entrepreneurship (JIE) (SPRINGER Open Source)**, http://www.springer.com/business+%26+management/entrepreneurship/journal/13731

Dimitri Uzunidis, Professor of Economics, University of Littoral and Westford Business School.

After having worked in various international and Hellenic institutions (Ministry of Industry and the Economy), Dimitri Uzunidis was named as an associate professor in 1992 at the new University of Littoral Côte d'Opale (Dunkirk, France). He participated in the establishment of this university, where he founded and managed the Research Unit on Industry and Innovation (Lab.RII). A specialist in the international political economics and in the economics of innovation and entrepreneurship, he currently teaches in some French-speaking and Greek universities.

Dimitri Uzunidis has published and edited many books on international economics and on economics of innovation. The research he has developed on the innovation, entrepreneur, and the dynamics of capitalism has given rise to some major publications at the international level: *John Kenneth Galbraith and the Future of Economics* (Palgrave MacMillan, London, 2005); *Innovation, Evolution and Economic Change: New Ideas in the Tradition of Galbraith* (E. Elgar, Cheltenham, 2006); *Genesis of Innovation: Systemic Linkages Between Knowledge and Market* (E. Elgar, Cheltenham, 2008); *Powerful Finance and Innovation Trends in a High-Risk Economy* (Palgrave MacMillan, 2008); *Innovation Networks and Clusters: The Knowledge Backbone* (Peter Lang, Brussels, 2010); and *Crisis, Innovation and Sustainable Development: The Ecological Opportunity* (E. Elgar, Cheltenham, 2012).

Dimitri Uzunidis has also significant responsibilities in the scientific edition sector, he is the editor of international journals: Innovations, Cahiers d'économie de l'innovation and Journal of Innovation Economics. The former in French and the latter in English are published by De Boeck and Cairn. He is also director of publication of the series Marché et organisations and L'esprit économique at L'Harmattan, Paris. He is also editor of Business and Innovation series, Peter Lang, Brussels.

Dimitri Uzunidis is currently president of the Research Network on Innovation (http://2ri.eu).

Contributors

Marian Adolf Karl Mannheim Chair for Cultural Studies, Zeppelin University, Friedrichshafen, Lake Constance, Germany

Ömer Akin School of Architecture, Carnegie Mellon University, Pittsburgh, PA, USA

Carol R. Aldous School of Education, Flinders University, Adelaide, SA, Australia

Andrei G. Aleinikov International Academy of Genius, Monterey, CA, USA

Laurice Alexandre-Leclair Research Network on Innovation, CEDAG Paris Descartes University, Paris, France

Sharam Alijani Department of Strategy and Entrepreneurship, Reims Management School, Reims, France

Darien Allan Faculty of Education, Simon Fraser University, Burnaby, BC, Canada

Carl Martin Allwood Department of Psychology, University of Gothenburg, Göteborg, Sweden

Beth Altringer Harvard School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA

MIT International Design Center, Cambridge, MA, USA

Alessandro Antonietti Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Markus Arnold Faculty of Interdisciplinary Studies (IFF), Institute for Science Communication & Higher Education Research (WIHO), Alpen-Adria University of Klagenfurt, Vienna, Austria

Arvind Ashta Burgundy School of Business (ESC Dijon-Bourgogne), CEREN, CERMi, Dijon, France

Jonathan Bainée ENSTA ParisTech, Université Paris 1 Panthéon-Sorbonne – France, Paris, France

Mohamed Bakhouya Department of Engineering Design and Production, Aalto University School of Science and Technology, Aalto, Finland

Chaffik Bakkali University of Montpellier 1, Montpellier Recherche Management, ISEM, Montpellier, France

Pierre Barbaroux French Air Force Research Center, BA 701-EOAA/CReA, Salon Air-France, France

Gerald Bartels Université de Montréal, Montreal, Canada

Thorsten D. Barth Political Scientist & Academic Entrepreneur, Vienna Democracy Ranking Organization - Academic Ranking Team, Vienna, Austria

Redouane Barzi Ecole Nationale de Commerce et Gestion, Université Ibn Tofail, Kenitra, Morocco

Tim Basadur College of Business, Krauss Hall 215, Concordia University Chicago, River Forest, IL, USA

Min Basadur Michael G. DeGroote School of Business, McMaster University, Hamilton, ON, Canada

Gerald Bast University of Applied Arts Vienna, Vienna, Austria

Alain Philippe Batsale University of Paris 12, Paris, France

Frank Beckenbach University of Kassel, FB Wirtschaftswissenschaften, Kassel, Germany

Guy Ben-Ari Defense Industrial Initiatives Group, Center for Strategic and International Studies, Washington, DC, USA

Nicolas Bencherki Center for the Sociology of Innovation, Mines ParisTech University, Paris, France

Philippe Béraud TELECOM Bretagne & CIAPHS, Université de Rennes 2, Campus de Rennes, Cesson Sévigné, France

James Berry Kenan-Flagler Business School, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Tarek R. Besold Institute of Cognitive Science, University of Osnabrück, Osnabrück, Germany

Sonali Bhattacharya Symbiosis Centre for Management and Human Resource Development, Pune, Maharashtra, India

Shubhasheesh Bhattacharya Symbiosis Institute of International Business, Pune, Maharashtra, India

Peter S. Biegelbauer Department Foresight and Policy Development, Austrian Institute of Technology, Vienna, Austria

Magdalena Bielenia-Grajewska University of Gdansk, Gdansk, Poland

Scuola Internazionale Superiore di Studi Avanzati (SISSA), Trieste, Italy

Andreas Binder Industrial Mathematics Competence Center, MathConsult GmbH, Linz, Upper Austria, Austria

Mauro Birattari IRIDIA, Université Libre de Bruxelles, Bruxelles, Belgium

Alan F. Blackwell Computer Laboratory, Crucible Network for Research in Interdisciplinary Design, University of Cambridge, Cambridge, UK

Gerhard W. E. Blasche Center for Public Health, Medical University of Vienna, Vienna, Austria

Vincent Boly Equipe de recherche sur les processus innovatifs (ERPI), Université de Lorraine, Nancy, France

Maria Bonnafous-Boucher Novancia Business School Paris, Paris, France

Najoua Boufaden ISG – Institut Supérieur de Gestion, Paris-France, Paris, France

Hélène Perrin Boulonne France Angels, Paris, France

Pierre Bourgogne CAIRN-INNOVATION Consulting Agency, BLENOD-LES-PAM, France

Sophie Boutillier Research Unit on Industry and Innovation/CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France

Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Jay L. Brand Ideation, Haworth, Inc., Holland, MI, USA

Pascale Brenet IAE, Université de Franche-Comté, Besançon, France

Marc Bühlmann Année Politique Suisse, Institute of Political Science, University of Bern, Bern, Switzerland

Thierry Burger-Helmchen BETA- Bureau d'Economie Théorique et Appliquée, EM Strasbourg, Université de Strasbourg, Strasbourg, France

Cyndi Burnett International Center for Studies in Creativity, Buffalo, NY, USA

Kevin Byron Queen Mary, University of London, London, UK

John F. Cabra International Center for Studies in Creativity, Buffalo State, Buffalo, NY, USA

Anuja Cabraal Graduate School of Business and Law, College of Business, RMIT University, Melbourne, VIC, Australia

Mauricio Camargo ERPI, University of Lorraine, Nancy, France

David F. J. Campbell Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria

University of Applied Arts, Vienna, Austria

George S. Campbell Vienna, Austria

Elias G. Carayannis Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA

Hernan Casakin School of Architecture, Ariel University Center of Samaria, Ariel, Israel

Didier Chabaud Université d'Avignon IUT TC, Avignon, France

Ming Ming Chiu University at Buffalo, State University of New York, Buffalo, NY, USA

Denis Choulier University of Technology of Belfort Montbéliard, Belfort, France

Francois Christophe Department of Engineering Design and Production, Aalto University School of Science and Technology, Aalto, Finland

Eric Coatanéa Department of Engineering Design and Production, Aalto University School of Science and Technology, Aalto, Finland

Cinzia Colapinto Department of Management, Ca' Foscari University Venice, Venice, Italy

Barbara Colombo Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Franck Cormerais Université of Bordeaux 3 & MICA, Bordeaux, France

Mawuli Couchoro CERFEG, FASEG, Université de Lomé, Lome, Togo

Jerry Courvisanos The Business School, University of Ballarat, Ballarat, Victoria, Australia

Helen De Cruz Somerville College, University of Oxford, Oxford, UK

Centre for Logic and Analytical Philosophy, Katholieke Universiteit Leuven, Leuven, Belgium

Alexander Damianisch Support Art and Research, University of Applied Arts, Vienna, Austria

Marie-France Daniel Département de kinésiologie, Université de Montréal, Montréal, Québec, Canada

Maria Daskalakis University of Kassel, FB Wirtschaftswissenschaften, Kassel, Germany

Jim Davies Institute of Cognitive Science, Carleton University, Ottawa, ON, Canada

James Day Department of Physics and Astronomy, University of British Columbia, Vancouver, Canada

Karl Dayson Department of Sociology and Criminolgy, University of Salford, Salford, UK

Robert L. DeHaan Division of Educational Studies, Emory University, Atlanta, GA, USA

Marc-Hubert Depret University of Poitiers, IRIAF, CRIEF, Niort, France

Robert H. Desmarteau Department of Strategy, Social and Environmental Responsabilities, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

Faridah Djellal Clersé-CNRS, University Lille 1 and RRI, Villeneuve d'Ascq, France

Marija Dobrovolska-Stoian Thinking Approach Group (TA Group), Riga, Latvia

Igor N. Dubina Economic Information Systems, Altai State University, Barnaul, Russia

Susanne Durst University of Liechtenstein, Vaduz, Liechtenstein

Geert Duysters Brabant Center of Entrepreneurship, Eindhoven University of Technology and Tilburg University, Eindhoven, The Netherlands

Robert P. Eckert New & Improved, LLC, Paul Smiths, NY, USA

Ingi Runar Edvardsson University of Iceland, Reykjavik, Iceland

Michihiko Esaki Wisdom Management Research, DTCN International Incorporation, Gifu City, Japan

Dawn Eubanks Behavioural Science and Strategy, Warwick Business School, The University of Warwick, Coventry, UK

Nikolaos G. Evangelatos Intensive Care Unit, Klinikum Nürnberg, Bayern, Germany

Joshua Fairchild The Pennsylvania State University, State College, PA, USA

Alain Fayolle EM Lyon Business School, Grenoble, France

Gregory J. Feist Department of Psychology, San Jose State University, San Jose, CA, USA

Roger Firestien Innovation Resources Inc., Buffalo, NY, USA

Joëlle Forest EVS-ITUS UMR5600, National Institute of Applied Sciences of Lyon, University of Lyon, Villeurbanne, France

Claude Fournier Réseau de Recherche sur I'Innovation (RRI), Laboratoire de recherche sur I'industrie et I'innovation (Lab.RII), Dunkerque, France

Janice Francisco BridgePoint Effect, Ottawa, Canada

Liane Gabora Department of Psychology, University of British Columbia Okanagan Campus, Kelowna, British Columbia, Canada

Andrea Gaggioli Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Mathieu Gagnon Université de Sherbrooke, Sherbrooke, Québec, Canada

Delphine Gallaud INRA CESAER (UMR 1041), Unité Mixte de Recherche INRA-Agrosup, Dijon Cedex, France

Faïz Gallouj Clersé-CNRS, University Lille 1 and RRI, Villeneuve d'Ascq, France

Christian Garaus Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Raghu Garud Department of Management and Organization, The Pennsylvania State University, State College, PA, USA

Brigitte Gay University of Toulouse, Toulouse Business School, Toulouse, France

Robert M. Gemmell Department of Strategy and Entrepreneurship, Robinson College of Business, Georgia State University, Atlanta, GA, USA

Horst Geschka Geschka & Partner Unternehmensberatung, Darmstadt, Germany

Michael Gibbons SPRU (Science Policy Research Unit), University of Sussex, Brighton, UK

Georg Glaeser Institute of Arts and Technology, Department of Geometry, University of Applied Arts Vienna, Vienna, Austria

Aytac Gogus BAGEM, Center for Individual and Academic Development, Sabanci University, Istanbul, Turkey

Richard Tabor Greene De Tao Master's Academy, Beijing, China

System Design & Management, Keio University, Tokyo, Japan

Samapti Guha Tata Institute of Social Sciences, Mumbai, Maharashtra, India

Priya Dhamija Gupta Symbiosis Centre for Management and Human Resource Management, Pune, Maharashtra, India

Wolfgang H. Güttel Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Samia Haddad Institute of High Commercial Studies of Tunis (IHEC), Tunis, Tunisia

Mavis Haigh Faculty of Education, The University of Auckland, Auckland, New Zealand

Abdelillah Hamdouch Planning Department, Polytechnic School, University of Tours, Tours, Cedex 3, France

Ulrike Hanke Department of Educational Science, Albert-Ludwigs-University of Freiburg, Freiburg, Germany

Cynthia Hardy Department of Management & Marketing, University of Melbourne, Parkville, VIC, Australia

Phillip Sinclair Harvard EIGSI – University of La Rochelle, La Rochelle, France

Parina Hassanaly IEP (Institute of Political Studies), Aix en Provence, France

John Haworth Manchester Metropolitan University, Manchester, UK

Thomas Heinze Lehrstuhl für Organisationssoziologie, Bergische Universität Wuppertal, Germany

Andreas Heller University of Klagenfurt | Vienna Graz, Faculty of Interdisciplinary Studies (IFF Vienna) Department of Palliative Care and Organisational Ethics, Vienna, Austria

Ludger Helms University of Innsbruck, Institute of Political Science, Innsbruck, Austria

Sven Hemlin Gothenburg Research Institute (GRI), School of Business, Economics and Law & Department of Psychology, University of Gothenburg, Göteborg, Sweden

Beth A. Hennessey Wellesley College, Wellesley, MA, USA

MIT International Design Center, Cambridge, MA, USA

Takeo Higuchi Idea-Marathon Institute (IMS Institute)/University of Electro-Communications, Tokyo, Japan

Rae Ann Hirsh Early Childhood, Carlow University, Pittsburgh, PA, USA

Indiana University of Pennsylvania,

Josef Hochgerner Centre for Social Innovation (ZSI), Vienna, Vienna, Austria

Bjørn M. Hofmann University College of Gjøvik, Gjøvik, Norway

University of Oslo, Oslo, Norway

W. David Holford Department of Management and Technology, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

Werner Hölzl Austrian Institute of Economic Research (WIFO), Vienna, Austria

Jesus Huerta de Soto Catedrático de Economía Política, Universidad Rey Juan Carlos, Madrid, Spain

Samuel T. Hunter The Pennsylvania State University, State College, PA, USA

Dirk Ifenthaler Department of Educational Psychology, University of Oklahoma, Norman, OK, USA

Jonathan Impett School of Media and Performing Arts, Middlesex University, London, UK

Jean-Pierre Issa International Center for Studies in Creativity, Buffalo State College, State University of New York, Buffalo, NY, USA

Anna Katharina Jacob Zentrum fuer Hochschul- und Qualitaetsentwicklung (ZfH), Universitaet Duisburg-Essen, Duisburg, Germany

Garrett Jaeger University of Georgia, Athens, GA, USA

Sabina Jaeger Auckland University of Technology-New Zealand, Auckland, New Zealand

Jonatan Jelen Parsons The New School for Design, New York, NY, USA

Björn Johnson Department of Business and Management, Aalborg University, Aalborg, Denmark

Renata Jonina Thinking Approach Group (TA Group), Riga, Latvia

Nowshade Kabir Knolee Group, Toronto, ON, Canada

Robert Kaiser Seminar of Social Sciences, University of Siegen, Siegen, North-Rhine Westphalia, Germany

Thomas Kaiserfeld Departmant of Arts and Cultural Sciences, Lund University, Lund, Sweden

Bahman Kalantari Department of Computer Science, Rutgers, The State University of New Jersey, New Brunswick, New Jersey, NJ, USA

Dafna Kariv The School of Business Administration, The College of Management Academic Studies, Rishon Lezion, Hamerkaz, Israel

James C. Kaufman Department of Psychology, Learning Research Institute, California State University at San Bernardino, San Bernardino, CA, USA

Uwe H. Kaufmann Centre for Organisational Effectiveness/COE, Singapore, Singapore

Ralph Kerle The Creative Leadership Forum, Willoughby, Australia

Stefan Kesting Auckland University of Technology-New Zealand, Auckland, New Zealand

Daehyun Kim University of Georgia, Athens, GA, USA

Kyung Hee Kim The College of William and Mary, Williamsburg, VA, USA

Laurens Klerkx Knowledge, Technology and Innovation Group, Wageningen University, Wageningen, The Netherlands

David A. Kolb Department of Organization Behavior, Weatherhead School of Management, Case Western Reserve University, Cleveland, OH, USA

Stefan Konlechner Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Gerhard Krauss Faculty of Social Sciences, University of Rennes 2, Rennes, France

Georg Krücken International Centre for Higher Education Research (INCHER), University of Kassel, Kassel, Germany

Ulf Krumnack Institute of Cognitive Science, University of Osnabrück, Osnabrück, Germany

Stefan Kuhlmann Science, Technology, and Policy Studies (STePS), University of Twente, Enschede, Netherlands

Kai-Uwe Kühnberger Institute of Cognitive Science, University of Osnabrück, Osnabrück, Germany

Hubert Lackner Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Thomas Lans Education and Competence Studies Group, Wageningen University, Wageningen, The Netherlands

Blandine Laperche Research Unit on Industry and Innovation/CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France

Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Edgar Lasevich Thinking Approach Group (TA Group), Riga, Latvia

Kung Wong Lau Institute of Textiles & Clothing, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Eric Michael Laviolette Novancia Business School Paris, Paris, France

Divya Leducq School of Geography and Planning, University of Lille 1, Villeneuve d'Ascq, France

Johannes Leitner University for Applied Sciences bfi Vienna, Vienna, Austria

Nadine Levratto EconomiX, UMR 7235 CNRS, University Paris Ouest Nanterre La Défense and Euromed Management, Nanterre, France

Loet Leydesdorff Amsterdam School of Communication Research (ASCoR), University of Amsterdam, Amsterdam, The Netherlands

Gordana Licina Michael G. DeGroote School of Business, McMaster University, Brampton, ON, Canada

Peter Liljedahl Faculty of Education, Simon Fraser University, Burnaby, BC, Canada

Malin Lindberg Department of Business Administration, Technology and Social Sciences, Luleå University of Technology, Luleå, Sweden

Bengt-Åke Lundvall Department of Business and Management, Aalborg University, Aalborg, Denmark

Stuart Mackenzie The Business School, University of Ballarat, Ballarat, Victoria, Australia

Steve Maguire Desautels Faculty of Management, McGill University, Montreal, Canada

Michel Marchesnay ERFI, Université de Montpellier, Montpelier, France

Ben R. Martin SPRU – Science and Technology Policy Research, The Freeman Centre, University of Sussex, Brighton, UK

Jason L. Mast Karl Mannheim Chair for Cultural Studies, Zeppelin University, Friedrichshafen, Lake Constance, Germany

Ruth Mateus-Berr Institute of Art Sciences and Art Education, Institute of Art & Society, University of Applied Arts Vienna, Vienna, Austria

Camargo Mauricio ERPI, University of Lorraine, Nancy, France

Kurt Mayer REFLACT – Sustainable Consulting, Vienna, Austria

Galina Medyna Department of Engineering Design and Production, Aalto University School of Science and Technology, Aalto, Finland

Céline Merlin-Brogniart CLERSE, Lille, France

University of Lille–France, Villeneuve d'Ascq, France

Karim Messeghem University of Montpellier 1, Montpellier Recherche Management, AES, Montpellier, France

Michael Meyer Nonprofit Management Group, WU – Vienna University of Economics and Business, Vienna, Austria

Winter Meyer Learning Research Institute, California State University at San Bernardino, San Bernardino, CA, USA

Dimis Michaelides Performa Consulting, Nicosia, Cyprus

Blair Miller Blair Miller Innovation, Evanston, IL, USA

Alfonso Montuori Department of Transformative Inquiry, California Institute of Integral Studies, San Francisco, CA, USA

Seana Moran Singapore University of Technology and Design, Singapore, Singapore

MIT International Design Center, Cambridge, MA, USA

Laure Morel ERPI, University of Lorraine, Nancy, France

Piera Morlacchi Department of Business and Management, School of Business Management and Economics (BMEc), University of Sussex, Falmer, East Sussex, UK

Barbara Müller Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Karl H. Müller Wiener Institut für Sozialwissenschaftliche Dokumentation und Methodik (WISDOM), Vienna, Austria

Marc Muller International University Institute, Munsbach, Luxembourg

Francis Munier BETA, Université de Strasbourg, Strasbourg, France

Abu Saleh Mohammad Musa Credit and Development Forum (CDF), Dhaka, Bangladesh

Bence Nanay Centre for Philosophical Psychology, University of Antwerp, Antwerp, Belgium

Peterhouse University of Cambridge, Cambridge, UK

Ferreira Nathalie Research Network of Innovation, Paris, France

Patrice Noailles RRI – Marne-la-Vallée University, Seillans Investissement, MemoPage.com, Paris, France

Kamisah Osman Faculty of Education, Universiti Kebangsaan Malaysia, The National University of Malaysia, Bangi Selangor, Malaysia

Andreas Panagopoulos University of Crete, Rethymnon, Greece

Elke Park Institute for Science Communication and Higher Education Research (WIHO), University of Klagenfurt, Vienna, Austria

Florin Paun ONERA – The French Aerospace Lab, Palaiseau Cedex, France

Ingrid Vaileanu Paun Institut de l'Evaluation Participative de la Valeur Territoriale, Issy-les-Moulineaux, France

Michael Pawlikowski University at Buffalo, State University of New York, Buffalo, NY, USA

Michael Peneder Austrian Institute of Economic Research (WIFO), Vienna, Austria

Julien Pénin University of Strasbourg – BETA (UMR 7522 CNRS-UdS), Strasbourg Cedex, France

Yvon Pesqueux Conservatoire National des Arts et Métiers, Développement des Systèmes d'Organisation, Paris, France

Francesca Petrella Lest CNRS, Aix-Marseille Université, Aix-en-provence, France

Thomas Pfeffer Department for Migration and Globalization, Danube University Krems, Krems, Austria

Institute for Science Communication and Higher Education Research, Klagenfurt University, Vienna, Austria

Fabienne Picard University of Technology of Belfort-Montbeliard, Belfort, France

Robert A. Pierce Christopher Newport University, Newport News, VA, USA

Carlotta Piscopo IRIDIA, Université Libre de Bruxelles, Bruxelles, Belgium

Christian Poncet ART-Dev, University of Montpellier, Montpelier CEDEX 01, France

Colin Porlezza Institute of Media and Journalism, University of Lugano, Lugano, Switzerland

Barbara Prainsack Department of Sociology and Communications, Brunel University School of Social Sciences, Uxbridge, Middlesex, UK

Heiko Prange-Gstöhl DG Research & Innovation, European Commission, Brussels, Belgium

Hector Ramos Department of Educational Psychology, College of Education & Human Development, Texas A&M University, Bryan, TX, USA

Suzanna J. Ramos Department of Educational Psychology, College of Education & Human Development, Texas A&M University, College Station, TX, USA

Kathleen Randerson University of Grenoble IUT2-CERAG, Grenoble, France

Clint Randles Center for Music Education Research, School of Music, MUS 317 College of the Art, University of South Florida, Tampa, FL, USA

Jacques-Laurent Ravix University of Nice Sophia Antipolis and CNRS, Valbonne, France

Julie Ray Réseau de Recherche sur l'Innovation, Dunkerque, France

Olga M. Razumnikova Cognitive Physiology Laboratory, State Research Institute of Physiology SB RAMS, Novosibirsk State Technical University, Novosibirsk, Russia

Sophie Reboud UWA Western Australia

Groupe ESC Dijon Bourgogne, Burgundy School of Business, Dijon, France

Renaud Redien-Collot Novancia Business School Paris, Paris, France

Nadine Richez-Battesti Lest CNRS, Aix-Marseille Université, Aix-en-provence, France

Alan G. Robinson Isenberg School of Management, University of Massachusetts, Amherst, MA, USA

Serge Le Roux Research Unit on Industry and Innovation, University of Littoral, Dunkerque, France

Research Network on Innovation, Paris, France

Mark A. Runco University of Georgia, Athens, GA, USA

Anne-Laure Saives Department of Management and Technology, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

Sylvie Sammut University of Montpellier 1, Montpellier Recherche Management, ISEM, Montpellier, France

Aljona Sandgren School of Business, Åbo Akademi University, Turku/Åbo, Finland

Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden

Helene Schiffbaenker JOANNEUM RESEARCH, Vienna, Austria

Willi Schlegelmilch Manager, Accounting System Standardisation, Schönaich, Germany

Adele L. Schmidt School of Education and Professional Studies, Griffith University, Brisbane, QLD, Australia

Russell Schneck WorkingLessons, Red Hook, NY, USA

Wilfred Schoenmakers Management Studies Group, Wageningen University and Research Centre, Wageningen, The Netherlands

Klaus Schuch Centre for Social Innovation (ZSI), Vienna, Austria

Angela Schwering Institute for Geoinformatics, University of Münster, Münster, Germany

Norbert M. Seel Department of Education, University of Freiburg, Freiburg, Germany

Franz Seifert Austrian Science Fund FWF (Funding Organization), Vienna, Austria

Imen Selmi National Engineering School of Gabes (ENIG), Gabès, Tunisia

Pieter Seuneke Rural Sociology Group, Wageningen University, Wageningen, The Netherlands

Robina Shaheen The Open University, Milton, Keynes, UK

Dean Keith Simonton Department of Psychology, University of California, Davis, CA, USA

Ph Nina Slanevskaya St. Petersburg Centre for Interdisciplinary Neuroscience Ltd., St. Petersburg, Russia

David A. Smarsh International Academy of Genius, Monterey, CA, USA

Johan De Smedt Department of Philosophy & Ethics, Ghent University, Ghent, Belgium

Uehiro Centre for Practical Ethics, University of Oxford, Oxford, UK

Alexander Sokol Thinking Approach Group (TA Group), Riga, Latvia

Hefa SONG Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

Markku Sotarauta School of Management, University of Tampere, Tampere, Finland

Philippe Spieser Groupe Escpeurope, Paris, France

John E. Spillan School of Business, University of North Carolina At Pembroke, Pembroke, NC, USA

Nico Stehr Karl Mannheim Chair for Cultural Studies, Zeppelin University, Friedrichshafen, Lake Constance, Germany

Anne Stenros KONE Corporation, Espoo, Finland

Sam Stern College of Education, Oregon State University, Corvallis, OR, USA

Billy Strean Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB, Canada

K. S. Subramanian Tata Institute of Social Sciences, Mumbai, Maharashtra, India

Gregory Tassey National Institute of Standards and Technology, Gaithersburg, MD, USA

Leïla Temri Montpellier SupAgro, Montpellier, France

Stephen Thaler Imagination Engines, Inc., St. Charles, MO, USA

Mazzarol Tim UWA Business School, Crawley, WA, Australia

André Torre AgroParistech, UMR SAD-APT, Paris, France

Olivier Torrès University of Montpellier South of France, Montpellier, France

Faruk Ulgen UFR ESE-University of Grenoble II, Grenoble Cedex 9, France

Eskil Ullberg Interdisciplinary Center for Experimental Science, George Mason University, Fairfax County, VA, USA

Diego Uribe-Larach Universidad Adolfo Ibañez, Las Condes, Santiago, Chile

Vuk Usković Therapeutic Micro and Nanotechnology Laboratory, Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, CA, USA

Dimitri Uzunidis Research Unit on Industry and Innovation/CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France

Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Jonathan Vehar Center for Creative Leadership, Greensboro, NC, USA

Etienne Vignola-Gagné Competence Centre New Technologies, Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany

Life–Science–Governance Research Platform, Department of Political Science, University of Vienna, Vienna, Austria

Daniela Villani Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Yingxu Wang Department of Electrical and Computer Engineering, International Institute of Cognitive Informatics and Cognitive Computing (ICIC), University of Calgary, Calgary, AB, Canada

Peter R. Webster Department of Music Studies, Henry and Leigh Bienen School of Music, Northwestern University, Evanston, IL, USA

Gerhard Weiss Department of Economics and Social Sciences, University of Life Sciences and Natural Resources, Vienna, Austria

European Forest Institute Central–East European Regional Office (EFICEEC), European Forest Institute, Vienna, Austria

Claudia Wenzel University of Klagenfurt | Vienna Graz, Faculty of Interdisciplinary Studies (IFF Vienna), Department of Palliative Care and Organisational Ethics, Vienna, Austria

Marian Wielezynski Université du Littoral (RRI Dunkerque), Consulting-European Union, Beauvais, France

Lee Wilson Division of Social Anthropology, Department of Archeology and Anthropology, University of Cambridge, Cambridge, UK

David M. Wineroither Department of Political Science, University of Innsbruck, Innsbruck, Austria

Jeffrey G. Woods School of Business, University of Indianapolis, Indianapolis, IN, USA

Fangqi Xu The Institute for Creative Management and Innovation, Kinki University, Higashi-Osaka, Osaka, Japan

Shinya Yamamoto Primate Research Institute, Kyoto University, Inuyama City, Aichi Prefecture, Japan

Titus Yong Singapore Management University, Singapore, Singapore

Sureyya Yoruk University of Georgia, Athens, GA, USA

Christopher Ziemnowicz Department of Management, Marketing, and International Business, The University of North Carolina at Pembroke, Pembroke, NC, USA

Andrea Zirm Hochschule für Angewandte Wissenschaften (HAW), Wentorf, Hamburg, Germany

Boris Zlotin Ideation International Inc., Farmington Hills, MI, USA

Alla Zusman Ideation International Inc., Farmington Hills, MI, USA

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Abductive, Deductive, and Inductive Thinking

▶ Method for Creating Wisdom from Knowledge

Absolute Leadership

▶ Creative Leadership

Abstract Intelligence

▶ In Search of Cognitive Foundations of Creativity

Academic Entrepreneur, Academic Entrepreneurship

Thorsten D. Barth[1] and Willi Schlegelmilch[2]
[1]Political Scientist & Academic Entrepreneur, Vienna Democracy Ranking Organization - Academic Ranking Team, Vienna, Austria
[2]Manager, Accounting System Standardisation, Schönaich, Germany

Synonyms

Academic firm; Entrepreneur; Entrepreneurship

Introduction

In the scientific theory, the terms *academic entrepreneur* and *academic entrepreneurship* are defined and developed further in very different ways. From the traditional perspective *academic entrepreneurship* means an "university spin-off" or an institutional transfer of research, development, or technology to start innovations or ventures (see, for example, Shane 2004). According to Beckman and Cherwitz (2009), *academic entrepreneurship* can be defined as an "intellectual enterprise," in which universities cooperate with local communities to create new values or ideas. With the special focus on the production of knowledge an *academic entrepreneurship* is close to the definition of an "*academic firm*" (Campbell and Güttel 2005), which sees an *academic entrepreneur* operating simultaneously as intellectual actor (= *academic*) and as entrepreneurial actor (= *firm*). As a summarization, the terms *academic entrepreneur* and *academic entrepreneurship* can be described as follows.

Definition of Terms: Academic Entrepreneur/Academic Entrepreneurship

Academic Entrepreneur

An *academic entrepreneur* defines an occupational profile for an actor being scientifically active and at the same time working as an

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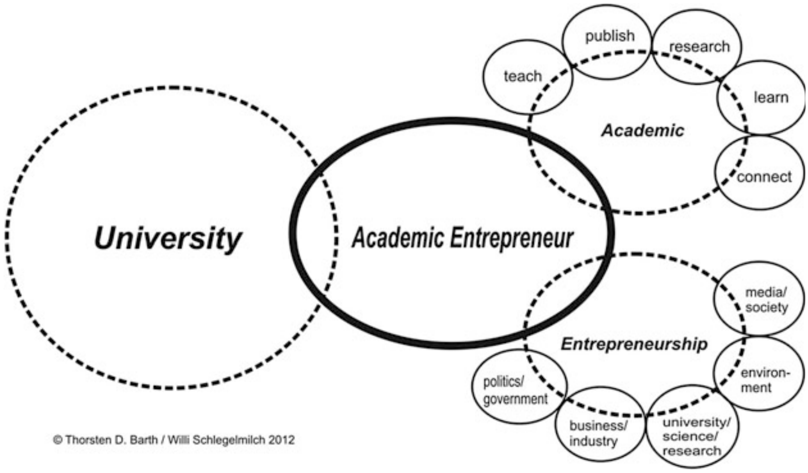


Academic Entrepreneur, Academic Entrepreneurship, Fig. 1 The academic entrepreneur

entrepreneur. Based on the academic education, scientific activities and integrated in the academic network combined with the entrepreneurial thinking and acting the *academic entrepreneur* creates income, earnings, and profit with self-employment. In a modern market-driven society the *academic entrepreneur* is the link between the academic world (= *oriented toward knowledge*) and the commercial world of the societies (= *oriented toward innovation*). Inevitable assets for the *academic entrepreneur* are its creativity, richness of ideas, exploratory urge, and a network within the scientific discipline as well as across disciplines (= *know-how*). The value added by an *academic entrepreneur* is created by the utilization of academic knowledge (*Patents, Ideas, Technologies, Think Tanks,* etc.) for customers belonging to different sectors (*Business & Industry; Government & Politics; Media & Society; Environment; University, Science & Research*) (see Fig. 1). The success of an *academic entrepreneur* comes along with the search for innovative solutions in a more and more digitalized world and through changes in the societies in times of increasing globalization. Following this, an *academic entrepreneur* is a symbol for the modernization of the universities and the transformation of the science and market-driven societies in the twenty-first century.

Academic Entrepreneurship

The term *academic entrepreneurship* articulates, that an *academic entrepreneur* acts commercially (= *entrepreneurship*) with, e.g., creating profits from patent developments, as well as noncommercially (= *academic*), e.g., with scientific publications of research results (see Fig. 1). *Academic entrepreneurship* is positioned between the academic production of knowledge and the demand for advanced knowledge and know-how from societies or private enterprises. In most cases, *academic entrepreneurship* comes from so-called spin-offs or start-ups in the context of innovative ideas, developments, and cooperations, which were already created at universities or are still under research. These spin-offs or start-ups are the universities' answer to the changes in the sciences and research over the last 30–40 years. An *academic entrepreneurship* start-up or -spin-off therefore has the primary objective to establish the needed link between the academic world and the world of private enterprises and by this to satisfy the still existing demand of the societies for new products, services, and ideas.

The Models of Innovation and its Relevance for Academic Entrepreneurship

> Entrepreneurship among academic scientists is by no means a new phenomenon. (Zhang 2007, 1)

The emergence of *academic entrepreneurship* goes along with the changes in the sciences and research over the last decades (see Lacetera 2009, 443). The increasing concatenation of the sciences and research with different sectors of the economy and the society as well as the change from a traditional university to an *entrepreneurial university* promotes *academic entrepreneurships*. D'Este et al. describes an *academic entrepreneur* in the following way:

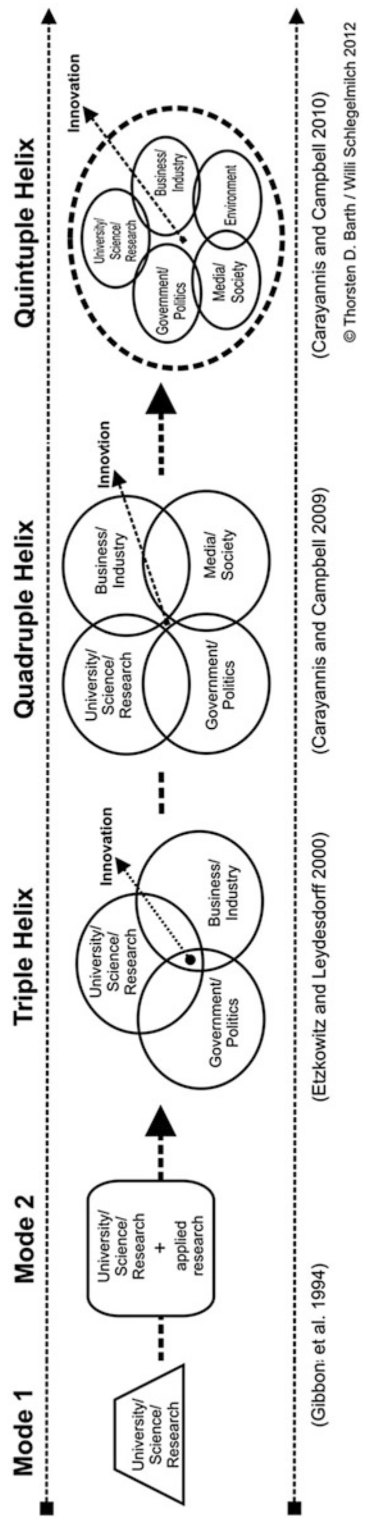
> The literature on university-industry technology transfer defines an academic entrepreneur as an university scientist who engages in the commercialisation of the result of his/her research, largely by patenting and/or setting up a business. (D'Este et al. 2005, 2)

Academic entrepreneurships are mostly founded as spin-offs or start-ups established by universities, in cooperation with universities or by university graduates based on innovative ideas, developments, or patents. In the course of change in the sciences and research, an *academic entrepreneur* defines the necessary link between the academic world and the world of private enterprises. The big difference between an *academic entrepreneurship* and a university, however, is that the *academic entrepreneur* while creating knowledge and innovation always is also interested in creating commercial income, earnings, and profits:

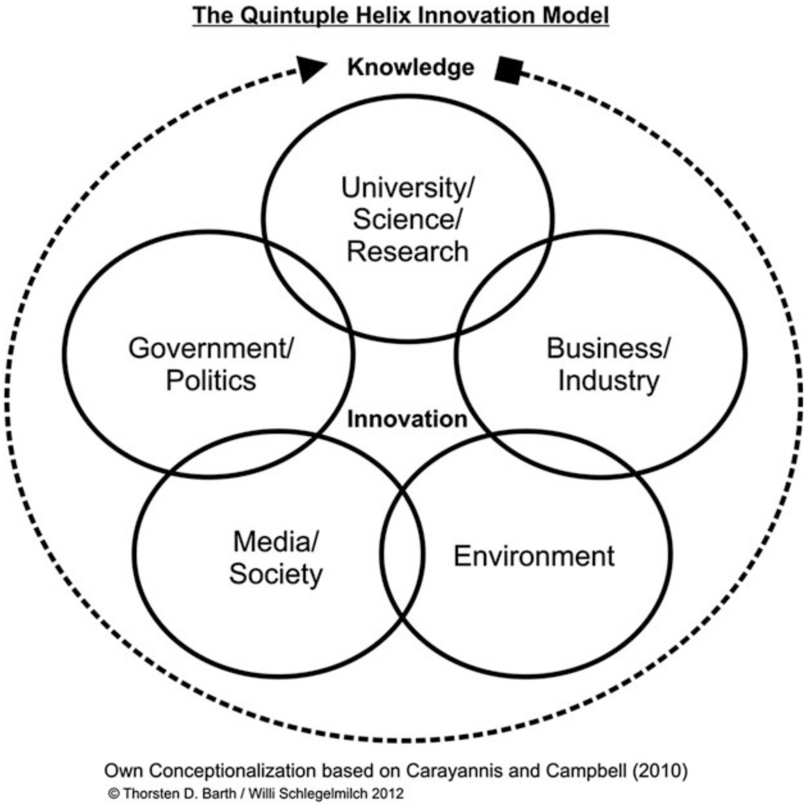
> Academic entrepreneurs are therefore characterized as having multiple missions: they derive direct utility from the completion of a project and the monetary returns from its commercialization (just like industrial actors), as well as from the research activities that precede commercialization. (Lacetera 2009, 444)

The increasing demand of private enterprises, political parties, nongovernmental organizations, media, or the public sector (e.g., governments) for new knowledge and know-how from the academic sector supports the foundation of more and more *academic entrepreneurship start-ups* or *spin-offs*. With respect to this, Shane explains the five advantages of an *academic entrepreneurship* spin-off (see Shane 2004, 20, 25, 27, 30, 32): (1) to "encourage economic development," (2) to "enhance the commercialization of university technologies," (3) "spin-offs help universities with their mission," (4) "spin-offs are high potential companies," (5) "creating spin-offs is more profitable than licensing to established companies." In a study about *academic entrepreneurs* in the United States of America conducted by Junfu Zhang, it was found out that in most instances, *academic entrepreneurship start-ups* or *spin-offs* were founded by professors, followed by research scientists, academic directors, and executives (see Zhang 2007, 33). This tendency in the formation of *academic entrepreneurships* is linked to the changes in the models of innovation. This can be visualized with and described based on Fig. 2:

Figure 2 visualizes that a change has taken place in the production of knowledge and innovation and by this new areas of work are created for *academic entrepreneurs* as well as an increasing demand for new knowledge and know-how. Over time new models of innovation were built, which created more chances for university graduates to act as entrepreneurs. At the beginning, the focus was on the traditional linear innovation model "Mode 1" (Gibbons et al. 1994), in which the production of knowledge at the universities was done with the support of predefined "disciplinary" und "hierarchically established peers" (see Carayannis and Campbell 2010, 48). Compared to the model "Mode 1," further developments toward innovation model "Mode 2" and all further nonlinear models of innovation have created new opportunities for the production of knowledge. Especially the innovation model "Mode 2" represents a model, in which institutions not belonging to universities take over a new role for the creation and



Academic Entrepreneur, Academic Entrepreneurship, Fig. 2 The models of innovation



Academic Entrepreneur, Academic Entrepreneurship, Fig. 3 The quintuple helix innovation model

production of knowledge. Research topics going across scientific disciplines can as well be described much better with this model. The specific characteristics of the innovation model "Mode 2" compared to the model "Mode 1" are the following ones: (1) knowledge is "produced in the context of application"; (2) "heterogeneity and organizational diversity"; (3) "social accountability and reflexivity"; (4) "quality control" (Gibbons et al. 1994, 3–4). Based on innovation model "Mode 2," an additional change in the creation and production of knowledge could be initiated. This resulted in and is described with the "Triple Helix Model" (Etzkowitz and Leydesdorff 2000, 118, 111–112). A triple helix is a "model of trilateral networks" to describe the "university-industry-government relations" as basis for exchanging knowledge and know-how through newly established cooperations. The innovation model of the "Triple Helix" was followed by the "Quadruple Helix Model," which added the "fourth helix" of "media-based and culture-based public and civil society" as integrative part for innovations. By this the model involves the society and its cultural background in the process of knowledge creation and production (see Carayannis and Campbell 2009, 218, 206). As the fifth helix in the enhanced model of innovation represents the "natural environment," the currently ongoing transformation from the "Quadruple Helix" to the "Quintuple Helix" (see also Fig. 3) makes visible that a sustainable development will be a definite part of the creation and production of innovations and knowledge (Carayannis and Campbell 2010, 51, 62). In addition the "Quintuple Helix" as improved model of innovation shows that in the twenty-first century, the creation and production of knowledge and innovation must be "transdisciplinary" and "interdisciplinary" at the same time. This is especially needed to work against the dangers resulting from the climate change and the destruction of the environment. The described complex changes in and the development of the models of innovation should make clear that the currently given complexity in the areas of work and research requires an *academic entrepreneur*.

As a summarization the relevance of an *academic entrepreneur* with relation to the development of the described models of innovation can be defined as follows: *The academic entrepreneur increasingly becomes a central actor to facilitate the production of knowledge and innovation. The transformation of the innovation models requires a cooperative and targeted exchange between the academic world and the world of private enterprises. In this context, it is the academic entrepreneur to create new and advanced solutions for the different knowledge areas based on gained knowledge and know-how.*

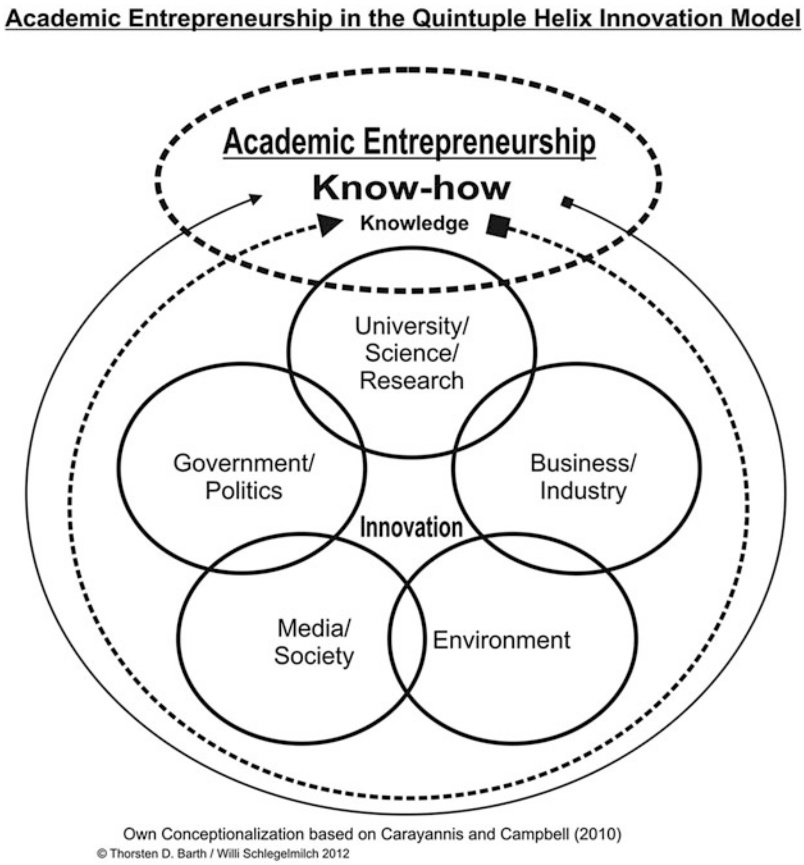
> Academic entrepreneurs are viewed as important players in the process of technology transfer from university to industry. (Zhang 2007, 1)

Examples of Academic Entrepreneurship in Practice

What is the motivation to become an *academic entrepreneur*? Following D'Este et al. (2005, 2) the "identification and exploitation of profitable opportunities" is a decisive factor, whether an *academic entrepreneurship* is founded. The authors additionally draw the conclusion, that there are four important factors to influence the "opportunity" of an entrepreneurship (see D'Este et al. (2005), 22–23): (1) "Collaboration with users and networking" meaning that "the type of networks the researchers belong to matters," (2) "Prior entrepreneurial experience" meaning "prior experience in entrepreneurial activities matters for the future of academic entrepreneurship," (3) "Combining multiple bodies of knowledge" meaning, only with a broadly arranged field of work and research, long-lasting independency and sustainable results could be achieved with *academic entrepreneurships*, (4) "Scientific Excellence" meaning that for a young university graduate, it is far more difficult to establish an *academic entrepreneurship start-up* than for "Scientific Excellence." In any case it is of advantage for the acquisition of assignments as entrepreneur to be already well known in science and research as well as being embedded in established networks.

What does an *academic entrepreneur* do in the occupational praxis and in which areas can work be done? An *academic entrepreneur* mainly focuses disciplinary in its area of specialization. However, in order to create best possible solutions for the customers, actions, research, and networking must also be concentrated on interdisciplinary areas. In the following section practical examples and potential focus areas for an *academic entrepreneur* are shown based on the innovation model and the knowledge areas of the Quintuple Helix (see Fig. 4):

1. An *academic entrepreneur* working in the helix area of "Government/Politics" utilizes the academic knowledge and know-how, which was for example gained through research activities done as political scientist at the university (= *academic*) to offer targeted political consultancy from a consulting company (= *entrepreneurship)* as self-employment. Application areas are, for example, support of political parties for an election program, organizing a campaign for a political party, or consulting a government to establish a new political agenda.
2. An *academic entrepreneur* working in the helix area of "Business/Industry" focuses the expertise as self-employed consultant to develop new and innovative methods for the strategy development of private enterprises (= *entrepreneurship*). At the same time, new findings could be published in a specialized scientific journal or invited lectures could be given at universities (= *academic*).
3. An *academic entrepreneur* working in the helix area of "Environment" could, for example, be employed as a natural scientist at the university (= *academic*). At the same time, patents could be registered for the university and promoted in cooperation between the university and a pharmaceutical enterprise (= *entrepreneurship*).



Academic Entrepreneur, Academic Entrepreneurship, Fig. 4 Academic entrepreneurship in the quintuple helix innovation model

4. An *academic entrepreneur* working in the helix area of "Media/Society" could be a self-employed journalist writing articles and working for several newspapers (= *entrepreneurship*). At the same time, textbooks, scientific articles, and contributions to specialized journals could be written for the scientific discipline of journalism (= *academic*).
5. An *academic entrepreneur* working in the helix area of "University/Science/Research" utilizes the academic knowledge and know-how gained as research fellow in the area of research at the university (= *academic*) to create information about needed strategic changes in the area of university development (= *entrepreneurship)* for the customers, for example, by consulting the ministry of science about foreseeable and expected changes in the world of sciences.

Currently in the USA the most *academic entrepreneurships* can be found in the following disciplines (see Zhang 2007, 33): Engineering, Medical science, Bioscience, Business, and Chemistry. Zhangs' research findings also indicate that *academic entrepreneurships* can mainly be found in scientific disciplines, where traditionally cooperations with private enterprises exist since long. New ventures can also be found, where based on academic innovations or developments, marketable enterprises could be founded. Besides the disciplines mentioned in this study, other academic disciplines offer opportunities and markets for *academic entrepreneurships* also. The special point about an *academic entrepreneurship* hereby is, that "… universities and academic scientists offer something that other actors, e.g. 'pure firms,' cannot re-plicate." (Lacetera 2009, 443)

Conclusion and Future Directions

Finally following definition can be given with relation to further developments of the innovation models and the profession of the *academic entrepreneur*: Through the transformation of the innovation models, there will be a more and more tight and targeted exchange between the academic world and the world of the private enterprises. Subsequently the profession of the *academic entrepreneur* will become normality in the scientific practice. There will be an increasing demand for *academic entrepreneurs* especially in the humanities and the social sciences. This is for the reason, that based on their specialized knowledge and know-how the *academic entrepreneurs* will better be able to face the social and political challenges resulting from more and more crisis to be expected for the advanced societies. There will always be good chances for creative enterprises and *academic entrepreneurship start-ups* also in the fine arts and the cultural sciences. As conclusion it can be said, that *academic entrepreneurships* should be supported more intensively in all academic disciplines. Especially in Europe this enterprise model should be further developed at universities and new career opportunities for young university graduates, for example, based on Ph.D. programs, should be offered. The specialized know-how of an *academic entrepreneur* and the related expertise to utilize academic knowledge for the commercial world has a huge potential in the present as well as in the future. Especially this aspect makes the *academic entrepreneur* a central actor for the production of knowledge and know-how in the present and in future.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Academic Firm
- ▶ Entrepreneur
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Quadruple Helix
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Start-up
- ▶ Triple Helix of University-Industry-Government Relations
- ▶ University Research and Innovation

References

Beckman GD, Cherwitz RA. Intellectual entrepreneurship: an authentic foundation for higher education reform. Plan High Educ. 2009;4(July–September):27–36.

Campbell DFJ, Güttel WH. Knowledge production of firms: research networks and the scientification of business R&D. Int J Technol Manage. 2005;31(1/2):152–75.

Carayannis EG, Campbell DFJ. “Mode 3” and “Quadruple Helix”: toward a 21st century fractal innovation ecosystem. Int J Technol Manage. 2009;46(3/4): 201–34.

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. Int J Soc Ecol Sust Dev. 2010;1(1):41–69.

D’Este P, Mahdi S, Neely A. Academic entrepreneurship: what are the factors shaping the capacity of academic researchers to identify and exploit entrepreneurial opportunities? DRUID working paper no. 10-05, ISBN 978- 87-7873-287-3, 2005, pp 1–34.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and “Mode 2” to a triple helix of university-industry-government relations. Res Policy. 2000;29:109–23.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.

Lacetera N. Academic entrepreneurship. Manage Decis Econ. 2009;30:443–64.

Shane S. Academic entrepreneurship: university spinoffs and wealth creation. New horizons in academic entrepreneurship. Northampton: Edward Elgar; 2004.

Zhang J. A study of academic entrepreneurs using venture capital data, discussion paper no. 2992, Aug 2007. Institute for the Study of Labor (IZA): Bonn, 2007, pp 1–43.

Academic Entrepreneurship

Julie Ray
Réseau de Recherche sur l'Innovation,
Dunkerque, France

Synonyms

Scientist entrepreneurship; University entrepreneurship

Key Concepts

Commercialization, applied research, Science-based entrepreneurial firms (SBEFs) (Colombo et al. 2009), University (research) related start-up venture/spin-off firms (Bathelt et al. 2010), High-tech companies; Technology-based academic entrepreneurs, University technology transfer, Knowledge-based economic development.

The scientific and technological potential generated by universities can be promoted and transferred through commercial application and be a source of revenue. Academic entrepreneurship is a means of commercialization, which is the transformation of knowledge into products, processes, and organization and their contribution to economic growth and innovation. In this way, a legal framework and institutional mechanisms have been set up through policies promoting the development of collaboration between industry and university. Facing territorial attractiveness and competitiveness stakes in a knowledge-based economy, politicians rely upon universities to product marketable new knowledge. Academic entrepreneurship is also a key concept, because of its catalyzing role of the potential of universities to contribute to local economic development and innovation through the transfer of the outcomes of faculty research to economic application. Academic entrepreneurship has managerial and policy implications for the faculty members involved in academic research and its commercialization, as well as for all the economic actors of innovation: university, industry, State, and networks. Which activities, within the different stages of the academic entrepreneurship process, are the actors and key success factors associated with?

Notions: Emerging of the Concept

Entrepreneurship grows on the motto of the economic and social development worldwide. Entrepreneurs are seen as the mainstays of the market economy: Their activities create value, jobs, and many advantages for the consumers. According to Audretsch and Thurik (2001), we are now living in a model of entrepreneurial economy. This model is the answer given to a knowledge-based economy and entrepreneurial capital. The entrepreneurial capital is the capacity to sign up an entrepreneurial activity or to generate it. Entrepreneurship is not limited to the creation of enterprise in the private sector. Indeed, it concerns all the existing organizations, whatever their size and the stakeholders, including the public sector, even if university becomes entrepreneurial (Etzkowitz and Leydesdorff 1996).

Academic entrepreneurship could sound like a paradox. In fact, the concept is linked to the university's changing role over time and in particular to its increasing mission of *commercialization*. This reflects the more active role that the universities have to take in promoting the direct transfer of academic research.

Since the 1980s, following the example of the Silicon Valley, public authorities have increasingly encouraged universities to commercialize the outcomes of their research work by the creation of interfaces to enable their transfer to the economic world. Commercialization is the process of transforming fundamental knowledge into innovative marketable products (applied research) through the creation of an economic activity within the university (intrapreneurship) or outside (spin off). It consists in the transfer of the knowledge developed by public research through activities with an economic application in the private sector (the market). Universities in industrial countries have to deal excessively with commercialization in addition to their traditional missions of production and transmission of knowledge. Those activities were previously mostly realized through research and teaching.

This process of transferring public knowledge to industrial and private application may prove essential for the durability of the universities in developing countries as well. Indeed, significant legislative reforms give emphasis to the commercialization of the results of the public research all over the world. This evolution starts in the USA with the signing of the Bayh Dole act in 1980. In particular, it gives researchers the possibility to patent their invention and to receive royalties from the selling of patents or licenses. The Bayh Dole act provides a mechanism by which the intellectual property generated under federal research grants can become the property of the university instead of the funding agency sponsoring the research. This legislation allows universities to transfer intellectual property to the society and encourages research laboratories to engage in technology transfer and commercialization activities. But university patents represent only one mechanism of transfer of academic research results to the marketplace. Academic entrepreneurship as a means of commercialization can take on several forms.

Different Forms of Academic Entrepreneurship

Academic entrepreneurship enables to protect and capitalize the results of basic research through activities such as collaborative research, contract research and consulting, as well as ad hoc advice, networking with practitioners, and the generation of spin-off. It also encompasses vocational training, teaching, joint publication with industry, and personnel-related learning activities such as staff exchange (transfer of people) and joint student supervision. External engagement is also sometimes referred to as an informal technology even though interactions are often formalized via contracts. Cooperation in product development and consulting is one of the mechanisms that is mostly used to transfer technology to the customer.

The Production of Knowledge in Research Laboratories of Universities

The mission given to universities to commercialize the results of scientific activities modifies the organization of the public research itself, but also the means of production of the research. Research laboratories and public centers become economic actors, who have a substantial role to play in the innovation process. Innovation is to be seen as any invention discovered through university research and offering potential for commercial use. Innovations may have economic applications that could lead to entrepreneurial activity. In that sense, laboratories produce factors of production and combine those "inputs" to create new, marketable "outputs."

The paradigm of the knowledge in the industrialized countries places more and more emphasis on the knowledge capital every economic actor has to deal in economic activities. In this way, the inputs a laboratory will mobilize consist much more in knowledge than labor and capital. To produce new knowledge transferable on the market, a laboratory, as a collective of scientists, will identify and combine several and different kind of inputs: resources and skills, knowledge and know-how, investments and remarkable equipment.

The management of the human resources of a laboratory is a critical point for commercialization activities. *The academic entrepreneur* or entrepreneurial scientist (Viale and Etzkowitz 2010) is a faculty member, a staff member, or a student, who creates an activity on the basis of the results of its research, with the purpose to commercialize it within or outside the university.

The academic entrepreneur is the innovator archetypal as he will carry out the transformation of an invention to an innovation thanks to commercialization activities. The innovation, defined by Van Hippel as "the successful exploitation of an idea," supposes entrepreneurship and creativity to come to the market. One research faculty member might embrace academic entrepreneurship process taking several roles in the different stages of the project. But the inventor can prefer to devote the entrepreneurial role to other stakeholder within public/private partnerships.

The two main mechanisms to transfer university's potential innovations to a larger community consist in the use of technology licensing agreement (intellectual property) or via the launch of a new venture/business commonly called "spin-off." Technology licensing agreement facilitates commercialization by transferring a potential innovation in return for a fixed fee or continuing royalties' payments.

University has also the possibility to commercialize an innovation by her side through *firm formation based on research*. University spin-off firms, also termed university spin-outs or research-related start-up ventures, can be defined as:

SBEFs (Science-based entrepreneurial firms): Firms that are created with the aim to exploit commercially the scientific knowledge developed in universities and other public research organizations (Colombo et al. 2009).

Synonyms: Academic start-up, New technology based firms, Academic spin-off, Spin-off from public research (Colombo et al. 2009). University spin-off is a subcategory of research spin-off.

Spin-out companies are defined in two ways: (1) the founder was a faculty member, staff member, or student who left the university to start a company or who started the company while still affiliated with the university and/or (2) a technology or technology-based idea developed within the university.

According to Steffensen et al. (1999), a spin-off is a new company that is formed (1) by individuals who were former employees of the parent organization and/or (2) a core technology that is transferred from the parent organization. An entrepreneurial spin-off arises when an entrepreneur leaves an organization to start a firm of her/his own.

The firm formation based on research as a medium for scientific and technological development is the most common way in USA to commercialization and innovation. This entrepreneurial science model tends to be developed in other parts of the world, but in Europe for instance, the commercialization is much more investigated through patent and license assignment or collaborative research program. European government authorities incite to the firm creation in a top-down approach with less success than in the USA where university entrepreneurship is born and represents a stage in the career of a faculty member.

Science-based entrepreneurial firms (SBEFs) are acknowledged in the literature as one of the key drivers of economic changes and growth and of the rejuvenation of high-tech industries. In the mid-1980s, economists observed a significant increase of technological start-up created by faculty members in areas at the cutting edge of technology like in the Silicon Valley in California, or the route 128 in Boston or in Cambridge (Viale and Etzkowitz 2010). This development is to be seen in the context of the strengthening of the links between university and industry.

Rationale for the Development of the Opening of Universities to Industry

Different factors made the university move of its position of "ivory tower" (mode 1) to an evolution to the entrepreneurial paradigm (mode 2) (Etzkowitz and Leydesdorff 2000).

Since the 1980s, universities became progressively a pivotal economic actor of the system of innovation and regional development thanks to their assignment of producing knowledge, training human resources and by creating spin-off as well. Public research, through the application of results of basic research plays an important role in the development of products, goods, services, processes, in relation to state-of-the-heart technologies especially within high-opportunity technology platforms such as computer science, molecular biology, and material science.

This evolution in the production of knowledge is an intrinsic part of the industrial development initiated in XIX century. Today, in a Knowledge-based economy, the *technical and scientific* *contents of all types of industrial production* are more and more complex: knowledge is everywhere as a "joint product of every production and consummation activity" (Foray 2001). Governmental organization as for instance the Organization for Economic Co-operation and Development recognized Knowledge as critical for economic growth in addition to physical capital and labor. In this context, academic research constitutes a way to feed the constant need of new knowledge generated by the scientific progress and technological development.

The *speed of science development* has also an impact on academic entrepreneurship and on the intensifying collaboration between university and industry. The delays for the development of transformation of knowledge based on basic research to concrete industrial application got considerably shortened. Thus, faculty members can make profit from the results of their researches by themselves and appropriate some or all monetary benefits of generated applications in the framework of a commercial exploitation.

Factors Affecting the Development of Academic Entrepreneurship

The government policies aimed at raising the economic return of publicly funded research. Consequently, universities have to find new sources of academic research funding in a context of budgetary stringency.

Influence of the Legal Framework and Institutional Contexts (System Level)

Legislative context regulates the status of public faculty members to stimulate university technology-transfer and academic entrepreneurship in several ways: mobility (spin-off), layoff during firm formation and development; substantial investment to an SBEF formation, incentives to patent and license and to research contracting as well. Indeed, university's policies drew more and more attention to academic entrepreneurship as his role has been emphasized in regional economic development and capitalization of knowledge. The application of science to economy highlights innovation as the main function of growth and economic development. *Innovation* carries out the increasing development of techno cities births since 30 years. Providing an interface between industries and research, the mythical model of the Californian Silicon Valley Stanford University was spread out throughout the world.

Two main economic trends conceptualized this entrepreneurial model, focusing on relationships between actors of the economic development: The Innovative Milieux (Freeman, Nelson and GREMI) and the Triple Helix (Etzkowitz and Leyersdorf).

Some studies suggest that the entrepreneurial model is strongly relying on the significant range of specific assets in the regions and different countries. Indeed, the support of regional/local institution and the legislative context terms are determinant in the development of the commercialization process. But, the approaches are contingent on countries. For instance, the US entrepreneurial university emerged "bottom-up" in contrast to Europe where the introduction of academic entrepreneurship is a recent "top-down" phenomenon in response to the innovation gap between the USA and Europe.

The model of the triple helix emphasizes the influence of three key actors of the commercialization process: University, Industry, and Government. This thesis states that the university can play an enhanced role in innovation in knowledge-based societies. The National System of Innovation (NSI) approach (Lundvall, Nelson) considers much more that the firm is leader in the innovation process, while the Triangle Model of Sabato underlines the role of the State.

Effectively, the relationships between State, University, and Industry have changed since the restriction of military spending after the end of the "cold war." Today the "new technologies" drive industrial sectors and nation States to a reorganization which places the university as a knowledge producer at the center of the innovation process. In reality, each of the three partners of the triple helix is depending on the two others to play his role in the innovation process.

Contributing to Innovation: Compensate Mechanisms

Policies and firm strategies foster the mission of university of direct contributions to industry focusing on academic entrepreneurship and above all on creation of university spin-off firms.

As a consequence, the role of universities has evolved in the direction of a new "mode" of production of knowledge. Before their commercialization assignment, faculty members were paid by the State to produce academic research and make the science progress on the knowledge about fundamental laws. In the ancient system (mode 1), the results of academic research were promoted by publications and conferences and assessed by peers. In the new model (mode 2) of commercialization, the scientific validity of the knowledge is still evaluated thanks to the academic promotion process, except that the diffusion of the results gains a commercial value as well. Consequently, the scientific and technical progression of the public knowledge becomes appropriable by the private sector, so knowledge is developed into marketable. This evolution leads public laboratories to engage partnerships with industry, giving priority to applied research as a way to finance their basic research and functioning costs.

Thus, in the mode 2, enterprises have to pay to exploit the results of the research which were free of access in the mode 1. In the other hand, firms have also the opportunity to give an orientation to the works of research of public laboratories in function of their own development strategy, upon condition that they are able to pay the costs for technology development.

Innovation, Entrepreneurship, and Risk

Technology-oriented spin-offs are at risk of developing sophisticated technological products which are not market-oriented and so have greater chances of market failure. Indeed, the costs of innovation present a considerable high level and risk, mostly because they include non-recoverable costs especially at investment phase level (Death Valley). So, the venture of a university spin-off can appear as hazardous for a scientist entrepreneur.

In presence of a risk (Kenneth Arrow 1921) a competitive market will not necessary lead economic agents to mobilize the optimal quantity of resources, all the more in a pre-recession context. Besides, the value of an innovative project is unknown, and marketing studies often do not guarantee the absorptive capacity of consumers, in particular in the case of the small size of the market.

At the same time, investors could find hard to select a project with high profit and innovative potentials because of the complexity of a science-based project, which needs translation for neophytes. Furthermore, banks, venture capitalists, or business angels ask for guarantees before committing in the financing of the development of a start-up. At last, innovations may not find directly their market for they do not necessarily match with the short-term logics of shareholders (Return on Equity principle).

This is why the States compensate for market imperfections by supporting correcting mechanisms favorable to the emergence of collaborative research and development activities. Mechanism such as clusters aims at developing solid and fluent links between the actors of the triple helix. The objective is to conduct the actors to converging, developing synergies and cooperation, and building new ways to get out of path dependency. A cluster gathers on a given territory enterprises, research laboratories, training organization, national and local public authorities, as well as associated services are handed out to the members of the cluster.

Internal Mechanisms in Universities

Strong policies to further academic entrepreneurship and commercialization attempt to overcome barriers to entry. Barriers to entry to SBEF is also decreasing, thanks to the development by universities of mechanisms in order to assist the process in company formation and development, to accompany start-up and pass major difficulties facing spin-out companies. Studies show that the success of scientist ventures depends strongly on the support that an academic entrepreneur will find on a consistent academic strategy (Clarysse et al. 2011).

Universities have developed *Technology Transfer Offices* (TTO) as well as commercialization of university intellectual property and platforms (incubators) beyond the scope of facilitating the process of transfer of technologies. The TTO provide administrative technical and juridical assistance to scientist entrepreneurs in the different steps of creation, implementation, and development of their entrepreneurial activities. They secure the disclosure of university's innovations and the security of intellectual property protection as well. The TTO have a challenging role in facilitating the transfer of the university's intellectual property to commercialization activities. TTO, as a mediator between the inventor and the market, verifies the opportunity to secure intellectual property, in reference to the budget and the axis of development of the university's strategy. Indeed, patenting requires efforts and time, and could result as really costly. Consequently, the TTO have to ensure the potential of the innovation. To achieve this target, it is necessary to sort out a decisive element regarding the commercialization of an innovation, which consists in determining if pointing the transfer policies to patenting or to the development of high potential research giving innovation. All the more so high-potential innovations are sometimes not easy to detect at the first glance. The TTO staff may not understand the possible application of the technology to a small market niche. It is really rare that the researcher chooses to further develop and test the commercial viability of the discovered technology without the support of the TTO. Incentives to develop innovations have been proposed to researchers to compensate those asymmetries. But they run up against a common phenomenon in the academic world: Researchers are more likely concerned by the publication of their research outcomes rather than an economic application.

The effectiveness of TTO and policy implications to support academic entrepreneurship and SBEF in particular were assessed all over the world with unequal results. Economists agree to establish a correlation with the development of synergies between the stakeholders of the academic entrepreneurship process and success stories. The main difficulty consists in mediate stakeholders around a project because they face differently the stakes of commercialization according to their position: researcher, industrial and businessman, federal agent, TTO staff. Therefore, a key factor could lay in a common formulation and implementation of coherent and feasible technology transfer/commercialization strategies.

Studies attribute success stories to the *behavior of key inventors* as well and suggest that faculty inventors have a critical role in the identification of marketable technologies and disclosure of these technologies to university technology transfer offices (Hoye and Pries 2009). Indeed, the policies and the management of human resources within universities are essential to promote academic entrepreneurship as a stage in an academic career or an alternative career. Therefore, researchers will either follow traditional career path or be interested in commercialization activities. But is it possible to do both? The figure of Janus to describe the entrepreneurial behavior of some faculty member emerges as a dialectical process: science-based commercializing activities may feed the academic research at the same time as research fields will be extended thanks to experimentation in commercialization.

Thus, the frontiers between academic and business worlds tend to reduce in an entrepreneurial society, which states that everyone is able to become an entrepreneur and just need to acquire skills in that field. Training needs might be correlated with the more marked mission given to universities since the mid-1980s to prepare students to enter into the market labor. For instance, students have to apply academic knowledge within training periods in enterprises. At the same time, entrepreneurship as a scientific field has been investigated and universities have developed entrepreneurial contents in academic courses such as developing competencies in firm formation or elaborate business plan.

Growth and Challenges

Knowledge's Production Change, Capitalization of Knowledge, Partnerships and Networks

In addition to the facilities given to researchers to commercialize, reforms of the academic system in the direction of scientist entrepreneurship (Aldridge and Audretsch 2011) make the profession deeply evolve. The knowledge creation in academic field is not an exception to the common new rule developed in other sectors of production which gives the primacy to the network.

Thanks to its creation and transfer of knowledge duty, university is becoming a driving force for a transition to knowledge-based economy: knowledge spillovers positively affect technological change and economic growth. In its strategy definition, the entrepreneurial university will take into account the key factors of commercialization (Laperche 2002). University, in this way, will take up with establishing close relationships with its entrepreneurial milieu by networking. The faculty member, therefore, fits his research activity into the scheme of the strategies of his/her university. Knowledge management and its capitalization are situated at the center of knowledge transmission.

But the existing knowledge might be not commercialized to its full content and go through to a filter first. According to the economist expert of knowledge Dominique Foray, knowledge transfer to society involves a codification to establish a model. In this way, a codified knowledge comes close to the characteristics of a good. The codification takes part of the knowledge capital that an organization will mobilize to participate in the production of new knowledge. Today, all kind of organizations are led to association through partnerships to combine skills and resources. Indeed, the terms of access to a network are predicated on the inputs and outputs that a system will be able to build up; as well as its learning capacity of new knowledge. Managing knowledge in the sense here signifies to identify, to retain and to promote cognitive resources, learning abilities and skills one is holding. Knowledge diffusion requires a codification, because of its tacit nature in order to let the complementary assets develop through academic entrepreneurship activities such as spin-off. It is necessary to be able to rely on fluent transmission channels to set up a codification process and to rest upon actors who appropriate the approach.

To hold a critical position in a system of innovation means to insert in networks aiming at commercialization activities in order to prove its (cap)ability to contribute to innovation. One of the challenges a firm has to take up in its research and development strategy is to cope with the necessity to reduce the transaction costs (Oliver Williamson 1932) in order to acquire new knowledge with (public) research laboratory. In that sense, universities have to deal with the prevention of industrials regarding academic entrepreneurship and the difficulty to find a common language concerning the commercialization process and economic impact of potential innovation. On the other hand, public research needs to be sponsored and considers academic entrepreneurship as a source of revenue. This would lead universities to the formation of partnerships with entrepreneurs and business partners, looking for the qualified partners. Those partnerships are challenging because they represent a consequent key success factor for academic entrepreneurship, although they require the universities to make the academic culture evolve in the direction of economic application.

Conclusion and Future Directions. Contributing to Innovation: What is the Best Way?

The selection of appropriate mechanism for transferring an innovation may depend on its nature: theory discerns two main types of innovation, such as incremental or radical (Tidd et al. 2005).

An innovation is weather based on existing technology (incremental) or represents a radically new and unknown technology. The creation of a spin-off can appear as the best way to innovation in case of a pioneer technology with high development potentialities and substantial economic returns. Moreover, in the evaluation of transferability, the project leader will identify the field of the technology to transfer in function of the scale "time to market." Access to venture capital is critical in the phase of development (the prototype creation stage needs capital), as well as spatial proximity with stakeholders, and convergence with regional economic policies. Those environmental factors influence more particularly a firm formation in high tech.

In any case, academic entrepreneurship and its potentialities to lead to new ideas grows up when taking benefit of all kind of formal and informal collaboration in research processes. Commercialization activities odds of success depend at last on developing marketing activities, key networks and distribution channels. To build networks at the early stage of an academic venture will permit to get more stakeholders involved directly or indirectly in the ultimate commercialization stage. Field of transfer possibilities is increasing at the same time as it provides new thematic for research, which may lead to innovation enhancing well-being for society.

Cross-References

- ▶ Academic Firm
- ▶ Business Incubator
- ▶ Clusters
- ▶ Entrepreneurship Policies
- ▶ Information Asymmetry and Business Creation
- ▶ Innovation and Entrepreneurship
- ▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
- ▶ Knowledge Capital and Small Businesses
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)
- ▶ Patents and Entrepreneurship
- ▶ Risk
- ▶ Risk, Uncertainty, and Business Creation
- ▶ Spin-off
- ▶ University Research and Innovation

References

Aldridge TT, Audretsch D. The Bayh Dole Act and scientist entrepreneurship. Res Policy. 2011;40: 1058–67.

Audretsch DB, Thurik R. What's new about the new economy? Sources of Growth in the Managed and Entrepreneurial economies. Industrial and corporate change. 2001;1(10):267–315.

AUTM, Association of University technology Managers. http://www.autm.net/Home.htm. Accessed 20 Oct 2011.

Bathelt H, Kogler DF, Munro AK. A knowledge-based typology of university spin-offs in the context of regional economic development. Technovation. 2010;30:519–32.

Clarysse B, Tartari V, Salter A. The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. Res Policy. 2011;40:1084–93.

Colombo M, Mustar P, Wright M. Dynamics of science-based entrepreneurship. Tech Transfer. 2009; 35:1–15.

Etzkowitz H, Leydesdorff L. Emergence of a triple helix of university-industry-government relations. Sci Public Pol. 1996;XXIII:279–286.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of University–industry–government relations. Res Policy. 2000;29:109–23.

Foray D. L'économie de la connaissance, Repères, La Découverte, Paris; 2001.

Hoye K, Pries F. Repeat commercializers, "the habitual entrepreneurs" of university–industry technology transfer. Technovation. 2009;29:682–89.

Laperche B. The four key factors for commercializing research. The case of a young university in a region in crisis. Higher Educ Manage Policy. 2002;14(3):149–51.

Steffensen M, Rogers EM, Speakman K. Spin-offs from research centers at a research university. J BusVentur. 1999;15:93–111.

Tidd J, Bessant J, Pavitt J. Managing innovation: integrating technological, market and organizational change. 2nd ed. Wiley; 2005.

Viale R, Etzkowitz H. The capitalization of knowledge. A triple helix of university-industry-government. Cheltenham: Edward Elgar; 2010.

Academic Firm

David F. J. Campbell[1,2], Elias G. Carayannis[3] and Wolfgang H. Güttel[4]
[1]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[2]University of Applied Arts, Vienna, Austria
[3]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA
[4]Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

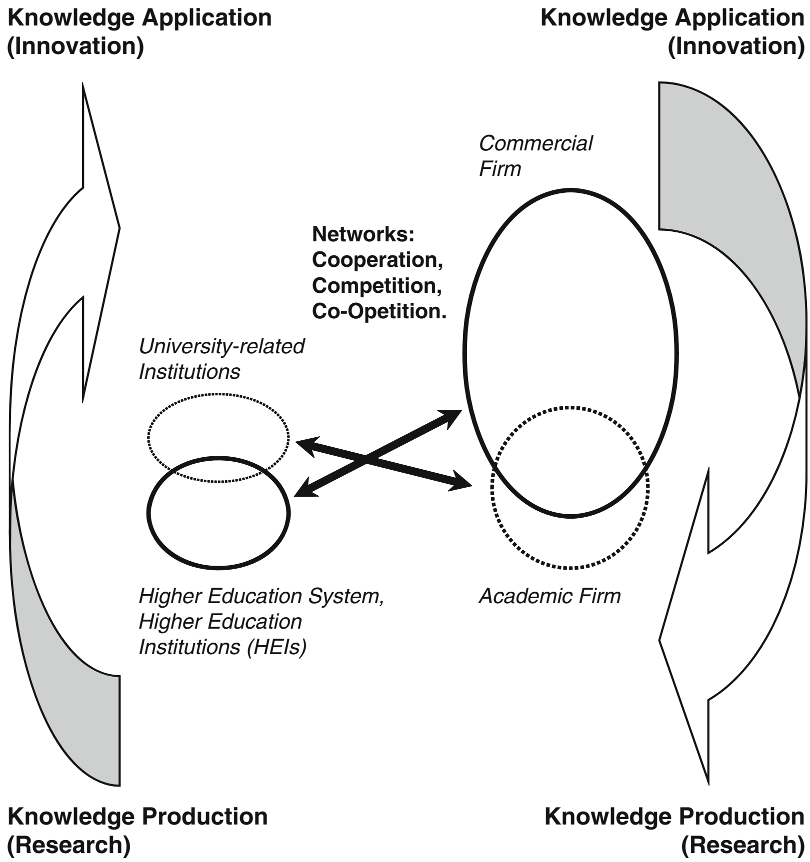
Synonyms

Commercial firm; Cross-employment; Ecosystem; Entrepreneurial university; Knowledge application; Knowledge production; Linear innovation; Mode 1; Mode 2; Mode 3; Mode 3 university; Modularity; Networks; Network absorptive capacity; Nonlinear innovation; Research (R&D)

The Conceptual Definition of the Academic Firm

The "academic firm" represents a type of firm (firm-based organization) that focuses on encouraging, supporting, and advancing knowledge production (research, research and experimental development, R&D) and knowledge application (innovation). The academic firm is also inclined to generate profit (revenues), but follows here more the logic of a "sustainability" in balance with knowledge production and the principles of knowledge production. The contrary concept to the academic firm would be the "commercial firm," which is primarily being motivated and driven out of an interest of maximizing profit (revenues). Between these two conceptual poles of understanding, there are various possibilities of a gradual or also unconventional (radical) combination of principles for the empirical organization of a concrete firm, its organizational manifestation. The shortcut for a definition therefore is as follows: "The *Commercial Firm* concentrates on maximizing or optimizing profit, whereas the *Academic Firm* focuses on maximizing or optimizing knowledge and innovation" (Carayannis and Campbell 2012, p. 27).

Knowledge and innovation are crucial key drivers for the academic firm. Academic firms can follow the logic of linear innovation but also the logic of nonlinear innovation. The model of linear innovation often is being assigned to Vannevar Bush (1945). This model assumes a sequential "first-then" relationship, where there is first basic research at universities that gradually diffuses out into society and economy and where firms then translate the lines of basic research into application and economic as well as commercial uses and profits. But nonlinear innovation favors a different approach. Nonlinear innovation is interested in a more direct and parallel coupling of knowledge production and knowledge application, where there are mutual interferences and parallel as well as parallelized interactions between basic research and knowledge application. The organization of nonlinear innovation encourages creative organizational designs (Campbell and Carayannis 2012). In context of firm-based organizations, also for the academic firm, the processing and advancement of nonlinear innovation may imply the following: (1) firms (academic firms) engage simultaneously in different technology life cycles at different levels of technology maturity; (2) firms (academic firms) accept to a certain extent, even encourage, cross-employment of their employees with other institutions, for example, academic institutions, such as universities or other higher education institutions. Cross-employment, as a concept, identifies forms and varieties of multi-employment, where an individual person is being simultaneously employed by more than one organization (by at least two organizations): should those organizations also root in different sectors, then cross-employment displays characteristics of a trans-sectoral network-building (Campbell 2011).



Academic Firm, Fig. 1 Knowledge production, linear and non-linear innovation interaction between academic firms, commerical firms, and universities (higher education institutions) (Source: Authors' own conceptualization based on Carayannis and Campbell (2009, p. 211; 2012, p. 25) and on Campbell and Carayannis (2013, p. 29))

Academic firms express a particular interest to network with universities, other higher education institutions, university-related institutions, and all forms and manifestations of organizations that conduct an academically based type of research or basic research. Academic firms explore also possibilities, options, and opportunities of networking with other firms (academic firms, but also commercial firms). There always remains the challenge, how to balance and how to refer to each other (out of the perspective of the firms) with regard to cooperation and competition. Furthermore, networks can integrate aspects of cooperation and competition. The organizational design of patterns of cooperation and competition allows creativity and can also be captured and described by the notion and concept of "co-opetition" (Brandenburger and Nalebuff 1997) (see Fig. 1).

Knowledge production in context of universities and the higher education system has been explained on the basis of the models of "Mode 1" and "Mode 2" of knowledge production. Mode 1 emphasizes a traditional understanding and refers to university basic research, with no particular interest in knowledge application, and being organized in context of academic disciplines. Here, the established peers of the academic disciplines define and decide on quality (acceptance and rejection of work). Mode 2 already expresses a greater interest in knowledge application and is characterized by the following principles: "knowledge produced in the context of application," "transdisciplinarity," "heterogeneity and organizational diversity," "social accountability and reflexivity," and finally "quality control" (Gibbons et al. 1994, pp. 3–8, 167; see furthermore Nowotny et al. 2001, 2003 and 2006).

"Mode 3" universities or higher education institutions are inclined to seek and to explore creative, novel, and innovative combinations of Mode 1 and Mode 2. One key interest of Mode 3 is "basic research in the context of application" (Campbell and Carayannis 2013, p. 34). Mode 2 as well as Mode 3 universities clearly meet and fulfill some of the characteristics of the "entrepreneurial university." However, it is important to realize that a Mode 3 university is more than an entrepreneurial university, in the sense that Mode 3 universities are still interested in focusing on and in conducting basic research. But the Mode 3 university does not assume an intrinsic contradiction between basic research and innovation (knowledge application): in fact, quite contrarily the Mode 3 university sees benefits and opportunities in a parallel (nonlinear) approach to knowledge production and knowledge application, to forms of combinations between basic research and innovation. Mode 3 universities (higher education institutions) have the opportunity of offering and developing "Creative Knowledge Environments" (on creative knowledge environments, see Hemlin et al. 2004).

Mode 2 and Mode 3 higher education institutions are the perfect organizational vis-à-vis of academic firms to engage in trans-sectoral networks and to perform good knowledge production. Here, a creative and innovative hybrid overlapping in regular frequency occurs or should possibly occur. This represents a coming together and networking on equal and fair grounds. The universities (higher education institutions) should not adapt one-sidedly to firms and their economic needs, but both sides should learn mutually from each other to the benefit of all involved parties, actors, and institutions. The assertion is that "While the entrepreneurial (Mode 2) university represents a partial extension of business elements to the world of academia, the academic firm could serve as an example for an extension of the world of academia to the world of business. Academic firms are knowledge-oriented, interested in engaging in networks with universities (the higher education sector), encourage 'academic culture and values' to motivate their employees, allow forms of academic work (such as academic-style publishing), and support continuing education and life-long learning of and for their employees (flexible time schemes, honoring life-long learning and continued continuing education with internal career promotion)" (Carayannis and Campbell 2012, p. 27).

In organizational terms, there are several possibilities, options, and opportunities on how the academic firm can be realized and can be structured (Carayannis and Campbell 2012, p. 27):

1. "A whole firm"
2. "A subunit, subdivision, or branch of a 'commercial' firm"
3. "Certain characteristics or elements of a whole (commercial) firm"

A whole firm can be organized and designed in accordance with principles of an academic firm. However, it is also possible only to organize subunits (branches) of a firm according to principles of academic firms. Alternatively, the focus may be placed primarily on certain principles of an academic firm, and these principles then can be applied to or across the whole (commercial) firm or at least to substantial divisions of the whole (commercial) firm. The term "academic firm" perhaps invites us to the belief, imagination, or vision that this would always mean a whole firm. What the analysis presented here however demonstrates is that this would be an artificially narrowing down of the concept and idea of the academic firm. It is important to note that the academic firm can address a whole firm, or only specific organizational units (subunits), processes, or principles of a whole firm. In fact, this even would allow for hybrid combinations and overlapping arrangements between the academic firm (knowledge focused and knowledge driven) and the commercial firm (profit driven). Currently it is difficult to assess how common or uncommon academic firms or principles of the academic firm are in the world of contemporary business. The conventional wisdom would be that the commercial firm represents (still represents) the dominant type of organizational representation for how to structure and how to develop firms (companies). In metaphorical terms, this is also the visualized image and picture in Fig. 1. With the advancement of economy and knowledge economy in context of the knowledge society (and knowledge democracy), it is plausible to assume that expectations are justified that a diffusion and spreading of academic firms appear to be reasonable. Academic firms have all the potential of substantially transforming (in a bottom-up mode and fashion) how the economy and economic activity are being understood and processed. The academic firm invites the introduction of academic values, lifestyles, and working methods into business, because the academic firm believes that academic research and the academic context to academic research are beneficial to the capacities and capabilities of firms focusing on knowledge production (research) and knowledge application (innovation). For the academic firm, academic research is not external but is being conceptualized, remodeled, and incorporated as an intrinsic process and an intrinsic form of organization within the boundaries of a firm. Academic firms also engage in academic research, where research is linked and interconnected with innovation. Academic firms express and encourage a "limited 'scientification' of business R&D" (Campbell and Güttel 2005, p. 170; see also Carayannis and Campbell 2009).

Organizational Aspects of the Academic Firm

In organizational terms, the following aspects appear to be important for academic firms:

1. *Strategic Governance*: Academic firms are characterized by employees with a high level of background knowledge. Academic education and experience allow them (in principle) to make decisions based on their own judgment. They are able to understand the firm's strategy and to connect information from outside meaningfully to the firm's existing knowledge base. However, the firm's strategy decides on whether organizations can allow employees to make decisions on their own or to restrict their behavioral freedom by imposing structures. Also within an organization, decision-making rights are distributed differently as some domains require precision and efficiency, sometimes even the R&D department, while others profit from creativity and improvisation. Thus, academic firms either build upon at least implicitly a control-based or on a commitment-based HRM (human resource management) system to strategically govern their employee behavior. Depending on the strategy, even academic firms have to make a decision on their HRM system, that is, how to govern experienced employees. Firms that need to combine exploration and exploitation on a high level in order to achieve ambidexterity have to develop structures for either separation of control- and commitment-based HRM systems in the form of an internal differentiation (structural ambidexterity) or integration based on a commitment-based HRM system (contextual ambidexterity).
2. *Modularity*: Specialization in academic firms often requires the development of highly sophisticated competencies on individual and on group level. Therefore, modularity provides an organizational structure to allow specialization and integration concurrently. The development of linkages and the creation of a basic understanding between specialized employees and groups are necessary in order to jointly perform either within an organization or within a network of multiple organizations.
3. *Network Absorptive Capacity:* The development of an integrative frame of reference between different specialized knowledge providers is a key requirement within networks. Network partners need sufficient absorptive capacity within the network to understand and to interlink the contributions of other network partners. Joint development groups, strategic meetings to align network partners, temporary employee transfer, or joint project meetings serve to establish network-internal absorptive capacity. If network-internal absorptive capacity is high, the entire network is able to profit from specialized network partners who are able to absorb knowledge in their particular environment. Network-internal absorptive capacity serves as a means to circulate information from various network partners internally.

Conclusion and Future Directions

In search for an ideal-typical portraying of the academic firm and the concept of the academic firm, the following characteristics and principles can be listed and again summarized:

1. The academic firm is a type of firm (firm-based organization or institution) that is being driven by focusing on encouraging, supporting, and advancing knowledge production (research, research and experimental development, R&D) and knowledge application (innovation). The academic firm is also interested in generating profits (revenues), but this should be a "sustainable profit" in comprehensive terms and well in balance with the good principles of a good knowledge production and knowledge application (innovation). The academic firm operates in a whole knowledge-based ecosystem.
2. The academic firm is and behaves as knowledge based, knowledge oriented, knowledge driven, knowledge producing, and knowledge creating. The academic firm displays (often) an inclination for applying and following the logic of nonlinear innovation, by this demonstrating flexibility. The academic firm regards basic research in the context of application as an opportunity.
3. The academic firm incorporates academic values to motivate its employees and to create bonds of trust and of a good relationship between the organization and the individual employees. The academic firm qualifies a disciplinary variety of the background of its employees (and their competences) as a potential opportunity and asset to perform creatively in knowledge production and knowledge application.
4. The academic firm has an interest to engage in networks with universities (higher education institutions) or other academic research institutions, driven out of a desire to access university knowledge (e.g., basic university research). In general, the academic firm values engagement in diversified networks as a form for creating knowledge as well as benefitting from opportunities.
5. The academic firm allows and encourages academic research work (academic publications can act as incentives for employees to codify their tacit knowledge).
6. The academic firm supports continuing education, further education, and lifelong learning of its employees and has in principle a positive attitude in favor of a flexibility concerning the load of working hours and their flexible adaptation for their employees and their needs (full-time, part-time, perhaps shifting back-and-forth), but also for partial absence or partial leave of its employees. Cross-benefitting cross-connections between careers and career schemes with continuing education are being explored by the academic firm.
7. The academic firm accepts in principle, in certain situations even promotes, split employment or "cross-employment" (multi-employment) of its employees with other (academic) organizations or institutions, for example, universities or other higher education institutions.
8. The academic firm is interested in creating internally "Creative Knowledge Environments" (Hemlin et al. 2004) within the internal boundaries of its organization.

The academic firm has the potential of transforming and changing the way how knowledge-based and knowledge-oriented economic work is being organized and performed.

However, does the academic firm represent primarily an ideal-typical concept, or does the academic firm exist (do academic firms exist) also in real terms? The commercial firm appears to define the dominant and established norm in the world of contemporary business. The empirical appropriateness or the proof of fitness for the ideas of the academic firm perhaps still needs to be demonstrated or verified. Academic firms are or would be exposed to an economic environment, where success often means to cope with and to profit from mechanisms and forces of severe competition in a continuously globalizing world. But the concept of "co-opetition" (Brandenburger and Nalebuff 1997) suggests also that success in competition means to develop networks with overlapping patterns of cooperation and competition. Between the two (conceptually) extreme poles of the academic firm and the commercial firm, many and several in-between forms of organization or hybrid combinations are possible. *The academic firm represents a challenging proposition for current business; the academic firm, however, indicates also routes and paths, for how next-stage changes and future changes and future successes in the world of business and the knowledge economy (in the knowledge economy) can be approached and achieved.* The academic firm is interested in bringing together innovation and entrepreneurship for development, more so for sustainable development.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Ambidexterity
- ▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
- ▶ Artistic Research
- ▶ China's National Innovation System
- ▶ Creative Knowledge Environments
- ▶ Cross-Employment
- ▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation
- ▶ Epidemiology of Innovation: Concepts and Constructs
- ▶ Epistemic Governance and Epistemic Innovation Policy
- ▶ Global University System in World Society
- ▶ Higher Education and Innovation
- ▶ Innovation Policies (Vis-à-Vis Practice and Theory)
- ▶ Innovation System of India
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
- ▶ Multi-level Systems of Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Nonlinear Innovations
- ▶ N-Tuple of Helices
- ▶ Palliative Care and Hospice - Innovation at End of Life
- ▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Systems Theory and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)
- ▶ Triple Helix of University-Industry-Government Relations
- ▶ University Research and Innovation

References

Brandenburger AM, Nalebuff BJ. Co-Opetition. New York, NY: Doubleday; 1997.

Bush V. Science: the endless frontier. Washington, DC: United States Government Printing Office; 1945. http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm#transmittal

Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als Chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE, 2 Feb 2011. http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500

Campbell DFJ, Carayannis EG. Epistemic governance in higher education. Quality Enhancement of Universities for Development. SpringerBriefs in Business. New York: Springer; 2013. http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6

Campbell DFJ, Carayannis EG. Lineare und nicht-lineare knowledge production: innovative Herausforderungen für das Hochschulsystem. *Zeitschrift für Hochschulentwicklung* 2012;7(2):64–72. http://www.zfhe.at/index.php/zfhe/article/view/448

Campbell DFJ, Güttel WH. Knowledge Production of Firms: Research Networks and the "Scientification" of Business R&D. International Journal of Technology Management. 2005;31(1/2):152–175.

Carayannis EG, Campbell DFJ. "Mode 3" and "Quadruple Helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manag. 2009;46(3/4):201–34. http://www.inderscience.com/browse/index.php?journalID=27&year=2009&vol=46&issue=3/4 and http://www.inderscience.com/search/index.php?action=record&rec_id=23374&prevQuery=&ps=10&m= or

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development. SpringerBriefs in Business. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3
Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies. London: Sage; 1994.
Hemlin S, Allwood CM, Martin BR. Creative Knowledge Environments. The Influences on Creativity in Research and Innovation. Cheltenham: Edward Elgar; 2004.
Nowotny H, Scott P, Gibbons M. Re-thinking science: mode 2 in societal context. In: Carayannis EG, Campbell DFG, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport: Praeger. p. 39–51.
Nowotny H, Scott P, Gibbons M. Re-thinking science. Polity Press: Knowledge and the public in an age of uncertainty. Cambridge; 2001.
Nowotny H, Scott P, Gibbons M. Mode 2 Revisited: The New Production of Knowledge. Minerva. 2003;41:179–194.

Academic Spin-Off

► Extrapreneurship

Accompaniment

► Business Start-Up: From Emergence to Development

Accompaniment of Business Creation

Didier Chabaud[1], Karim Messeghem[2] and Sylvie Sammut[3]
[1]Université d'Avignon IUT TC, Avignon, France
[2]University of Montpellier 1, Montpellier Recherche Management, AES, Montpellier, France
[3]University of Montpellier 1, ISEM UFR Administration Economique, Montpellier, France

Synonyms

Business support

Accompaniment is an important topic, as the time spent in an incubation structure makes it possible to increase the survival rate of the businesses created (CSES 2002). However, although incubation structures have been the focus of attention for researchers for many years (Smilor 1987), it is not until recently that there has been any attempt to fully understand the reasons behind the performances of incubators (Hackett and Dilts 2004), by entering into the black box of the incubation process (Hackett and Dilts 2008), to focus on the relationship between the incubatee and his accompanier (Rice 2002). Analyzing the relationship between the accompanier and the accompanied requires identification of its characteristics (1), common points and divergences (2). On this basis, it is then possible to better understand the levers behind accompaniment performances (3).

The Accompanier-Accompanied Relationship: Characteristics

Entrepreneurship literature often approaches accompaniment as a technique (making up for what is lacking at the legal, financial, organizational, etc., levels), more than a process. This then results in the identification of types of functional services, raising few questions at the human and temporal levels. It is necessary to borrow from other fields such as social sciences or psychology (Paul 2003) to try to appreciate accompaniment from an overall point of view.

The debate on accompaniment continues with the wide variety of types of accompaniment available. Accompaniment is not a single item, but many. From accompaniment by peers to coaching, via mentoring, there are many forms, often cumulative as the entrepreneur can combine them.

Accompaniment must be understood as a nonlinear entrepreneurial process, an entrepreneurial process that is not linear. It is a process inscribed in time and in constructed interpersonal action. It is subject both to hazards and to the intersubjectivity of the key players involved.

The accompaniment process is composed of three dimensions: cognitive, structuring, and legitimizing.

The cognitive dimension is based on the fact that accompaniment increases the base of knowledge of those who are accompanied. Accompaniment effectively allows entrepreneurs to open themselves up to new, previously unsuspected, and/or not mastered potentialities. The knowledge integrated is tested by experience. This process allows the entrepreneur to stand back on the one hand from the action carried out and, on the other, from endogenized knowledge. This reflexive logic makes it possible to link learning and action, and to potentially "break" the defensive routines that are harmful for change and thereby seize new opportunities (Argyris and Schön 1978).

The structuring dimension implies that those accompanied must organize and structure (Giddens 1991) the knowledge learned. Those accompanied must be able to rationalize their knowledge in such a way as to use it to good effect, even if the problems encountered are completely new. The knowledge is thus instrumentalized, or codified, by those who have it in order to become mastered.

The legitimizing dimension refers to the "burden" of the youth of the newly created company. The creator suffers from a lack of recognition (Stinchcombe 1965) in relation to companies present on the market for longer. Accompaniment allows the creator to give credibility to his actions and to make it easier for him to integrate into the environment. It is seen as an "antidote" for companies that have no past (Zimmerman and Zeitz 2002).

These three dimensions are designed on the one hand for the entrepreneur and on the other hand for the organization of which he is in charge. Entrepreneurs who choose to be accompanied effectively do so not at the personal level but in the context of their mission as an entrepreneur. From there, the knowledge that they integrate, organize into their reflection schema, and use in their daily actions is for both at the personal and the organization level.

Finally, the process for accompanying creators (PAC) can be analyzed on the combined basis of the three associated components (Sammut 2009): cognitive faculty (C), propensity for structuration (S), and legitimation strategy (L). These three interactive ($\times$) components (C, S, L) apply ($\subset$) to the dialogical entrepreneur-organization (E, O) relationship.

$$\mathrm{PAC} = \mathrm{f}[(\mathrm{C} \times \mathrm{S} \times \mathrm{L}) \subset (\mathrm{E}, \mathrm{O})]$$

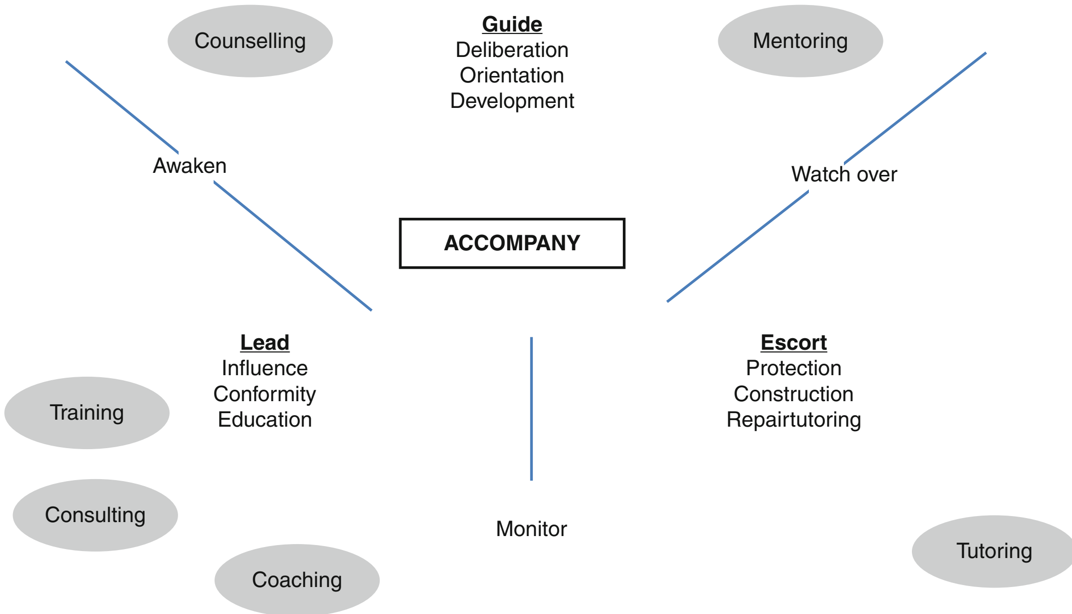
Characterizing the PAC is important because it highlights the dimensions implemented in accompaniment and will make it possible to reveal the performance elements. However, it is necessary to perceive the diversity to be found in the underlying forms of accompaniment behind the identification of these dimensions.

Diversity in the Forms of Accompaniment

This is, without doubt, the specificity of accompaniment: to appear to be a process marked by a high level of diversity, to the point where some people highlight its nebulous nature (Paul 2004). While this has undoubtedly damaged any clear recognition of this theme in literature at the international level, it can be noted that – in the French context – specialists from the field of education sciences have asked questions about "what accompaniment means" on the one hand and the diversity to be found in accompaniment on the other (Paul 2003, 2004). More recently, Segers et al. (2011) have tried to take this into account – in a closed context. This diversity – which appears as a diversity of forms, of what is available and also of the requests for accompaniment – thus results in a need for an in-depth analysis of the levers of performance.

Diversity of forms. Traditionally, five forms of accompaniment can be identified: coaching, mentoring, counseling, peer accompaniment, and consultancy.

Coaching implies a transfer of knowledge. It is also associated with the psychological dimension designed to reinforce the creator's confidence. The accompaniment has a date and is paid for.



Accompaniment of Business Creation, Fig. 1 Accompaniment registers (Paul 2004; Deschamps et al. 2010)

As for mentoring, it implies a desire to "resemble" the mentor, who acts as a model. The emphasis is placed on the personality of the individuals who recognize and appreciate each other, even before they develop a relationship. This form is not traditionally paid for.

Counseling is more based on understanding the personality, representations, lifestyle, and social roles of individuals. The psychological dimension is very much present. This type of practice implies payment.

Peer accompaniment, or tutoring, implies that each of the two key players is an entrepreneur and that an "exchange" of resources (knowledge, legitimacy, network, client lists, etc.) is possible in the form of a gift for a gift. The concept of sharing is essential and payment is prohibited.

Finally, consultancy, in the sense of a service provided by a qualified person (the consultant), is occasional, has a specific date, and covers a specific period. This period can however be renewed if the person being accompanied so requests. Consultants act in the place of the creator and their aim is limited to resolving the problem or problems identified. This is a commercial relationship.

Paul (2004) proposed combining this diversity of forms by emphasizing the diversity to be found in their underlying relational registers (Fig. 1). Both the objective and the method or type of accompaniment diverge so as to accompany the entrepreneur in constructing his own autonomy.

Diversity of the offer. The diversity to be found in forms of accompaniment goes hand in hand with diversity in the offer of accompaniment, with the relationship resulting in either payment or not. Certain forms are thus based on volunteers while others require payment for their services by the entrepreneur and/or public subsidies. The wide range of key players and organizers of accompaniment is thus significant: from consultancies to networks of volunteer accompaniers, such as the "entreprendre" network in France or the "M" network at the Entrepreneurship Foundation in Canada, via a very particular key player – business incubators, within which the entrepreneur's project can in certain cases be deployed. In this case, the entrepreneur has a fixed starting point which allows him to benefit from a range of accompaniment services, which will be used depending on how much progress has been made in the project, the entrepreneur's needs, expectations, and demands.

Diversity of the demand. Finally, entrepreneurs committed to a project can make use of accompaniment in different ways. Although it is possible to imagine using different forms of accompaniment simultaneously, Verzat et al. (2010) showed how accompaniment needs differ in relation to the life phases of the entrepreneur, while Couteret (2010) underlines the importance of the nature of the commitment – voluntary or forced – in the entrepreneurial act.

Diversity of forms, of the offer and also of what is demanded are all characteristic of accompaniment. It is possible to imagine, beyond this diversity, that there is a need to ask questions on how to identify what determines performance.

Performance in Accompaniment

Evaluating the performances of incubators has given rise to a major, heterogeneous field of research in the literature (Greene and Storey 2004; Bergek and Norrman 2008). In the early 1990s, Gibb (1992) affirmed the need to develop a specific research field for evaluation that could be used to provide conceptual information for public accompaniment policies. In almost 20 years, literature has developed (Lambrecht and Pirnay 2005; Greene and Storey 2007) without fully succeeding in understanding "what works and what does not" (Greene and Storey 2007, 213). Many indicators have been developed to respond to these different objectives. While some focus on the financiers, others focus on incubators or business creators. The following table summarizes the main indicators proposed in the literature for six categories: results, incubatees, resources, networks, processes, and management (Table 1).

Accompaniment of Business Creation, Table 1 Performance indicators for evaluating incubators (Messeghem et al. 2010)

Types of indicator	Indicators
Indicators focused on results	Number of projects accompanied
	Project completion rate
	Jobs created by the new company
	Business survival rate
Indicators focused on the incubatee	Incubatee satisfaction rate
	Incubatee selection
Indicators focused on financial resources	Access to financial resources
	Facilitated access to economic and commercial partners
	Decreased operating costs
Indicators focused on networking	Identify the key players in the network and the resources that must be mobilized
	Integration of the incubatee into professional networks
Indicators focused on processes	Capacity of the structure to provide a tailored response
	Mastery of the legislation
	Active participation
	Availability of tools
	Services proposed
Indicators focused on management	Innovation and quality of the incubator's management
	Information system adapted to the structure
	Exchange of good practices
	Experience of the accompaniers
	In-house training for the accompaniers

For Hackett and Dilts (2008), these indicators do not take sufficiently into account the incubation processes that too often seem to be a black box. To compensate for this limitation, the balanced scorecard method can be used (Messeghem et al. 2010). This method was devised by Kaplan and Norton (1996) as a means of evaluating the performances of organizations. It makes it possible to propose a multidimensional, contingent approach and to associate management control and strategic vision. The connection between strategy and measurement of performances is assessed by means of a strategy map, which is based on the causal relationships between four levers of performance: the financial axis, the client axis, the internal processes access, and the learning-innovation axis.

There are three advantages to this model. First, constructing a strategy map is a collaborative process that can be open to all the parties involved. In the field of incubation, it is essential that financiers, structure directors, and even the project bearers themselves be associated. Second,

Accompaniment of Business Creation, Table 2 Evaluation grid for the performances of incubators (From Messeghem et al. 2010)

Social and Economic Development	*Incubators*	*Company – Individual*	*Financiers*
	Number of collaborators designated for incubation Number of incubatees in the course of a year Number of effective business creations/number of projects incubated Incubator's overall budget	Development of the skills of the business creator Support for the mourning of failed projects Business creator's salary Forecast turnover/actual turnover Return to employment	Spatial justice Number of jobs generated within the incubated businesses Durability rate of the incubated businesses
Incubatees	*Product/service attributes*	*Relations*	*Image*
	Availability of tools making it possible to formalize services Explicit reference to financiers in the services	Satisfaction rate of the creator with regard to the services Creator's integration into professional networks Maintaining contact post-creation	Using communication tools Certification and/or labeling for the incubator Renown of the incubator
Incubation process	*Operations management process*	*Incubatee management process*	*Innovation process*
	Ability to respect specifications Mastery of the legislation concerning business creation Use of accompaniment tools Identification of the key players in the network and the resources that need to be mobilized Distance accompaniment Implementation of a quality approach	Involment in project Shared post-incubation review Incubator's ability to provide a tailored response Respect of confidentiality Progressive validation of the stages in the incubation process	Active participation in collective reflection on incubation methods Commitment to experimentation within the incubator
Learning	*Human capital*	*Informational and relational capital*	*Organizational capital*
	Referentials or grids of skills of the incubator's personnel Efforts in in-house training Personnel's past experience in incubation and/or business creation Identification of the key players and resources with key skills	Integration into networks Information systems Information intelligence Exchange of good practices Participation in events	Management in teams Versatility of the personnel Specialization of the personnel Formal or informal collaborative arrangements Turnover

the balanced scorecard makes it possible to reconcile the two visions of management control described by Simons (1995): *diagnostic control*, based on *a posteriori* control of results and the implementation of well-thought-out strategies, and *interactive control*, which is oriented toward organizational learning, searching for opportunities and the emergence of new strategies. Third, the balanced scorecard retains a dialectic approach and thus makes it possible to combine different types of ago-antagonistic indicators: indicators of results and processes, financial and nonfinancial indicators, qualitative and quantitative indicators, and so on.

Messeghem et al. (2010) have already shown that the different aspects of the balanced scorecard can be used to evaluate the performances of incubators. A qualitative study followed by a quantitative study of 109 French incubators allowed the authors to specify the nature of these four axes and to validate the indicators associated with them. Table 2 summarizes the four axes of the balanced scorecard adapted to accompaniment activities. Each axis has been divided into three subdimensions to which the indicators are attached.

The approach based on the balanced scorecard makes it possible to retain a plural approach to evaluation. On the one hand, it takes into account the objectives of the various parties involved. On the other, it adopts a multidimensional reading by cross-referencing indicators of different natures. More broadly speaking, the approach proposed makes it possible to penetrate the very heart of the black box of incubation and to better understand performance and its determinants.

Conclusions and Future Directions

Accompaniment is often seen as an amorphous group of practices (Paul 2004). As a result, in entrepreneurial terms, the diversity of forms, what is on offer and what is being demanded by entrepreneurs can reinforce this impression. However, by penetrating the "black box," it seems to be possible to better characterize the accompaniment process as a means of identifying the factors of performance. This is thus a new field of research that is starting to emerge (Chabaud et al. 2010), the development of which is essential given what is at stake in terms of job creations and public policy.

Cross-References

- ▶ Business Incubator
- ▶ Entrepreneurship Policies
- ▶ Entrepreneurship Policy
- ▶ Innovative Milieus and Entrepreneurship (Volume Entrepreneurship)
- ▶ Network and Entrepreneurship
- ▶ Territory and Entrepreneurship

References

Argyris C, Schön D. Organizational learning: a theory of action perspective. Reading, MA: Addison Wesley; 1978.

Bergek A, Norrman C. Incubator best practice: a framework. Technovation. 2008;28(1–2):20–8.

Chabaud D, Messeghem K, Sammut S. L'accompagnement entrepreneurial ou l'émergence d'un nouveau champ de recherche. Gestion 2000. 2010;27(3):15–24.

Couteret P. Peut-on aider les entrepreneurs contraints? Une étude exploratoire. Revue de l'Entrepreneuriat. 2010;9(2):6–33.

CSES (Centre for Strategy & Evaluation Services). Benchmarking of business incubators, Final Report, European Commission. 2002.

Deschamps B, Fatien P, Geindre S. Accompagner le repreneur d'entreprise: conduire, escorter mais aussi guider. Gestion 2000. 2010;27(3):77–88.

Gibb AA. Can academe achieve quality in small firms' policy research? Entrepreneurship Reg Develop. 1992;2:127–44.

Giddens A. Modernity and self identity. Cambridge: Polity Press; 1991.

Greene FJ, Storey DJ. Issues in evaluation: the case of shell livewire. In: Audretsch DB, Grilo I, Thurik RA, editors. Handbook of research on entrepreneurship policy. Cheltenham: Edward Elgar; 2007. p. 213–33.

Hackett SM, Dilts DM. Inside the black box of business incubation: Study B- scale assessment, model refinement, and incubation outcomes. J Technol Transf. 2008;33(5):439–71.

Kaplan RS, Norton DP. The balanced scorecard: translating strategy into action. Boston: Harvard Business School Press; 1996.

Lambrecht J, Pirnay F. An evaluation of public support measures for private external consultancies to SMEs in the walloon region of belgium. Entrepreneurship Reg Dev. 2005;17:89–108.

Messeghem K, Naro G, Sammut S. Construction d'un outil stratégique d'évaluation de l'accompagnement à la création d'entreprise: apport du tableau de bord prospectif. Gestion 2000. 2010;27(2):95–112.

Paul M. Ce qu'accompagner veut dire. Revue de Carriérologie. 2003;9(1):121–44.

Paul M. L'accompagnement: une posture professionnelle spécifique. Paris: L'Harmattan; 2004.

Rice MP. Co-Production of business assistance in business incubators: an exploratory study. J Business Venturing. 2002;17(2):163–87.

Sammut S. De la phase de démarrage à l'accompagnement du créateur. Contribution au champ de l'entrepreneuriat. Habilitation à diriger des recherches, Université Montpellier 1. 2009.

Segers J, Vloeberghs D, Henderickx E, Inceoglu I. Structuring and understanding the coaching industry: the coaching cube. Acad Manag Learn Educ. 2011;10(2):204–21.

Simons R. Levers of control. Boston: Harvard Business School Press; 1995.

Smilor R. Managing the incubator system: critical success factors to accelerate new company development. IEEE Trans Eng Manag. 1987;34(3):146–55.

Stinchcombe P. Social structure and organizations. In: March J, editor. Handbook of organizations. Chicago: Rand McNally; 1965. p. 153–93.

Verzat C, Gaujard C, François V. Accompagner des futurs entrepreneurs en fonction de leurs besoins à chaque âge de vie. Gestion 2000. 2010;27(3):59–74.
Zimmerman M, Zeitz GJ. Beyond survival: achieving new venture growth by building legitimacy. Acad Manage Rev. 2002;27(3):414–31.

Achievement and Age

▶ Creativity and Age

Achievement in Life

▶ Creativity and Age

Actor-Network-Theory and Creativity Research

Gerald Bartels[1] and Nicolas Bencherki[2]
[1]Université de Montréal, Montreal, Canada
[2]Center for the Sociology of Innovation, Mines ParisTech University, Paris, France

Synonyms

ANT; Sociology of innovation; Sociology of translation

Introduction

Gilles Deleuze (1998) defines creation as the making of configurations – a position close to that, say, of British philosopher Alfred N. Whitehead (see, e.g., Cloots 2001). Studying creativity, therefore, can be understood as the study of the way new relations or connections are established between elements in order to make up new beings or bodies – in the broadest sense of these words. For Deleuze, creativity is not an optional activity; it is instead a necessity: "A creator is not someone who works for pleasure. A creator only does what he absolutely needs" (p. 135). It is also a necessity because it is in the name of his or her creation that the creator may speak. In other words, the configurations that he/she builds consequently entangle and constitute him/her as a subject.

The study of creativity, therefore, is not only the observation of specific moments when people come up with new ideas, for example, new products, new advertisement campaigns, or new popular songs. It is rather the study of ongoing practices by which participants continuously establish relations with each other and with artifacts and thus create new configurations and constitute themselves as acting subjects. Such a relational view of the world is common to a number of philosophers, including William James (1912), and it became popular in the realm of sociology thanks to actor-network theory.

Actor-Network Theory

One of the main vehicles of this relational approach in sociology has been actor-network theory (ANT), also known as enrolment theory, the sociology of translation, or sociology of innovation, which was first formulated by Bruno Latour and Steve Woolgar in their 1979 *Laboratory Life*. This book and Latour's 1987 *Science in Action* are the two works usually cited when referring to ANT. They outline some of the theory's basic features: its anchoring in an ethnographic methodology and in the study of everyday practice, its reliance on emic categories and the reflexivity of the participants (the two first features being inherited from ethnomethodology; see Garfinkel 1967), and – this is its major innovation – its strong belief that the material dimension of practice is constitutive of practice itself.

ANT began as an approach to science and technology studies (STS), and this may explain the theory's concern for sociotechnical processes, that is to say, the intertwining of the social and the technical, of humans and artifacts. Indeed, Latour and Woolgar have powerfully shown, as Howard Becker did in the field of art (Becker 1974, 1982), that creation is not a solitary endeavor and that the invention (as a thing) is not the product of the inventor, but rather an outcome of the stabilization of the relationships between the interests of many actants, humans, and nonhumans. A key concept here is that of *translation*: the invention "works" because it is able to translate the "wants" of those actants. For example, Bijker (1995) discusses the case of the bicycle, which obtained its current form because it could translate both Victorian morals (especially regarding the possibility for women to ride them while preserving discretion) and concerns over safety and speed.

The theory then gradually moved away from STS as such and started claiming a broader application, positioning itself as a different way of doing sociology, on the grounds that the work of science is not fundamentally different from other social activities and does not approve either social or technical determinism (for ANT's application to the anthropology of law, see Latour 2002; for financial markets, MacKenzie 2008). The fact that ANT has been increasingly recognized can be, among other things, attributed to the rising prevalence of science in society. The growing role of science can be witnessed in human sciences literature, which is concerned with issues such as the increase of collaborative knowledge, the transition to a knowledge-based society, and collective sociotechnical processes (a quick search for these terms in Google's Ngram Viewer illustrates the trend). ANT allows refocusing these debates by showing that what is at stake is not only a specific process within the arts, sciences, or business but that knowledge and technological artifacts concern the very constitution of society and collective action, through the relationship they establish.

The Hybrid Character of Action

ANT scholars have always been careful not to embrace dualism, for example, by pitting technological determinism against a vision of technology as a mere tool available to society (such concerns have deep roots, see, e.g., Heidegger 1977). For proponents of ANT, Plato's advice to "be determined to avoid the extremes and choose the mean" (in Benjamin Jowett's translation) may be read as a call for a theoretical model capable of exploring the blurred contours of such intermediate areas. One of ANT's favorite concepts is "hybridity," meaning that the social and action are always the products of complex entanglements and never pertain to pure domains such as nature or culture. This entails that well-known and established models, which prefer either technical (see McLuhan 1965; White 1962; Innis 1950, 2008) or social (see Gehlen 1980; Latour's 1993, remarks in *We have never been modern*) explanation, are not suitable to explicate or even illustrate those configurations. To ANT, hybridity is not an axiom, but rather something anyone can witness when faithfully applying the theory's motto, "to follow the actors themselves" (Latour 2005, p. 12), by which it enables the emergence of theoretical terminology and models.

The rejection of the "bifurcation" between two alternatives is made explicit in *We Have Never Been Modern*, Latour's (1993) manifesto for "symmetrical anthropology" (see especially p. 105). The divide between nature and society, or technology and culture, he points out, should be overcome and either end of the spectrum should not call for a different form of explanation. As a consequence, we should acknowledge that there are not, on the one hand, human subjects and, on the other, *nonhuman* objects, but rather quasi-subjects or quasi-objects, *hybrids* of mixed ontology. If one single contribution of actor-network theory should be stressed, it would be its conceptualization of the actor as a network, an idea that could be summarized, in Latour's (1996) words: "When one acts, others proceed to action" (p. 237). Action is not understood as springing from the intentional will or the desire of an already-constituted subject, but rather as the effect of the hybrid association of entities of various ontologies. In ANT's version of action, humans and nonhumans coalesce to achieve *programs of action* that cannot be reduced to the intention or design of either party (Latour 2005). The necessity of providing equal consideration for both human and nonhuman factors occurring in a collective involves three principles

(Callon 1986) upon which the ANT is based, which are (a) agnosticism – the impartial treatment of both human and nonhuman factors, (b) generalized symmetry – the description of conflicting perspectives by using the same terms through neutral vocabulary and abstracts so that no one or the other factor is accorded with a special explanation, and (c) free association – the elimination of all general propositions on the distinctions between the technological and social.

The associations are not the expression of any one party, the others being its tools or executives. Especially, nonhumans cannot be understood as mere intermediaries, faithfully translating their human user's desires. They are rather what Latour (2005) calls *mediators;* in other words, for the object to be able to carry the impulse it receives, it has to change it or to return to a concept we already introduced, translate it into something different albeit equivalent – *traduttore traditore* ("translator, traitor," as the Italian saying goes; see, e.g., Latour 1999b, Chap. 2). Michel Callon (1986), in his groundbreaking study of a failed experiment to domesticate scallops, coined the term "sociology of translation" to highlight the fact that for any endeavor to be undertaken successfully, the parties – whatever their nature – must be able to translate each other's program of action or risk being challenged as a *spokesperson* (see, e.g., Benoit-Barné 2009).

Building a Society by Moving Action Through Time and Space

This view has important consequences as it allows objects to enter the social realm. Rather than thinking of nonhumans merely as the backdrop of the social or as a more or less constraining "context," ANT considers technical objects to be in fact participants to the constitution of *collectives*. Our society, explains Latour (1996), is different from that of apes not because theirs would be simple while ours is complex: primatologists have shown that, among apes, sociability implies many sophisticated interactions. To stress what is different between simians' "state of nature" and humans' "today's society," Latour offers to distinguish between *complex* and *complicated*. While apes have no option but to deal with whatever interactions occur and must continually rebuild their social order through them – their society is complex – humans have the option to treat interactions sequentially and to fold the previous one into the next as a *black box*, thanks to technical objects – human societies are complicated. In other words, artifacts allow the circumscription of interactions, their stabilization, and the transportation of that stabilized form into other interactions. That is why, for example, once I have convinced the Department of Transport examiner that I am able to drive, the driver's license he/she gives me and my file in the computer network allow me not to prove all over again, each time I meet a police officer, that I am capable and authorized of driving. Thanks to the driver's license, my interaction with the Department of Transport examiner is black-boxed, that is taken for granted, and consequently the event between the police officer and I takes places as expected.

It is this ability of technical objects to carry interaction that leads Cooren (2004; Cooren and Fairhurst 2004, 2009) to speak of the *dislocated* character of interaction: an interaction always involves events taking place in other places and, at other times, through their being presented here and now by accounts, documents, and other objects.

Implications for Creativity

This leads to a radically different way of studying creativity and innovation. It should be mentioned that ANT was for the most part developed at the Centre de Sociologie de l'Innovation (Center for the Sociology of Innovation, CSI), in Paris, where Latour was a researcher until 2007 and where other influential ANT scholars such as Antoine Hennion or Madeleine Akrich are still working (Michel Callon recently retired; outside the CSI, we can mention John Law, Annemarie Mol, Peter-Paul Verbeek, Vincent Lépinay, and many others). The key element to ANT's vision of innovation, as it should now be clear and as is well illustrated by Antoine Hennion's work on music amateurs (Hennion 1983, 1989, 2010; Hennion and Gomart 1999), is that creativity is far from being a solitary process (a point also made, differently, by Becker 1974; Becker 1982; see also Deleuze 1998, for some nuance). As Hennion (1983) notes in the case of popular music, not only has creative work become distributed among a "creative collective," it also relies on methods, techniques, and devices "which act as veritable mediators of public taste while accomplishing a production job which must also be technical, financial and commercial" (1983, p. 160). For example, Hennion explains that the song is not limited to the music *per se* or even to the mixture of music and lyrics (understood as "3-minute novels"); it also includes character – in the sense of a theatrical performance, including a voice and an image, which cannot be limited to the work of the artists but cannot merely be reduced to a form of "construction" by amateurs. Accounting for the "consensual self-abandonment" music produces "implies that there are techniques, settings, devices and collective carriers which make this active dispossession possible. But to talk about these we need stop asking, temporarily at least, about the sources of action. Questions such as "who acts?" no longer work" (Hennion and Gomart 1999, p. 221).

An important element of the relationship of ANT to creativity is the necessity, for action to be possible, of the notion of configuration. ANT does not locate action within an individual – be it a human or not. Action is never the product of a singular will, but rather the outcome of the relationship between several entities – the *actor-network*. Therefore, the study of how people and objects built such configurations amounts to the study of the programs of action they make possible or deter. In other words, people are not only involved in the business of building an environment or a setting for their actions but also in building a world where action is possible at all, for they act *with* the world they build. Making new things possible is, hence, not only the effort of a mind that strives to have new ideas but also the outcome of the ways in which we interact with other people and with the artifacts that surround us. An example could be that of the painter who mixes his colors: in doing so, he/she is not only preparing an already-planned action (although it may also be the case) but also discovering new possibilities of action as new color blends appear and suggest new combinations.

The transition from acknowledging the multitude of beings, human or not, that populate the world and action is possible with the help of Greimas' narratology. The French linguist (see Greimas 1987) has had an important influence on the development of ANT and provided it with a distinct analytical apparatus. Especially, Greimas's approach suggests a semiotics of action that can be used beyond the study of texts proper. Greimas shows, among other things, that as the "hero" moves through the phases of his quest, he/she gradually acquires objects, competencies, and helpers that can be said to act as he/she acts (for a similar argument see Eco 1965). Think, for example, of the poor peasant who becomes a knight after being given a magic sword. The knight is an actor-network; it is the-peasant-with-a-magic-sword that can kill the dragon. While each part of the peasant/sword duo can claim or be attributed the deed, none can do it without the other. For Greimas, the mechanics of action can be described and analyzed as a series of conjunctions and disjunctions, as objects of value (which can be money but also a princess, a mission, or self-respect) are circulated between *actants*. This term, actant, designates for Greimas a position within a narrative, independently from the actual actor who fills it and independently from the actor's ontology (e.g., being the hero's helper is a role that can be "played" by a magician, a donkey, or a sword). Latour extends the term and uses it as a replacement for sociology's actor. The actant, therefore, is not so much a person or an object as it is a position within a network of relations. That is why conjunctions and disjunctions transform the involved actants and provide them with different subjective statuses with respect to the actions in question. For example, the conjunction of John with wealth makes John rich: saying

"John has a pot full of gold pieces" is functionally equivalent to saying "John is rich" (Greimas 1987, pp. 88–89). This is especially important to understand the connection of having and being (two notions that, in fact, "express the same logical function," see Greimas 1987, p. 88; for a discussion on being as having see Tarde 1893), that is to say, the transformative potential or (re)configuration.

The study of creativity, then, can profit from ANT's externalist (with respect to psychology) perspective: understanding creativity does not require access to individual minds, but is displaced instead in the observation of the practices through which relationships are established (through series of conjunctions and disjunctions), which constitute the world in which we act and in which individuals are in their turn constituted. This world – as an assemblage of heterogeneous entities – allows or impedes possible actions and suggests new programs of actions, that is to say, even further relationships. It is therefore by following "actors themselves," but without restricting them to humans and extending the observations to the artifacts, machines, computers, whiteboards, and other entities (or actants) that populate our everyday work and life environments, that we can observe the deployment of creativity. This calls, according to ANT, for an ethnographic method, inherited from ethnomethodology, for it is in the minutia of participants' work that the establishment of relationships can be witnessed. For example, it is in the detail of the way pedologists (who deal with the science of soils) sort samples in a compartment box that, Latour explains, they can accomplish a continuity between on-site work in Amazonia and laboratory analyses in France (Latour 1999a). The banality of those compartments may trump the casual observer: it is in fact those boxes that perform the attribution of each sample to a specific site and it is thanks to them that the results of the analyses can then be plotted on maps. Keeping in mind Deleuze's definition of creativity, as the making of configurations, we must not follow the actors hoping for a creative moment to emerge or for a special event to occur. Instead, we should consider the work of creativity as constant, for actants ceaselessly enter in conjunction with each other to make up new assemblages, including social entities, groups, and project teams – which are just as innovative as may be songs, paintings, or sculptures.

Conclusion and Future Research

There are several directions in which future research could benefit from (and extend) ANT's contribution to the study of creativity. The first we wish to suggest is the study of the way devices and technologies may contribute to creativity. As social networks, cloud computing, and mobile phones are gradually becoming everyday work and entertainment gears, and if we follow some of medium theory's insights regarding their capacity to extend our senses and cognitive capacities, then it seems natural that their contribution to creativity should be an important focus of research. This invitation should not be limited to the study of the creative user interacting with electronic devices, but should include the observation of the way those tools dynamically reconfigure relations and change the connections that may be established between entities, ideas, and people. The ways we share links and pictures on Tumblr, Pinterest, Facebook, and Twitter, for example, allow several, simultaneous relationships to exist between those elements, which, while being singular, are included in several different walls, blogs, or feeds. This leads to our second suggestion: the constitution of subjectivities as creative individuals. The work of French communication theorist Fanny Georges (see, e.g., 2011) is interesting in this regard. She points out that online profiles, inasmuch as they bring together a collection of various elements (statuses, pictures, links, and so on), constitute subjective positions from which users speak and interact, which cannot be reduced to the person's "physical" identity. This observation can also be extended to "creative workers," for example, to the digital artists studied by Damien Charrieras (2011), whose very ability to exist as such depends on assemblages of heterogeneous elements, including technologies, venues, and people. Finally, the last suggestion we would like to make for future research consists in a call for the study of *banal* creativity. In other words, we should not suppose that creativity is limited to specific people (artists, publicists, or entrepreneurs). If creativity is defined as the establishment of relations that allow new programs of action, then it is pervasive and should be looked at as a process that takes place continually rather than as an isolated event. We may then realize that there is much more creativity within and outside our organizations than we are willing to acknowledge and that a multitude of small revolutions are occurring on a daily basis that change the way we look at the world and the way in which we interact with it.

Cross-References

► Research on Creativity

References

Becker HS. Art as collective action. Am Sociol Rev. 1974;39(6):767–76.
Becker HS. Art worlds. Berkeley: University of California Press; 1982.
Benoit-Barné C. Reflections on science and technology controversies, material recalcitrance and empty reservoirs that suddenly become full. Paper presented at the concerning argument, Washington, DC, 2009.
Bijker WE. Of bicycles, bakelites, and bulbs: toward a theory of sociotechnical change. Cambridge, MA: MIT Press; 1995.
Callon M. Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. In: Law J, editor. Power, action and belief: a new sociology of knowledge? London: Routledge; 1986. p. 196–223.
Charrieras D. Trajectories, circulation, assemblages. The heterogeneous modes of endurance of digital arts practice in Montréal. Paper presented at the ISEA 2011. McGill Institute for the Study of Canada Research Workshop, Sept. 23rd 2011.
Cloots A. The metaphysical significance of Whitehead's creativity. Process Stud. 2001;30(1):36–54.
Cooren F. The communicative achievement of collective minding. Manage Commun Quarter. 2004;17(4):517–51.
Cooren F, Fairhurst GT. Local? Global? No, dislocal: how to scale up from interactions to organization. Paper presented at the The 54th conference of the international communication association, 2004.
Cooren F, Fairhurst GT. Dislocation and Stabilization: How to Scale Up From Interactions to Organizations. Building Theories of Organization: The Constitutive Role of Communication. Eds. L.L. Putnam & A. Nicotera. New York: Routledge, 2009. p. 117–152.
Deleuze G. Qu'est-ce que l'acte de création? Trafic. 1998;27:133–42.
Eco U. The narrative structure in Fleming. In: Del Buono O, Eco U, editors. The bond affair. London: Macdonald; 1965. p. 35–75.
Garfinkel H. Studies in ethnomethodology. Englewood Cliffs: Prentice-Hall; 1967.
Georges F. L'identité numérique sous emprise culturelle. De l'expression de soi à sa standardisation. Les cahiers du numérique. 2011;7(1):31–48.
Gehlen A. Man in the age of technology. New York: Columbia University Press; 1980.
Greimas AJ. On meaning: selected writings in semiotic theory. Minneapolis: University of Minnesota Press; 1987.
Heidegger M. The question concerning technology, and other essays. 1st ed. New York: Harper & Row; 1977.
Hennion A. The production of success: an anti-musicology of the pop song. Popular Music, 3 (ArticleType: research-article/Issue Title: Producers and Markets/Full publication date: 1983/Copyright © 1983 Cambridge University Press), 1983, pp. 159–93.
Hennion A. An intermediary between production and consumption: the producer of popular music. Sci Technol Hum Val. 1989;14(4):400–24.
Hennion A. La mémoire et l'instant. Improvisation sur un thème de Denis Laborde. Tracés. Revue de Sciences humaines. 2010;2010(18):141–52.
Hennion A, Gomart É. A sociology of attachment: music amateurs, drug users. In: Law J, Hassard J, editors. Actor network theory and after. Oxford: Blackwell; 1999.
Innis HA. Empire and communications. Oxford: Clarendon Press; 1950.
Innis HA. The bias of communication. Toronto: University of Toronto Press; 2008.
James W. Essays in radical empiricism. New York: Longman, Green; 1912.
Latour B. Science in action: how to follow scientists and engineers through society. Cambridge, MA: Harvard University Press; 1987.
Latour B. We have never been modern. Cambridge, MA: Harvard University Press; 1993.
Latour B. On interobjectivity. Mind Culture Activity. 1996;3:228–45.
Latour B. Circulating reference: sampling the soil in the Amazon forest. In: Latour B, editor. Pandora's hope: essays on the reality of science studies. Cambridge, MA: Harvard University Press; 1999a.

Latour B. Pandora's hope: essays on the reality of science studies. Cambridge, MA: Harvard University Press; 1999b.
Latour B. La fabrique du droit: une ethnographie du Conseil d'État. Paris: La Découverte; 2002.
Latour B. Reassembling the social: an introduction to actor-network-theory. Oxford/New York: Oxford University Press; 2005.
Latour B, Woolgar S. Laboratory life: the social construction of scientific facts. Beverly Hills: Sage Publications; 1979.
MacKenzie D. Material markets: how economic agents are constructed. Oxford: Oxford University Press; 2008.
McLuhan M. Understanding media: The extensions of man. New York: McGraw-Hill; 1965.
Tarde G. Monadologie et sociologie. Chicoutimi: J.-M. Tremblay; 1893.
White L. Medieval technology and social change. Oxford: Clarendon; 1962.

Actors Management

▶ Technological Entrepreneurship and Asymmetries

Adaptation

▶ Conflict and Creativity

Adaptive Creativity and Innovative Creativity

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Adaptive creativity refers to thinking that applies existing solutions, techniques, or products to new scenarios or changed conditions. Innovative creativity refers to thinking that results in new (innovative) solutions. Adaptive creative thinkers try to do things better, while innovative creative thinkers try to do things differently. Adaptive creative thinkers create original ideas that are more likely to fit the existing paradigms, whereas innovative creative thinkers create original ideas that are more likely to challenge paradigms. Those who are adaptively creative generally apply a disciplined systematic approach, want to solve (rather than identify) problems, refine current practices, and work well with a group. Those who are innovatively creative approach problems from unusual perspectives, discover problems, uncover and question the status quo, and are often insensitive to others (Kirton 1976). Together, adaptive creativity and innovative creativity describe the processes that give rise to new ideas (Maherly and Goldsmith 1987).

Adaptive creativity occurs more commonly than innovative creativity. Once a successful innovation occurs, systems emerge to support it. Over time, the systems themselves grow more complex and rigid. As a result, opportunities for innovation diminish (McIntyre 1987). Any new fundamental (innovative) change is not merely representing a new idea, however good it may be; it also must compete with an extant complex network of supporting systems, reliance on which may have merits and which may serve vested interests. As a result of the inflexibility imposed by these systems, most opportunities for improvement of a product or process are small changes within the system (Fagerberg 1987). Kuhn (1962) demonstrated that innovative creativity in science occurs extremely rarely and that most scientists are fundamentally conservative and work within existing paradigms. Most science research produces discoveries framed in the assumptions of the existing system or paradigm (and are, therefore, really a form of replication study) and nuance, or give depth to the existing paradigm rather than fundamentally challenging it (though in their replication studies, scientists may discover "anomalies" that may come to constitute the basis for an eventual innovation in the paradigm).

For businesses, adaptive creativity is commonplace and often is cheaper than innovative creativity, at least in the short run. The development of new products (innovation) takes time, requires capital, and is nonlinear. Innovative creativity typically requires extended development of a new product or service: the product must be developed, introduced, and ushered through a growth phase (if the product or innovation is favorably received by consumers before it reaches a stage of maturity). During these early stages, development costs, initial promotion, and capital requirements to support the trade cycle require considerable resources, all with the presumption that these investments will produce a new product with a net benefit or profit. During the initial stages, there is considerable risk, as generating sales or customers for a new product may be costly and may fail. When a business introduces a genuine innovation (e.g., interactive touch screens), long-run profits can be considerable. In the short run, however, innovation is costly. Fagerberg (2005) has argued that most economic benefits come from adaptive or "incremental" innovations rather than wholly new products or innovations.

Because of the costs and other risks associated with innovative products, businesses often focus instead on adaptive creativity: for example, by modifying (adapting) the marketing mix. The marketing mix is generally considered to be made up of 7 "P's": price, promotion, product, place, process, physical evidence, and people. Though considerable variance exists according to product or industry, a basic model of adaptation in a business is to evaluate periodically each of the components of the marketing mix to look for ways to adapt it to enhance the marketability of the product (Quinn et al. 1997). This method for adaptation considers new ideas for the product, though still anchoring the marketing mix in the basic framework of the existing product or brand. The intention is to enhance marketability. The process involves synthesis of information (the company's product and its marketing mix in relation to those of competitors). The result of this process of adaptation is commonly called an "extension strategy."

If an extension strategy is successful, the changes will result in an extension of the product life cycle. An extension strategy can serve business exceptionally well. Typically, an extension strategy has lower development costs than does the development and introduction of a new product. Further, the extension strategy builds on the existing brand identity (and leverages brand identity). Finally, because the extension strategy builds on a product that has gone through its growth stage, the firm typically has the working capital to support continued sales.

Innovative creativity occurs far less commonly than adaptive creativity. Innovation requires thinking independently of the existing paradigm. Sometimes innovation occurs as a spark or a burst of insight, and other times it comes from more systematic approaches, such as the tedious trial-and-error experiments applied by Thomas Edison in developing the light bulb. Innovative creativity typically is beyond the context of standard protocols, such as marketing mix reviews and marketing audits, which, as noted above, can produce highly profitable adaptations and high returns on investment for businesses (Quinn et al. 1997).

To be successful, innovation must have meaningful points of social contact to be adopted: the product must be useful, or perceived as useful. Sometimes, a product will not be developed because business leaders do not understand or anticipate a market need. In the 1940s and 1950s, for example, business leaders in the United States saw no possibilities for the computer, largely because they could not imagine its potential impact (Katz and Phillips 1982). Acceptance of new ideas in the marketplace is often unknown, and thus represents risk. Many innovations require support systems, which may take years to emerge, as, for example, automobiles that run on alternative fuels will require appropriate fueling stations.

Without both adaptive and innovative creativity, society stagnates. An economy or a society – any system, in fact – will eventually collapse, if the entropic costs of the system cannot be dissipated (Clark 1997). To forestall the eventual decay, the system (or society or economy) must innovate its fundamental systemic basis and operation to employ new energy inputs and alternate dissipative structures. When that happens, a society renews itself. Day to day, a society (or business or an economy) relies on adaptive creativity. Periodically, though, innovation has to occur. Both types of creativity are needed. The pace of change in contemporary society and the strain on the existing systems from a growing population of seven billion people build pressure for innovative creativity.

Relationships with Convergent and Divergent Thinking

Divergent and convergent thinking are two poles on a spectrum of cognitive approaches to problems or questions (Duck 1981). Divergent thinking considers multiple perspectives and uncovers multiple possible answers to questions or problems. Convergent thinking assumes that a question has one right answer or a problem has one solution (Kneller 1971). Divergent thinking generally resists the accepted way of doing things and seeks alternatives. Divergent thinking is better at finding additional ideas, whereas convergent thinking has a more difficult time finding additional ideas. Convergent thinking, because it begins by assuming that the way things have always been done is the right way, often has an innately conservative bias. Convergent thinking is a part of creative thinking and intelligence (measured by IQ), whereas divergent thinking is not a part of intelligence.

Adaptive creativity and innovative creativity both require convergent and divergent thinking, though in different degrees. Adaptive creativity arises more from convergent thinking but requires at least some ability to think divergently. Adaptive creativity is common in fields, such as science, where thinkers are trying to understand problems generally through accepted scientific paradigms (Kuhn 1962); history, a field in which historians typically rely on the so-called magisterial theses for frames of reference; or business, where practitioners use generally accepted categories. In these contexts, thinkers gather and synthesize data in relationship to an operationally accepted framework. As academic fields, science and history typically draw highly intelligent people. For entry into the fields, both require a considerable degree of advanced knowledge, which can serve as a blinder to new ideas. Further, the only meaningful judgment of scientists and historians is by other university-level practitioners in the field, a situation that creates a fundamentally conservative environment (otherwise, the contributions of others, including those performing formal or informal peer reviews, would be problematized). This situation acts as a constraint on radical change or creative contributions. Business has its own constraints on frequent, genuinely original contributions. Genuine innovation often requires more capital than that which is generally available to most business people, while adaptive creativity, such as modifying the marketing mix, can often yield satisfactory profits. Finally, the fear of risk of loss of capital functions as a constraint on genuinely innovative ideas. Thus, for a variety of reasons, certain fields are more suited to adaptive creativity. In these fields, creativity typically comes only in small increments by way of adaptation.

In important respects, modern university systems favor adaptive creativity rather than innovation or inventions. Compared to nonacademic research facilities, universities only occasionally contribute important inventions (Mowery and Sampart 2005). The progression of a young scholar from undergraduate to graduate student to assistant professor often reinforces the existing paradigms of thinking. To earn grades good enough to advance to graduate school, students must internalize the values and knowledge of the professorate in their field. In this context, radically innovative ideas are often frowned upon, or at worst, rejected. Fred Smith, the founder of Federal Express, which today is the largest airline in the world based upon freight carried, came up with the idea for the company he found while an undergraduate at Yale University. In a paper, he argued that modern contemporary demand for consumer electronic products would justify a high-speed delivery system based upon air transport and door-to-door pickup and delivery. To ensure accurate sorting and dispatching of every item of freight, the carrier would fly it from all of its pickup stations to a central clearinghouse, from where the entire operation would be controlled. For this paper, on the grounds that the idea was not feasible, his professor awarded him a "C"; Smith went on to find Federal Express.

Despite claims that the doctorate represents "original research," some graduate schools function to entrench young scholars within the existing paradigms of thinking. Students must master a body of literature, propose a research hypothesis based upon the existing knowledge, and then test the hypothesis with original research. Because the dissertation proposal must be based on the foundations of existing knowledge (often produced by students' professors), the original research tends to strengthen existing paradigms rather than challenge them. Further, advancing to the doctorate involves mastering an academic discipline and its epistemologies. Highly innovative creativity involves the opposite: thinking outside the boundaries of existing ways of knowing and existing relationships.

Innovative creativity arises more from divergent thinking than convergent thinking but requires at least some ability to think convergently. Artistic creativity tends to involve more innovative creativity than adaptive creativity. This situation is for both material and ideological reasons. Unlike business, artistic products are less dependent on capital-intensive systems for implementation. Artistic innovation is generally less capital intensive and, thus, the risks associated with failure, at least from the point of view of capital, are significantly lower. Finally, the environment of the arts, at least since the invention of the camera (which liberated artists from the obligation to record the world "as it is"), generally fosters an innovative spirit. Artistic production is not without convergent thinking – artists still need mastery of their craft and the ability to solve core problems of their craft – but artists are free to innovate than in many walks of life.

Invention/Innovation and Adaptive and Innovative Creativity

Invention, innovation, and adaptation are all creative processes requiring all the components of creativity, including (but not limited to) divergent thinking. As with the spectrum of divergent to convergent thinking, all three fall on a spectrum (Verspagen 2005). Invention is the creation of a new idea or product. Sometimes an invention has no practical application, and the invention (or idea for it) is purely a creative act; it goes no further than its original conception or creation. Invention requires a high degree of divergent thinking (by making connections no one else has before and imagining a whole new product or tool) and some convergent thinking (the product has some connection to human patterns and practices). On the spectrum, invention is the most creative as it requires an open and curious mind for the inventor to see what others have heretofore not seen. Invention also requires making connections or understanding a relationship that others have failed to recognize. Next on the spectrum is innovation, which is the first move to put the invention into practice (Fagerberg 2005). Innovation requires more convergent thinking because it involves making the invention relevant to existing markets and systems. Innovation includes the generation of scientific and technological knowledge, the translation of this knowledge into working products or tools, and responding to and shaping market demand (Pavitt 2005). Further along the spectrum is adaptation, which involves modifying an existing product to extend its life or to improve a process; it represents incremental change. An adaptor, rather than thinking of something wholly new, makes incremental changes to something that already exists. As the intention is to adapt a product or idea to be retained, adaptation (and adaptive creativity) involves less divergent thinking and more convergent thinking.

Having the right balance of divergent and convergent thinking determines the successfulness of inventions, innovations, and adaptations. Thinking that is too "out of the box" can produce ideas that do not have relevance. Leonardo da Vinci, for example, had many ideas that were so far ahead of their time (the parachute) that they had no practical application. In the case of the parachute, the idea was too far beyond the imaginative possibility for other thinkers, and in a world without human flight, no need existed for the product. Others, like General William Mitchell (1879–1936) of the United States Army, have ideas that are relevant (in his case, the idea that air power would, in the near term, be the primary means whereby wars would be fought), but existing systems, paradigms, and interests are too rigid to fully accept the idea. In Mitchell's case, though he was largely "right" about the near-term future of air power, his ideas were so forward-thinking, so imaginative, that his superiors could not appreciate them. Alienated from them, Mitchell retired from the Army, leaving to others the development of the modern American air forces. On the other hand, thinking that is too convergent can sometimes lead to adaptations that are insufficient to resolve the challenges of the day. This is routinely the case with consumer products that are not regularly updated or which are updated but not in sufficient degree to forestall declining sales. The stakes can be higher. In World War I, improvements in defensive military technologies, most notably the invention of the machine gun, created challenges for offensive military strategies that general officers on both sides, the Allies and the Central Powers, were unable to overcome. Though adaptations were made to existing offensive strategies, none proved sufficient. The general officers lacked the creativity to arrive at effective solutions. For that failure, millions of soldiers died.

Conclusion and Future Directions

Both adaptive creativity and innovative creativity contribute new ideas. Although innovative creativity is often considered more noteworthy, adaptive creativity occurs commonly and probably has a greater economic impact. Business and other types of organizations can often foster adaptive creativity through ordinary protocols; with innovative creativity, it is much harder to do.

Invention, innovation, and adaptation, all creative processes, require both divergent and convergent thinking, though in different degrees. Compared to invention, innovation requires more convergent thinking; adaption requires even more. The success of these types of creative thinking varies according to environments. In some environments, adaptive creativity produces better results than innovation or invention and is also less jarring to the existing systems. However, in the long run, invention and innovation are necessary for invigoration of a business, a society, or an economy.

In popular imagination, creativity is often seen as semimystical and is characterized by the lone creative genius (Sternberg and Lubart 1999). While in some rare cases, a small kernel of truth may reside in this stereotype, creativity more commonly plays out in comparatively mundane ways: operationalizing an invention or creative insight (innovation) or improving an existing product, process, or tool (adaptation). For several reasons, popular perceptions of the lone creative genius and radically divergent thinking need some correction. For one, the very notion of a lone creative genius flies in the face of systemic attempts to foster creativity; it also encourages the idea that creativity is a more brilliant, even mystical, insight than hard work. Adaptive creativity or, on the spectrum, less radical innovative creativity requires more convergent thinking and greater expertise within the existing paradigm of thinking. More commonplace than the lone creative genius, these forms of creativity stem from hard work, study, and application within the existing paradigm. Though less glitzy or flashy than invention or radical innovation (and certainly less dramatic than the lone creative genius), these comparatively ordinary forms of creativity may contribute more to society, at least in the short run, and can be more easily fostered in systemic ways. Awareness of the contributions of less radical forms of creativity may also encourage students and employees to seek improvement in products and process as well as encourage researchers to find improved techniques for fostering creativity.

Cross-References

- ▶ Creative Personality
- ▶ Divergent Versus Convergent Thinking
- ▶ Invention and Innovation as Creative Problem-Solving Activities

References

Clark R. The global imperative: an interpretive history of the spread of humankind. Boulder: Westview Press; 1997.

Duck L. Teaching with charisma. Burke: Chatelaine Press; 1981.

Fagerberg I. Innovation: a guide to literature. In: Fagerberg J, Mowery D, Nelson R, editors. The Oxford handbook of innovation. Oxford: Oxford University Press; 2005. p. 1–26.

Katz BG, Phillips A. Government, economies of scale, and comparative advantage: the case of the computer industry. In Giersch H, editor. Proceeding of conference on emerging technology, Kiel Institute of World Economics. Tubingen: J. C. Mohr; 1982.

Kirton M. Adaptors and innovators: a description of measure. J Appl Psychol. 1976;61(5):622–9.

Kneller GF. Introduction to the philosophy of education. 2nd ed rev. New York: Wiley; 1971.

Kuhn T. The structures of scientific revolutions. Chicago: University of Chicago Press; 1962.

Maherly TA, Goldsmith R. The two faces of creativity. In: Timpe AD, editor. Creativity. New York/Oxford: Facts on File Publications; 1987.

McIntyre S. Obstacles to corporate innovation. In: Timpe AD, editor. Creativity. New York/Oxford: Facts on File Publications; 1987.

Mowery D, Sampart B. Universities in national innovation systems. In: Fagerberg J, Mowery D, Nelson R, editors. The Oxford handbook of innovation. Oxford/New York: Oxford University Press; 2005. p. 209–39.

Pavitt K. Innovation process. In: Fagerberg J, Mowery D, Nelson R, editors. The Oxford handbook of innovation. Oxford/New York: Oxford University Press; 2005. p. 86–114.

Quinn JB, Baruch JJ, Zien KA. Innovation explosion: using intellect and software to revolutionize growth strategies. New York/London: The Free Press; 1997.

Sternberg RJ, Lubart TI. The concepts of creativity: prospects and paradigms. In: Sternberg RJ, editor. Handbook of creativity. Cambridge: Cambridge University Press; 1999. p. 3–15.

ADD

▶ Attention-Deficit/Hyperactivity Disorder and Creativity

Addition

▶ Product Innovation, Process Innovation

Adverse Selection

▶ Information Asymmetry and Business Creation

Aesthetic Innovation

▶ Preparing a “Creative Revolution” – Arts and Universities of the Arts in the Creative Knowledge Economy

Aesthetic Research

▶ Preparing a “Creative Revolution” – Arts and Universities of the Arts in the Creative Knowledge Economy

Affect

▶ Creativity and Emotion

Age and Creative Productivity

Dean Keith Simonton
Department of Psychology, University of California, Davis, CA, USA

Synonyms

Career trajectories in creative achievement

Introduction

Typically, creators exert impact through products. Inventors devise inventions, scientists publish articles in scientific journals, poets write poems, composers create music, architects design buildings, and so forth. Moreover, for most high-impact creators, such productive activity is not a one-shot affair. Although some creators may produce a single notable work during their entire lifespan, many creative persons generate multiple contributions across the course of a very long career (Simonton 1997). This latter behavior raises questions of how creative output changes with age (Lehman 1953; Lindauer 2003; Simonton 1988). At what age does productivity normally begin? At what age does the output rate usually attain a peak? And at what age does productivity commonly end? What factors might affect the answers to these questions? These questions have more than scientific interest, for they have potential practical implications besides. Some countries still impose compulsory retirement of university scholars under the assumption that after an arbitrary age those scholars can no longer be expected to maintain their creative productivity (Stroebe 2010).

To address these questions, researchers usually adopt the same procedure (Simonton 1988). The investigation begins by collecting a sample of productive individuals in a particular domain of creative achievement. Sometimes these samples are confined to creative elites, such as Nobel laureates. Other times the sample is more inclusive, such as a random sample of all Ph.D. recipients in a specific domain. The next step is to compile for each creator in the sample a list of their contributions: patents, publications, poems, compositions, designs, and so forth, depending on the domain. Then for each creator these contributions are tallied into time series consisting of 1-year, 5-year, or 10-year periods. Finally, the resulting data are subjected to a statistical analysis. Although the analyses can become rather intricate, the core idea is to fit a curve that specifies how output changes over time (Stephan and Levin 1992). Inquiries using this basic methodology have produced a considerable number of empirical findings as well as theoretical interpretations. It is to these that shall be treated in turn.

Empirical Findings

The first scientific investigation devoted to the age-productivity relation was published in 1835, making it one of the oldest research topics in the social sciences. Since that time, one generalization has been replicated innumerable times: the typical age curve (Lehman 1953; Simonton 1988). Creative output usually starts around the mid-20s and then increases rapidly until reaching a peak somewhere in the late 30s or early 40s. Thereafter, the output gradually declines until about half the rate at the career peak by the time the creator enters his or her 70s. This general description of the longitudinal changes has several complications, however (Simonton 1997). These are six in number:

First, the specific shape of the age curve depends on the domain of creativity. In some domains, like poetry and mathematics, the ascent is more rapid, so that the peak arrives earlier, and the descent may be accordingly more rapid. In other domains, like novels and the earth sciences, the rise is more gradual, the peak later, and the decline less conspicuous. Indeed, in domains like history and philosophy, it may not be possible to speak of a genuine post-peak decline. Output just reaches a plateau and then stays there well into the 70s.

Second, the longitudinal trajectory of creative productivity appears to be a function of career age, not chronological age. That is, the crucial factor is when a creative person began his or her career. If someone starts later than normal, he or she will exhibit a correspondingly later peak. The latter situation often applies to those who have started second creative careers. In a sense, the career switch resets the chronological clock.

Third, it is essential to distinguish between quantity and quality of creative output. Quantity represents everything a creator might produce, whereas quality represents that small proportion that represents truly creative work. Of course, the latter is the subset of the former. More significantly, the productivity curves across time tend to be the same for both total works and just major works. As a consequence, the "hit rate," or the ratio of high-impact works to total output, tends to fluctuate over the course of the career without exhibiting any significant trends. If a trend does appear, however, the hit rate tends to increase with age, a larger proportion of the total productivity generating creative contributions.

Fourth, of a creator's high-impact contributions, three can be identified as career landmarks: the first major contribution, the best single contribution, and the last major contribution. The first landmark usually appears when the creator is around 30 years old, the second around 40, and the third around 50, albeit the specific placement will depend on the domain. In particular, those domains where productivity attains an early peak will often have the middle career landmark, the best contribution, appear earlier as well. Thus, the best poem or mathematical theorem will appear at a younger age than the best novel or geological monograph.

Fifth, the foregoing statements about career landmarks are contingent on individual differences in total lifetime output. The more prolific the creator, the earlier the first major work appears. Similarly, the more prolific the creator, the last major work appears. Yet the single best work tends to appear at the same expected age (for the domain) regardless of whether or not the creator is prolific.

Sixth and last, all of the preceding statements represent statistical averages only. For example, although the typical age curve is described by a single-peaked function, some creators may exhibit two or more peaks, or no peak at all. Likewise, although the single best work tends to appear about midway between the first major work and the last major work, exceptions can occur in certain rare cases. Hence, the creator's best work might be either their very first major work or their very last major work. One source of exceptions is a creator's life span. If the person dies right after producing their best work to date, then the best work will necessarily be the last work.

It should be pointed out that some of these findings may change over the course of history. As a case in point, as domains become more developed, the peak of the productivity curve may be shifted toward later ages. It not only takes longer to master the domain-specific knowledge and skills, but also it may require more time to create and develop new ideas.

Theoretical Interpretations

Although researchers have reached a consensus on the central empirical results, there is far more disagreement regarding how these results would be explained. Of the numerous accounts, probably the following six explanations stand out (Simonton 2012).

First, physical health can decline appreciably in the final years, a decline that can cause a decrease in creative productivity. What this explanation would suggest is that any age decrement toward the end of the career should have diminished in recent times. Not only have life expectancies increased, but also creators can maintain health later in old age. Although this first explanation no doubt has some grain of truth, it cannot explain the finer features of the phenomenon. Certainly, it cannot account for why the productivity curves differ across creative domains. Greater physical vigor is required to travel on geological excursions than to prove a mathematics theorem.

Second, creative productivity may depend on specific psychological variables that change over time. To illustrate, creativity is positively correlated with openness to experience, divergent thinking, and fluid intelligence. Scores on these three variables tend to decline with the age. For example, divergent thinking ability decreases after age 40. One major drawback to this explanation is that it predicts that the age curve should be a function of chronological rather than career age. Accordingly, someone whose creative career got a late start would not be expected to attain a peak in the 50s or 60s.

Third, creative output over time may be a consequence of the process that sociologists call "accumulative advantage" (Petersen et al. 2011). The basic idea is that the "rich get richer and the poor get poorer." Those creators who are fortunate to be rewarded early in their career – an early "first hit" – will receive more incentives and resources than those creators who are not so lucky. Early success then leads to more successes and an extended productive career, whereas the initial failures may eventually drop out of the competition. According to accumulative advantage, all creators can be equal in ability and yet come out very unequal in achievement by the "luck of the draw." One objection to this explanation is that it does not explain why the age-productivity relation should differ across domains. Another objection is that it does not provide an obvious explanation for the post-peak decline.

Fourth, economists tend to favor an interpretation in terms of investment in "human capital." Education and training in a particular domain provides the basis for creative productivity, but this acquired expertise becomes "used up" as the career progresses. Ideas become increasingly obsolete or old fashioned, making it more difficult to keep up with the "leading edge." Moreover, once the career begins, it becomes very different to replenish that human capital. A mature creator cannot usually go back to school for a few years to retool his or her expertise. The decline then becomes inevitable. Unlike the previous explanation, which cannot easily account for the post-peak decline, the human capital explanation cannot readily explain the pre-peak ascent.

Fifth, another theory argues that the age-productivity relation is a function of a two-stage combinatorial process by which creative ideas are produced. The creator begins with a sample of domain-specific ideas that generates ideational combinations. This is the first stage. Then in the second stage, the resulting combinations are elaborated into finished products. The resulting mathematical model then yields a single-peak function. In addition, because the theory assumes that the rates of ideation and elaboration are domain specific, it can account for domain differences in the expected curves. The theory also allows for individual differences in the size of the ideational samples as well as the age at career onset. The result is a complex model that can explain the principal features of the relation between age and creative productivity. The main disadvantage of this explanation is its complexity and abstraction, the whole theory being expressed as a mathematical model.

At present, no theoretical interpretation has won universal acceptance. That lack of consensus probably reflects the fact that the relation between age and creative productivity is an extremely complicated phenomenon that involves multiple causes. Perhaps all of the explanations operate together, sometimes in opposition and other times in collaboration.

Conclusion and Future Directions

Empirical research conducted over the years since 1835 have produced a wealth of diverse information about the relation between age and creative productivity. Besides discovering the overall form of the longitudinal curve – the single-peaked function – researchers have learned how this curve is dependent on other factors. These factors include (a) individual differences in lifetime output and the age at career onset, (b) the domain of creative achievement, and (c) the distinction between quantity and quality of output. These factors enables researchers to differentiate more finely various types of career trajectory. For example, some creators may be early bloomers who launch their careers at relatively young ages and other creators may be late bloomers who only get their creative careers off the ground when they are far more mature (Galenson 2005).

Although the empirical findings are quite rich and diversified, the theoretical interpretations are even more so. This means that there is a greater need for the development of theory than the generation of more empirical results. If theoretical models are developed that are more precise and comprehensive, they will then direct investigators to the most fruitful lines of inquiry. Especially valuable would be theories that provide the basis for critical tests that would enable researchers to weed out the possibilities. Those same theories might also provide better guidance about how to apply the empirical findings. It is hoped that such comprehensive and precise theories will emerge sooner rather than later.

Cross-References

▶ Creativity and Age
▶ Divergent Thinking
▶ Knowledge Capital and Small Businesses
▶ Scientific Creativity as Combinatorial Process

References

Galenson DW. Old masters and young geniuses: the two life cycles of artistic creativity. Princeton: Princeton University Press; 2005.
Lehman HC. Age and achievement. Princeton: Princeton University Press; 1953.
Lindauer MS. Aging, creativity, and art: a positive perspective on late-life development. New York: Kluwer/ Plenum; 2003.
Petersen AM, Jung W-S, Yang J-S, Stanley HE. Quantitative and empirical demonstration of the Matthew effect in a study of career longevity. Proc Natl Acad Sci. 2011;108:18–23.
Simonton DK. Age and outstanding achievement: what do we know after a century of research? Psychol Bull. 1988;104:251–67.
Simonton DK. Creative productivity: a predictive and explanatory model of career trajectories and landmarks. Psychol Rev. 1997;104:66–89.
Simonton DK. Creative productivity and aging: an age decrement – or not? In: Whitbourne SK, Sliwinski M, editors. Handbook of developmental psychology: adult development and aging. New York: Wiley-Blackwell; 2012. p. 477–96.
Stephan PE, Levin SG. Striking the mother lode in science: the importance of age, place, and time. New York: Oxford University Press; 1992.
Stroebe W. The graying of academia: will it reduce scientific productivity? Am Psychol. 2010;65:660–73.

Age Zero Firm

▶ Startup

Agency Dilemma

▶ Principal–Agent Model in Universities, Problems and Solutions

Agglomeration Effect

▶ Entrepreneurship in Creative Economy

Agricultural Entrepreneurship

Thomas Lans[1], Pieter Seuneke[2] and Laurens Klerkx[3]
[1]Education and Competence Studies Group, Wageningen University, Wageningen, The Netherlands
[2]Rural Sociology Group, Wageningen University, Wageningen, The Netherlands
[3]Knowledge, Technology and Innovation Group, Wageningen University, Wageningen, The Netherlands

Synonyms

Agricultural innovation; Entrepreneurship in agriculture

Key Concepts: Defining Agricultural Entrepreneurship

Why Agricultural Entrepreneurship?

Traditionally, agriculture is seen as a low-tech industry with limited dynamics dominated by numerous small family firms which are mostly focused on doing things better rather than doing new things. Over the last decade, this situation has changed dramatically due to economic liberalization, a reduced protection of agricultural markets, and a fast changing, more critical, society. Agricultural companies increasingly have to adapt to the vagaries of the market, changing consumer habits, enhanced environmental regulations, new requirements for product quality, chain management, food safety, sustainability, and so on. These changes have cleared the way for new entrants, innovation, and portfolio entrepreneurship. It is recognized by politicians, practitioners as well as scientists that farmers and growers increasingly require entrepreneurship, besides sound management and craftsmanship, to be sustainable in the future (McElwee 2008; Pyysiäinen et al. 2006). Recent studies show that agricultural entrepreneurship is not only wishful thinking or a new hype: it has a profound impact on business growth and survival (Lans et al. 2011; Verhees et al. 2011).

What Is Agricultural Entrepreneurship?

But what is exactly meant by agricultural entrepreneurship? To start, there is no fixed definition of entrepreneurship; a wide diversity of definitions can be found. In daily language, the term "entrepreneur" is often interchangeably used with business owner, starter, someone who is self-employed, sole-trader, or farmer, thereby confusing status (a position in society) with role (behavior in a particular position) McClelland (1967). Agricultural literature is in this perspective not helpful since it provides a multitude of operational definitions of the agricultural entrepreneur. Definitions about entrepreneurship are fuelled by disciplinary inheritance, for instance, building further on the classic economist Schumpeter (1934), or departing from the personal psychologist McClelland (1967).

Many attempts have been made to establish some clarity in this semantic confusion in order to provide the field of entrepreneurship its own distinct signature. Definitions of entrepreneurship have moved from a focus on individual traits (e.g., local of control, need for achievement), toward entrepreneurial behavior (e.g., entrepreneurial orientation), cognitions (e.g., decision making) and social capital (e.g., networks). Over the last decade, there has been a growing consensus that a fundamental, distinctive feature of entrepreneurship is the identification, evaluation, and pursuit of business opportunities (Shane and Venkataraman 2000). Entrepreneurial opportunities differ from normal possibilities to optimize the efficiency of existing products in the sense that the former involves new means–ends relationships (Shane and Venkataraman 2000). It means that the obtainment of a larger milk quota or the acquisition of additional greenhouses which are already up and running are not considered as true entrepreneurial opportunities. There are several arguments that can be put forward why the opportunity definition as an overarching definition is attractive for agricultural entrepreneurship.

1. It does not limit the study of agricultural entrepreneurship to specific situations such as new venture creation (e.g., most of the agricultural businesses are already in existence for decades).
2. Learning and development are the heart of entrepreneurship: The fact that some farmers exploit entrepreneurial opportunities and others do not is *not* due to lack of certain personality traits, but due to (the lack) of specific competence, and experience.
3. It recognizes the importance of the broader working environment the entrepreneur engages in. Interpretation, understanding and creativity, core processes in opportunity development process, all do not happen in isolation, but are influenced by, for instance, the farmer's wife, employees, competitors, network, and chain partners or extension services.

In sum, a focus on the identification and pursuit of opportunities as the core of agricultural entrepreneurship emphasizes the creative, alert, proactive, and networking aspects of entrepreneurial activity (DeTienne and Chandler 2004). It enables researchers to shift from the question "who is the entrepreneur?" to the question "what does the entrepreneur do?" (Gartner 1989), thus helping to avoid the conceptual swamp of defining the "true" entrepreneur.

Open-Ended Issues

Is Agricultural Entrepreneurship Different from "Normal" Entrepreneurship?

A classic question posed in debates about agricultural entrepreneurship is whether agricultural entrepreneurship is different from entrepreneurship in nonagricultural firms. The answer is yes and no, depending on the type of research question and research paradigm employed. Certain elements of entrepreneurship seem to be relatively universal, context independent (Rauch et al. 2009) (e.g., the importance of opportunities, pro-activeness, risk taking, and entrepreneurial self-efficacy), other elements are more dependent on the type and context of entrepreneurship (Lans et al. 2008) (e.g., entrepreneurial learning). For studying agricultural entrepreneurship, the following characteristics have to be taken into consideration:

The agricultural sector. Historically, the agricultural working setting did not necessarily educe entrepreneurial behavior. Over the last 50 years, in many western countries, agriculture became a highly specialized domain focused on efficiency and productivity (Van der Ploeg et al. 2002). For instance, in Europe, post-war agricultural modernization was very successful for its original aims, to provide food security. However, this system did not stimulate diversification and innovative entrepreneurship. Farmers were trained to be craftsmen, producing food and fibers. The development of an entrepreneurial identity, skills, and behavior are, consequently, not self-evident (Vesala et al. 2007).

The direct farm environment. Farms are strongly regionally embedded: A convenient geographical location is therefore an important factor for entrepreneurial opportunities. The opportunities to develop new activities are much bigger when the family farm is located in an attractive region with other businesses, close to urbanized areas (providing a market), with good infrastructure and a well-developed supporting network (Wilson 2008).

The family firm. Agriculture is dominated by small family farms (Gasson et al. 1998). The family farming culture and associated logic influences agricultural entrepreneurship. Unlike general entrepreneurs, farming families are less driven by ideas of growth and profit maximization. Higher priority is given to survival, preserving family heritage, autonomy, rural lifestyle, and passing through a healthy farm on to the next generation (Jervell 2011). Moreover, family farms are passed on through from father to son. This selection process creates communities lacking heterogeneity with a strong tension toward conformity. The presence of other generations in the farm, in combination with a conservative mentality, does not particularly stimulate change and innovative thinking (Jervell 2011).

Gender. Farm women play an important role in agricultural entrepreneurship. Farm women are, in many cases, the ones who initiate and develop new on-farm business activities (Bock 2004). The initial entrepreneurial behaviors of farm women are characterized by "fitting in and multitasking." Typically, farm women start by fitting their new activities into the existing farm and combine entrepreneurship with existing farm and family duties (Bock 2004). However, farm women change their strategy over time and develop themselves as more expert entrepreneurs: investing in further development, taking risks and identifying, and presenting themselves as entrepreneurs (Bock 2004).

Conclusion and Future Directions

As the sections above show, agricultural entrepreneurship shares many characteristics of "generic" entrepreneurship, but also has its distinct features due to the specific context of the agricultural sector. A substantial body of literature on agricultural entrepreneurship has emerged, discussing several aspects of agricultural entrepreneurship. However, several avenues for research remain. Below, we will discuss four areas for future research in agricultural entrepreneurship.

Entrepreneurial Orientation (EO). EO (Lumpkin and Dess 2001) is a helpful, well-established, construct, originally from general entrepreneurship research but increasingly used in agricultural entrepreneurship research. EO can be defined as a farmer's "*willingness to innovate to rejuvenate market offerings, take risks to try out new and uncertain products, services and markets, and be more proactive than competitors towards new marketplace opportunities*" (Wiklund and Shepherd 2005). The original entrepreneurial orientation construct combines three key elements of entrepreneurial behavior, namely, innovativeness, risk taking, and pro-activeness, originally on the firm level. The EO elements together allow firms to identify and exploit opportunities for organizational renewal and creating more customer value. Research among farms and horticultural growers confirms the positive relationship between EO and performance (Verhees et al. 2011), although more specific research about the exact mechanism is needed (Verhees et al. 2012 (in press)). Furthermore, the original items for measuring the EO construct have been translated to agricultural entrepreneurship by Verhees and colleagues (2012 (in press)).

Entrepreneurial styles and roles. Although the scientific bases for typology research in entrepreneurship are controversial (Woo et al. 1991), typologies help to group and at the same time show the diversity in entrepreneurship. Moreover, typologies or configurations also have a strong basis in agricultural research, for instance, in the concept of farming styles (Van der Ploeg 1994). Business owners can take on different roles depending on the specific situation, context, and phase of the firm (Gartner 1989). Three roles can be assumed by the owner of firm, namely, the entrepreneurial, managerial, and technical role (Chandler and Jansen 1992). Whereas the craftsmen role highlights technical competence (i.e., green fingers, agronomy, crop protection), the entrepreneurial role emphasizes activities such as identifying customer needs, scanning the environment, identifying opportunities, formulating strategies, networking and collaboration, taking initiative and risks (Lans et al. 2011). At present, there are many studies in agriculture focusing on necessary knowledge, skill, and competence in the entrepreneurial role (Pyysiäinen et al. 2006; Lans et al. 2010).

Nascent, novice, and expert entrepreneurs. A third helpful angle for studying agricultural entrepreneurship comes from expertise research, showing that expert entrepreneurs differ from novices in the way they deal with new situations (Baron and Ensley 2006). Entrepreneurs can be classified as nascent (thinking about it), novice (first time out), and expert (several business, portfolio or serial) entrepreneurs. Pioneering research in this context was done by Carter (1999) who, as one of the first, framed the development of new activities by farmers as *portfolio* entrepreneurship. Portfolio entrepreneurs use their existing firm as a fertile basis to develop new businesses and are, hence, considered advantaged compared to their nascent and novice counterparts, who first have to acquire their resources (Westhead et al. 2005). In agriculture, employing new entrepreneurial activities is relatively easy because farmers generally have many useful resources at their disposal such as: land, buildings, machinery, labor, networks, etc. Access to good resources alone is, however, not a guarantee for success. It all depends on the farmers' entrepreneurial abilities to access, see the potential of, and use the resources available (Alsos et al. 2011). Entrepreneurial learning plays a key role in this process (Seuneke et al. 2012).

Agricultural entrepreneurship support. The developing field of dedicated agricultural entrepreneurship support is a fourth focus point for research. Traditionally, problem solving and innovation in the agricultural sector was supported by so-called extension services, which were often funded and provided by the state in line with food security and agricultural modernization policies. These extension services often had a supply-push orientation and worked within a linear paradigm of innovation (innovations developed by agricultural research were uniformly disseminated to farmers by extension services), and the one-size-fits all modernization agenda neglected the heterogeneity of farming styles and entrepreneurial styles of farmers (Van der Ploeg 1994). Because of this changing structure of agricultural markets and the agricultural sector (earlier mentioned phenomena like multifunctionality, integration in production chains driven by consumer demands, societal demands such as food safety, animal welfare, and ecological sustainability), a one-size-fits all model of innovation and entrepreneurship support has become inadequate. This realization, coupled with the privatization of applied agricultural research institutes and agricultural extension services, has induced major changes in innovation and entrepreneurship support in agriculture. Farmers are now served by a pluralistic system of advisors (both specialized and independent advisors, and those connected to agricultural input supply such as seeds and fertilizers) (Klerkx and Jansen 2010). Since addressing the heterogeneous support demands of farmers includes a shift from a mere production-technical focus toward providing services aimed at improving more generic business, management, and entrepreneurial skills (Phillipson et al. 2004), farmers need to access different kinds of advisors. In some cases, the formation of adequate advisory networks which provide a complementary set of both technical advice and advice in support of entrepreneurship (management, strategy, finance) happens autonomously (Klerkx and Proctor 2013). However, often farmers have difficulties in finding their way around in this pluralistic advisory system, and need to be supported by an agency who acts as a broker (Phillipson et al. 2004). To this end, in recent years, several dedicated "innovation centers" or "business support centers" have emerged, which help farmers articulate their entrepreneurial strategy and their entrepreneurship and innovation support needs, search suitable support providers and match these with farmers, and, if needed, facilitate their further collaboration (Klerkx and Leeuwis 2009a). Furthermore, initiatives have sprouted which stimulate informal networking among farmers, to share experiences and learn on topics of joint interest. Some of these initiatives explicitly aim to stimulate entrepreneurial learning by challenging farmers to pay more attention to other topics than craftsmanship in crop and animal management, offering, for example, master classes by successful entrepreneurs from nonagricultural sectors (Klerkx and Leeuwis 2009b). As many of these initiatives are of recent date, more research is needed on issues such as their form, focus, and impact on agricultural entrepreneurship skills.

Cross-References

- ▶ Entrepreneurial Capability and Leadership
- ▶ Entrepreneurship Policies
- ▶ Environmental Determinants of Entrepreneurship
- ▶ Entrepreneur's "Resource Potential," Innovation and Networks
- ▶ Female Entrepreneurship

References

Alsos GA, Carter S, Ljunggren E, Welter F, editors. The handbook of research on entrepreneurship in agriculture and rural development. Cheltenham/Northampton: Edward Elgar; 2011.

Baron RA, Ensley MD. Opportunity recognition as the detection of meaningful patterns: evidence from comparisons of novice and experienced entrepreneurs. Manag Sci. 2006;52(9):1331–44.

Bock BB. Fitting in and multi-tasking: Dutch farm women's strategies in rural entrepreneurship. Sociol Rural. 2004;44(3):245–60.

Carter S. Multiple business ownership in the farm sector: assessing the enterprise and employment contributions of farmers in Cambridgeshire. J Rural Stud. 1999;15(4):417–29.

Chandler GN, Jansen E. The founder's self-assessed competence and venture performance. J Bus Venturing. 1992;7(3):223–236.

DeTienne DR, Chandler GN. Opportunity identification and its role in the entrepreneurial classroom: a pedagogical approach and empirical test. Acad Manag Learn Educ. 2004;3(3):242–57.

Gartner WB. 'Who is an entrepreneur?' is the wrong question. Entrep Theory Pract. 1989;13:47–68.

Gasson R, Crow G, Errington A, Hutson J, Marsden T, Winter M. The farm as a family business: a review. J Agr Econ. 1988;39:1–41.

Jervell AM. The family farm as a premise for entrepreneurship. In: Alsos GA, Carter S, Ljunggren AE, Welter F, editors. The handbook of research on entrepreneurship in agriculture and rural development. Cheltenham/Northhampton: Edward Elgar; 2011.

Klerkx L, Jansen J. Building knowledge systems for sustainable agriculture: supporting private advisors to adequately address sustainable farm management in regular service contacts. Int J Agric Sustain. 2010;8(3):148–63.

Klerkx L, Leeuwis C. The emergence and embedding of innovation brokers at different innovation system levels: insights from the Dutch agricultural sector. Technol Forecast Soc Change. 2009a;76(6):849–60.

Klerkx L, Leeuwis C. Shaping collective functions in privatized agricultural knowledge and information systems: the positioning and embedding of a network broker in the Dutch dairy sector. J Agric Educ Ext. 2009b;15(1):81–105.

Klerkx L, Proctor A. Beyond fragmentation and disconnect: networks for knowledge exchange in the English land management advisory system. Land Use Policy. 2013;30(1):13–24.

Lans T, Biemans H, Mulder M, Verstegen J. Self-awareness of mastery and improvability of

entrepreneurial competence in small businesses in the agrifood sector. Human Resour Dev Q. 2010;21(2): 147–68.
Lans T, Biemans H, Verstegen J, Mulder M. The influence of the work environment on entrepreneurial learning of small-business owners. Manag Learn. 2008;39(5): 597–613.
Lans T, Verstegen J, Mulder M. Analysing, pursuing and networking: a validated three-factor framework for entrepreneurial competence from a small business perspective. Int Small Bus J. 2011;29(6):695–713.
Lumpkin GT, Dess GG. Linking two dimensions of entrepreneurial orientation to firm performance: the moderating role of environment and industry life cycle. J Bus Venturing. 2001;16(5):429–51.
McClelland DC. The achieving society. New York: First Free Press; 1967.
McElwee G. A taxonomy of entrepreneurial farmers. Int J Entrep Small Bus. 2008;6:465–78.
Phillipson J, Gorton M, Raley M, Moxey A. Treating farms as firms? The evolution of farm business support from productionist to entrepreneurial models. Environ Plan C Govern Policy. 2004;22(1):31–54.
Pyysiäinen J, Anderson A, McElwee G, Vesala K. Developing the entrepreneurial skills of farmers: some myths explored. Int J Entrep Behav Res. 2006;12:21–39.
Rauch A, Wiklund J, Lumpkin GT, Frese M. Entrepreneurial orientation and business performance: an assessment of past research and suggestions for the future. Entrep Theory Pract. 2009;33(3):761–87.
Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard; 1934.
Seuneke P, Lans T, Wiskerke JSC. Entrepreneurial learning in multifunctional agriculture. In: International conference on multifunctional agriculture and urban-rural relations ‘agriculture in an urbanising society’. Wageningen, The Netherlands (2012)
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manage Rev. 2000;25(1):217–26.
van der Ploeg JD. Styles of farming: an introductory note on concepts and methodology. In: van der Ploeg JD, Long A, editors. Born from within: practice and perspectives of endogeneous rural development. Assen: Royal van Gorcum; 1994.
van der Ploeg JD, Long A, Banks J, editors. Living countrysides, rural development processes in Europe: the state of the art. Doetinchem: Elsevier; 2002.
Verhees FJHM, Kuipers A, Klopcic M. Entrepreneurial proclivity and farm performance: the cases of Dutch and Slovenian farmers. Int J Entrep Innov. 2011;12(3):169–77.
Verhees F, Lans T, Verstegen J. The influence of market- and entrepreneurial orientation on strategic marketing choices: the cases of Dutch farmers and horticultural growers. J Chain Network Sci (2012) (in press)
Vesala KM, Peura J, McElwee G. The split entrepreneurial identity of the farmer. J Small Bus Enterp Dev. 2007;14(1):48–63.
Westhead P, Ucbasaran D, Wright M, Binks M. Novice, serial and portfolio entrepreneur behaviour and contributions. Small Bus Econ. 2005;25:109–32.
Wiklund J, Shepherd D. Entrepreneurial orientation and small business performance: a configurational approach. J Bus Venturing. 2005;20(1):71–91.
Wilson GA. From ‘weak’ to ‘strong’ multifunctionality: conceptualising farm-level multifunctional transitional pathways. J Rural Stud. 2008;24(3):367–83.
Woo CY, Cooper AC, Dunkelberg WC. The development and interpretation of entrepreneurial typologies. J Bus Venturing. 1991;6(2):93–114.

Agricultural Innovation

▶ Agricultural Entrepreneurship

AI

▶ In Search of Cognitive Foundations of Creativity

Ailment

▶ Technological Invention of Disease

Alteration

▶ Product Innovation, Process Innovation

Alternate Reality Games as Inventions

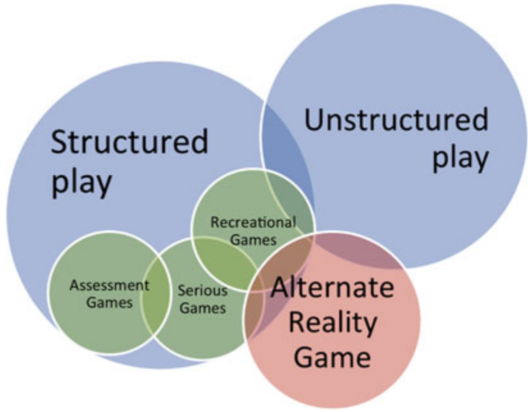
Dirk Ifenthaler
Department of Educational Psychology, University of Oklahoma, Norman, OK, USA

Synonyms

Online role playing game; Serious game

Key Concepts and Definition of Terms

Games are a universal part of human experience and are present in all cultures. Characteristics of a game include goals, rules, competition, and interaction (Huizinga 1955; Ifenthaler et al. 2012). Serious games are entertaining and interactive learning environments including a purposeful curricular focus (Ritterfeld et al. 2009). Alternate reality games, or ARGs, represent an innovative game genre that requires use of the Internet yet imports other media and methods of communication to facilitate play (Szulborski 2005).



Alternate Reality Games as Inventions, Fig. 1 Classification of alternate reality games

Theoretical Background

Serious games have emerged as "a new form for education and training" (de Freitas and Liarokapis 2011, p. 9). In fact, the innovations of serious games have such great consequence that they envision them to be capable of providing "a paradigm shift in how education and training are delivered in the twenty-first century" (de Freitas and Liarokapis 2011, p. 9). Given the omnipresence of gaming in culture and society, and the recent advances in technological capabilities, it is not surprising that gaming for learning and instruction could hold such possible value as well (Ifenthaler et al. 2012; Ritterfeld et al. 2009). As to a specific definition of serious games, they generally can be characterized as digital games with a curricular focus and are not used just for entertainment purposes (de Freitas and Liarokapis 2011; Ritterfeld et al. 2009). The appeal and effectiveness of serious games reside in the power of the games to provide an escape from the tedium of reality, as well as to feel immersed in an activity and the world created around it. Most importantly, a delicate balance must be struck to ensure that learning objectives are met without sacrificing the entertainment of the game (de Freitas 2006; de Freitas and Liarokapis 2011; Ifenthaler et al. 2012).

Alternate reality games (ARGs) are interactive narratives that take place in real time and evolve according to the learners' responses (Klopfer and Squire 2008). ARGs are best described by the "*TINAG* philosophy," which stands for "***T****his* ***I****s* ***N****ot* ***A*** ***G****ame*" (Szulborski 2005, p. 1). The innovation of an ARG is the lack of predefined rules for game play, game space, and game materials, in addition to the absence of specific win/loss scenarios. This fact separates ARGs from the constraints of serious games, thereby facilitating implementation of the *TINAG* philosophy (see Fig. 1). The illusion, therefore, is of participating in reality, and not in fiction. Thus, it is important to note that ARGs are vastly different from simulations (Szulborski 2005). However, ARGs are about participating in "*alternate realities.*" Accordingly, well-designed ARGs will allow users to feel as though their game participation flows out of real life, and is as natural as other features of daily living, especially within the context of information and communication technology (ICT). This is due in large part to the types of components utilized in ARGs.

Media such as websites, e-mail messages, videos, Internet blogs, phone calls, learning management systems, and even real-world interactions can all be used to enable play in ARGs (McGonigal 2003; Szulborski 2005). More importantly, such media are likely to be used in players' everyday lives.

Some ARGs have served a marketing function; others have educational objectives or focus on social as well as economic issues (McGonigal 2011). An innovation of ARGs is the story which is revealed in pieces after a specific problem has been solved by the player (Szulborski 2005). Finding out the ultimate goal of the ARG is an important feature which facilitates the immersion into the ARG, i.e., the feeling of being deeply engaged where players enter a make-believe world as if it is real.

Another innovation of ARGs is rabbit holes which function as the beginning of the game. Rabbit holes represent an opening to another world (the alternate reality world). They are realistic and intriguing and motivate the player to proceed further into the alternate reality world. The rabbit hole, e.g., an encrypted message in an e-mail advertisement, leads to a series of websites including further information, e.g., about the characters involved in the ARG. The innovative learning objective of the ARG is the change of real-world behavior of the players. Yet, empirical research regarding the effectiveness of ARG for learning and instruction is rare. An implementation of an experimental ARG curriculum showed significant gains on player's achievement when compared to computer-based instruction (Warren et al. 2012). Still, further research is required in order to provide empirical evidence for the instructional benefits of the innovations provided by ARGs.

Conclusion and Future Directions

Digital game-based technologies are nudging the field to redefine what is meant by learning and instruction. Proponents of game-based learning argue that we should prepare the students to meet the demands of the twenty-first century by teaching them to be innovative, creative, and adaptable so that they can deal with the demands of learning in domains that are complex and ill structured (Gee 2003; Ifenthaler et al. 2012; Shaffer 2006). On the other hand, opponents of games argue that games are just another technological fad, which emphasize superficial learning. In addition, opponents argue that games cause increased violence, aggression, inactivity, and obesity while decreasing prosocial behaviors (Ifenthaler et al. 2012; Mishra and Foster 2007; Walsh 2002).

As the border between *game, play*, *learning*, and *instruction* is getting blurry, we are once again faced with paradigm shifts in epistemology, learning theory, and instructional theory. However, before we get excited and claim that alternate reality games will change education, we need to empirically study what it means for learning and instruction. A mature theory of game-based learning should take into account the underlying principles by which they work as learning environments. Despite the arguments for the potential of digital game-based learning, the empirical evidence for their effectiveness is scant (Eseryel et al. 2011). Therefore, the need to systematically study which instructional design strategies work in game-based learning environments to take full advantage of what these emerging technologies can offer for education and training is evident. Toward this goal, a scientific attitude with regard to the design of alternate reality games requires validated measures of learning outcomes and the associated assessment methods in order to determine which design elements work best, when, and why (Ifenthaler et al. 2012).

Cross-References

▶ Innovation

References

de Freitas SI. Using games and simulations for supporting learning. Learn, Media Technol. 2006;31(4):343–58.

de Freitas SI, Liarokapis F. Serious games: a new paradigm for education? In: Ma M, Oikonomou A, Jain LC, editors. Serious games and edutainment applications. New York: Springer; 2011. p. 9–23.

Eseryel D, Ifenthaler D, Ge X. Alternative assessment strategies for complex problem solving in game-based learning environments. In: Ifenthaler D, Kinshuk, Isaias P, Sampson DG, Spector JM, editors. Multiple perspectives on problem solving and learning in the digital age. New York: Springer; 2011. p. 159–78.

Gee JP. What video games have to teach us about learning and literacy. New York: Palgrave-Macmillan; 2003.

Huizinga J. Homo ludens: a study of the play-element in culture. Boston: Beacon; 1955.
Ifenthaler D, Eseryel D, Ge X. Assessment for game-based learning. In: Ifenthaler D, Eseryel D, Ge X, editors. Assessment in game-based learning. Foundations, innovations, and perspectives. New York: Springer; 2012. p. 3–10.
Klopfer E, Squire K. Environmental detectives – the development of an augmented reality platform for environmental simulations. Educ Technol Res Dev. 2008;56(2):203–28. doi:10.1007/s11423-007-9037-6.
McGonigal J. 'This is not a game': immersive aesthetics and collective play. Fine Art Forum. 2003;17(8).
McGonigal J. Reality is broken: why games make us better and how they can change the world. New York: Penguin; 2011.
Mishra P, Foster A. The claims of games: a comprehensive review and directions for future research. In: Carlsen R, McFerrin K, Price J, Weber R, Willis DA, editors. Proceedings of the 18th international conference of the society for information technology & teacher education. San Antonio: Association for the Advancement of Computing in Education (AACE); 2007.
Ritterfeld U, Cody MJ, Vorderer P, editors. Serious games: mechanisms and effects. New York: Routledge; 2009.
Shaffer DW. How computer games help children learn? New York: Palgrave Macmillan; 2006.
Szulborski D. This is not a game: a guide to alternate reality gaming. Raleigh: Lulu Press; 2005.
Walsh D. Video game violence and public policy. http://www.soc.iastate.edu/sapp/videogames2.pdf (2002). Retrieved 27 Oct 2011.
Warren S, Dondlinger MJ, McLeod J, Bigenho C. Opening the door: an evaluation of the efficacy of a problem-based learning game. Comput Educ. 2012;58(1):397–412. doi:10.1016/j.compedu.2011.08.012.

Ambidexterity

Christian Garaus, Wolfgang H. Güttel, Stefan Konlechner, Hubert Lackner and Barbara Müller
Institute of Human Resource and Change Management, Johannes Kepler University, Linz, Upper Austria, Austria

Synonyms

Balanced organizational learning; Exploration-exploitation balance

The question how organizations survive and prosper within changing environments is a central topic in contemporary management theory and practice. In order to gain and sustain competitive advantage, organizations need to reconcile two seemingly incompatible learning capabilities simultaneously: exploration (building new competencies) and exploitation (i.e., using and refining existing ones) (March 1991). The tensions between exploration and exploitation emerge from their competition for scarce resources and their self-reinforcing nature (Gupta et al. 2006). Most firms tend to overemphasize exploitation because payoffs of exploitation are more predictable and closer in time. Although firms focusing solely on exploitation may reap the short-term benefits of exploitation, they suffer from the lack of new ideas in the long run ("competency trap"). Likewise, focusing on exploration to the exclusion of exploitation results in high costs of experimentation without harvesting its benefits ("failure trap") (Levinthal and March 1993).

Ambidexterity Basically Refers to a Firm's Ability to Pursue Exploration and Exploitation Simultaneously

Current definitions consider ambidexterity as the simultaneous pursuit of exploration and exploitation. Firms can command resources (e.g., time, management attention, human, and financial resources) to one of the learning capabilities to either facilitate exploration or exploitation. In contrast to monodexterity (i.e., pursuing one learning capability to the exclusion of the other) and sequential approaches (i.e., punctuated equilibrium), ambidexterity is based on a continuous pursuit of both learning capabilities. Current research on the performance implications of ambidexterity shows that ambidexterity is positively related to such diverse performance measures as survival, innovation, or sales growth. Moreover, scholars have investigated ambidexterity in various fields with a remarkable variety of involved theoretical approaches such as organizational learning, strategic management, innovation management, marketing, organizational design, human resource management, knowledge management, or even neuroscience (cf., e.g., Raisch and Birkinshaw (2008) and Simsek et al. (2009) for an overview).

Previous research suggests that there are two different ways of achieving ambidexterity: structural separation and contextual integration of the learning capabilities. Structural ambidexterity builds on the assumption that exploration and exploitation require fundamentally different processes, mindsets, and subcultures (Benner and Thusman 2003). Thus, structurally ambidextrous organizations separate their innovative activities from existing core business in order to prevent "cross-contamination" (O'Reilly and Tusman 2004). In contrast, contextual ambidexterity refers to a firm's ability to resolve the tension between exploration and exploitation within the same unit by establishing an organizational context that allows employees to switch between exploration and exploitation according to their own judgments (Gibson and Birkinshaw 2004). Such contextually ambidextrous organizations need to establish a common frame of reference that enables individuals to perform exploratory as well as exploitative activities (Güttel and Konlechner 2009).

To create (structural or contextual) ambidexterity, organizations do not only need to balance exploration and exploitation but also to link the two learning capabilities. Linking exploration and exploitation through knowledge flows allows for stimulating new ideas. Thus, ambidextrous firms seek cross-fertilization without cross-contamination. Existing literature emphasizes the role of the top-management team and cross-functional teams to establish this links. In this vein, Tushman and O'Reilly (1996) stress the importance of a common vision and a corporate culture with broadly shared norms and values to maintain ambidexterity. Güttel et al. (2012) emphasize the role of rules for maintaining exploration and exploitation concurrently and for integrating both learning streams.

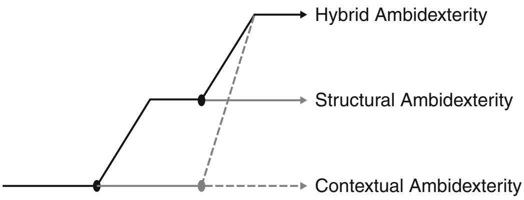
Existing ambidexterity research focuses on very diverse levels of analysis (e.g., network, organizational, subunit, group), leading to a fragmented body of knowledge. By synthesizing prevailing "snapshots" from the ambidexterity literature, the following dynamic model of ambidexterity integrates diverse and sometimes even contradictory findings by adopting a process perspective along the pathway of organizational development. The next section highlights (a) how ambidextrous organizations balance exploration and exploitation at different phases of development or growth over time, (b) how they manage the transition from one phase to another (strategic decision points), and (c) how the top-management teams role changes according to different development phases (from "doing exploration and exploitation" to "balancing and linking exploration and exploitation" and "orchestrating various learning units").

Ambidexterity Along the Pathway of Organizational Development

Building upon a dynamic states perspective (i.e., a configuration of structures and processes to match the organization with the external environment), Levie and Lichtenstein (2010) allows capturing the evolutionary development of organizations and their learning capabilities. Although the definite number of states for any organization cannot be predicted a priori, the model proposes that all states can be categorized in three basic architectures of ambidexterity, indicating an abstract representation of common structural configurations and processes in the existing ambidexterity literature (see Fig. 1): *(1) contextual ambidexterity*, *(2) structural ambidexterity*, and *(3) hybrid forms of ambidexterity* where both previous forms of ambidexterity coexist within one firm.

Architecture I: Contextual Ambidexterity

Contextual ambidexterity allows for the management of exploration and exploitation within the same organizational unit. Thus, for small firms that are just too small to structurally divide their learning capabilities, contextual ambidexterity is the most appropriate choice (e.g., small architect offices or consulting firms). In contrast to large



Ambidexterity, Fig. 1 Basic ambidextrous architectures

firms that need to break up organizational inertia through new exploratory activities, small firms become ambidextrous through keeping their entrepreneurial spirit alongside the evolving core business. Within a simple organizational structure, firms can combine their exploratory mindset with a focus on exploiting the current competencies. Employees contribute to exploration and exploitation by judging whether to pursue exploratory or exploitative activities. Therefore, the organization needs to mitigate the decision how to balance exploration and exploitation to the individual level. Spatial proximity of the employees facilitates knowledge sharing, mutual learning, and thus the interaction of exploration and exploitation.

Within contextually ambidextrous firms, the top-management teams' (or founder's) role is to create a context allowing the combination of exploration and exploitation and to establish guiding principles that prevent individuals from drifting to only exploration or exploitation (e.g., via shared vision, target agreements). Particularly in such small firms, the top management (or founder) can communicate the integration of exploration and exploitation by serving as a role model ("doing exploration and exploitation") ("▶ Entrepreneurial Capability and Leadership").

Critical Decision Point: Threat of Chaos

Organizational growth makes it difficult to maintain the simple organizational design ("▶ Small Businesses and Sustainable Development"). Contextually ambidextrous firms may deliberately choose to stay small enough to sustain the benefits of contextual ambidexterity such as flexibility and market proximity. However, if they decide to grow, the increasing complexity requires new forms of organizing, such as groups specializing on exploration or exploitation. As a result of this development, the firm needs to adapt a different architecture to support its learning processes: structural ambidexterity.

Architecture II: Structural Ambidexterity

Structural ambidexterity refers to the creation of separate units, which generate their own subculture and routines in order to ensure high specialization (i.e., to facilitate (mass-)production on the one hand and to support radical innovations on the other) ("▶ Joseph A. Schumpeter and Innovation"). Pharmaceutical companies may serve as examples of structurally ambidextrous firms with separated business units to research on radically new products for serving future markets and to efficiently supply the current market with developed products.

The structural separation of exploration and exploitation leads to two key challenges for the organization. First, in contrast to contextual ambidexterity, the top-management team needs to balance exploration and exploitation by allocating resources to exploratory and exploitative activities. Second, while knowledge flows in a way automatically in contextual ambidextrous organizations, organizations need to manage knowledge flows more strategically in structurally ambidextrous architectures. To combine both learning capabilities, scholars emphasize the integrative function of the top-management team and the necessity of an overarching vision and a corporate culture. Moreover top-management teams can foster knowledge flows between functionally separated units by implementing knowledge-management projects or cross-functional teams.

Critical Decision Point: Threat of Inertia

Further increasing firm size results in rigid hierarchies and slow decision-making processes leading to a loss of flexibility. The structures and formalized systems, which were developed to handle the increasing complexity, ultimately lead to *structural* inertia. Additionally, the organization's success in the short term is reflected in the shared expectations of the way "how we do things around here," leading to *cultural* inertia. Under such circumstances, an organization – still eager to grow – has to renew its competencies and regain its entrepreneurial spirit, without losing the advantages of functional specialization. By blending structural separated units with newly established contextually ambidextrous units, organizations can combine the advantages of both previous architectures.

Architecture III: Hybrid Forms of Ambidexterity

Organizations employ hybrid ambidexterity by combining structurally separated explorative, exploitative, and contextually ambidextrous units. Setting up new contextually ambidextrous units serves as means to regain entrepreneurial spirit in large companies. Under such circumstances, the role of top-management teams changes from managing the interface of exploration and exploitation to orchestrating diverse units with different tasks. Furthermore, top-management teams can nourish continuous exploration at high level by creating or acquiring specialized explorative units or by intensifying the search for new knowledge in strategic alliances and networks ("► Clusters, Networks, and Entrepreneurship").

Critical Decision Point: Threat of Disintegration

Particularly complex ambidextrous firms need to constantly communicate their shared vision and foster the corporate culture as growing decentralization and differentiation leads to an increasing call for autonomy from the business units. As a response, many firms create separated and independent strategic business units operating in different areas/industries, often losing the advantage of cross-fertilization of exploration and exploitation.

Conclusion and Future Directions

Increasing environmental uncertainty, speeding product life cycles, and growing worldwide competition raise the importance of persistently building new capabilities while using and refining existing ones. Ambidexterity refers to the organizational capability to simultaneously pursue the conflicting learning capabilities of exploration and exploitation. Organizations can adopt three basic architectures of ambidexterity: contextual, structural, and hybrid forms of ambidexterity. While contextual ambidexterity is most appropriate for small firms and structural ambidexterity for more established companies, hybrid forms of ambidexterity combine the advantages of both, making it the most desirable option for large companies. Firms being able to balance and to link exploration and exploitation (i.e., allowing cross-fertilization without cross-contamination) will not only be competitive in the short run but also outperform competitors in the long run. However, more (qualitative) research is necessary to further develop the notion and the practice of ambidexterity.

References

Benner MJ, Tushman ML. Exploration, exploitation, and process management: The productivity dilemma revisited. Acad Manage Rev. 2003; 28:238–256.

Gibson CB, Birkinshaw J. The antecedents, consequences, and mediating role of organizational ambidexterity. Acad Manage J. 2004; 47:209–26.

Gupta AK, Smith KG, Shalley CE. The interplay between exploration and exploitation. Acad Manage J. 2006; 49:693–706.

Güttel WH, Konlechner S. Continuously hanging by a thread: dynamic capabilities in ambidextrous organizations. Schmalenbach Bus Rev. 2009; 61:150–72.

Güttel WH, Konlechner S, Müller B, Trede JK, Lehrer M. Facilitating ambidexterity in replicator organizations: artifacts in their role as routine-re-creators. Schmalenbach Bus Rev. 2012; 64:187–203.

Levie J, Lichtenstein BB. A terminal assessment of stages theory: Introducing a dynamic states approach to entrepreneurship. Entrepreneurship Theory Pract. 2010; 34:217–350.

Levinthal D, March J. The myopia of learning. Strat Manag J. 1993;14:95–112.

March JG. Exploration and exploitation in organizational learning. Organ Sci. 1991; 2:71–87.

O'Reilly CA, Tusman ML. The ambidextrous organisation. Harv Bus Rev. 2004;82(4):74–81.

Raisch S, Birkinshaw J. Organizational ambidexterity: antecedents, outcomes, and moderators. J Manag. 2008;34:375–409.

Simsek Z, Heavey C, Veiga JF, Souder D. A typology for aligning organizational ambidexterity's conceptualizations, antecedents, and outcomes. J Manag Stud. 2009; 46:864–94.
Tushman ML, O'Reilly CA. Ambidextrous organizations: managing evolutionary and revolutionary change. Calif Manage Rev. 1996;38:8–30.

Analogies and Analogical Reasoning in Invention

Ulf Krumnack[1], Kai-Uwe Kühnberger[1], Angela Schwering[2] and Tarek R. Besold[1]
[1]Institute of Cognitive Science, University of Osnabrück, Osnabrück, Germany
[2]Institute for Geoinformatics, University of Münster, Münster, Germany

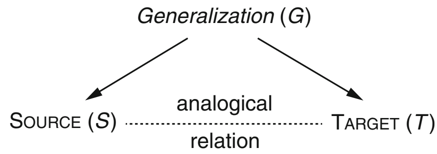
Synonyms

Analogy; Creativity; Invention

The Concepts "Analogy" and "Invention"

Analogy

An analogy is usually considered as a structural mapping between a source (base) and a target domain. To establish an analogy, common substructures of the two domains are identified and mapped to each other, resulting in an analogical relation. The establishment of an analogy is usually governed by certain constraints, like systematicity, structural consistency, or a one-to-one restriction on possible mappings, although there is no general accepted set of such principles. Analogy-making can also be regarded as the establishment of a generalization, identifying an abstract core that consists of the common structures of both domains and ignores surface appearance and domain peculiarities (cf. Fig. 1). Analogies are usually not judged right or wrong; rather, they can be more or less plausible, based on the degree of structural coherence that they exhibit, possibly depending on the context and analogical conclusion they allow to draw.



Analogies and Analogical Reasoning in Invention, Fig. 1 Analogy via generalization

Analogical reasoning uses an analogical relation to transfer structures, relational properties, or conceptions from the source to the target domain. Parts of the source domain that have no correspondence on the target side are candidates for transfer and can be fitted into the target by translating them based on the analogical mapping. Unlike other inference mechanisms that basically make implicit knowledge about a domain explicit, analogical reasoning can import new conceptions into the target domain. It is important to notice that an analogical inference does not result in factual knowledge, even when source and target domain consist of definite facts. It is the task of the reasoner, to carefully examine the results, may it be for logical consistency or for empirical evidence, before accepting them as part of the knowledge about the target domain.

Analogies have been identified as a core mechanism of human cognition. The recall of memories based on current impressions, the understanding of a new situation in terms of a familiar one, the creation of abstract concepts, or the ability to learn from quite restricted sets of examples is most likely based on analogy-making. Especially, analogical reasoning allows for the introduction of new ideas into a domain and thereby provides an explanation of human creativity.

A wide variety of models for analogical thinking have been introduced, which differ in the way they represent knowledge the analogy is based on and in the methods used to establish the analogical relation and to realize the analogical transfer. On the symbolic side, the Structure Mapping Theory (SMT) uses graphs to represent the domains and computes analogical relations by identifying maximal matching subgraphs. The logic-based Heuristic-Driven Theory Projection (HDTP) represents domain theories by sets of axioms and generalizes matching subtheories. The copycat model of Hofstadter's fluid analogy group is based on the notion of conceptual slippage, and analogies are found by adjusting the representation of source and target. Kokinov's DUAL/AMBR architecture realizes its memory as a network of micro-agents, in which analogies are found by a hybrid process of spreading activation and marker passing. There are also models which are based on connectionist and subsymbolic representations. Holyoak and Hummel created a framework for Learning and Inference with Schemas and Analogies (LISA) that is based on a neural network model that uses temporally synchronized activation between neurons to signify a mapping between source and target elements. Vector Symbolic Architectures (VSAs) use high-dimensional vectors which can be accessed by simple mathematical operations, to store, retrieve, or analogically reason about information.

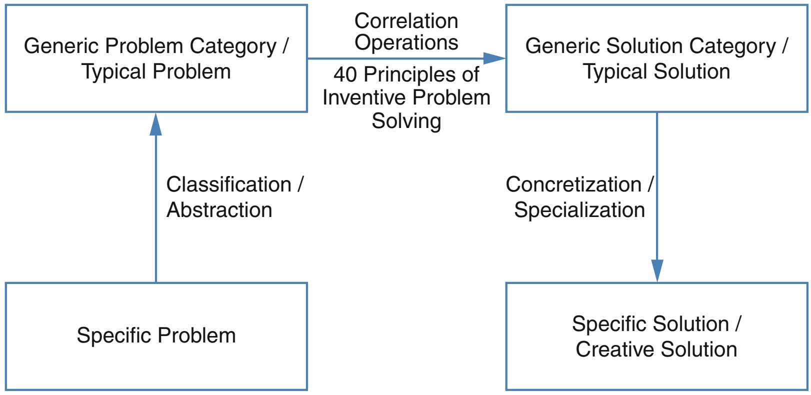
Invention

Creativity, innovation, and invention are three abstract concepts that are strongly interrelated and can be used for specifying the process of how to generate new ideas, products, or solutions to problems. Whereas creativity describes a general cognitive capacity that is in different degrees involved in any process of generating an invention, the concepts invention and innovation describe properties of concrete products, services, or ideas. From a more engineering- and business-oriented perspective, an invention is usually considered as the manifestation of the creative mental act, resulting in a new artifact (prototype), a new type of service, a new concept, or even the mental concretization of a conception. An innovation requires standardly the acceptance of the invention by the market, where market is not exclusively restricted to business aspects. Therefore, there can be non-inventive innovations (e.g., a product that has market success, but is not pioneering in any sense), non-innovative inventions (e.g., a pioneering product that has no market success), and also inventions that lead finally to innovations (e.g., a pioneering product that has market success) (Burki and Cavalluci 2011).

Inventions are also important milestones for the progression in art, culture, and science. Inventions in such fields are not necessarily coupled with concrete products or services; rather, insights of the artists or scientists cause the development of new concepts and new ideas.

- Examples for scientific inventions are the discovery of the complex plane in mathematics, enabling a geometric interpretation of algebraically defined complex numbers (Argand 1813), Einstein's theories of special and general relativity, or Chomsky's insight that natural language can be described by a recursive mechanism (phrase structure grammar) (Chomsky 1957). Although the term "discovery" (instead of invention) is most often used in the science context, it is not undisputed whether scientific research discovers existing entities (e.g., Platonic ideas) or just invents models that approximate and explain reality. In this entry, the term "invention" is also used for the scientific domain.
- Examples for artistic inventions are numerous. Not only the invention of new forms (types) of art, like, in the case of music, the form of a symphony starting in the seventeenth century or rock-and-roll music in the mid-twentieth century, but also many other types of inventions like the building of new instruments in music, new techniques for painting, new methods to compose texts (sometimes together with other forms of media content, like pictures), etc., can be subsumed under invention.

Creativity as the underlying cognitive ability to produce inventions in science and art is, similar to the cases mentioned above, the necessary cognitive prerequisite for pioneering developments. Nevertheless, the term "innovation," although obviously usable and important also in science and art, is only indirectly measurable contrary to many business products and services.



Analogies and Analogical Reasoning in Invention, Fig. 2 The general TRIZ architecture of an inventive problem solving process

The Role of Analogy in Invention

Invention in Engineering and Business Processes

An explicitly dedicated framework for a theory of invention in the engineering and business domain is TRIZ, the Russian acronym for the *Theory of Inventive Problem Solving* ("теория решения изобретательских задач"). TRIZ was developed in its original form by Genrich Altshuller, a Russian inventor who examined more than 40,000 patent abstracts in order to find common patterns and principles behind business relevant inventions (Altshuller 1984). TRIZ is based on the idea that at the beginning of an inventive problem solving process a technical or physical contradiction arises. According to TRIZ, this contradiction can be resolved by applying 40 principles of invention (mostly parameter settings in engineering problems) relative to an ideal system. The general architecture behind the solution process is depicted in Fig. 2.

An interesting feature of TRIZ is the explicit lifting of a given problem (contradiction) to an abstract level, in order to apply the principles of inventive problem solving. The lifting process itself can be understood as an analogy-driven process, because similar problems need to be consulted to find the right generic problem category (compare Fig. 1). In this sense, TRIZ uses analogy-making in a nontrivial sense for generating inventive solutions.

Besides TRIZ, many problem setups for innovation processes, invention creation, and the design of inventive products are strongly related to optimization problems. A framework originally developed for the statistical assessment of optimality in quality management is 6σ. In order to make already existing processes adequate for optimization, the so-called DMAIC cycle proposes five steps: define, measure, analyze, improve, and control such processes. For each step, 6σ proposes tools for the optimization process. Nowadays, 6σ is widely used in the manufacturing industry and the financial sector.

Also, computational methods for inventive problem solving have been proposed. An example could be case-based reasoning (CBR), originating from research in artificial intelligence. The idea of CBR is to build a new solution for a given problem (domain) by using solutions of similar problems that are stored in a knowledge base. The algorithmic process is divided into four steps: (1) retrieve and (2) reuse a similar solution stored in the knowledge base, (3) refine it to a new solution, and finally (4) retain the new solution. The appropriateness of the new solution is strongly dependent on the chosen similarity measure between the problems. Quite often, CBR is mentioned directly as an instance of analogical reasoning. Although there are significant differences between the analogy concept specified above and CBR (e.g., the lack of the systematicity principle in CBR or lack of a transfer process of knowledge from source to target), it is rather clear that both methods are related to each other and CBR can be interpreted as a strongly constrained form of analogy-making.

Invention in Science and Mathematics

Throughout history, analogies have been reported as a driving force for invention and scientific discovery. Holyoak and Thagard (1995) mention that already in ancient times the Roman engineer Vitruvius observed similarities between water waves and sound. Later in the seventeenth century, an analogy between sound and light was established, giving rise to the wave theory of light. Also, Rutherford's atom model, based on an analogy to the solar system, although physically disproven, is still used in education, because it is easy to conceptualize and appropriate for a first conception of a new domain.

Analogies are also seen indispensable in the formation of mathematical concepts. Georg Polya (1954) emphasizes the central role of analogies in the development of mathematical concepts and proofs. Based on linguistic evidence, Lakoff and Núñez (2000) describe the development of mathematical ideas as a long series of analogies ("conceptual metaphors" in the terminology of the authors), starting with grounding metaphors which relate basic arithmetic operations to physical actions in the world. From these basic notions, further linking metaphors give rise to ever more abstract concepts like infinity, transfinite numbers, and the continuum via generalization and blending. In a case study, Martinez et al. (2012) describe Argand's invention of complex numbers interpreted as vectors in the complex plane as a network of analogical mappings and conceptual blend spaces between arithmetic and geometric ideas. Similarly to the business processes and engineering problems, Argand started with a contradiction: There was no possibility to give complex numbers an appropriate interpretation on the (real) number line.

In engineering, new technical devices have often been introduced based on analogies to biological and physical systems. Bell designed his telephone based on an analogy with the human ear. The Wright brothers got inspiration from soaring birds when they developed aircraft and de Mestral invented the velcro fastener by imitating burdock burrs. The whole discipline of bionics is concerned with the creative transfer of methods and structures from biology and natural systems to the engineering world. This transfer can be described by an analogical projection of biological structures to an engineering problem space.

On the other hand, an improper analogy can also hobble the development of an invention. Schoen (1963) describes the case of a developer team working on synthetic fiber paintbrushes. The conceptualization of painting as a smearing process and the comparison to natural-bristle brushes based on this idea led to no satisfactory results. Finally, the comparison to a pumping process and the reconceptualization of the problem in terms of this analogy paved the way to a solution. In general, the choice of an appropriate source domain can be considered a key issue of establishing a successful analogy and so an invention often is the end of a long series of different analogical interpretations of a situation.

Invention in Art

Initially having defined invention as the manifestation of the creative mental act, resulting among others in a new artifact, concept, or the mental concretization of a conception, each artistic act is closely related to an inventive process: The artist expresses a perception or emotion by reinventing it in terms of his respective chosen means of artistic expression. Here, the degree to which the inventive component of the artistic act becomes obvious can clearly vary to a high degree, featuring more prominently and accessibly in a cubistic portrait than in a landscape painting dating back to the era of Classical Realism, and becoming easier perceivable in a Dadaistic poem than in a naturalistic play. Nonetheless, in all these different forms of art, a unique creative mental act finds its manifestation in an external means of representation, giving rise to a new piece of art, and thus fulfilling the defining criteria of invention.

Invention in art does not only play a role on the microscopic scale of the individual artist, but is also crucial on a more macroscopic level: The beginning of new styles and epochs in arts always coincides with major inventions and inventive acts, sometimes triggered by developments outside of arts, occasionally arising from within arts itself. Newly available techniques and materials allow for previously unknown means and ways of manifesting art, and new theoretical paradigms, ways of thinking, and ideologies provide the basis for new developments in arts. Examples are numerous: The invention of the tracery marks at the start of the Gothic age, the beginning of modern painting clearly was related to the (re)invention of the one-point perspective in the Renaissance (presumably by F. Brunelleschi), the invention of the modern piano by B. Cristofori allowed for new ways and forms of composition heavily influencing music as an art, the invention of motion picture by E. Muybridge sparked entirely new forms and branches of arts, and the invention of digital media, followed by the uprising of the Internet and the World Wide Web allowed for online art and massively distributed, decentralized art projects. Also, a considerable number of artists were at the same time active and recognized as inventors, like R. B. Fuller, working as an author and designer, also inventing the geodesic dome, or C. Hoberman, architectural designer and inventor of folding toys and structures.

Concerning the role of analogy within the inventive process in arts, its impact seems more frequent on the microscopic level of the individual artist. There, it mainly features in two ways, on a sublevel conveying meaning and contributing to the overall impression from within the piece of art and on a supralevel working across several pieces of art, providing content via contextual and background effects.

- Within a piece of art, analogies may be used to provide meaning via codified metaphors and symbolic elements grounded in the artist's and audience's environment and perception, or via free associations. Most prominent examples for this use of analogy are probably the numerous symbolic and iconographic elements that can be found in paintings like, e.g., J. van Eyck's famous "Arnolfini Marriage," with cherries on a tree possibly symbolizing love, or a single lit candle alluding to the presence of the Holy Ghost via an analogy to a sanctuary lamp.
- On the supralevel, quotations and references within a new piece of art referring to already well and widely known earlier artworks are often to be found (providing additional information and meaning via an analogy-based contextualization mechanism). Since the Renaissance, paintings often make reference to scenes from Classical Antiquity, providing contextual information via the spectator's knowledge about these classical themes and legends. Also, different compositions quote from known and locatable sources, e.g., Dvorak's Symphony No. 9, "From the New World," which makes wide use of themes from Native American music and African-American spirituals.

Nonetheless, also on the macroscopic level, mostly at turning points of the development within a certain branch of arts, analogical mechanisms may be at work. A prominent example for such a process is the beginning of Cubism: In its initial phase, P. Gauguin, H. Matisse, and P. Picasso drew inspiration from, among others, African, Micronesian, and Native American art by transferring perceived basic principles of these styles to a European arts context.

Implications for Theory and Practice

Computer-Aided Innovation

The development of software tools for the computational support of design, e-learning, manufacturing processes, and the like is an industry in itself. A well-known example of such support systems is computer-aided design (CAD) comprising a large number of different software systems. In comparison to such economically important and technically already very advanced products, the research field of computer-aided innovation (CAI) is still in a rather premature state, currently being rather an academic discipline without reaching yet a substantial economic impact. Nevertheless, the coupling of recent advances in the research of analogy-making with insights from cognitive science about the cognitive foundations of innovation processes and the inspiration of classical creativity models and frameworks for innovative problem solving is a very promising approach for the future. Such a merger of methodologies has the potential not only to achieve theoretically new insights, but also to find practical applications that will guide engineers and managers in developing new products and services. Due to the fact that research in analogy-making is strongly driven by the development of computational models, there is a convergence of methodologies for CAI.

Computational Creativity

In the domain of applied Computational Creativity, analogy and analogy-related inventions are relevant and can find applications galore, supporting, enhancing, or even replacing human abilities and activities. This can be done in two different ways: Supporting the creative activity in a purely passive tool-like way, e.g., applying analogy-based mechanisms in search or retrieval tasks, or partly replacing human efforts in a more active collaborative way, for instance, using analogy in computing proposals for a problem solution or interactively designing a shape.

The use of so-called references (i.e., images of artificial or natural forms) as visual analogs and metaphors in architectural design gives an example where a computational analogy engine can provide support for a human user: Several databases offer sample images for such a purpose. Unfortunately, the respective data sets are mostly indexed only with textual information describing, e.g., the origin of the image or the architect, which might not be directly relevant when searching for similar pictures to a given image. Here, systems like Drawing Analogies by Do and Gross (1995) provide an integration of a search mechanism for analogous shapes to an already encountered image or even to a shape provided by the user, e.g., via a sketchpad.

The second important application area of computational analogy-making in applied Computational Creativity are systems directly getting involved in the creative act in a computer-aided design process by introducing new design variables. As described by Goel (1997), an example for such a system is DSSUA (Design Supporting System Using Analogy), which addresses mechanical design problems within the context of architectural design. DSSUA applies an analogy-based mechanism using design prototypes, representing knowledge about familiar designs, and is even able to conduct analogical transfer for introducing additional new variables into an initial solution to the design problem at hand.

So far of mostly academic interest is a second reading of the term Computational Creativity, in this case denominating the attempt of modeling, simulating, or replicating human creativity using a computer. An illuminating example is McGraw (1995), which is an attempt to implement a model of the creative human act of artistic letter design of the Roman alphabet. Although remarkable progress has been made, e.g., in the mentioned domain of letter design, in the fields of interactive automated storytelling or interactive drama, in automatically generated poetry or in automatically creating creative answers to sequence completion tasks, the results still fall short when being compared to real human performance.

Closely connected to Computational Creativity are the domains of Computer-Aided and Computer-Generated Art. While Computer-Aided Art normally refers to an artistic process, where the computer is only used as a tool, with the artwork being created by the artist, Computer-Generated Art means the creation of artworks by using autonomous processes without direct human control. In both subfields, analogy can play an important role: For Computer-Aided Art, the situation is similar to a Computational Creativity support system like sketched in the Drawing Analogies example above. In the Computer-Generated Art domain, analogy engines can find applications at the hour of creating variations of a motive, or when computing the composition of a scenery provided an overall topic or theme is given.

Conclusions and Future Directions

As invention is the manifestation of creative mental acts, an understanding of these mental processes is crucial to foster new inventions, be it by human inventors or by artificial systems. Analogies provide an explanation of invention as the creative transfer of a solution to an unknown problem. A given problem constitutes the poorly understood target domain, which can be reconceptualized by establishing an analogy to a better-known source domain. Then, solution strategies can be developed by transferring concepts and ideas from the source to the target. Here, in order to identify a suitable analogy, the choice of an appropriate source domain is essential. There exists no general strategy to solve this task: Often closely related problems are considered first, but in many cases more dissimilar domains have proven to be the most valuable bases for analogy. However, of course, most domains do not lead to a sensible analogy at all, and also many analogies can be misleading in the search for a solution to a given problem. At this point, the introduction of automated support systems is promising. An analogy engine, which operates on a knowledge base containing a large collection of domains, could propose analogies that exhibit a good structural compatibility to the given problem domain and would provide a solution to this problem. In particular, in the field of computer-aided innovation, the combination of computational techniques of analogy-making and creative problem solving is a promising direction for future research. Similarly important for future applications, although more difficult because of the lack of a controlled underlying domain, is the usage of analogy engines in computational creativity, e.g., in order to autonomously generate art by programs or to support artists by computer-aided support systems.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Cognition of Creativity
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity in Invention, Theories
▶ In Search of Cognitive Foundations of Creativity
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Invention Versus Discovery
▶ Mathematical Discovery
▶ Mental Models and Creative Invention
▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education
▶ Models for Creative Inventions

References

Altshuller G. Creativity as an exact science. New York: Gordon & Breach; 1984.

Argand J-R. Philosophie mathématique. Essai sur une manière de représenter les quantités imaginaires, dans les constructions géométriques. Annales de Mathématiques pures et appliquées. 1813;4:133–46.

Burki L, Cavalluci D. Measuring the results of creative acts in R & D: literature review and perspectives. In: Cavalluci D, de Guio R, Cascini G, editors. Building innovation pipelines through computer-aided innovation, CAI 2011. Heidelberg: Springer; 2011. p. 163–77.

Chomsky N. Syntactic structure. The Hague/Paris: Mouton; 1957.

Do EY, Gross MD. Drawing analogies: finding visual references by sketching. Proceedings, Association for Computer Aided Design in Architecture, 1995 National Conference; 1995; Seattle.

Goel AK. Design, analogy and creativity. IEEE Expert. 1997 May-June; 12(3): 62–70.

Holyoak KJ, Thagard P. Mental leaps: analogy in creative thought. Cambridge, MA: MIT Press; 1995.

Lakoff G, Núñez R. Where mathematics comes from: how the embodied mind brings mathematics into being. New York: Basic Books; 2000.

Martinez M, Besold TR, Abdel-Fattah A, Gust H, Schmidt M, Krumnack U, Kühnberger K-U. Theory blending as a framework for creativity in systems for general intelligence. In: Wang P, Goertzel B, editors. Theoretical foundations of artificial general intelligence. New York: Springer; 2012.

McGraw GE. Letter spirit (part one): emergent high-level perception of gridletters using fluid concepts. PhD Thesis, Indiana University; September 1995.

Polya G. Mathematics and plausible reasoning: induction and analogy in mathematics. Princeton: Princeton University Press; 1954.

Schoen D. Displacement of concepts. New York: Humanities Press; 1963.

Analogy

▶ Analogies and Analogical Reasoning in Invention

Angel Funding

▶ Entrepreneurship and Financial Markets

Angel Investors

Hélène Perrin Boulonne
France Angels, Paris, France

Synonyms

Business angels; Informal venture capital

Introduction

An angel investor is a person who provides capital, in the form of debt or equity, from his own funds to a private business owned. But angel investors, also called business angels, are more than just investors. They also give nonmonetary support to start-ups: due diligence, time, expertise, and network.

Angel investors are an important source of equity for small firms and start-ups with high potential in their early stage of development before to become attractive for venture capital. Most of the time they invest in seed stage, but they also invest in later stage. Angel investors may have been entrepreneurs themselves, and invest in start-ups after several success stories. They have also an important place in the development of entrepreneurial spirit and activities. They support a large range of innovation; they invest locally and in all sectors of activity. They do not only invest in technology intensive firms or high growth firms. As they are concerned by return on investment, they invest in innovative firms.

Delivering funding to a large (but unknown) number of entrepreneurs, business angels are one of the most important but least understood players in the entrepreneurial ecosystem (Van Osnabrugge and Robinson 2000). Researches on the angel market are linked with research on the early stage equity financing of entrepreneurial ventures.

The first studies focused on defining the concept: behavior, motivation, and characteristics. Then, studies evaluating the number of angel investors and the market associated appear in the late 1980s.

The fist studies on performance of angel investment, and method of exit appears in the middle of the 2000 in the USA, and are still unavailable in Europe.

Who are Angel Investors?

Angels Investors are Part of Venture Capital

Venture capital refers to financial capital provided to firm at their early stage. Venture capitals generally finance high potential start-ups and also are high-risk investment.

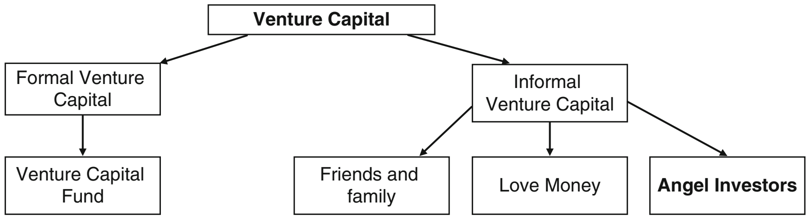
Venture capital may be subdivided in: institutional venture capital (venture capital fund) and informal venture capital (love money, friends and family, and angel investors).

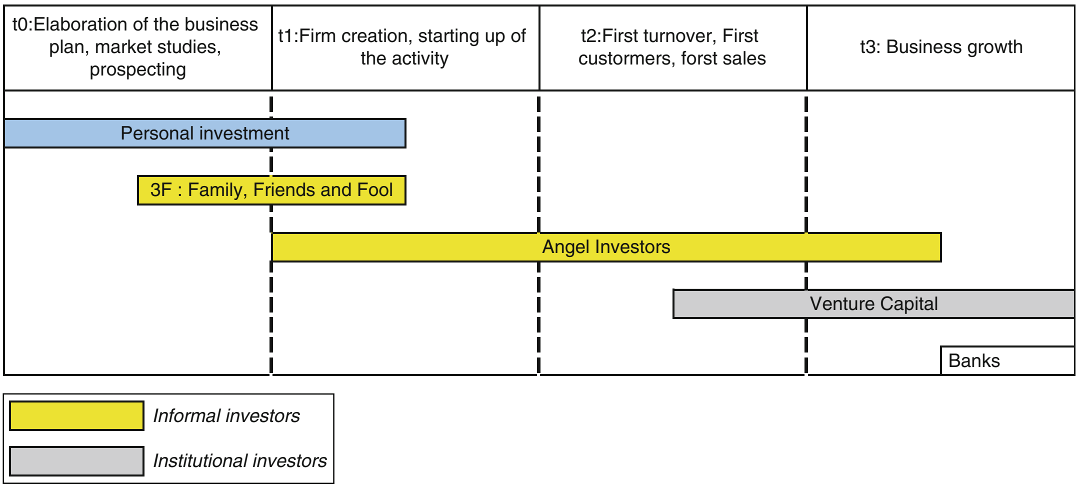
Amount invested by venture capital fund is well known, but the amount invested by the informal capital is difficult to estimate. Angel investments are made by individual who do not constitute a homogeneous population. The informal capital is by definition hidden: Angel's services are not listed in the yellow pages (Wiley 1989) (Fig. 1).

A more common subdivision of venture capital is linked to the stage of development of the company. Usually angel investors, intervene after seed-investors (Friends and family and Love Money) and before Venture capital fund. They are one of the most important ways to feel the gap between seed money and the venture capital fund. Generally, angel investors cover a broader range of business types than venture capital funds (Fig. 2).

For small amount of capital, start-up used what is called "friends fool and families" (seed money) or personal investment. The Angel investors make investment from 100,000 up to 1 million dollars. The biggest, more than 1 million

Angel Investors, Fig. 1 Venture capital (Source : Author)





Angel Investors, Fig. 2 Stage of development and type of investment (Source : Author)

dollars, projects are financing by venture capitalist. Angel's investments cover the gap between seed money and venture capital. This gap is also called equity gap.

The most important differentiation with other type of capital is the face to face between entrepreneurs and investors. Angel investors face a high level of risk and make their own decision. Business angels even if they are in a network make their own due diligence, and take personal decision to invest or not.

Angel Investors are Individual's Investors

There is no common definition for angel investors, but it's largely admitted in literature that: Angel's investors are wealthy individuals who invest their own money, along with their time and expertise. Business angels invest in all sectors and all regions in a country.

More restrictive definition (Van Osnabrugge and Robinson 2000; Shane 2009) considers that the business has to be operated by someone else who is neither a friend nor a family member." Mason and Harrison (2008) defined angels investors as "a high net-worth individual, acting alone or in a formal or informal syndicate who invests his or her own money directly in an unquoted business in which there is no family connections and who after making the investment, generally takes an active involvement in the business."

Wetzel also contribute to establish the existence and role of private investors. Later studies conducted by Freear, Sohl and Wetzel expanded on this beginning through the establishment of the complimentary role of business angels and venture capitalists and the characteristics of the latent angel population.

The most common image is an entrepreneur who has been successful and wants to invest in start-ups in the same sectors (that's part of the Silicon Valley myth). But a large part of angel investors are wealthy individuals but not necessary entrepreneurs. Part of business angels are regrouped in networks or associations, where they benefit of advice, access to a deal flow, and training.

The angel investment market is highly heterogeneous. Authors have developed typologies to classify the angel investors according criteria: investment motivation, personal experience, number and amount of investments made, independence or network appurtenance. Mason and Harrison (2000) point out the importance of dividing the angel investors in several categories.

Some countries' legislation, also, define accredited investors (case in the USA, Regulation D under the securities act of 1933) as angel investors. This accredited investors benefit from fiscal incentive aims to increase the number and the amount invested by angel investors. Even if the legislation does not define angel investors, most countries in Europe have high fiscal incentive public policies to encourage angel's investment.

Angel Investors Network, Group or Association

Angel's investors are individual investors but part of them, and particularly in Europe, join a network or an association.

Angels acting in a network, association or group are relatively well known. They are represented by organization, like EBAN (European Business Angels Association) or ACA in the USA. The Angel Capital Association in the USA gives the following definition: "Individuals angels joining together with other angels to evaluate and invest in entrepreneurial ventures. The angel can pool their capital to make larger investment" (ACA website).

They team up to find investment opportunities, share due diligence and expertise, pool their capital, and negotiate together. Angels groups offer advantages : reduce the due diligence cost, give the possibility to invest higher amount of money in one project, training, access to a larger deal flow, monitoring the start-up after the investment may be easier. But even acting in a network; a business angels make his own decision of investing or not in a start-up. There is no evidence of differences between angels in networks and angels acting alone in terms of return on investment and profile. Angels in networks are more visible and easier to reach for young entrepreneurs.

How Many Angel Investors?

One challenge for the research on angel investors is the lack of data. For most countries the only available data concern angels association and networks, which represents the "visible" market (Harrison and Mason 2010).

The first study paying attention to the number of angel investors was initiated by the Small Business Investment Act in 1986. This study (Gaston and Bell 1988) on informal supply of capital shown that 500,000 angels' investors invested 60 billion dollars in early stage in the USA. More recently, using the largest definition (Sohl 2003) consider that between 300,000 and 350,000 angels investors invest about 30 billion dollars annually in about 50,000 firms in the USA.

Another survey conducted by the Small Bureau of Advocacy (Shane and Heights 2008) estimated that between 331,000 and 629,000 angels have invested between 12.7 billion and 36 billion dollars each year during the period 2001–2003 in the USA.

Angels Investors are less developed in Europe. The only available data for Europe comes from European Business Angels Network (EBAN), and concern only the visible part of angel's investment market. According to EBAN there are approximately 75,000 business angels in Europe investing 4 billion Euros in 2010.

Founder friends and family	*Angel Investors*	*Equity Gap*	*Venture capital funds*
25 K USD	500 K USD	1 million USD	5 millions

Angel Investors, Fig. 3 Source : Author

OECD (2011) estimates that the visible market represents only 7% of the whole angels investment.

The Rule of Angel Investors in Financing Entrepreneurship

Address the Equity Gap

Fast-growing small businesses drive economic growth. It is high-risk funding, from angels and institutional venture investors, that fuel these companies with the capital they need to grow.

Venture capitalist firms are not able to face the cost for the smallest projects: due diligence costs, risk costs, moral hazard costs. Venture capitalists do not often invest in early stage, especially in Europe, where the rate of return on investment is negative.

Lack of finance for new firms and firms seeking medium amounts of investment (between 100 dollars to 1 million dollars) may be solving by the angel investments. To reduce the equity gap, angel investors often coinvest with other angel investors or venture capital funds.

The equity gap for early-growth-businesses is still pregnant, in particular in Europe. It is widely admit that angels help to bridge this equity gap. Venture capitalist fund have move from early stage investment to larger and later stage deals.

OECD has also initiated a work on the role of angel investors in financing high growth firms. The study (OECD 2011) gives a large overview on angel investing across developing countries. According to OECD, the angel investment market has developed significantly in a number of countries throughout the world, particularly over the past 5–10 years (Fig. 3).

Economic Impact Still to be Measured

Studies (Shane and Heights 2008) indicate that new firms with angel's investment have been important contributor to economic growth and job creation.

The place of the angels investors in the financial system of entrepreneurship is consider as very important but quiet unknown, due to difficulties to access data.

The Center for Venture Research at the University of New Hampshire conducts a survey on entrepreneurial ventures each year since 2003 (Sohl 2011). The study shows the importance of angel investors in terms of job growth with the creation of 370,000 new jobs in the USA in 2010.

Almost half of the investment returns nothing, but small parts of investment are highly profitable. All studies come to the conclusion that in average angel's investment are profitable.

Market Failure

The market of angel's investment suffers of information asymmetry.

> "One of the most consistent findings in research on business angels: the majority is unable to find sufficient investment opportunities" (Mason 2009)

It is difficult to reconcile the fact that the angel investors are finding it difficult to invest their capital at the same time entrepreneurs and public policy makers are decrying the lack of it.

The market in particular in Europe is still very young. In one hand, the business angels complain of a lack of good projects and, in the other hand, entrepreneurs often failed to find financing. Angel's network may contribute to solve this market inefficiency.

OECD recommends public policies in order to support angel investors.

Public Policy Support

Public policy support is well developed in the USA. In Europe, the public support is relatively recent (late 1990s). According to DeGennaro, there are six types of public intervention:

- Fiscal incentives
- Business angels networks
- Securities legislation
- Capacity building entrepreneurs
- Capacity building investors
- Government coinvestment vehicles

Public policies to encourage angel investments are well developed in many countries, and may be a subject for further research. Public policies alone are not sufficient. A healthy entrepreneurial ecosystem is critical for successful angel investing (OECD 2011).

Conclusion and Future Directions

Angel investors play an important role in early stage financing, but despite their importance for entrepreneurship, angel investors have been less studied. There number, the amount of money invested, the return on investment, and the economic impact are still relatively unknown. More researches are needed to understand the impact of angel investment on economic growth, productivity, and job creation. Scope for research is still largely open. Recently, encouraging by the Kauffman Foundation, the concept has received more attention from researchers.

The angel market is in constant flux, and the recent volatility of the private equity market has provided additional motivation to understand the role of these critical early stage investors.

Recently, Angel's investors are also considered as investment combining financial sustainability with social and environmental impact.

Cross-References

▶ Financing Entrepreneurship
▶ Informal Venture Capital
▶ Love Money

References

ACA website. www.angelcapitalassociation.org

DeGennaro R. Angel investors: who they are and what they do, can i be one, too? J Wealth Manag. 2010;13(2):55–60.

Freear J, Sohl JE, Wetzel WE. Angels: personal investors in the venture capital market. Entrepreneurship Reg Devel. 1995;7:85–94.

Gaston RJ, Bell S. The informal supply of capital. Washington, DC: US Small Business Administration; 1988.

Harrison RT, Mason C. Annual report on the business angels market in the United Kingdom. 2010.

OECD. Financing high-growth firms, the role of angel investors. Paris: OECD; 2011.

Shane S, Heights S. The importance of angel investing in financing the growth of entrepreneurial ventures. Washington, DC: SBA Office of Advocacy; 2008.

Sohl J. The angel investor market in 2010: a market on the rebound. Center for Venture Research; 2011.

Van Osnabrugge M, Robinson RJ. Angel investing: matching start-up funds with start-up companies. San Francisco: Jossey Bass; 2000.

Wetzel WE. Angels and informal risk capital. Sloan Manage Rev. 1983;24(4):23–34.

Angels Investors

▶ Microfirms

ANT

▶ Actor-Network-Theory and Creativity Research

Antitechnology Movements: Technological Versus Social Innovation

Franz Seifert
Austrian Science Fund FWF (Funding Organization), Vienna, Austria

Synonyms

Protest movements; Social controversy

Introduction

Resistance against technological change is a recurrent feature of the history of technological innovation and diffusion. Frequently, however, advocates of technological innovation misread the ensuing social controversies and regard antitechnology movements as anachronistic hurdles to inevitable and necessary technological change. They tend to overlook the fact that controversies over technological change carry both a democratic and an innovative potential in themselves as they prompt societies to negotiate political choices on socio-technological issues, instead of choices based on purely military or economic rationales, and force them not only to seek alternative technologies but also alternative forms of social organization as well as new forms of democratic conflict resolution. This entry's objective is threefold: firstly, to shed light on the deeper causes and rationales of resistance against technological innovation; secondly, to suggest that social innovation can often be seen as an alternative to technological innovation; and thirdly, to highlight certain types of social innovation which are in fact spawned by technological controversies. These theses will be outlined using the examples of several outstanding technological controversies. In historical order, these are the Luddites' machine-smashing campaign in early nineteenth-century England, the conflict over nuclear power, the controversy over agrofood biotechnology which will receive a special focus and serve to illustrate the theses raised above in greater detail, and the debate about nanotechnology.

Mechanization in Early Nineteenth-Century Textile Industry

The term "Luddite" is an inherent part of the English language and stands for radical action against new technologies with a certain odor of irrational technophobia. In fact, however, the nineteenth-century Luddites not only present the paradigmatic case of an antitechnological movement but also exemplify how the social cause and meaning of such a movement might be overlooked and misinterpreted for long periods. The Luddites were a movement of machine breakers spreading across southern England in the early nineteenth century. In 1813, the insurgence was crushed by harsh repression including military deployment, mass trials, deportations, and death penalties. In the eyes of posterity, the movement came to be seen as adverse to any technological innovation, and its campaign as futile rearguard battle against the inevitable dynamic of technological progress. Historiography also largely ignored the Luddites, which Eric Hobsbawm explained with the fact that the movement was at odds with the dominant rival ideologies of liberalism and socialism which both found common ground in their praise of industrial and technological innovation. Yet, by the mid-twentieth century, historians came to appraise the Luddite's organizational structure, deeper causes, and social achievements (Hobsbawm 1952). The Luddites were found to be a well-organized social movement that deliberately attacked machinery, exacerbating ruinous work conditions and craftsmen's deskilling in the textile industry, and their struggle revealed technology's social purpose: wage dumping, unrestricted competition, efficiency maximization, and profit making at whatever social cost.

Technological Progress Disputed

The Luddite's major historical merit thus is to have been the first to effectively challenge the common view according to which technology is a neutral tool to be put to either good or bad uses. Instead, they exposed technology as intrinsically purposeful, reinforcing the dominant socioeconomic ownership and power structures. Furthermore, the Luddite movement, as far as it engaged in machine wrecking for the purpose of bargaining better work conditions, also can be seen as a primordial form of unionism which, together with emerging cooperative and mutualist movements, was to become a major social innovation of the late nineteenth and early twentieth century.

Nuclear Energy

With the emergence of social movements in the 1960s and 1970s of the twentieth century, controversies over technological innovation became more frequent. While, today, social movements are part and parcel of political life, at this time, they constituted a new type of political force. Distinct from political parties and advocacy groups, social movements are marked by the following characteristics: a collective protest behavior directed against clearly identified opponents; an organization as fluid, informal networks; and a distinct collective identity (Della Porta and Diani 2006).

As prominent as the civil rights, peace, and environmental movements was (and in some countries, such as Germany, still is) the antinuclear movement. In the 1970s, oppositional movements arrived on the scene in the USA and virtually all Western European countries which embarked on the technology that promised to satisfy their steadily rising energy demands. The intensity, timing, and impact of these national movements varied according to different national contexts (Kitschelt 1986). The nuclear accidents or disasters respectively of Three Mile Island (1979), Chernobyl (1986), and Fukushima (2011) gave further boosts to the antinuclear movements and brought about a diminishing of global nuclear power plant construction. Today a considerable number of countries take an antinuclear stance, and the governments of Germany, Switzerland, and Japan have decided to phase out the technology, and the current worldwide search for alternative energy sources is not only a search for alternatives to fossil fuels but also alternatives to nuclear power which is increasingly regarded as uncontrollable catastrophic risk in the long term.

Wider Social Issues

On the face of it, the antinuclear movement opposes the technology primarily for the risks it entails, both catastrophic risks due to accidents and long-term risks such as nuclear waste storage or nuclear proliferation via illegal trade in enriched nuclear waste materials. Less obvious, however, are the movement's underlying causes and implications. The antinuclear movement does denounce not only nuclear risks but also the social institutions that manage these risks. Banking on its capacity to mobilize public support, the movement promotes and prospers on popular distrust against the nuclear industry and governments which simultaneously act as its promoters and regulators. In particular, it effectively challenged the authority of those who have assured the public so long that nuclear power is safe – scientific experts. The widespread understanding that prestigious experts often assist the nuclear industry in bolstering the claim that nuclear energy is safe, the deconstruction of their arguments by counter experts linked to the antinuclear movement, and the catastrophic falsification of their assurances by the great nuclear accidents contributed to the relativization and devaluation of scientific authority.

Scientific Authority Questioned

A major legacy of the antinuclear movement, the first grand antitechnology movement of the late twentieth century, is to have put scientific authority into political perspective. Here and in many ensuing conflicts over health, technology, and environment, scientific arbitration over contentious technological and environmental issues proved to be increasingly complex, contested, and even unworkable. Therefore, the philosophers of science Silvio Funtowicz and Jerome Ravetz (1992) have suggested that in controversial situations such as these, when decisions of high political salience have to be made while knowledge remains incomplete, science cannot proceed in a "normal" manner, that is, based on traditional peer review conducted by certified, professionally accredited experts. Instead, "post-normal" science needs to find new approaches, notably to open up its traditional borders and engage in "extended peer review," allowing science outsiders – stakeholders, civil society actors, and policy makers – to participate in its problem-solving process. While, to date, no single, conclusive answer has been found as to how to deal with the dilemmas of "post-normal science," the term captures a significant shift in the relationship between the technology, the public, and the political decision-making which is both a new challenge and a stimulus for democracy.

Agro-food Biotechnology

The movement against modern biotechnology – that is, the creation and use of genetically modified organisms (GMOs) by transferring genes from one species to another – in agriculture and food cropped up in the mid-1990s in Europe and, since then, grew to be the most influential and wide-ranging antitechnology movement since the controversy over nuclear power, leading to occasionally dramatic social conflicts over GMOs in Europe, Latin America, Africa, India, and East Asia. While this movement was the culmination of a long controversial debate that set in the mid-1970s as first experiments proved the technology's viability but at the same time prompted concerns over potential hazards for human health and the environment, it was not until the appearance of unlabelled GM foods in European markets amidst a series of food crises in several European countries the anti-biotechnology movement began to take shape, pressuring national governments to effectively block GMO cultivation. Some of these movements, those in the United Kingdom and in France in particular, even embarked on "Luddite" strategies to have their way, vandalizing hundreds of GM fields mostly prepared for experimental cultivation. By the end of the 1990s, a group of governments stepped in to block the authorization of GM products in the European Union (EU). While the EU was eager to revise and considerably tighten regulations on the labeling of GM food and GMO field releases, the US government filed a lawsuit at the World Trade Organization (WTO) against the standstill in authorizations which they regarded as undue restriction to free trade. Even though the WTO's decision did not escalate the conflict, as a result of the anti-biotechnology movement, today, the EU and the USA constitute two fundamentally different social and regulatory environments for agro-food biotechnology.

Today, in the EU, only Spain engages in the commercial cultivation of GM crops; in addition the EU has set up a regulatory system that – coupled with retailers' exclusionary marketing strategies – practically keeps out GM food from the human (though not the animal) consumption. In the USA, by contrast, major cultivated food and animal feed crops – particularly soy and maize – are GM to a large extent, and the population largely acquiesces in the fact that GM food is unlabeled.

Precautionary Regulation

A further important difference between their regulatory systems is that the scientific assessment of physical hazards, the heart piece of the authorization processes for GM products in both, follows different approaches: whereas the USA requires that restrictions be justified by scientifically confirmed risks, the EU embraces the precautionary principle which concedes that GM products can be prohibited in the light of convincing arguments alone even though scientifically unproven.

These regulatory differences in terms of risk regulation between the USA and the EU do not only demonstrate the deep-reaching political and legal consequences of the anti-biotechnology movement. They also highlight the fact that risks to human health and the environment – in the liberal legal frameworks of Western societies and in global trade constitute the regulatory bottlenecks of product innovation – have to be understood as scientific and legal constructs instead of mere scientific facts. Thus, the newly emerging precautionary principle also constitutes a case of social innovation in that it deals with dangers arising in the context of post-normal science, that is, high uncertainty and political stakes.

Alternatives to Productivist Agriculture

The comprehensive European reaction also illustrates another social innovation when looked at against the backdrop of the promissory predictions that accompanied agro-food biotechnology's industrial advance. Biotechnology used to be presented as key technology which no national economy could allow to disregard at risk of being outcompeted by technologically advanced, thus more productive agricultural regions. In the EU, however, an alternative paradigm took hold. Firstly, European producers and consumers get along well without agro-biotechnology (with the exception of animal husbandry, however, as animal feed stuff still contains quantities of imported GM materials). Secondly, GM-free agricultural production goes well with European agricultural policy which is torn between the – conflicting – goals of competing in the global market, protectionism, and multifunctionality. European agricultural policy, struggling with domestic overproduction and environmental degradation on the one hand and global competition by ascending agro-producing regions on the other, has increasingly resorted to policies designed to curb production and, at least in some countries, keep uncompetitive farming in business. Agricultural GMOs – for the European context in the main herbicide- and insect-resistant GM maize – are essentially efficiency-increasing, production-enhancing technologies. Besides their alleged environmental side effects and health risks, this is the major criticism the anti-biotechnology movement raises against GMOs: agro-biotechnology corporations have designed their products to excel in technology- and capital-intensive productivist agriculture. It is argued, however, that this dominant type of agriculture accounts for much of our environmental crisis and comes at high social cost as it forces small- and middle-sized farming out of business and lets large-scale farming and agro-business reap the profits.

Agro-biotechnology's opponents argue that agriculture's current ecological and social challenges call for political and social innovations rather than technical enhancement. More specifically, if agriculture is to become sustainable, it needs to deplete less resources and space so as to minimize loss of biodiversity and it needs to offer income opportunities to a greater portion of the rural population. The EU region, due to its affluence and high level of political integration, has proved to be in a superior position to develop such alternative social innovations.

Organic farming is a case in point. This production system is specifically designed to sustain human health and the intactness of ecosystems by relying on natural processes and avoiding inputs with adverse effects such as industrially produced fertilizers and herbicides or industrial livestock farming. Organic farming is a social innovation: even though resembling a preindustrial type of agriculture, its development dates to the biodynamic agriculture movement in the twentieth-century's 1920s as outlined in the anthroposophical teachings of Rudolf Steiner. In the wake of the ecological movement of the 1970s and 1980s, the social innovation gained currency, and during the 1990s it found wider recognition as an alternative production system and established itself as a market niche in a number of countries. For the most part, small- and medium-sized farms engage in organic farming as a niche strategy, while large farms tend to exploit their comparative advantages. Thus, organic constitutes an alternative to high-productivity agriculture, which is also a chief argument of the anti-biotech movement. In Europe, the juxtaposition of agro-biotechnology versus organic farming, of technical versus social innovation, came to a head: since international statutes legally bind organic farmers to ban GMOs from their production processes, the hardly controllable risk of involuntary contamination became a major reason to virtually ban agro-biotechnology in most of the EU (Seifert 2006).

It is evident that organic agriculture or other forms of low-input, small-scale farming which, in Europe, are antagonistic to agro-biotechnology do not necessarily constitute a globally feasible social alternative to technologically boosted intensive agriculture in other parts of the world. European agriculture, organic agriculture included, is highly subsidized, and saturated consumer markets sustain high-end products such as organic food. Yet, alternative social innovations in agriculture are urgently needed particularly in many developing countries where small-scale farming often constitutes the bulk of agriculture and plays a vital role in the nation's food supply and demographic balance and the socially destructive tendencies of intensive agriculture are therefore painfully felt. Thus, to a large extent the controversy over agro-biotechnology has been played out in developing countries in Africa, South Asia, and Latin America (Schurman and Munro 2010; Scoones 2008). These are the arenas where the search for social innovations in the key field of agriculture is most pressing.

Nanotechnology

Nanotechnology is the manipulation of matter on an atomic and molecular scale, stricto sensu on a range from 1 to 100 nm where quantum mechanical effects occur. In the year 2000, nanotechnology was identified as key technology in the USA and became the object of substantial funding campaigns, at first in the USA, consequently in the EU, Japan, and a number of newly industrializing countries.

Public Engagement

What matters in this context is that, as a policy field, nanotechnology features specific social innovations which arguably mirror a changed relationship between technology innovation and the public. Clearly, more than any earlier technology campaign, this policy field features an abundance of measures aimed at fostering interactive forms of science communication as well as stakeholder and public involvement at an early stage of technology development. In the USA and the United Kingdom, for example, a series of consensus conferences took place in which lay citizens were invited to deliberate on nanotechnology and devise policy recommendations; in Germany, a high-level national commission on nanotechnology brought together stakeholders from industry, science, and civil society; and in France, federal authorities conducted a controversial nationwide public debate. It is still an open question to what extent these new forms of public engagement actually have a bearing on the policy process, yet there is no doubt that as a result of past controversies over technologies, social innovations fostering participation, dialogue, and idea of an early and more democratic engagement of the public have become part of nanotechnology governance (Kurath and Gisler 2009).

Future Directions

This entry focused on the antagonistic side of the relationship between technological and social innovation. Obviously, there is a synergistic side to this too. In fact, often technological and social innovation goes hand in hand. The microelectronics and telecommunications revolution is an obvious case in point, as is illustrated by the many social innovations it brought about: Internet market places, file-sharing networks, crowd sourcing, hacker communities, open-access science, or social networks mushrooming in the World Wide Web. Yet, while technological innovation often provides the ground for social innovation, it might also aggravate socioecological problems or simply seal false solutions. Technologies might further deskill, impoverish, and enslave the weakest strata of society; technologies might burden present and future generations with uncontrollable risks; and they sometimes support practices which are detrimental to the ecosystem. This entry, therefore, highlighted the socially innovative function of movements opposing certain technologies, the public controversies they trigger, and the alternative social innovations that emerge in their wake. These innovations have cultural, institutional, political, and economic dimensions. On the cultural dimension, they might show in an altered understanding of technological change, dismissing the idea of technological innovation as progress and necessity and, instead, recognizing science and technology's power to transform society, the role of power and interests in their evolution, but also their essentially political nature and thus their amenability to be subjected to democratic deliberation; on the political dimension, technology controversies might bring about new regulatory concepts such as the precautionary principle; institutionally and economically, they might bring about new modes of consumption, production, and exchange better suited to meet socioeconomic challenges.

As future direction for social analysis and policy making, it is therefore important to recognize the significance of social innovation given the general tendency in corporate and political decision-making to favor technological over social problem solutions which, in the end, might prove cheaper and more effective (albeit less profitable). Thus, instead of purchasing diagnostic kits for detecting genetic predispositions for cardiovascular disease, it might be more effective to monitor body weight and check for hypertension to determine individual risks; instead of taking vitamin supplements, a reasonable diet rich in fruits and vegetables might do a better job to prevent cancer; and instead of employing technologies designed to boost agricultural output, more sustainable production-consumption models might be tried out.

The quest for sociopolitical alternatives to technological innovation often comes in the guise of public resistance to and controversy over technology. It has been shown that resistance is based on genuine social grievances and guided by meaningful motives and that social controversies fulfill an important societal function in that they cast light on the blind spots of technological innovation and as a result provide the ground for the testing of social innovations. Besides of exploring social innovations that emerge in synergy with technological evolution, future directions in social research and policy making might also take more interest in those social innovations that emerge in antagonism and as alternative to technical innovation.

Cross-References

- ▶ Agricultural Entrepreneurship
- ▶ Green Enterprising and Green Entrepreneurs
- ▶ Innovation and Democracy
- ▶ Innovations of Direct Democracy
- ▶ Low-Tech Entrepreneurship
- ▶ New Forms of Entrepreneurship in a Sustainable Knowledge-Based Service Economy
- ▶ Social Entrepreneurship
- ▶ Social Innovation
- ▶ Techno-Globalization and Innovation

References

Della Porta D, Diani M. Social movements: an introduction. 2nd ed. Malden: Blackwell; 2006.

Funtowicz SO, Ravetz JR. Three types of risk assessment and the emergence of post-normal science. In: Sheldon K, Golding D, editors. Social theories of risk. Westport/London: Praeger; 1992. p. 251–74.

Hobsbawm EJ. The machine breakers. Past Present. 1952;1:57–70.

Kitschelt HP. Political opportunity structures and political protest: anti-nuclear movements in four democracies. Br J Polit Sci. 1986;16:57–85.

Kurath M, Gisler P. Informing, involving or engaging? Science communication, in the ages of atom-, bio- and nanotechnology. Public Underst Sci. 2009;18(5): 559–73.

Schurman R, Munro WA. Fighting for the future of food. Activists versus agribusiness in the struggle over biotechnology. Minneapolis: University of Minnesota Press; 2010.

Scoones I. Mobilizing against GM crops in India, South Africa and Brazil. J Agrar Change. 2008;8(2–3): 315–44.

Seifert F. Regional GM opposition as multilevel challenge? The case of Upper Austria. Tailoring Biotechnol. 2006;2(3):11–36.

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams

Ruth Mateus-Berr
Institute of Art Sciences and Art Education, Institute of Art & Society, University of Applied Arts Vienna, Vienna, Austria

Synonyms

Art education; Creativity; Design education; Entrepreneurship; Innovation; Innovation diplomacy; Invention; Social design; Work in teams

Introduction

Thanks to all my students and colleagues and especially my daughter Iuna and my husband Tommy.

Ruth Mateus-Berr

Evolution of the *Applied Design Thinking Lab* (ADTL), Vienna

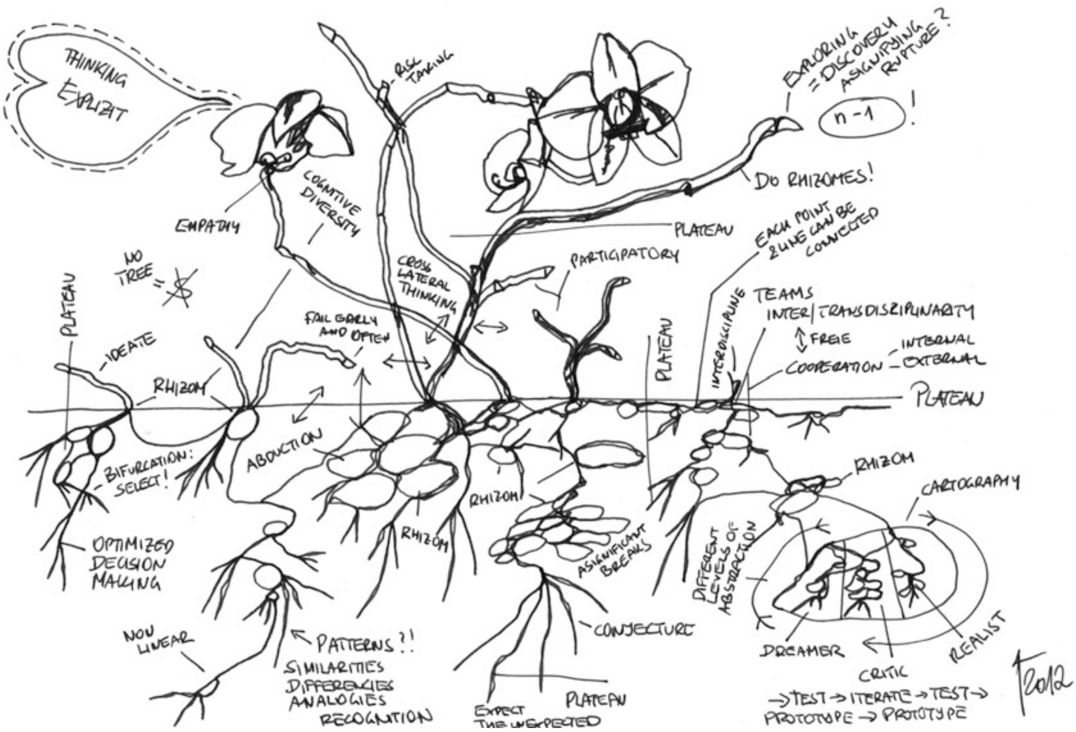
The *Applied Design Thinking Lab* (ADTL), Vienna, is situated at the University of Applied

Arts in Vienna and was founded by the author in 2009. It might be understood as an application model for universities, companies and institutions of all kind, as it can be considered as a "hypothesis and action model." Since 2004, the author followed the vision of inter/transdisciplinary work with diverse institutions, universities, and companies (which will be described in chapter **Previous Projects**), cooperation instead of "single combat" was the strategy.

ADTL approaches inter/transdisciplinary topics with interdisciplinary teams from different departments of universities, institutions, and companies. The aim of this Lab is to facilitate innovative solutions for complex problems through interdisciplinary collaboration. Applying tools of *Design Thinking* strategies, the participants develop their own specific art/design work, inspired by peers, their own broad knowledge, interest of various topics, disciplines, and empowered with creativity. The participants derive from the fields of arts, design, graphic, fashion, architecture, performance, mathematics, restoration, jurisprudence, education, etc. Experts from various disciplines (mathematicians, fashion designers, etc., regarding each topic) are invited to join the group, reflect on their work, and discuss it. According to Kristensen (2004, 89–96), many design problems arise because there is little integration between the environment, people, and technology. He recommends that physical, virtual space and a visual working methodology need to be interconnected in order to enhance a collaborative participation and performance for dispersed teams. The ADTL is such a space and develops innovative and performative transfer of design (and involved disciplines) knowledge. Art and design-based research is biased scientifically and applied practically at once. Developed innovative tools may be transferred in the fields of educational subjects (schools and universities), interdisciplinary applied in technologies or unto the fields of the creative industries, change mindsets of companies, and enhance creativity of institutions. *Design Thinking* is a well-established term; a search on Google gives over 340.000.000 hits. But the terminology Thinking rather refers to Aristoteles *épistêmê* (*intellectual knowledge*) *than making* (*poesis*) *and action* (*technê, praxis*) (Parry 2007). ***Applied*** *Design Thinking* combines both, as Schön described the "reflective practioner" (Schön 1983). Knowledge embodied in art, which has been analyzed as tacit, practical knowledge, is cognitive, though nonconceptual (Borgdorff 2012, 49) and interconnects disciplines. Also basic and applied research is intertwined at the ADTL (compare Fig. 8 Carayannis and Campbell 2009, 25). A good example is Stokes' (1997, 71–72) analysis of Louis Pasteur in the field of microbiology. Pasteur followed a perfect synthesis of the aims of "understanding" of the bacteriological process and "use" of controlling these effects (Borgdorff 2012, 98). This approach ("mode 2") "focuses on knowledge application and a knowledge-based problem solving that involves the following principles: *knowledge produced in the context of application*, *transdisciplinarity*, *heterogeneity, and organizational diversity*; *social accountability and reflexivity* and *quality control* (Carayannis and Campbell 2009, 3; Gibbons et al. 1994), but further more can be described as "mode 3": "top-down government, university, and industry policies and practices and bottom-up civil society and grassroots movements initiatives and priorities to interact and engage with each other toward a more intelligent, effective and efficient synthesis" (Carayannis and Campbell 2009, 3–5), a "knowledge nugget" (Carayannis 2004) because it requires and supports practical and application-oriented decision making with regard to knowledge, knowledge optimization and especially through inter/transdisciplinary habits, leveraging of knowledge for other purposes" (Carayannis and Campbell 2009, 5). ADTL embodies *understanding* and *experimental applying*. The twenty-first century academy organized itself firmly around the concepts of disciplinary conceptual structures, problems, and methods. In Austria ministries of art, education and science tend to regulate basic research for universities and applied research for colleges (Fachhochschulen, [FH's]). There is not only an intersection between disciplines, but also

-Translators, team players	… possess empathy, translate into other languages, try to solve misunderstandings, are friendly, listening, diplomatic, and are eager to reduce deficiencies (DeWachter 1976, 53). They understand “interdiscipline” as a challenge of “breakage or rupture, when continuity is broken and the practice comes into question” (Mitchell 1995, 541; 2009, 819, 262-277) … are cooperative, mild, perceptive and diplomatic, listens, builds, averts friction (Belbin 2012)
-Innovators	… are creative, intensely imaginative, solve difficult problems (Lieshout 1998; Matt 1999, 115), are responsible for the development of an innovation or the introduction of a new idea (2.5 percentage of any overall group) (Raymond 2010, 18)
-Early adopters (Implementers)	“are close friends or colleagues of the innovator, high degree of interconnectedness or involvement with other groups, highly visible, are happy to be exposed to new ideas and ways of doing things from an individual or group of people they trust and respect” (13,5 percentage of any overall group) (Raymond 2010, 18). … are disciplined, reliable, conservative and efficient; turn ideas into practical actions (Belbin 2012)
-Pioneers (Resource investigators)	… are extrovert, enthusiastic, eloquent, research new facilities, develop contacts (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Coordinator (chairman)	… are trustfully, good chairman, explains aims, encourages decision making process, delegates well (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Movers (Shapers)	… are challenging, dynamic, exert pressure, have courage to overcome any difficulties (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Observers (Monitor evaluator)	… are quiet, strategic, very perceptive, overviews all possibilities, judges exactly (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Converters	… are rigorous, reliable and effective, putting ideas into practice, into action (Lieshout 1998; Matt 1999, 115)
-Perfectionists (Completer finisher)	… are diligently, conscientiously, detects errors, delivers on time (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Specialists	… are self-centered, engaged, delivers know-how which is hardly available (Lieshout 1998; Matt 1999, 115; Belbin 2012)
-Idea Suppliers (Plant)	… build upon the ideas of others. Creative, imaginative, unorthodox, solves difficult problems (Belbin 2012)
-Secretary	… documents, reports
-Moderator	… plans, performs and evaluates the meetings
-Time manager	… monitors the time schedule
-Organizer	… organizes meetings, research papers, exhibitions, presentations in coordination with the team

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 1 Team members at ADTL, © Ruth Mateus-Berr, Graphic: Ruth Mateus-Berr



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 2 Designrhizom, © Ruth Mateus-Berr, Graphic: © Ruth Mateus-Berr

a division in methods and organizational structures, and between theory and practical knowledge. Europe is considered to take a second life through the "Bologna process" in setting intellectual standards for disciplines, scholars are tuning the contours of "the disciplines" for the twenty-first century (Schneider 2010, xv). In inter/transdisciplinary work, practitioners must be able to cooperate with fellow team members and make referrals and offer educational services (Klein 1990, 150). The National Research Council (NRC) of the USA tracked series of research reports and announced that most significant growth in knowledge production in recent decades was occurring due to Interdisciplinary Design Research (NRC report 1986, 1990). Within curricula of universities in Austria, you will hardly find inter/transdisciplinary elements. The University of Applied Arts Vienna has unique academic programs as Transarts and ► Social Design. Studying Transarts you may decide your study elements depending on your interests, studying Social Design, the teacher staff, and the students work in teams.

Reviewer of scientific submissions assess entries in their own disciplines, reviewers for inter/transdisciplinary calls and topics are rare to find all over Europe, though, for example, in the USA, interdisciplinary approach is considered as a key factor for submissions.

Discipline, Interdisciplinarity, Transdisciplinarity, Multidisciplinarity

The terminologies of **discipline, interdisciplinarity, transdisciplinarity, multidisciplinarity** in contemporary science discourse and its discussions within the fields of art and design are relevant to innovation potential. Innovation needs

Matrix of diverse approaches:

ADTL	**Plattner, d.school, Brown, IDEO, Torrance, Mitchell Martin, Shinozaki & Cavagnaro, Weingardt, Kelley & Littmann, Krippendorf, …**	**Kimbell, Stables, Goldschmidt, …**	**Cross, Lawson, …**	**Deleuze, Guattari Carayannis, Campbell**	**Dilts**
-Discovery (Peirce 1935-1966, 5.189) -Design brief: ill-defined problem -Divergent thinking (Rhea 2003, 148-149) -Need-assesment -Interviews -Field studies -Research-in-action -Participatory Design (PD) *"The secret of success is understanding the viewpoint of another person"* (Henry Ford)	-Empathy-synthesize -Participatory design Krippendorf (2006, 135)	-"Unpacking tasks" (Kimbell et al. 2008, 164) -"identifying values" (Kimbell et al. 2008, 165)	-clarifying the task (Cross 2011, 122-123)	-1,2 principles heterogeneity, connections, each point can be connected with another -non-linear	-Dreamer
-Brainstorming (Osborn 1953) -cross lateral -"thinking out loud" (Fuller 1998, 218) -"stupid questions" (Morgan, Saxton 2006, 68-69), -"Expect The Unexpected" (Heraclitus ca. 535 -475BC; Oscar Wilde 1895) -"story-telling" (Laurel 2003) -Metaphors play a profound role in creativity and invention (Dasgupta 1994, 27) -"cognitive diversity" (Stephan 2010, 97)	-"Show, don´t tell" -"Radical Collaboration" (Shinozaki & Cavagnaro 2009) -Incubation model of teaching: "Defer Judgement, Making use of all the senses" (Torrance 1993) -"Build on the ideas of others" -"Go for quantity" -"Encourage wild ideas" -"One conversation at a time" -"Stay focused on the topic" -"Be visual" -"Capture all ideas" (Shinozaki & Cavagnaro 2009) -"Fail early and often" (Weingardt 2004) -"Expect The Unexpected" (Kelley & Littmann 2001, 147)	-"Making Thinking Explicit" -"encourage wild ideas" (Kimbell et al. 2008, 154-166) -"Innovative risc takers (risky exciting idea which invites failure" -"research in action" -"modeling possible futures" (Kimbell et al. 2008, 165)	Interdisciplinarity, "reflect on similarities and differences", cross lateral thinking, "handle different levels of abstraction simultaneously" (Cross 2006, 37) exploring the relationships, and looking for patterns in the available information (Lawson 2006)	-3 principles multiplicity, sprawling widely, different points of view -"Fractal Research, Education and Innovation Ecosystem" - FREIE (…) multilevel, multimodal, multi-agent system of systems (Carayannis & Campbell 2012, 11)	-Dreamer

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 3 (continued)

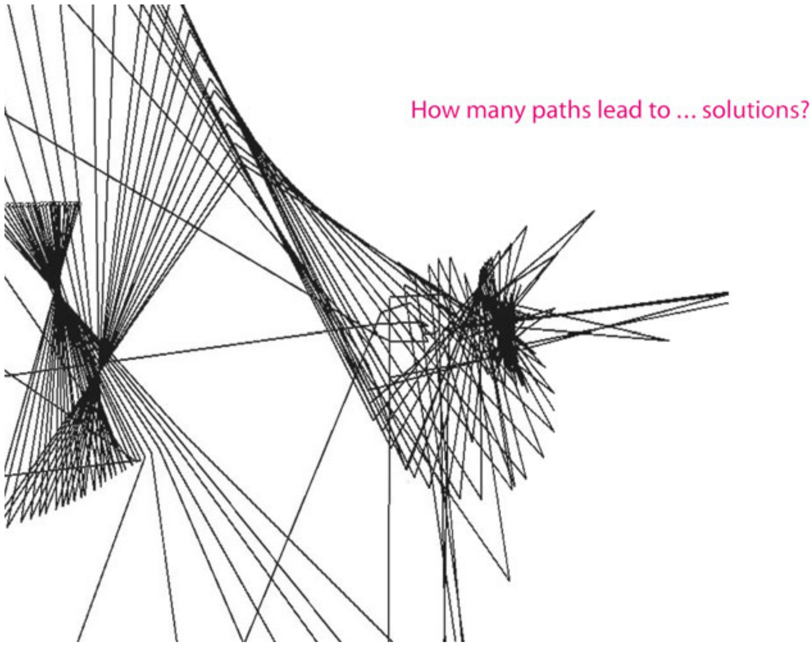
-Rebrief -“interdiscipline” – breakage or rupture, when continuity is broken and the practice comes into question”. (Mitchell 1995, 541)	-Fail Early And Often (Brown 2008, Weingardt 2004) -“interdiscipline” (Mitchell 1995, 541; 2009, 819)	-“Optimized decision making” (Kimbell et al. 2008, 166) -“Making Thinking Explicit” (Kimbell et al. 2008, 154-166) -dialectics of scetching (Goldschmid t 1991)	-“enable identification and recall of relevant knowledge” (Cross 2006, 37), -“lateral transformations” :creative shift to new solutions (Goel 1995), -Conversation through acts of naming and framing (Cross 2011, 120) -Searching for concepts (Cross 2011, 122-123)	-4. principles asignificant breaks	-Critic
-“Be realistic, demand the impossible! (SI, 1968) -against “academic nationalism”, keeping “departmental” turf jealousy protected” (Klein 1990, 77)	-Ideate-select -“challenge accepted explanations, and infer possible new worlds” (Martin 2009, 65)	-“Optimized decision making” (Kimbell et al. 2008, 166) -“Making Thinking Explicit” (Kimbell et al. 2008, 154-166) -dialectics of scetching (Goldschmidt 1991)	-experimenting, probing and transforming ideas into created spatial formations (…) -attend and identify areas of the solution space -(Dursun 2012, 2)	-5,6. cartography, decalcomony	-Critic
-designing maps, open ended, using abductive logic (Peirce 1935-1966, 5.189) -A map is a fractal	-Prototype-show -“Fail early and often” (Weingardt 2004)	-	-	-FREIE (Carayannis, Campbell 2012, 11)	-Realist
-designing an intermediate product for an exhibition or a conference	- Test-iterate	-	-Fixing the concept (Cross 2011, 122-123)	-	-Realist

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 3 Matrix of diverse approaches, © Ruth Mateus-Berr, Graphic: Ruth Mateus-Berr

teams (Kelley and Littmann 2001, 121). Klein (2010, 17) considers interdisciplinarity in science disciplines as a challenge “where almost all significant growth in knowledge production occurred at the borderlines between established fields”. Within the fields of art & design, “interdiscipline” (Mitchell 1995, 541; 2009, 819) is rather used than “interdisciplinary work” and interpreted as a challenge of “breakage or rupture, when continuity is broken and the practice comes into question.”

Definition of Discipline

The term *discipline* derives from the Latin word *disciplina* (“school, science, discipline, and order regarding school” Drosdowski et. al 1989, 131); it is associated with pedagogy and “signifies the tools, methods, procedures, exempla, concepts and theories that account coherently for a set of objects or subjects” (Klein 1990, 104); it brings “access and boundaries, with associations of profession, elitism, and exclusivity” (Dalrymple and Miller 2006, 29). The nature of disciplines



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 4 How many paths lead to . . . solution? convergence points, © Walter Lunzer, Polynomiography© 2009. Graphic: Walter Lunzer, ADTL-Team 2009: Petra Ilias, Ruth Mateus-Berr, Walter Lunzer, Presentation at DIMACS Workshop on Algorithmic Mathematical Art: Special Cases and Their Applications at the Rutgers University 2009, NJ, USA (Organizers: Bahman Kalantari, Helaman Ferguson Dirk Huylebrouck, Radmila Sazdanovic), And: ESSENCE 2009, Museum of applied Arts. LINK: The Way Polynomiography Things Go. http://www.youtube.com/watch?v=e8p161ylL48, http://dimacs.rutgers.edu/Workshops/MathArt/Slides/slides.html, http://dimacs.rutgers.edu/Workshops/MathArt/program.html, http://www.polynomiography.com/, http://www.dieangewandte.at

includes in discussions words as: territory, identity, belonging, and status. A discipline is considered as a "private property," a "mother lode"; specialists are locked in their "bastions of medieval autonomy"; these specialists nurture "academic nationalism," keeping "departmental" turf jealousy protected" (Klein 1990, 77).

Definition of Interdisciplinarity

The concept of interdisciplinarity and related controversies over its meaning offers ground for interesting discussions: 200 years ago Immanuel Kant warned against interdisciplinarity: "Es ist nicht Vermehrung, sondern Verunstaltung der Wissenschaften, wenn man ihre Grenzen ineinander laufen läßt" (Merging the spaces of the disciplines is not enhancing but defacing the sciences (Translation from Ruth Mateus-Berr; Kant 1989, VIII-IX). The father of cybernetics, Norbert Wiener (1968, 21), localized the "fertile areas" of science in a "no-man's-land" in between different established disciplines. Klein explains and demystifies the nature of the interdisciplinarity that marked twentieth-century scholarship and completed the first comprehensive bibliography of the interdisciplinary literature (1990) by documenting trends, traces historical patterns and precedents across the sciences, social sciences, and humanities and Klein shows practical advice for creating interdisciplinarity on campus cultures (2010). Interdisciplinarity is considered as a synthesis of two or more disciplines, establishing a new method of discourse (Klein 1990, 66) with the need of disciplinary behavior, which might seem paradox (Klein 1990, 106). When interdisciplinarity is successful, it becomes a discipline (e.g., electromagnetism, molecular biology, installation art,

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 5 (continued)

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 5 (**a**, **b**, **c**, **d**, **e**) Math goes design – post-it!, © Walter Lunzer, Concept/Design: © Konrad Cernohous, Dominik Gross, Walter Lunzer, Ruth Mateus-Berr. ADTL-team 2010: Konrad Cernohous, Dominik Gross, Jonathan Farley, Walter Lunzer, Ruth Mateus-Berr. Thoughts and statements developed during and after the project "Design goes Maths. Text: Konrad Cernohous, Dominik Gross, Walter Lunzer, Ruth Mateus-Berr. Grafikdesign: Walter Lunzer. Presentation at the Bridges Conference in Pécs, Hungary 2010: Konrad Cernohous, Jonathan Farley, Dominik Gross, Walter Lunzer, Ruth Mateus-Berr. LINKS: http://www.bridgesmathart.org/, http://www.dieangewandte.at. (**c**) © Thomas F. Berr. (**d**, **e**) © Franz Morgenbesser. Performance at Stephansplatz

visual culture, etc.). Borgdorff (2012, 92, 177) describes interdisciplinary research as "research operating within the frameworks defined by a particular discipline," and understands artistic research as a *border violation*. In "mode 2" production interdisciplinary and transdisciplinary research is put in the context of application (Gibbons et al. 1994). Sullivan (2010, 111) believes that "through an interdisciplinary investigation theories and practices are teased apart and meanings disclose." Maurice DeWachter believes in the possibility that through interdisciplinary processes, disciplines are reinforced in their autonomy and describes the need of permanent translation, the solution does not necessarily have to be interdisciplinary but can derive monodisciplinary (DeWachter 1976, 52–57). "Until there is willingness to change one/s mind and translate conviction into a language the other will fully appreciate, no interdisciplinary

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 6 Audible topics, communicated via Comics for communication of a shop in a shopping street, © Simon Repp, Graphic: @ Simon Repp. Presentation: for the district chair and the SME CEO. LINK: http://simonrepp.com/, http://www.hoer-akustik.com/

communication has taken place" (DeWachter 1976, 53). Dalrymple & Miller (2006, 31) believe that "interdisciplinarity encourages 'multilogical' thinking – the ability to think accurately and fair-mindedly within opposing points of view and contradictory frames of reference". The interdisciplinary nature of many art and design practices, their organizational diversity, their engagement with other life domains, and their quality assessment procedures highlight the importance of the key initiative for an ADTL though art and design. The ADTL discovers the "no-man's-land" of various disciplines involved in order to empower innovative solutions through practical applied and reflected

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 7 Mirror of the Dome. Concept: © Peter Hausegger. Foto: © Ruth Mateus-Berr. Presentation: Radio Stephansdom. LINKS: http://www.kathpress.at/site/nachrichten/archiv/archive/47661, html?SWS=b4c3caf6060a155e0db583046c1ac9f2&ts=0.704873001343133756, http://religion.orf.at/projekt03/news/1206/ne120622_engelslounge.html

research. Some of the most interesting research is happening at the interfaces of disciplines and between research and practice, projects that go beyond discipline and subject boundaries (Newbury 2011, 381–382).

Definition of Intradisciplinarity

Borgdorff (2012, 92) describes intradisciplinarity as "research, which is operating within the frameworks defined by a particular discipline," it is therefore considered as "research *in* and *on*" a discipline.

Definition of Transdisciplinarity

Klein (1990, 66) describes transdisciplinarity "as interconnectedness of all aspects of reality, transcending the dynamic of a dialectical synthesis to grasp the total dynamics of reality as a whole". Sullivan (2010, 111) believes that critical perspective, interrogation of systems, structures, and practices provoke changes, and are considered as transdisciplinary.

Definition of Multidisciplinarity

"Interdisciplinarity takes several forms, but the two most commonly discussed types are

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 8 Angels Lounge. Concept: © David Flattinger, Michael Adensamer, László Lukács. Foto: © Ruth Mateus-Berr. Thanks for support: Karim Momen/OSRAM, Johnny Ragland/Bereich Holz/Angewandte, Doris Müllner/Angewandte, P. Michael Schultes/Angewandte, Firma Finze GmbH., Art for Art, Company Osram, Anita K., Christine Bärnthaler: OFROOM. http://www.ofroom.at/index.php?id=499, Innovation Agecny. And to all participants from the University of Applied Arts Vienna and the archdiocese of Vienna. Presentation: Radio Stephansdom. LINKS: http://www.kathpress.at/site/nachrichten/archiv/archive/47661.html?SWS=b4c3caf6060a155e0db583046c1ac9f2%26ts=0.704873001343133756, http://religion.orf.at/projekt03/news/1206/ne120622_engelslounge.html

multidisciplinarity and transdisciplinarity. Multidisciplinarity signifies the juxtaposition of disciplines. It is essentially additive, not integrative . . .” (Boradkar 2010, 18; Klein 1990, 56). Borgdorff (2012, 158) observed that multidisciplinarity between artists and scientists takes place in two different forms, namely, science illuminates art or vice versa.

The team structure at ADTL has a large part in the proceedings (see Fig. 1).

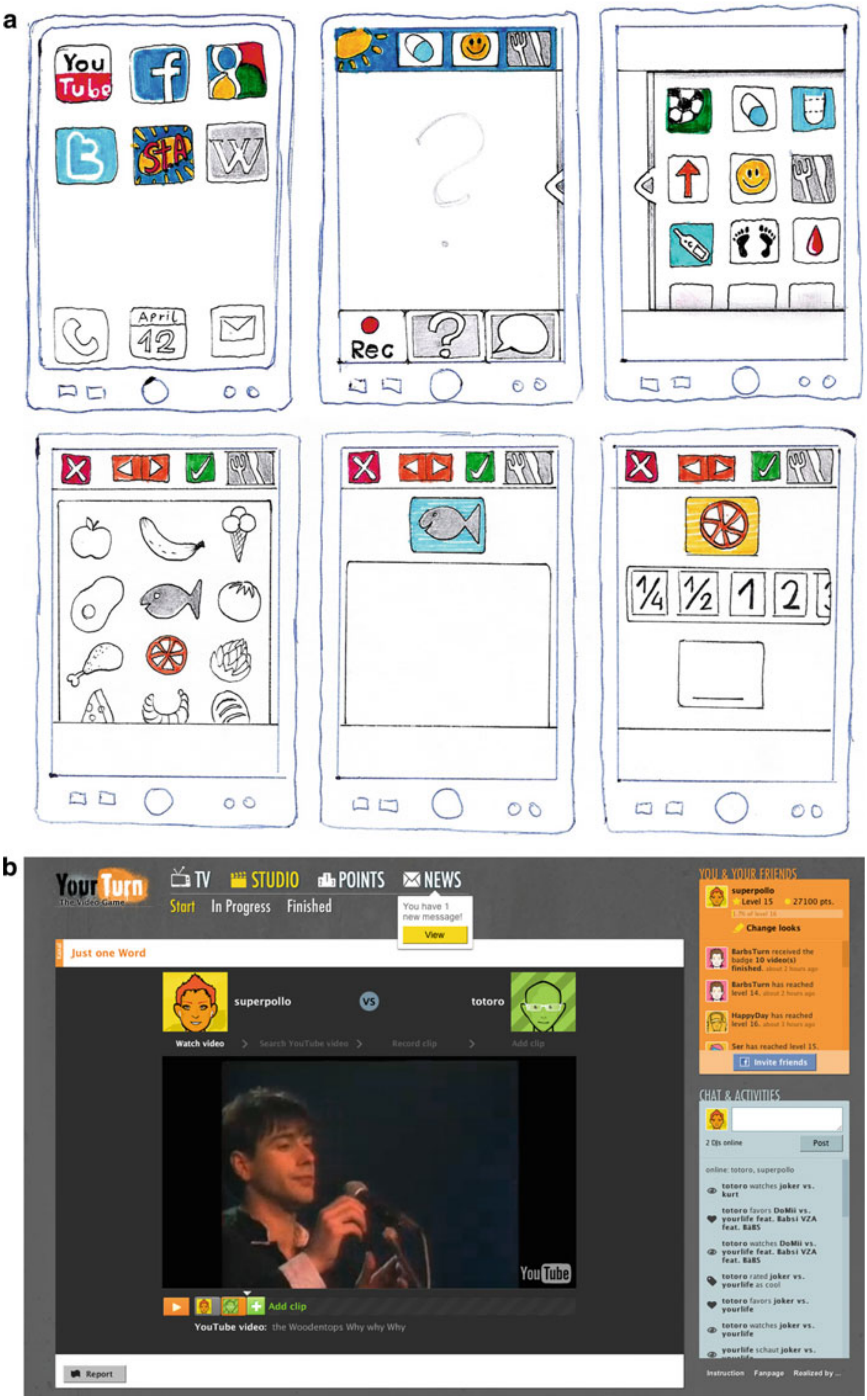
The ADTL Obtains Various Role-Types of Team Members in Accordance with Lieshout, Belbin, and Raymond

Each member at times might take a leadership role in a personal style. “Role-Playing” behaviors (Fig. 1) emerge in any team activity, depending on personality, experience and team members have to be sensitive to each other’s preferences (Cross 2011, 96).

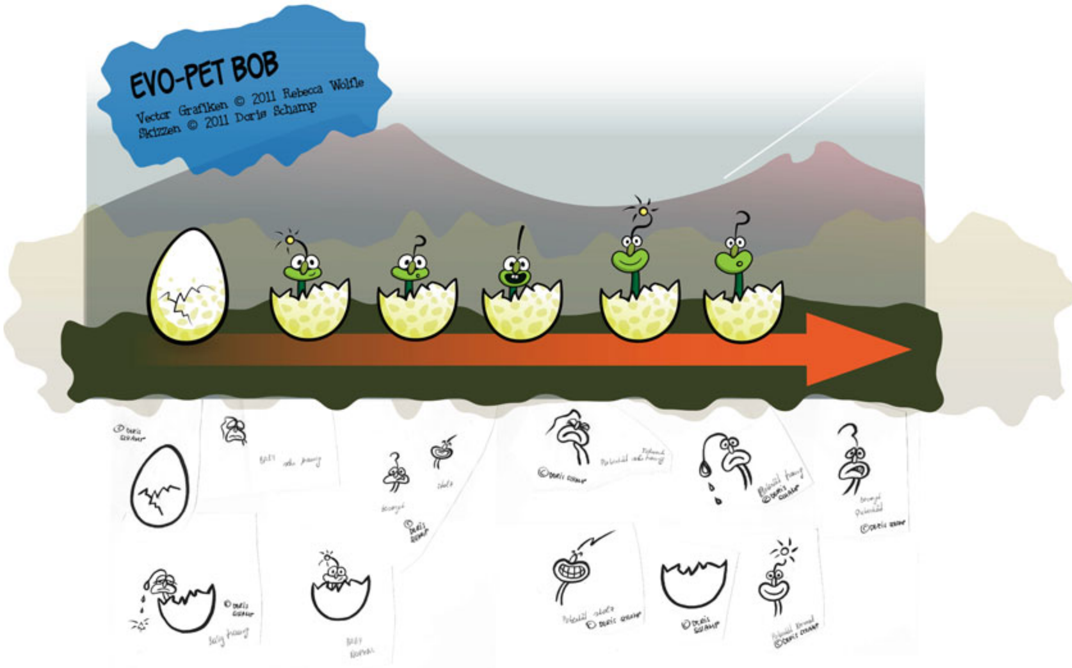
For all presentations, various performative formats (Peters 2011) were developed. Artists and designers that retained closeness to childhood engaging in playfulness can approach this topic by fun and storytelling. At the conferences, the audience should look over their shoulders and reconstruct idea development as well as innovative solutions. “We believe that there is room for innovation in every aspect of education, and that it can be taught,” Stanford’s website reads (Crandall 2013).

Methods, Rules, and Techniques

Design Thinking emerged from different interests and has various roots. When methods or techniques become successful, the fight starts who invented them. Maybe the design community in general: Design theorists and considerably consultants engaged with design and especially designers through their practical approach, as far they are “reflective practitioners” (Schön 1983; Lawson 2006) of design processes. Usually designers talk and reflect about the products of their designing, rather than the process, which led them to innovation. The moment of “Eureka” as described at Plutarch and Vitruvius, explaining the *Archimedean principle*, which led to an innovative solution for the product seems to be more conscious to most of the designers than the process of their thoughts and research. The philosopher Martin Heidegger believes that knowledge derived “from doing and from the senses” and therefore the “research in and through the arts” (Mittelstraß 2011, 18; Frayling 1993/1994, 1–5) represent the adequately methodology. “Handlability,” the “praxical knowledge”



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 9 (**a**) © ADTL 2010 Title: Apps Concept/Graphic: ADTL-team 2010; Andrea Reithofer, Manuel Kofler ADTL-team 2010: Meryem Bozkurt, Stefan Breiteneder, Dominik Hagelkruys, Christoph Hecht, Yavuz Ilkay, Manuel Kofler, Sophia Mairer, Andrea Reithofer, Johannes Schenk, Erdogan Tugba Martin Krikl



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 10 Evolution of an avatar. © Doris Schamp, Rebecca Wölfle. Concept/Graphic: © *Doris Schamp, Rebecca Wölfle*. Presentation: at the PATT 26 Conference, The Royal Institute of Technology, KTH, Stockholm. W. Grossmann, R. Mateus-Berr, C. Bast, Sophia Mairer, A. Reithofer 2012, Applied Design Thinking LAB Vienna: INTERACCT. Interdisciplinary Technology Education in the 21st Century. The PATT 26 Conference Stockholm Sweden 2012. Eds: Thomas Ginner, Jonas Hallström, Magnus Hultén. Linköping: Electronic Conference Proceedings Nr. 73 (p. 316–322). LINKS: http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073, http://www.dieangewandte.at/, http://homepage.univie.ac.at/wilfried.grossmann/, http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english, http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/, http://www.ani.univie.ac.at/~hlavacs/index.php?item=showcase, http://www.csg.ethz.ch/people/khummel, http://www.stanna.at/content.php?p=36, http://www.t-systems.at/, http://www.schulschiff.at/cms/front_content.php, http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/october/artikel/univ-prof-mag-dr-manuel-sprung/, http://www.wjh.harvard.edu/~msprung/, http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html, www.dorisschamp.at

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 9 (continued) Presentation: at the PATT 26 Conference, The Royal Institute of Technology, KTH, Stockholm W. Grossmann, R. Mateus-Berr, 2012, Applied Design Thinking LAB Vienna: INTERACCT. Interdisciplinary Technology Education in the 21st Century. The PATT 26 Conference Stockholm Sweden 2012. Eds: Thomas Ginner, Jonas Hallström, Magnus Hultén. Linköping: Electronic Conference Proceedings Nr. 73 (p. 316–322) (**b**) © Fares Kayali Title: YourTurn! The Video-Game Concept/Graphic: © Fares Kayali LINKS: http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073, http://www.dieangewandte.at/, http://homepage.univie.ac.at/wilfried.grossmann/, http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english, http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/, http://www.csg.ethz.ch/people/khummel, http://www.stanna.at/content.php?p=36, http://www.t-systems.at/, http://www.schulschiff.at/cms/front_content.php, http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/october/artikel/univ-prof-mag-drmanuel-sprung/, http://www.wjh.harvard.edu/~msprung/, http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html, http://fares.attacksyour.net, http://igw.tuwien.ac.at/seriousbeats, http://trans-techresearch.net/tef/vienna/, http://gamingwithapurpose.com/

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 11 Avatar interface. © Rebecca Wölfle, Doris Schamp. Concept/Graphic: © *Rebecca Wölfle, Doris Schamp*. Presentation: at the PATT 26 Conference, The Royal Institute of Technology, KTH, Stockholm. W. Grossmann, R. Mateus-Berr, C. Bast, Sophia Mairer, A. Reithofer 2012, Applied Design Thinking LAB Vienna: INTERACCT. Interdisciplinary Technology Education in the 21st Century. The PATT 26 Conference Stockholm Sweden 2012. Eds: Thomas Ginner, Jonas Hallström, Magnus Hultén. Linköping: Electronic Conference Proceedings Nr. 73 (p. 316–322). LINKS: http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073, http://www.dieangewandte.at/, http://homepage.univie.ac.at/wilfried.grossmann/, http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english, http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/, http://www.csg.ethz.ch/people/khummel, http://www.stanna.at/content.php?p=36, http://www.t-systems.at/, http://www.schulschiff.at/cms/front_content.php, http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/october/artikel/univ-prof-mag-dr-manuel-sprung/, http://www.wjh.harvard.edu/~msprung/, http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html, www.dorisschamp.at

(Heidegger 1996, 65), meaning that knowledge derives from doing and from the senses as well as experimental, action, and problem-based learning, studio-based and practical research generate new ways of modeling meaning, knowledge, and social relations. Heidegger proposes to stop “staring at the hammer” but instead using it (Heidegger 1996, 65). “Recognition of the natural course of development (. . .), always sets out with situations which involve learning by doing” (Dewey 1916; 2001, 192). Polanyi (2009, 15) stresses “the bodily roots of all thought,” similar to Richard Sennet (2008), and believes that it is a fact that “we can know more than we can tell” (2009, 4). Polanyi refers his research to the philosopher Gilbert Ryle who differed between “knowing that” and “knowing how” (also compare Mareis 2010, 121–143). Polanyi (1966, 140–44; Ryle 1949) discovered the meaning of “tacit knowledge” by describing a bicycle ride (Everyone knows, but – can one describe exactly the proceedings of the movements of the muscles?) and Collins quotes that even by knowing the formula for bike-balancing, our brains are not fast enough to apply (Collins 2010, 101). Nonaka and Takeuchi (1997, 73) describe the difference in western and eastern organization of knowledge. They examined the western based “explicit

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 12 (**a**, **b**) House. @ Anna Grossmann © Courtesy of Scratch. ADTL-team 2010: Seyma Aksoy, Lisa Baumgartner, Anna Grossmann, Esra Kacar, Andreas Roncat, Anna Hatice Özgan, Weninger, Desheng Wang, Katharina Weisssteiner. Title: Avatar with Scratch©. Presentation: at the PATT 26 Conference, The Royal Institute of Technology, KTH, Stockholm. W. Grossmann, R. Mateus-Berr, C. Bast, Sophia Mairer, A. Reithofer 2012, Applied Design Thinking LAB Vienna: INTERACCT. Interdisciplinary Technology Education in the 21st Century. The PATT 26 Conference Stockholm Sweden 2012. Eds: Thomas Ginner, Jonas Hallström, Magnus Hultén. Linköping: Electronic Conference Proceedings Nr. 73 (p. 316–322). LINKS: http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073, http://www.dieangewandte.at/, http://scratch.mit.edu/, http://homepage.univie.ac.at/wilfried.grossmann/, http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english, http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/, http://www.csg.ethz.ch/people/khummel, http://www.stanna.at/content.php?p=36, http://www.t-systems.at/, http://www.schulschiff.at/cms/front_content.php, http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/october/artikel/univ-prof-mag-dr-manuel-sprung/, http://www.wjh.harvard.edu/~msprung/, http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 13 Press Egg for Haptic Communication. @ Cornelia Bast. Foto: © Cornelia Bast. ADTL-team 2010: Teresa Auer, Cornelia Bast, Debora Däubl, Ines Jorda, Bettina Hochrinner, Adna Karabeg, Hubert Stadler. Presentation: at the PATT 26 Conference, The Royal Institute of Technology, KTH, Stockholm. W. Grossmann, R. Mateus-Berr, C. Bast, Sophia Mairer, A. Reithofer 2012, Applied Design Thinking LAB Vienna: INTERACCT. Interdisciplinary Technology Education in the 21st Century. The PATT 26 Conference Stockholm Sweden 2012. Eds: Thomas Ginner, Jonas Hallström, Magnus Hultén. Linköping: Electronic Conference Proceedings Nr. 73 (p. 316–322). LINKS: http://www.corneliabast.com/, http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073, http://www.dieangewandte.at/, http://homepage.univie.ac.at/wilfried.grossmann/, http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english, http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/, http://www.csg.ethz.ch/people/khummel, http://www.stanna.at/content.php?p=36, http://www.t-systems.at/, http://www.schulschiff.at/cms/front_content.php, http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/october/artikel/univ-prof-mag-dr-manuel-sprung/, http://www.wjh.harvard.edu/~msprung/, http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html

knowledge" which uses repetitive proceedings and the eastern used "implicit knowledge" which uses experience, metaphors, and analogies. To employ both (western, eastern, left-right brain) complimentary, is considered as a social process between human beings. Research on design processes will have to rely on tacit, implicit, and explicit knowledge. Two-sided brain research of the 1980s (Sperry 1981) is still recognized as state-of-the-art research, but recently, it was discovered by axial tomography (CAT scans) and FMRI that when the brain is engaged in rational or highly creative tasks, both halves are at work and both are speaking to each other, and to other parts of their hemisphere, in a collaborative and interconnected manner (Kandel 2006; Raymond 2010, 70). Trends in higher education in art and design have combined to make the question of research of design processes increasingly important. Therefore, design-based research as research-in (artists and designers research their art/design work) and through-the arts (Frayling 1993/1994, 1–5) is one of the very interesting contemporary challenges. The design researcher Nigel Cross believes that *Design Thinking* "(. . .) is something inherent within human cognition; it is a key part of what makes us human," and he argues that "we all design when we plan something new to happen, whether that might be a new version of a recipe or a new arrangement of the living room furniture" (Cross 2011, 3). Cross argues that expert designers "exercise very developed forms of certain tacit, deep-seated cognitive skills (. . .) and that designing is one of the highest human intelligence" (Cross 2011, 8). Tim Brown, consultant and CEO of IDEO (international design consultancy), describes *Design Thinking* – as a method of meeting people's needs and desires in a technologically feasible and strategically viable way and (. . .) as a discipline that uses the designer's sensibility and methods to match people's needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity" (Brown 2008). He believes that it was Thomas Edison who developed this method not only by developing the light bulb, but also "by his ability to conceive of a fully developed marketplace" (Brown 2008, 85). Edison approached problems as a broad generalist and was very innovative; therefore, he started the first industrial research lab in 1876 (Brown 2009, 180;

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 14 Body Index Cloth I. Concept/Design: © Jasmin Schaitl. 83 x 50 x 30 cm. Fashion, 100% Cotton with Satin ribbon. Foto: © Debora Däubl, Jasmin Schaitl. ADTL-Team: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. Presentation: Wiskunst Conference, Sint Lucas University, Gent Conference, Belgium 2011. Presentation: University of Coimbra, Portugal 2011. Presentation: Pecha Kucha Night Vienna Design Week 2011. LINKS: Pecha Kucha Night Vienna Design Week 2011: http://www.youtube.com/watch?v=9z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.jasminschaitl.com/, http://www.jasminschaitl.com/jasminschaitl/bibliografie/art-exhibition-catalog-2011/, http://gallery.bridgesmathart.org/exhibitions/2011-bridges-conference/jasmin-schaitl

Edison 2012). Brown believes that innovation is powered by thorough understanding, through direct observation of peoples' needs in a complex world. Eliel Saarinen (father of Eero Saarinen) suggested that designing should always include considering a larger context (a chair in a room, a room in a house, a house in an environment" (Jones 2010; Clarke 2011, 239). While industrialization was driven by sweeping innovations in technology service, business awareness was very slow. Professor of strategic management, Roger Martin, who believes that "innovation is about seeing the world not as it is, but as it could be," describes *Design Thinking*: " (. . .) it focuses on accelerating the pace at which knowledge advances from mystery (an unexplainable problem) to heuristic (a rule of thumb that guides toward a solution) to algorithm (a replicable success formula)" (Martin 2009, cover) and demands abductive reasoning (Peirce 1935–1966), which is rather "wondering," "guessing" than observation (Martin 2009, 64). *Design Thinking* was recently arranged by Hasso Plattner, cofounder of SAP who created the d.school (design school) of *Design Thinking* at the Stanford University, CA, USA, by Tim Brown, (Plattner et al. 2009), by Roger Martin, dean of the Rotman School of Management at the University of Toronto (2009), by Gavin Ambrose and Paul Harris (2010), by Thomas Lockwood, president and member of the Design Management Institute, visiting professor at the Pratt Institute, who is considered as an

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 15 Platonic solids. Paperjacket. Concept/Design: © Walter Lunzer. Foto: © Walter Lunzer, Konrad Cernohous.ADTL-Team: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. Presen-tation:Wiskunst Conference, Sint Lucas University, Gent Conference, Belgium 2011. Presentation: University of Coim-bra, Portugal 2011. Presentation: Pecha Kucha NightVienna Design Week 2011. LINKS: Pecha KuchaNight Vienna Design Week2011: http://www.youtube.com/watch?v¼49z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.stitching-sessions.com

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 16 Platonic solids. Paperjacket. Concept/Design: © Walter Lunzer. Foto: © Walter Lunzer, Konrad Cernohous.ADTL-Team: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. Presen-tation:Wiskunst Conference, Sint Lucas University, Gent Conference, Belgium 2011. Presentation: University of Coim-bra, Portugal 2011. Presentation: Pecha Kucha NightVienna Design Week 2011. LINKS: Pecha KuchaNight Vienna Design Week2011: http://www.youtube.com/watch?v¼49z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.stitching-sessions.com

expert in the area of innovation and design leadership (Lockwood ed. 2010), by Nigel Cross (2011) and many others.

Design Skills, Disney, Rhizomes, and Abductive Perspectives

ADTL works with methods of design skills (Kimbell et al. 2008, 154–166) as Design Thinking methods, interdisciplinarity, the philosophy of constructivism, Walt Disney Principles and Rhizomes (see Fig. 2), which are inherent to the design process. Hence, there is a wide description of definitions how the design process takes place. Herbert Simon explains design as a process "to devise action aimed at changing existing situations into preferred ones" (Simon 1969/2001, 111; Krippendorf 2006, 25). Simon's point of view could be interpreted for applied research

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 17 Moebius. Concept/Design: © Klaudia Kozma. Foto:© Thomas F. Berr Presentation: University of Coimbra, Portugal 2011. Performer: Daniel Aschwanden. www.dadax.org. Presentation: Pecha Kucha Night Vienna Design Week 2011. Presentation: Presentation of the Book: Best Spirit. Best Practice. Lehramt an österreichischen Universitäten. Heiligenkreuzerhof Wien 2011. Presentation: Explorers Night Budapest 2011. ADTL-team 2011: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. LINKS: Pecha Kucha Night Vienna Design Week 2011: http://www.youtube.com/watch?v=9z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.klaudiakozma.com/, https://plus.google.com/photos/110288139125029382508/albums?banner=pwa

(versus basic research) and excluding experimental approach, but it also can be seen as process of changing situations like in established arts, understood with Gibbons et al. and called "mode 2," when the aim (Marx) is not just to interpret the world but to change it. Around 1984 "a new conceptual orientation, a new methodological basis, and a new organizational identity for design came into existence" (Krippendorf 2006, 2).

While some authors believe in the structure of a hierarchical tree (Chomsky 1959, 41), the "theory of the rhizomes" (Deleuze and Guattari 2004, 20) which is process orientated and "mode 3" (Carayannis and Campbell 2012, 3) seems to be more enlightening (See Fig. 2). In the viewpoint of constructivist, the individual subject-related hypothesis is of importance and the rhizomes (n-1) may symbolize the design process with various ideas, approaches,

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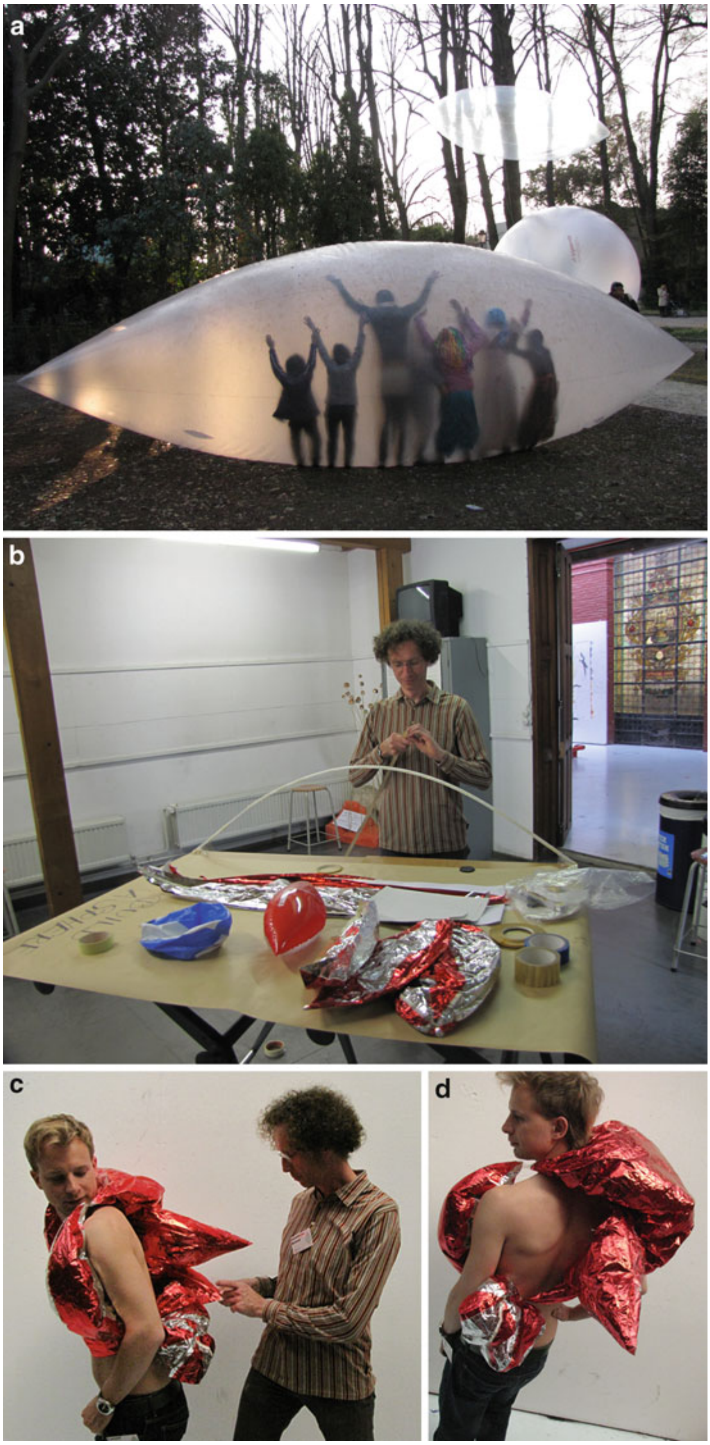
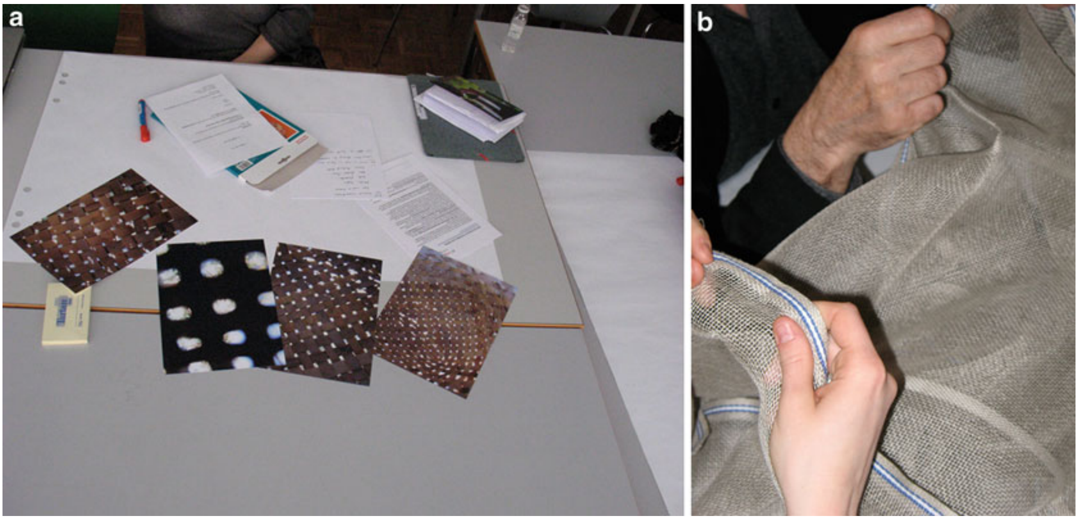
hypothesis, which decide here and there to transfer onto different plateaus within all different kinds of *abductive* perspectives and *fractal solutions* (Carayannis 2001, 169–170). Iterative Phases of Applied Design Thinking might also be compared to the Walt Disney Principles: *Dreamer, Critic, Realist* (Dilts 1994). The Neuro-Linguistic Programming (NLP) method uses methodologies such as shaping a successful behavior, in this case the designer Walt Disney, and applying the lessons learnt from his applied creative process. The *Dreamer* phase is the time for "wild ideas" and is a Brainstorming-process. "The *Dreamer* enabled new ideas and goals to be formed, the *Realist* turns the dreamer's ideas into reality, the *Criticer* is the one who will filter out any ideas that are too ambitious" (Wake 2010, 65) or not realizable. Though Disney has to be critically examined because of his political ideology and consumption-orientated *Disneyzation* (Bryman 2004) of the world, some of his strategies might have influenced the evolution of Design Thinking, because not only designers and design theorists researched on factors of success but consultants, too. Analyzing the derivation of Design Thinking with Disney, Deleuze, and Guattari will show conflicts very quickly: On the one hand, advocates of Neo-liberalism, input-output accounts, structure, capitalism, success, manipulation of desire and on the other hand, politics of desire, empowering people for their own interests and desires, "a theory which becomes an attempt to 'think otherwise,' to explore new kinds of thoughts and relations, new kinds of subjectivity and society," (Goodchild 1996, 6) demands its place. In former



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 19 (**a**) The Giant Cloud, experimental workshop for children during the Carnevale dei Ragazzi, Venice Biennale 2011. Foto © air-shaped cloud group – dieAngewandte (Maria Walcher, Elena Waclawiczek, Isis Várkonyi, Peter Michael Schultes, Stefanie Pichler, Niki Passath, Kerstin Nowotny, Klaudia Lässer, Dora Kuty, Carmen Fetz,

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 20 (**a**, **b**, **c**) Platonic solids. Concept/Design: © Walter Lunzer. Foto: Figure **a** © Ruth Mateus-Berr, Figure **b**, **c** © Walter Lunzer. ADTL-team 2011: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. Presentation: Wiskunst Conference, Sint Lucas University, Gent Conference, Belgium 2011. Presentation: University of Coimbra, Portugal 2011. Presentation: Pecha Kucha Night Vienna Design Week 2011. LINKS: Pecha Kucha Night Vienna Design Week 2011: http://www.youtube.com/watch?v=9z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.stitching-sessions.com

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 19 (continued) Konrad Ĉernohous, Clelia Baumgartner, Daniel Aschwanden, Agnes Achola). The Giant Cloud by airshaped cloud group # dieAngewandte is licensed under a Creative Commons Attribution-Share Alike 3.0 Austria License. (**b**, **c**, **d**) Inflatable membrane wear. Concept/Design © Konrad Cernohous, P. Michael Schultes. Foto 19,b, c, d © ADTL 2011. ADTL-Team: Konrad Cernohous, Dominik Gross, Petra Ilias, Klaudia Kozma, Walter Lunzer, Ruth Mateus-Berr, Jasmin Schaitl; P. Michael Schultes. Presentation: Wiskunst Conference, Sint Lucas University, Gent Conference, Belgium 2011. Presentation: University of Coimbra, Portugal 2011. Presentation: Pecha Kucha Night Vienna Design Week 2011. LINKS: Pecha Kucha Night Vienna Design Week 2011: http://www.youtube.com/watch?v=9z9g53kfzsI, http://www.bridgesmathart.org/, http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm, http://www.jasminschaitl.com/



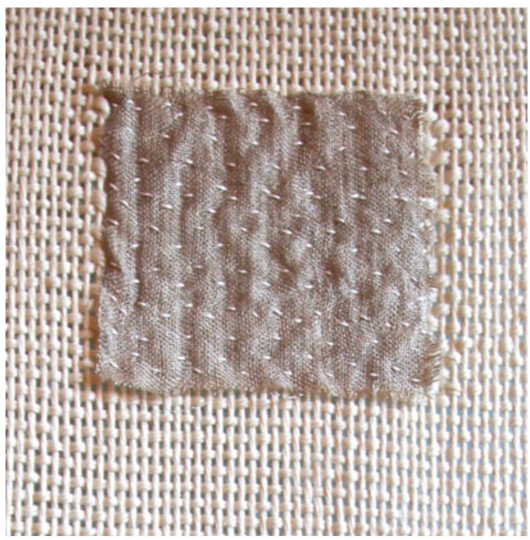
Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 21 (**a**, **b**): ADTL 2012 © ADTL 2012. Foto: © Ruth Mateus-Berr. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.corneliabast.com, http://www.elia-artschools. org/Activities/teachers-academy-2012-porto

times, design research method was determined by a simple process of surveying existing products in the marketplace including cultural, cognitive, and symbolical factors associated with product development. "Designers generally work intuitively, while managers seek systematic logic and minimisation of costly new product design (NPD) risk" (Maciver and O'Driscoll 2010).

Design Criteria of Rhizomes

Gilles Deleuze and Felix Guattari define in their book *A Thousand Plateaus* (1980, 2011) six criteria of the "rhizome" (Deleuze and Guattari 2004, 3–28): the principle of connection and heterogeneity (1, 2), the principle of multiplicity (3), the principle of asignifying rupture (4), and the principle of cartography and decalcomania (5, 6).

Design slogans changed: *Form Follows Function* (Louis Sullivan 1896), *Form follows Fear, Fiction, Finance* (Ellin 1999), *Design for need & the real world* (Victor Papanek 1973/2009). "Author-design", where the designer believed to know "what the world needs" (1980s) switched to Userdesign (Human – centered design), "looking for the needs of the users" finally entered. But



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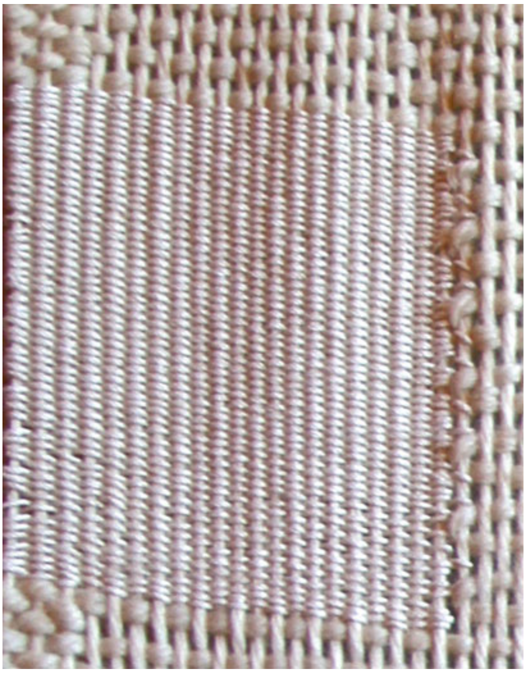
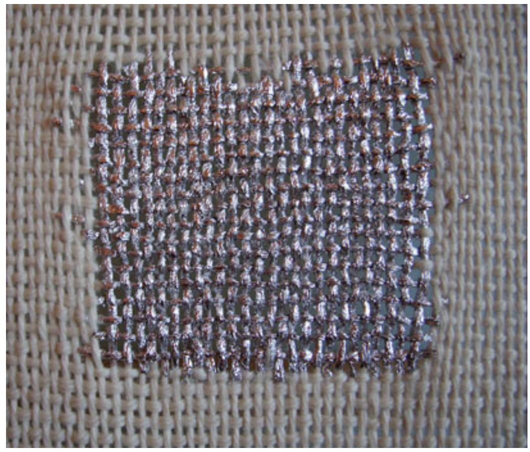


Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 23 Filtration 2. Concept/Design: © Cornelia Bast. Foto: : © Cornelia Bast. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.corneliabast.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto.

research & design (R&D) labs that are in search of a product application as it is by a desire to satisfy established user needs (...) involved a problem which is absence of research" (Veryzer and Borja de Mozota 2005). In Scandinavian IT (Information Technology) product design, "cooperative design" was applied already in the 1970s. They developed "reflecting on the practices" and approaching the computer system design with cooperative involvement of all parties (Greenbaum and Kyng 1991). *Empathic Design* (Luotain Helsinki DR project 2002–2005; Koskinen et al. 2011, 148–150) was followed by *participatory design* (PD) (Martin and Hanington 2012, 128), *Lead Users, User Driven Innovation, User Centered* (Von Hippel 2005, 17, 19, 107),



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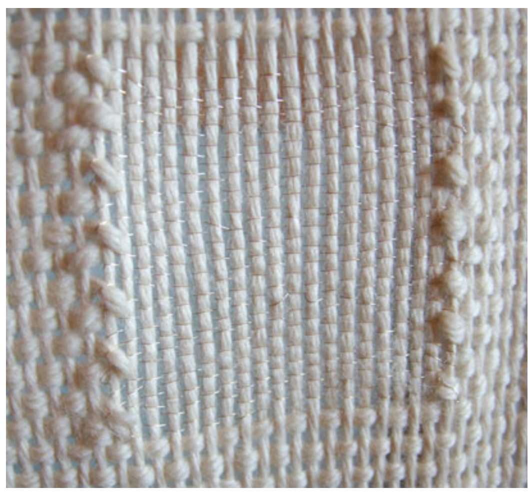

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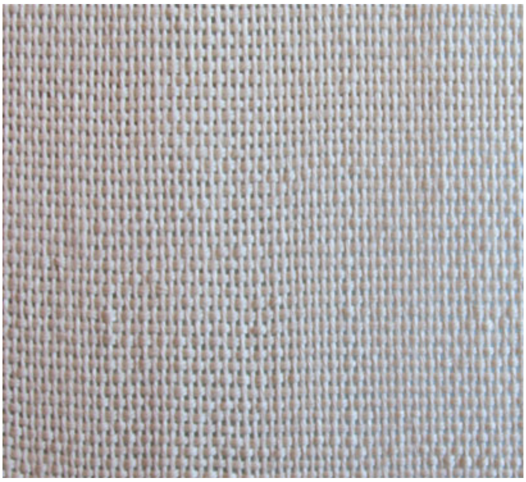

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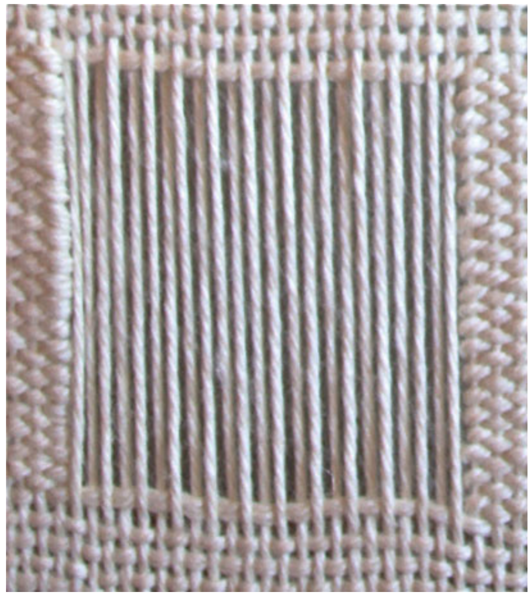

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and *User Created Content: Web 2:0* (Bauer 2011, 8) as *User Co-Creation* (Prahalad and Ramaswamy 2004; Buxton et.al. 2012) are design terms, which derive from North America. The designer Krippendorf (2006, 135) argues “Design competence needs to be given away, delegated to users, and encouraged everywhere.” At least since a Biennale conference in Seattle 1990 participatory design research was established. In participatory design democratizing design research (DR) took place. “(…) Human, effective, creative relationship between those involved in technology’s design and its use” (Schuler and Namioka 1993). Papanek (1973/2009) desired to involve all stakeholders at the very beginning whose interests were touched. Interdisciplinarity at the dreamers phase also implicates a “cognitive diversity” (Stephan 2010, 97). ADTL is far more a time for personal ideas, associations, which are shared within the interdisciplinary team. The design process starts with a problem, as good research does (Polanyi 2009, 21). Usually design problems are ill defined and have to be untackled (“Ill-defined Brief: “Design a glass”. Designer untackles with questions like: “For what kind of liquid? For what kind of target group?” etc.). “The distinction between well-defined and ill-defined problems has its origins in the specification of components of a problem space (Hayes 1978), that is, the space of possible move sequences given the context in which the problem is set and the information-processing limitations of the problem-solver” (Ormerod 2005, 1). The distinction between total and partial order planning can be observed through approaches of novices (total) and experts (partial) (Cross 2006, 26–27). Creative thinking defined as a process of seeing or creating relations (Spearman 1930),

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Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 29 Filtration performance 2012. Concept/Design: © Cornelia Bast. Foto: © Tatia Skhirtladze. Foto: ADTL-team 2012. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.corneliabast.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

analogies (Ribot 1906) with both as a conscious and subconscious process operating is facilitated in interdisciplinary groups and team atmosphere, but also preconscious experiences, memories (Kubie 1958), cultural identifications, and social habitus (Bourdieu 1987, 97–121) are evident. “The *Wallas process*: (Wallas 1926) preparation, incubation, illumination, and revision, which was adapted by de Bono (2005), Gordon, (1961), Osborn (1948), Parnes (1962, 185–191), and

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 30 (**a**, **b**) Filtration performance 2012. Concept/Design: © Cornelia Bast. Foto: © Tatia Skhirtladze. Foto: ADTL-team 2012. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.corneliabast.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

Parnes, (Parnes et al. 1977) Noller, and Biondi (1977) and many others" (Torrance 1993) can be used as definition for design processes in an iterative manner. Adelheid Mers proposes creativity as a transparent process, referring to S.I. (Situationiste Internationale) who introduced the radical attitude of non-disciplinarity and believed to change society by penetrating through art (Mers 2012, 260).

Rules

The fruitfulness of the associations of an interdisciplinary team can be endeavored in various situations. For this process, rules are defined: The actors work in an equal team. No discipline is more or less respected. The process starts with "thinking out loud" one's ideas and continues with associations of other persons and fields. For example, the value of pattern recognition within mathematics can be totally different as in medicine, but it might be awesome to reflect on similarities and differences and also it is important to translate knowledge for other team members into their language. At this phase, errors are welcomed, stupid questions allowed, and on the contrary realistic, critical, and economical reasoning forbidden. One of the major rules is to show or draw examples, prototypes, being visual

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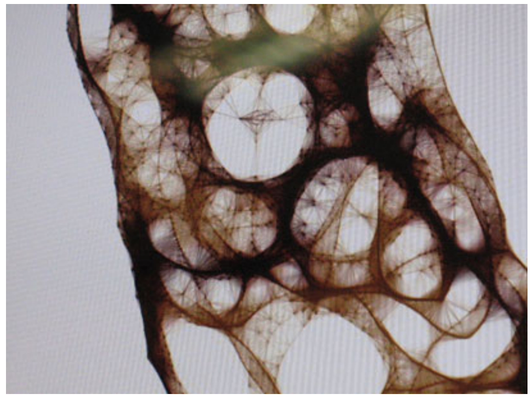

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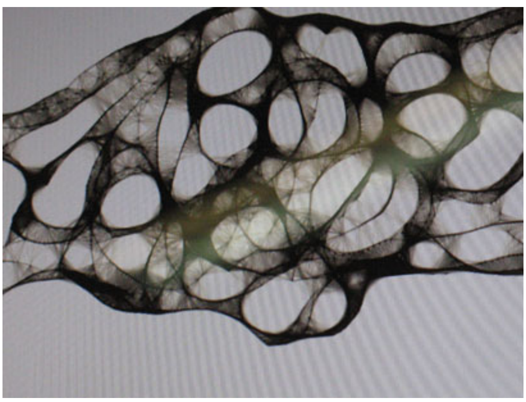

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 32 Sari-Irás 2012. Concept/Design: © Lukács László. Foto: © Ruth Mateus-Berr. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: www.weloveomaa.blogspot.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

("Show, don't tell," Entmystification following Wittgenstein). Empathy must be used to understand the other's interest, frames of each worldview (Johnson and Lakoff 2011), and images of ideas (In the sense of *zelem, eikon, imago as* abstract nonmaterial images and in order to perceive as constructivists the legendary pictures of Zeuxis)). One must try to walk in the moccasins of the other and try to explain it in his or her "language." This process might be called *Design Translation*. Role-types as translators are very efficient at this stage and they become a very important part in the team. When it is described as "building upon the ideas of others" it is meant just in a way of gathering ideas, not stealing ideas. This thought might be explained with the example of the "creative leap," where one designer at the workshop in the Delft Design Protocols Workshop (Cross et al. 1996) suggested a specific design concept "a little vacuum formed tray" which influenced the whole design group profoundly. Success of accepted and applied rules and work at eye level was proved at ADTL.

Problem-Solving Methods

Assemblage of ADTL problem-solving methods, which are all iterative and circulating, attempts to provide an overview (See Fig. 3):

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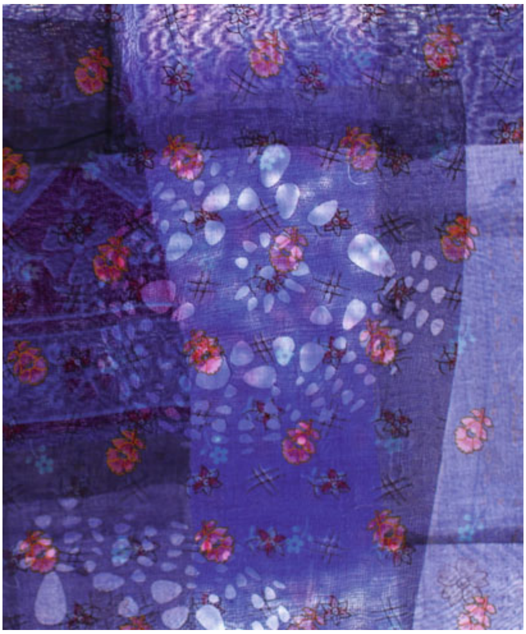
– (1,2 principle of rhizomes) heterogeneity, connections, each point can be connected with another/Brainstorming, Interdisciplinary, cross lateral thinking, "thinking out loud," "stupid questions": "A silly question" is a question which is usually not asked because the person who would like to ask it worries about looking silly (lacking confidence). Question-driven-theory is that asking questions is central to understanding (Morgan and Saxton 2006, 68–69). "Encourage wild ideas," SI (Situationiste Internationale): *Soyez réalistes, demandez l'impossible!* "Be realistic, demand the impossible!" (Graffiti Paris, 1968).
– (3 principle of rhizomes) multiplicity, sprawling widely, different points of view/Brainstorming, Interdisciplinarity, "Defer judgments," "Building upon the ideas of others," "Reflect on similarities and differences," "Research in action," "Empathy," cross lateral thinking, "Handle different levels of abstraction simultaneously" (Cross 2006, 37).
– (4 principle of rhizomes) *asignificant* breaks/although the designer might decide for one solution, he continues and develops other scenarios for more solutions, the solutions generate from each other, "enable identification and recall of relevant knowledge" (Cross 2006, 37), *Optimized Decision Making* (Kimbell et al. 2008, 154–166). *Lateral transformations*: creative shift to new solutions (Goel 1995), dialectics of sketching (Goldschmidt 1991). Experts versus novices: EEG –Examinations (Göker 1997) assumed that novices use the verbal abstract part of the brain during creative processes, experts use the visual-spatial cerebral area. Experts must refer therefore to their experience (Cross 2006, 90).
– (5,6 principle of rhizomes) cartography, decalcomania; not copying, but designing maps, open ended, using *abductive* logic which relies on wondering, guessing, not observation. It goal is to "challenge accepted explanations, and infer possible new worlds" (Martin 2009, 65).



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Designrhizom, Visualizing of the Designprocess at the ADTL

See Figure 2.

Matrix of diverse approaches

See Figure 3.

Previous Projects. Examples of Inter/transdisciplinary projects, ADTL

Project "Montagmöbel" (2004) in collaboration with Volkshilfe Beschäftigungsinitiative, Dorotheum, company Wilhelm Schmidt Stahlbau and other institutions: Aim: Empowering long-term unemployed by co- and redesigning old furniture in collaboration with art and design students;

Project "I-Sinne" (2005–2006) in collaboration with the Academy of Fine Arts Vienna, Univ.-Prof. Franz Pomassl and the University of

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 37 Title: Sari-Irás 2012. Concept/Design: © Lukács László. Foto: © Marie-Theres Wakonig. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: www.weloveomaa.blogspot.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 38 Sari-Irás 2012. Concept/Design: © Lukács László. Foto: © Marie-Theres Wakonig. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: www.weloveomaa.blogspot.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

Music and Performing Arts Vienna, Univ.-Prof. Igor Lintz-Maués; ***Project "Audible-Tangible Design" and "Go Snow" (2005–2006)*** with Univ.-Prof. James Skone; University of Music and Performing Arts Vienna, Prof. Igor Lintz-Maués; Company Edelweiser: Aim: interdisciplinary approach for new solutions for interdisciplinary exhibitions and concerts as well as in researching new movements for new sport-tools. ***Project "Maths Goes Design, Design Goes Maths" (2007–2010)*** with Univ.-Prof. James Skone; in collaboration with the University of Technology Vienna, Discrete Mathematics: Prof. Dr. Reinhard Winkler, Prof. Rudolf Taschner (math.space), University of Vienna: Prof. Ilse Schrittesser, Dr. Eva Sattlberger, Dr. Eveline Christof: Aim: How can design make complex mathematic phenomena tangible? Developing educational tools with students of two different institutions and disciplines.

Project "The Way Polynomiography Things Go. You real-eyes, what you in-habit" (2009) Prof. Bahman Kalantari developed a computer program Polynomiography© in order to demonstrate the beauty of algebraic equations and reduce the fear of mathematics. The ADTL researched Polynomiography©, its creative potentials, and its educational value. In 2009 the *Applied Design Thinking Lab Vienna* presented its outcomes at Rutgers University (USA, DIMACS Workshop on Algorithmic Mathematical Art: Special Cases and Their Application, May 2009.) Aim/Research question. The central question was, if, and how Polynomiography© stimulates creativity and where it leads to. Interdisciplinary approaches took place within the knowledge and associations of the participants (The polynomial pattern of a butterfly, the symmetry of a baroque garden, etc.). The program itself is a beautiful metaphor for *Applied Design Thinking*: To achieve a zero of a complex

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 39 Sari-Irás 2012. Concept/Design: © Lukács László. Foto: © Marie-Theres Wakonig. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: www.weloveomaa.blogspot.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

polynomial function, you start from any arbitrary point and approach the researched points in iterative steps, similar to a design process (Fig. 4). *Design Thinking* strategies involve parts of the philosophy of the radical constructivism. There are no objective conditions and viewpoints of the world and there is not one right solution, but various.

Project "*Math goes Design - Post It!*" (2010) Aim: The main questions were: How and what could those two disciplines, maths and design, learn from each other? Therefore, students and teachers had to develop various ways of communication and learn a new language. Dialogues through *Applied Design Thinking* methods might develop a new approach to mathematic education (Fig. 5a, b). The result of the project was unfolded throughout the method of the presentation (See Fig. 5c, d, e): art performance with *Post-its* (Peran 2008). The aim was to create and provoke a space for reflection through questions and statements about mathematics. Writing, talking, discussing, and postulating were expected in a determined chaos. By giving simple instructions how to act (Algorithm, Equation), the results were put into the initial values of the equation (Iteration) and developed chaos due to the determined initial conditions. An important role was played by bifurcations, situations, where decisions had to be made. These situations might end with an overshoot-and-collapse or order through bifurcation. In this situation, systems break locally through the structure of the system and temporarily through the periodical dynamic of the decision itself (Briggs and Peat 1999). This mathematical metaphor reassembles decision making in mind-mappings and design processes. For the presentation, 3 M-post-its were used and all participants became part of the performance. Post-its appeared and disappeared, could be removed without traces. Post-its have become an item for temporary improvisational design in urban landscapes, where urbanites recover space for their needs (e.g., free running/parcours, barbecuing, playing golf with tin holes, etc.). They are a symbol and reaction in form of civil disobedience. Post-its were used as a metaphor for disobedience in traditional mathematic education (See Fig. 5c, d, e). There is no space there for pupils needs concerning education, either.

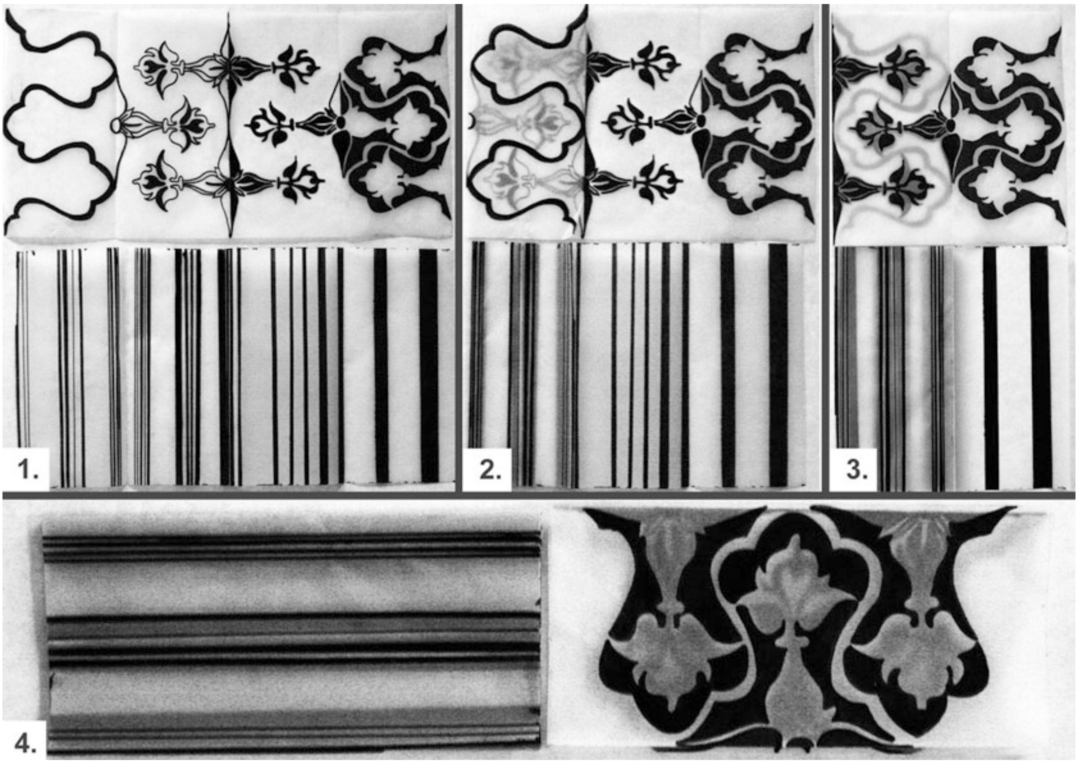
Project "Design with all Senses" (2010): in collaboration with HöR-AKUSTiK DöBLiNG e. U., a small Enterprise (SME) for Acoustic and Hearing Aids in Vienna: Aim: Research Questions: How can this place of business be placed more prominently within the regional shopping street? (Fig. 6)

Project "Swedish Traces in Austria" (2010–2011) in collaboration with University of Vienna, Head of the Department of European and Comparative Literature and Language Studies: Prof. Dr. Sven Rossel; Austrian-Swedish Society:

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 40 Sari-Irás 2012. Concept/Design: © Lukács László. Foto: © Marie-Theres Wakonig. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: www.weloveomaa.blogspot.com, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

President Dr. Ingela Bruner; Swedish Embassy; Aim: Research of Swedish traces in Austria by students from Scandinavian studies of the University of Vienna and art and design students from the University of Applied Arts in Vienna, development of educational tools of the results. Intercultural aspects as well as transfer of diverse cultural understandings were part of the research and solutions. ***Project "PlayDecide for blind and elderly people" (2010)*** in collaboration with Science Center Netzwerk, (PlayDecide EU-Microfund): CEO Dr. Barbara Streicher, Austrian Association in Support of the Blind and Visually Impaired; Aim: How can PLAYDECIDE for elderly people who are blind or can hardly see be developed, connect scientific knowledge with artistic activities? ***Project "Polyphon Oikos" (2011–2012)*** in collaboration with Archdiocese of Vienna; Aim: Design research and Design of a reception hall. Students from different departments as art and design education and graphic design worked together in the ADTL with P. Michael Schultes, H. Exc. Aux. Bishop Dr. Franz Scharl, CEO of the Categorial Pastoral Care of the Archdiocese Mag. Martin Wiesauer and Office Director for Construction DI Arch. Harald Gnilsen (See Figs. 7, 8) as well as Saskia Belem, Marina Boulaxis.

Project *"Design of Medical Communication Processes"* ***(2010–today)*** in collaboration with University of Vienna: Faculty of Informatics, Computer Science Didactics and Learning Research: Univ.-Prof. Dr. Wilfried Grossmann, Prof. Dr. Karl Anton Fröschl; Research Group Entertainment Computing: Univ.-Prof. Dipl.-Ing. Dr. Helmut Hlavacs; Dipl.-Ing. Dr. Karin Anna Hummel), Childrens' Cancer Research Institute at St. Anna Childrens' hospital (CCRI): Dr. Anita Lawitschka, Dr. Barbara Brunnmair; T-Systems (a division of Deutsche Telekom, systems integration, computing and network services and e-business), children of the Austrian high school "Schulschiff Bertha von Suttner"), Prof. Dr. Manuel Sprung, Faculty of Psychology, University of Vienna, Games4Resilence Lab Dr. Fares Kayali,: Aim: enhance interdisciplinary and participatory approaches in design and technology education, case study is design of an

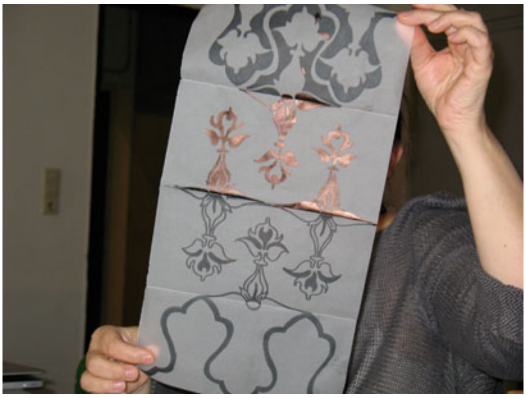


Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 41 Pattern didactics 2012. Concept/Design: © Klaudia Kozma. Foto: © Klaudia Kozma. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: http://www.klaudiakozma.com/, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

interactive web-based communication platform for improving quality of life for the patients of the stem cell lab department (SCT-INTERACT), improve medical communication and education in outpatient care after pediatric hematopoietic stem cell transplantation (SCT), spin-off is the design of a serious game where healthy and sick children are participatory involved as well as the students of different teaching subjects (informatics, art and design education), the caring medical staff, and the industry partner (See Figs. 9a, b, 10–12a, b, 13).

Project "Math Goes Fashion" (2010–2011) Since 2010, the Applied Design Thinking Lab Vienna concentrated on mathematics and fashion. In Western Europe, the making of patterns in garments mainly comes from one tradition. So far, no one has yet thought about an approach based on platonic solids (See Figs. 15, 16, 20a, b, c) or reformulated the traditional S, M, L, and XL sizes with a new mathematical interpretation, Body-Index-Cloth (See Fig. 14). Various forms allow innovative forms of clothes or new forms of play (See Fig. 19b, c, d) or Moebius-fashion (See Figs. 17–18). The Lab covered a broad range of problem domains from pattern making to fashion for buildings with inflatable membranes (See Fig. 20). Recent experiments revealed new perspectives for fashion and, additionally, brought up educationally fruitful methods for working with mathematical topics using a creative base.

Project "4 Layers of Sari" (2011–2012). Clean water, free of bacteria, is implicitness in Austria today. Water is an important resource for the development of a peaceful society. Globally,



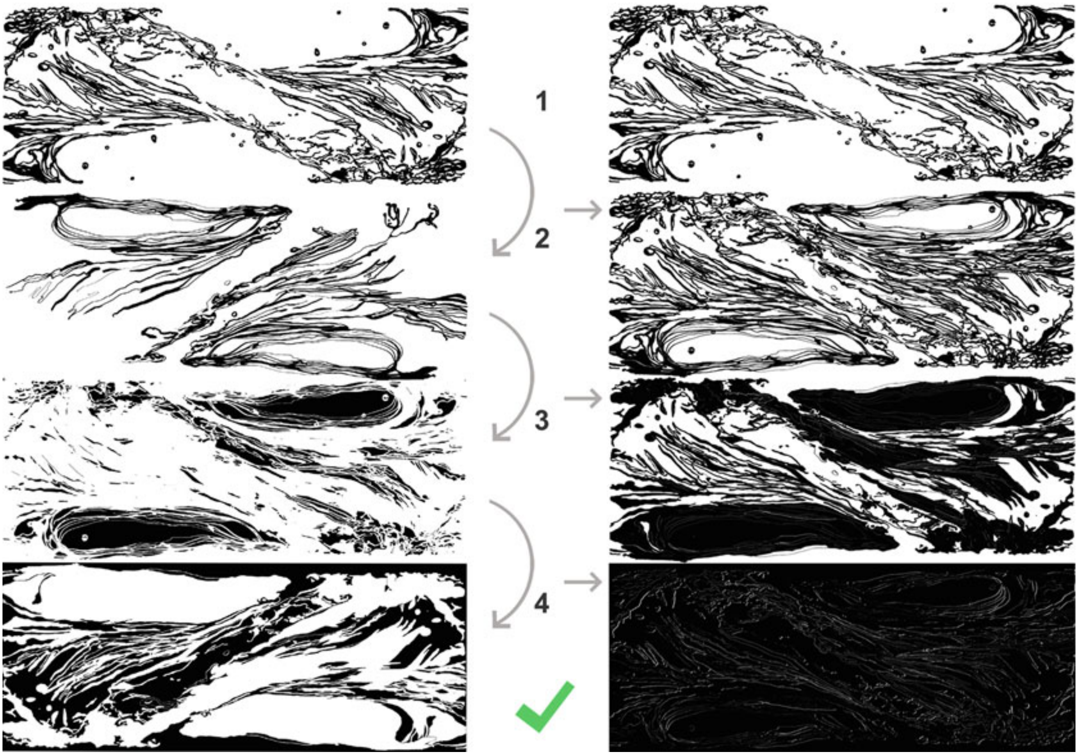
Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 42 Pattern didactics 2012. Concept/Design: © Klaudia Kozma. Foto: © ADTL 2012. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.klaudiakozma.com/, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

clean water, free of bacteria, is a scarce resource. With improvements in methods, through careful production, storage, use, and disposing of this valuable element, one will succeed in making clean hygienic water available to all human beings. Until now, cholera is a life-threatening epidemic infection in developing countries. Cholera provokes massive, life-threatening diarrhea attacks, intestinal cramps, and vomiting. Especially the youngest children are particularly vulnerable of dehydration due to high loss of fluids. Untreated, up to two third of children infected with cholera die within a few days (Huq et al. 1996). 1973 Rita R. Colwell et al. described the symbiotic life of *Vibrio cholerae* with zooplankton and copepods. Huq et al. (1996) invented a simple method of filtration: four layers sari filter out 99 % of *Vibrio cholerae*. In May 2011, the World Health Assembly recognized the reemergence of cholera as a significant global public health problem and adopted resolution WHA 64.15, calling for implementation of an integrated and comprehensive global approach to cholera control (World Health Organization 2011). In 2007, the author won a prize for her artwork on four layers of sari (Neptun Wasserpreis 2007- Verbund) and since 2011, she participates at the earth water catalog of Uwe Laysiepen (Mateus-Berr 2007, Laysiepen (Ulay) 2011). It is planned to design an object or sellable product which expresses the scientific work of Rita Colwell through the label: "four layers of sari" for rich target groups. Different innovative interpretations of material and saris are made. The students approach the project through research on the history as well as on "pattern language of saris," weaving with different fabrics to produce layers, designing a didactic pattern which explains the use of four layers by pattern recognition and silk screening designs. Inspired by a scientific result, innovation, and sustainable entrepreneurship might serve as a solution within the operational framework of *Open Innovation Diplomacy* (Carayannis and Campbell 2009) which "encompasses the concept and practice of bridging distance and other divides (cultural, socioeconomic, technological, etc.) with focused and properly targeted initiatives to connect ideas and solutions with markets and investors ready to appreciate them and nurture them to their full potential" (Carayannis and Campbell 2012, 2), or applied through "Mode 3" (Carayannis and Campbell 2009), where people, culture, and technology meet, interact, and build clusters (Carayannis and Campbell 2012, 4, 8–9). The collection (suit, shoes), designed by László Lukács, and pattern, designed by Klaudia Kozma, were codeveloped with manufacturing companies in Hungary. The briefing required an artistic interpretation or a design object, which could be designed by the students. If an interesting result is created, a realization might be planned, regarding the interests of the students.

Students Works

Filtration/Cornelia Bast

The term "filter" originally comes from "felt" and meant to let something flow through felt. Four layers of sari are able to hold back 99 % of Bacterium *Vibrio cholerae* that causes Cholera. The older and the more used the sari is, the more bacteria are held back. This fact causes to think



Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 43 Pattern didactics 2012. Concept/Design: © Klaudia Kozma. Foto: © Klaudia Kozma. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: http://www.klaudiakozma.com/, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

about which properties determine filtration. The main factors by the process of filtration are pore size and effective grain size. Every yarn of the textile has to manage its job, so that the gap between the threads is small enough to hold back the detrimental substances. This tension between protective separation and possible permeability is the theme of this work (See Figs. 21a, b, 22–30a, b).

Sari-Irás/Lukács László, Marie-Theres Wakonig
The project uses the pun of the Hindi word “sari” and the mirror writing “irás” what means letters. Old patterns, old fabrics (See Figs. 31–35) are used and redesigned into a sustainable-conscious haute-couture. A suit made of four layers of saris (Figs. 36–40) and shoes (Fig. 37), which were designed in cooperation with Hungarian manufacturing SME. In a social business the products should be produced and sold by SME’s in Bangladesh, Hungary or elsewhere.

Pattern Didactics/Kozma Klaudia
The project does not need language. The fabric is printed with designed patterns and four layers explain the important use without words (See Figs. 41–43). The artwork has the same size as an original sari (Figs. 44–46). The project was a collaboration between the student, workshops of the University of Applied Arts Vienna, and SME’s in Hungary.

Conclusion and Future Directions

It is evident that the vision of inter/transdisciplinarity unfolds throughout the ADTL, regarding the feedbacks and workflow of the

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Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 45 Pattern didactics 2012. Concept/Design: © Klaudia Kozma. Foto: © Klaudia Kozma. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´ Conference Porto. PT 2012. LINK: http://www.klaudiakozma.com/, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 46 Pattern didactics 2012. Concept/Design: © Klaudia Kozma. Model: Marie-Theres Wakonig. Foto: © Klaudia Kozma. ADTL-team: Cornelia Bast, Elisabeth Geymüller, Klaudia Kozma, László Lukács, Ruth Mateus-Berr, P. Michael Schultes, Marie-Theres Wakonig. Presentation at ELIA Teachers´Conference Porto. PT 2012. LINK: http://www.klaudiakozma.com/, http://www.elia-artschools.org/Activities/teachers-academy-2012-porto

participating students. Working cooperatively, students still develop their own visions, concepts, and designs. The multilevel and multimodal discourse between different students from different faculties and universities brighten up their worldviews and creativity. They work in competition for best results but on the same hand support each other in all different activities. They are knowledgeable, apply interactive techniques, and change their roles within the team if affordable or corresponding to a particular mood. They adapt that failures are important as well as part of action and learning important as well as part of action and learning as key of constructivist thinking. Entrepreneurship and a favorable democratic climate within the Lab empower them to design their own homepages, business cards, portfolios about their art for conferences where they present their work to an international community. Implementing or leading successful workshops with different target audiences (experts from different disciplines, families, children, companies, schools) completely new forms of conveying knowledge were developed and should be goal of education in general. Presentation of their designs at exhibitions and international conferences at international universities: students consider them as an estimated goal and milestone in their work, as well as to prepare extraordinary performative lectures for each event and copresent equally with professors (Figs. 5c, d, e, 28, 29a, b). Students who were part of the Lab integrated interdisciplinary know how and inspirations in workshops with non-designers for an emerging SME, or they reported that they won a business for designing stage for an international theater play and they had discovered how to work socially responsible and successful in teams. They were invited to design an international Science Night with workshops and cooperated with international universities. They lost their fear to talk about their work in English in front of an international audience and improved in networking with interesting and important personas. Working with long-term unemployed, students cooperated with microenterprises and shared the

Matrix of Collaboration:

Project	Year	Universities Austria	Universities International	Companies (SME, Manufactures, others) Austria	Companies (SME, Manufactures, others) International	Institutions
Montagmöbel	2004	x		xxxx		
I-Sinne	2005	xx				
Audible-Tangible Design	2005	xx	x			
GoSno	2006	xx	x	x		x
Maths Goes Design	2007-2010	xxxx	x			x
The Way Polynomiograp hy Things Go	2009	x	x			
Math goes design-post-it!	2010	x	x			
Design with all senses	2010	x		x		
Swedish traces in Austria	2010-2011	xx				xx
PlayDecide	2011	x				xxx
Polyphon Oikos	2011-2012	x		x		x
Design of Medical Communication Processes	2010-today	xx	x	x		xx
Math Goes Fashion	2010-2011	xx	xxx			xx
4 Layers of Sari	2011-today	xxx	x		xxx	

Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams, Fig. 47 Matrix of collaboration. Graphic: © Ruth Mateus-Berr

success of good results, which strengthened the self-awareness of both groups. They cooperated with manufactures and SME's in Austria and other countries (See Fig. 47), developed with them new solutions. At the beginning some SME's were afraid of the unconventional and new approaches, but during the cooperation, they valued the approach and were inspired by the spirit and were proud of finding and working with new materials and technologies, which were developed in teams. Institutions who cooperated with the ADTL describe the close cooperation describe as an inspiring experience, diverse solutions were found that they would have never dared to think about. Students were highly motivated, besides getting the chance to realize and present projects. Cooperation instead of "single combat" is the strategy between students, disciplines, SME's, and institutions (See Fig. 47). An ADTL might be a place about trying to think about and try out new possibilities, facilitating a public discussion about what should be presented at international events and coproduce culturally desirable sustainable products which might become commercially viable. Recommendations and future directions are concerned, the praxis of the ADTL should be continued as an exeptional unit at Universities and model for Innovation Diplomacy.

Cross-References

- ▶ Creative Pedagogy
- ▶ Creative Problem Solving
- ▶ Healthcare and Innovation
- ▶ Innovation Diplomacy
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Polynomiography and Innovation
- ▶ Social Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)

References

Bast G. Maths goes design. Kunst/Wien: Universität für angewandte, In-house publishers Angewandte; 2010.

Bauer CA, editor. User generated content – Urheberrechtliche Zulässigkeit nutzergenerierter Medieninhalte. Berlin/Heidelberg: Springer; 2011.

Belbin RM. The management of teams: why they succeed or fail. Amsterdam: Elsevier Science & Technology; 2010.

Belbin RM. Team roles: http://www.belbin.com/rte.asp?id=396. 2012

Boradkar P. Designing things. A critical introduction to the culture of objects. Oxford/New York: Berg Publishers; 2010.

Borgdorff H. The conflict of the faculties. Perspectives on artistic research and academia. Leiden: University Press; 2012.

Bourdieu P. Sozialer Sinn, Kritik der theoretischen Vernunft. Frankfurt am Main: Suhrkamp; 1987.

Briggs J, Peat FD. Die Entdeckung des Chaos. Eine Reise durch die Chaos-Theorie. München: Deutscher Taschenbuch Verlag; 1999.

Brown T. Change by design. How design thinking transforms organizations and inspires innovation. New York: HarperCollins; 2009.

Brown T. Harv Bus Rev 86 (6): 84-92, 141. 2008. www.ncbi.nlm.nih.gov/pubmed/18605031. Accessed 30 Sept 2011.

Bryman A. The disneyzation, of society. London/Los Angeles/London/New Delhi/Signapore/Washington, DC: Sage; 2004.

Buxton B, Sheelagh C, Greenberg S, Marquardt N. Sketching user experiences. Waltham: Elsevier/Morgan Kaufmann; 2012.

Carayannis EG. The strategic management of technological learning. Learning to learn and learning to learn-how-to-learn as drivers of strategic choice and firm performance in global, technology-driven markets. Boca Raton: CRC Press; 2001.

Carayannis EG. Measuring intangibles: managing intangibles for tangible outcomes in research and innovation. Int J Nucl Know Manag. 2004;1(1).

Carayannis EG, Campbell DFJ. “Mode 3” and “Quadruple helix”: toward a 21st-century fractal innovation ecosystem. Int J Technol Manag. 2009; 46(3/4), 201–234. http://www.inderscience.com/browse/index.php?journalID=27%26year=2009%26vol = 46%26issue = 3/4. Accessed 25 July 2012.

Carayannis EG, Campbell DFJ. Mode 3 knowledge: production in Quadruple helix innovation systems. 21st-Century Democracy, Innovation, and Entrepreneurship for Development,. New York: Springer; 2012.

Chomsky N. On certain formal properties of grammars. Inform Control. 1959;2:137–67.

Clarke A. Design anthropology. Object culture in the 21st century, Edition Angewandte, Springer, New York; 2011.

Collins H. Tacit and explicit knowledge. Chicago/London: The University of Chicago Press; 2010.

Colwell RR. Global climate and infectious disease: the cholera paradigm. Science. 1996; 274 (5295), 2025–2031. DOI: 10.1126/science.274.5295.2025, PMID:8953025.

Crandall R. Design thinking summer session. Resource document Stanford d.school k12 LAB. 2013. http://dschool.stanford.edu/use-our-methods/. Accessed 25 Jan 2013.

Cross N. Designerly ways of knowing. London: Springer; 2006.

Cross N. Design thinking. Oxford/New York: Berg Publishers; 2011.

Cross N, Christiaans H, Dorst K. Analysing design activity. Chichester: Wiley; 1996.

d.school. Hasso Plattner Institute of Design at Stanford. http://dschool.stanford.edu/. © 2013 Stanford University Institute of Design. Accessed 25 Jan 2013.

Dalrymple J, Miller W. Interdisciplinarity: a key for real-world learning. Planet No. 17, GEES Subject Centre, University of Plymouth, Plymouth; 2006.

Dasgupta S. Creativity in invention and design. Cambridge: University Press, Denkschule; 1994.

de Bono E. De Bonos neue Denkschule. Heidelberg: mvgVerlag; 2005.

Deleuze G, Guattari F. A Thousand Plateaus. London/New York: Continuum International; 2004.

DeWachter M. Interdisciplinary team work. J Med Ethics. 1976; 2. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2495117/. Accessed 11 Sept 2011.

Dewey J. Democracy and education. A Penn State Electronic Classics Series Publication (2001) (electronic). Hazleton, USA: Pennsylvania State University. 1916. http://www2.hn.psu.edu/faculty/jmanis/johndewey/dem%26ed.pdf. Accessed 25 Aug 2011.

Dilts R. Strategies of a genius, vol. 1. California: Meta Publications; 1994.

Douven I. "Abduction", The Stanford encyclopedia of philosophy. Spring 2011 ed. Zalta EN, editor. http://plato.stanford.edu/archives/spr2011/entries/abduction/. Accessed 29 Apr 2011.

Drosdowski G, Müller W, Scholze-Stubenrecht W, Wermke M (Hg.) DUDEN, Das Herkunftswörterbuch. Etymologie der deutschen Sprache. Bd.7., Meyers Lexikonverlag, Mannheim, Wien, Zürich; 1989.

Dursun P. Architectural theory and spatial analysis. An analytical tool for thinking and talking about space. Proceedings: eighth international space syntax symposium, Santiago, PUC, Chile. 2012. http://www.sss8.cl/proceedings/. Accessed 13 May 2011.

Edison T. http://www.nps.gov/edis/index.htm. Accessed 28 April 2012.

Ellin N. Postmodern urbanism. New York: Princeton Architectural Press; 1999.

Epstein S. Integration of the cognitive and the psychodynamic unconscious. Am Psychol. 1994;49:709–724. Ed. Norman B. Anderson. doi: 10.1037/0003-066X.49.8.709.

Frayling C. Research in art and design. In: Royal College of Art Research Papers, 1/1; 1993/1994.

Fuller B. Bedienungsanleitung für das Raumschiff. Erde und andere Schriften. Hg. Joachim Krausse. Amsterdam, Dresden: Verlag der Kunst; 1998.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The production of knowledge: the dynamics of science and research in contemporary societies. London: Sage; 1994.

Goel V. Sketches of thought. Cambridge, MA: MIT Press; 1995.

Göker MH. The effects of experience during design problem solving. Des Stud. 1997;18(4):DOI:10.1016/S0142-694X(97)00009-4.

Goldschmidt G. The dialectics of sketching. Creat Res J. 1991;1(2):123–143.

Goodchild P. Deleuze and Guattari: an introduction to the politics of desire. London/Thousand Oaks/New Delhi: Sage; 1996.

Gordon WJJ. Synectics. New York: Harper & Row; 1961.

Graffitti P. 1968. http://www.gerard-aime.com/phototheque/picture.php?/10617/category/2194. Accessed 11 May 2011.

Greenbaum J, Kyng M, editors. Design at work: cooperative design of computer systems. Hillsdale: Lawrence Erlbaum Associates; 1991.

Hayes JR. Cognitive psychology: thinking and creating. Homewood/Belmont: Dorsey Press; 1978.

Heidegger M. Being and time (trans. J. Stambaugh). Albany: State University of New York Press; 1996.

Huq A, Xu B, Chowdhury MAR, Islam MS, Montilla R, Colwell RR. A simple filtration method to remove plankton-associated *Vibrio cholerae* in raw water supplies in developing countries. AEM Appl Environ Microbiol. 1996, 2509–2512, PMCID: PMC168033.

Huq A, Yunus M, Sohel SS, Bhuiya A, Emch M, Luby S, Russek-Cohen E, Nair GB, Sacke RB, Colwell RR. Simple sari cloth filtration of water is sustainable and continues to protect villagers from cholera in Matlab, Bangladesh, DOI: 10.1128/mBio.00034-10 18 May 2010 mBio vol. 1 no. 1 e00034-10 http://mbio.asm.org/content/1/1/e00034-10.full. Accessed 1May 2012.

Johnson M, Lakoff G. Leben in Metaphern. Konstruktion und Gebrauch von Sprachbildern. Heidelberg: Carl-Auer Verlag; 2011.

Jones M. 2010. http://nearfuturelaboratory.com/pasta-and-vinegar/2010/02/19/matt-jones-on-mujicomp-and-mujicompfrastructures-at-technoark/. Accessed 26 July 2012.

Kandel E. In search of memory. New York: Norton; 2006.

Kant I. Kritik der reinen Vernunft. Stuttgart: Reclam; 1989.

Kelley T, Littmann J. The art of innovation: lessons in creativity from IDEO, America's leading design firm. New York: Currency Book; 2001.

Kimbell R, Stables K, Zeidler D. Researching design learning issues and findings from two decades of research and development, Science and technology education library, vol. 34. New York: Springer; 2008.

Klein JT. Interdisciplinarity: history, theory and practice. Detroit: Wayne State University Press; 1990.

Klein JT. Creating interdisciplinary campus cultures. A model for strenghth and sustainability. San Francisco: Wiley Imprint; 2010.

Koskinen I, Zimmerman J, Binder T, Redström J, Wensveen S. Design research through practice. From the lab, field, and showroom. Waltham: Elsevier; 2011.

Krippendorf K. The semantic turn. A new foundation for design. Boca Raton: Taylor %26 Francis; 2006.

Kristensen T. The physical context of creativity. Creat Innov Manag. 2004; 14, Nr. 2, 89–96. DOI: 10.1111/j.0963-1690.2004.00297.x. Accessed 3 Sept 2011.

Kubie KS. The neurotic atortion of the creative process. Lawrence: University of Kansas Press; 1958.

Laurel B, editor. Design research, methods and perspectives. Cambridge: MIT Press; 2003.

Lawson B. How designers think. The design process demystified. Amsterdam/Boston/Heidelberg/London/New York/Oxford/Paris/San Diego/San Francisco/Singapore/Sydney/Tokio: Elsevier Ltd. 2006.

Laysiepen U. (Ulay), Mateus-Berr R. Earth water catalogue. 2011. http://www.earthwatercatalogue.net/#project/181. Accessed 1 Apr 2012.

Laysiepen (Ulay) U, Earth water catalogue. http://www.earthwatercatalogue.net/#project/181. Accessed 1 May 2012.

Lieshout AV. Teamrollenprofil nach Selbsteinschätzung. The good, the bad + the ugly. Rotterdam: NAi Publishers; 1998.

Lockwood T, editor. Design thinking. Integrating innovation, customer experience, and brand value. New York: Allworth Press; 2010.

Maciver F, O'Driscoll A. Consultancy designer involvement in new product development in mature product categories: who leads, the designer or the marketer? 2010. www.drs2010.umontreal.ca/data/PDF/077.pdf. Accessed 1 April 2012.

Maddalena G. Guessing or reasoning? A philosophical account of hypothesis. In: de Almeida UB, Rojo J, editors. Euresis, Association for the Promotion of the Scientific Endeavour, Vol. 1 Summer 2011. 2011. http://www.scribd.com/doc/98312138/The-Event-of-Discovery. Accessed 13. July 2012.

Mareis C. The nature of design. In: Mareis C, Joost G, Kimpel K (Hg.), entwerfen, wissen, produzieren. Designforschung im Anwendungskontext, transcript Verlag, Bielefeld; 2010.

Martin R. The design of business. Why design thinking is the next competitive advantage. Boston: Harvard Business Press; 2009.

Martin B, Hanington B. Universal methods of design. 100 ways to research complex problems, develop innovative ideas, and design effective solutions. Beverly: Rockport; 2012.

Mateus-Berr R, Laysiepen U. Ulay, Earth water catalogue. 2011. http://www.earthwatercatalogue.net/#project/181. Accessed 1 April 2012.

Matt G. Get together. Kunst als Teamwork. Wien/Bozen: Folio Verlag; 1999.

Mers A. Transferdiskurse zr Künstlerpositionen, Kreativindustrien, Kreativität, Innovation, Ästhetik und Diagrammatik, In: Tröndle M (Hg.) Kunstforschung als ästhetische Wissenschaft, Beiträge zur transdisziplinären Hybridiesierung von Wissenschaft und Kunst, transcript Verlag, Bielefeld; 2012.

Mitchell W.J.T. Interdisciplinarity and visual culture. The Art Bulletin, 77(4), In: Winters T, Interdisciplinarity and Design Education. Conference Proceedings: copyright © 2009 Swinburne University of Technology and RMIT University. Conference Cumulus 38, Hemispheric Shifts across learning, teaching and research. Published in Melbourne, Australia by Swinburne University of Technology and RMIT University; 2009. http://www.swinburne.edu.au/lib/ir/onlineconferences/cumulus/welcome.htm. Accessed 10 Sept 2011.

Mittelstraß J. Art and research: an introduction. In: Rittermann J, Bast G, Mittelstraß J, editors. Kunst und Forschung/Art and research. Wien: Springer; 2011.

Morgan N, Saxton J. Asking better questions. Ontario: Pembroke; 2006.

National Research Council. Scientific interfaces and technological applications. Washington, DC: National Academies Press; 1986.

National Research Council. Interdisciplinary research: promoting collaboration between the life sciences and medicine and the physical sciences and engineering. Washington, DC: National Academies Press; 1990.

Newbury D. Research training in the creative arts and design. In: Biggs M, Karlsson H, editors. The Routledge companion to research in the Arts. Routledge/London/New York: Taylor %26 Francis; 2011.

Nonaka I, Takeuchi H. Die Organisation des Wissens. Wie japanische Unternehmen eine brachliegende Ressource nutzbar machen. Frankfurt am Main, New York: Campus Verlag; 1997.

Ormerod TC. Planning and ill-defined problems. In: Morris R, Ward G, editors. The cognitive psychology of planning. London: Psychology Press; 2005.

Osborn AF. Your creative power. New York: Charles Scribner's Sons; 1948.

Osborn AF. Applied imagination. principles and procedures of creative problem-solving. New York: Charles Scribner's Sons; 1953.

Papanek V (F. Pumhösl, T. Geisler, M. Fineder, G. Bast, (Hg.)). Design für die reale Welt. Anleitungen für eine humane Ökologie und sozialen Wandel. Edition Angewandte. Wien: Springer; 1973/2009.

Parnes SJ. Can creativitybe increased? In: Parnea SJ, Harding HF, editors. A source book for creative thinking. New York: Charles Scribner's Sons; 1962.

Parnes SJ, Noller RB, Biondi AM. Guide to creative action. New York: Charles Scribner's Sons; 1977.

Parry. 2007. http://plato.stanford.edu/entries/episteme-techne/. Accessed 15 July 2012.

Peirce CS. Collected papers. Vols. 1–8, Hartshorne C, Weiss P, Burks AW, editors. Havard University Press, Cambridge, MA; 1935–1966.

Peran M. Interview in: dérive (Pamela Bartar) Stadtplanungen in der Post-It City. Von Barcelona bis Valparaiso oder Wien. Dérive 38 Zeitschrift für Stadtforschung. Artikel aus der Ausgabe 33. 2008. http://www.derive.at/index.php?p_case=2%26id_cont=752%26issue_No=33. Accessed 16 July 2009.

Peters S. Der Vortrag als performance, transcript. Bielefeld: Verlag; 2011.

Plattner H, Meinel C, Weinberg U. Design thinking. Innovationen lernen, Ideenwelten öffnen, Wirtschaftsbuch. München: Finanzbuch Verlag GmbH; 2009.

Polanyi M. The logic of tacit inference. In: Grene M, editor. Knowing and being: essays by michael polanyi. Chicago/London: The University of Chicago Press; 1966. p. 140–4.

Polanyi M. The tacit dimension. London/Chicago: The University of Chicago Press; 2009.

Prahalad CK, Ramaswamy V. Future of competition: co-creating unique value with customers. Harvard Business Press Books. Pn.9535-SRN-ENG. 2004. http://cb.hbsp.harvard.edu/cb/search/cocreation%2520prahalad%2520ramaswamy?Ntk=HEMainSearch%26N=0. Accessed 23 April 2011.

Raymond M. The trend Forecaster's handbook. London: Laurence King; 2010.

Rhea D. Bringing clarity to the "Fuzzy front end". A predictable process for innovation. In: Laurel B, editor. Design research. Methods and perspectives. Cambridge: MIT Press; 2003.

Ribot T. Essays on the creative imagination. London: Routledge %26 Kegan Paul; 1906.

Ryle G. The concept of mind. Chicago: University of Chicago Press; 1949.

Schneider G. In: Klein JT, editor. Interdisciplinary campus cultures. A model for strength and sustainability. San Francisco: Jossey-Bass; 2010 xv.
Schuler D, Namioka A. Participatory design, principles and practices. Hillsdale: Lawrence Erlbaum Associates; 1993.
Schön DA. The reflective practitioner. How professionals think in action. Cambridge: Perseus Books; 1983.
Sennet R. Handwerk. Berlin: Berlin Verlag; 2008.
Shinozaki J, Cavagnaro LB. d.school brainstorming rules. 2009. http://www.youtube.com/watch?v=W1h5L_0rFz8. Accessed 29 April 2012.
Simon HA. The sciences of the artificial. 3rd ed. Cambridge, MA: MIT Press; 1969/2001.
Spearman CE. Creative mind. London/Cambridge: University Press; 1930.
Sperri RE. Nobelprize. 1981. http://www.nobelprize.org/mediaplayer/index.php?id=1606. Accessed 18 March 2012.
Stephan PF. Wissen und Nicht-Wissen im Entwurf. In: Mareis C, Joost G, Kimpel K, editors. Entwerfen wissen produzieren. Designforschung im Anwenderkontext, transcript Verlag, Bielefeld; 2010.
Stokes DE. Pasteur's quadrant. Basic science and technology innovation. Washington, DC: Brookings Institution Press; 1997.
Sullivan LH. The tall office building artistically considered. First published in Lippinicott's Magazine 57, (1896) http://de.scribd.com/doc/104764188/Louis-Sullivan-The-Tall-Office-Building-Artistically-Considered. Accessed 26 Jan 2012.
Sullivan G. Art practice as research, inquiry in visual arts. Washington DC/ Los Angeles/London/New Delhi/ Signapore: Sage; 2010.
Torrance EP. Understanding creativity: where to start? In: Psychological inquiry, Bd. 4, Nr. 3, Lawrence Erlbaum Associates, Mahwah. 1993, http://links.jstor.org/sici?sici=1047-840X%281993%294%3A3%3C232%3AUCWTS%3E2.0.CO%3B2-O. Accessed 26 July 2012.
Veryzer W, Borja de Mozota B. The impact of user-orientated design on new product development. An examination of fundamental relationships. J Prod Innov Manag. 2005;22(2):128–43. doi:10.1111/j.0737-6782.2005.00110.x.
Von Hippel EV. Democratizing innovation. Cambridge/London: The MIT Press; 2005.
Wake L. NLP. Principles in practice. St. Albans: Ecedemy Press; 2010.
Wallas G. The art of thought. New York: Harcourt Brace; 1926.
Weingardt M. Fehler zeichnen uns aus. Transdisziplinäre Grundlagen zur Theorie und Produktivität des Fehlers in Schule und Arbeitswelt. Bad Heilbrunn: Verlag Julius Klinkhardt; 2004.
Wiener N. Kybernetik. Regelung und Nachrichtenübertragung in Lebewesen und Maschine. Hamburg: Rowohlt Verlag; 1968.
Wilde O, An ideal husband. "mrs. cheveley. (To herself) How thoughtful of him! To expect the unexpected shows a thoroughly modern intellect". 1895. http://www.gutenberg.org/files/885/885-h/885-h.htm. Accessed 29 April 2012.
World Health Organization 2011, 86, 325–340, 29 July 2011, 86th year / 29 juiLLET 2011, 86e année No. 31, 2011, 86, 325–340 http://www.who.int/wer (Zugegriffen am 1.2.2012).

Links

http://www.designthinkingclub.com/blabber/category/design-thinking-definition
http://vimeo.com/13707896
http://www.youtube.com/watch?v=e8p161ylL48
http://dimacs.rutgers.edu/Workshops/MathArt/Slides/slides.html
http://www.grameencreativelab.com/users/ruth-mateus-berr
http://dimacs.rutgers.edu/Workshops/MathArt/program.html
http://www.polynomiography.com/
http://www.youtube.com/watch?v=9z9g53kfzsI
http://www.bridgesmathart.org/
http://etopia.sintlucas.be/3.14/Wiskunst/Speakers_Eng.htm
http://www.elia-artschools.org/Activities/teachers-academy-2012-porto?lang_id=2
http://www.facebook.com/pages/Applied-Design-Thinking-Lab-Vienna/203391663012464
http://www.montagmoebel.com/
http://www.volkshilfe-beschaeftigung.at/betriebeund-projekte/w%C3%BCrfel
http://www.dorotheum.com/en/auctions.html?no_cache=1
http://www.mdw.ac.at/I101/iea/klangprojektionen/en/rahmenprogramm/i_sinne.php
http://www.pomassl.com/
http://klangprojektionen.at/
viennanoiseorchestra.klingt.org
klangprojektionen.at
viennanoiseorchestra.klingt.org/auftritte/017_audible-tangible-design.html
viennanoiseorchestra.klingt.org/auftritte/020_go-sno.html
http://www.edelwiser.com/home/
http://dmg.tuwien.ac.at/winkler/
http://math.space.or.at/
http://www.hoer-akustik.com/
http://www.swfs.eu/index.php?id=295
skandinavistik.univie.ac.at/home/
http://www.swedenabroad.com/de-DE/Embassies/Vienna/Uber-Schweden/Projektarbeit-Schwedenspuren/
http://www.playdecide.eu/play/inspiringstories/1539
http://www.science-center-net.at/
http://www.erzdioezese-wien.at/content/news/articles/2012/06/21/a27832/
http://www.ep.liu.se/ecp_home/index.en.aspx?issue=073
http://homepage.univie.ac.at/wilfried.grossmann/
http://homepage.univie.ac.at/Karl.Anton.Froeschl/#english
http://cs.univie.ac.at/ec-team/infpers/Helmut_Hlavacs/
http://www.csg.ethz.ch/people/khummel
http://www.stanna.at/content.php?p=36
http://www.t-systems.at/
http://www.schulschiff.at/cms/front_content.php

http://medienportal.univie.ac.at/uniview/professuren/detailansicht/archiv/2011/October/artikel/univ-prof-mag-dr-manuel-sprung/
http://www.wjh.harvard.edu/~msprung/
http://igw.tuwien.ac.at/fares/Fares_Kayali/about.html
www.weloveomaa.blogspot.com
http://www.elia-artschools.org/Activities/teachers-academy-2012-porto
http://www.klaudiakozma.com/
http://www.experimonde.eu/
http://www.corneliabast.com
http://www.schmidtstahl.at/
www.dadax.org
www.dorisschamp.at
www.ruth-mateus.at
http://www.stitching-sessions.com

Participants and Experts. 2009: Math %26 Art %26 Design: The way Polynomiography things go

Performed at the conference: DIMACS, Rutgers University NJ, USA.
Participants: Petra Ilias, Walter Lunzer, Ao. Univ.-Prof. Ruth Mateus-Berr.
Mentor/experts: Prof. Bahman Kalantari, Prof. Georg Glaeser, Prof. Reinhart Winkler, Prof. James Skone.

Participants and Experts. 2010: Maths Goes Design

Performed at the Bridges Conference (Mathematics, Music, Art, Architecture, Culture) 2010, Pécs, Hungary.
Participants: Konrad Cernohous, Mag. Walter Lunzer, Dominik Gross, Prof. Jonathan Farley, ao.Univ.-Prof. Ruth Mateus-Berr.
Mentors/experts: Prof. Jonathan Farley, Dr. Michael Schreiber, Sebastian Prantl, Prof. James Skone, Franz Morgenbesser.

Participants and Experts. 2011: Math Goes Wherever/Math Goes Fashion

Performed at the Wiskunst Conference 2011, Sint Lucas University Gent, Belgium.
Participants: Konrad Cernohous, Mag. Petra Ilias, Mag. Walter Lunzer, Dominik Gross, Jasmin Schaitl, ao. Univ.-Prof. Ruth Mateus-Berr.
Mentors/experts: Prof. Dirk Huylebrouck, Prof. Reza Sharangi, Vy Hart, Prof. Reinhart Winkler, Prof. Kristof Fenyvesi, Dr. Michael Schreiber, Christian Leeb, Franz Morgenbesser.
Performed at the Bridges Conference (Mathematics, Music, Art, Architecture, Culture) 2011, University of Coimbra, Portugal.
Participants: Konrad Cernohous, Mag. Petra Ilias, Dominik Gross, Jasmin Schaitl, Klaudia Kozma, ao. Univ.-Prof. Ruth Mateus-Berr.
Performed at Pecha Kucha Night Vienna, Vienna Design Week.
Participants: Konrad Cernohous, Mag. Petra Ilias, Mag. Walter Lunzer, Dominik Gross, Jasmin Schaitl, Klaudia Kozma, Prof. Michael P. Schultes, ao. Univ.-Prof. Ruth Mateus-Berr.
Mentors/experts: Prof. Reinhart Winkler, Dr. Michael Schreiber, Prof. Georg Glaeser.

Participants and Experts. 2012: Applied Design Thinking Lab. 4 Layers of Sari

Performed at: Teacher's Academy ELIA, University of Porto 2012.
Participants: Cornelia Bast, Dr. Elisabeth Geymüller, Klaudia Kozma, László Lukács, ao. Univ.-Prof. Ruth Mateus-Berr, Prof. P. Michael Schultes, Marie-Theres-Wakonig.

Architectural Geometry

► Innovations in Geometry

Art

► Speaking Pictures: Innovation in Fine Arts

Art Education

► Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams

Art of Innovation: A Model for Organizational Creativity

Dimis Michaelides
Performa Consulting, Nicosia, Cyprus

Introduction

Innovation, the application of creativity to realize new value, can be applied to products, services, processes, business models, and more. It can be practiced systematically or selectively by individuals, teams, organizations, communities, cities, and societies. This entry is primarily concerned with innovation at the organizational level.

That innovation comes in different shapes and forms is highlighted by the list of 50 most innovative companies published in Businessweek for 2010 and compiled by the Boston Consulting Group(1). Quite clearly, innovation in IBM is very different from that of Apple and Google (all in the top 10), and Volkswagen, Toyota, BMW, Tata Group, Coca Cola, the Virgin Group, and Procter & Gamble (all in the top 25) innovate in a wide variety of ways.

While organizations approach innovation in many different ways depending on the characteristics of the industry, the business environment, company history, leadership style, and much more, it is safe to say that the most innovative organizations are *deliberately innovative*. Innovation is part and parcel of carefully crafted strategies and structures, and innovation constitutes an important company value, not only in words. And it is not only the stuff of start-ups. Even if the speed of innovation from new companies in recent years is little short of breathtaking, in many cases, large established firms have clear advantages over their smaller rivals in delivering innovation.

The Art of Innovation

The Art of Innovation (Michaelides 2007) is a model to integrate innovation in the way of life of organizations of all types: large and small, young and old, public and private, agricultural and industrial, consumer and business-to-business, etc.

It is based on the fact that it is possible to turn around uncreative organizations to make them more innovative – as has been well-documented in Whirlpool, for example (Snyder and Duarte 2003) – and that it is possible to make creative organizations more so – as the turnaround of IBM in the 1990s has shown to the world (Garr 2000). The Art of Innovation model examines the factors that drive innovation in an organizational context. These innovation drivers – 12 in all – are elements that organizational leaders must understand and promote if they want their organization to fully achieve its creative potential.

In this model, innovation is not a matter confined to the organization's top brass nor to the elite few in R&D or marketing or information technology. There is an innovation "potential" in every nook and cranny of all organization. In many organizations, much of this is untapped.

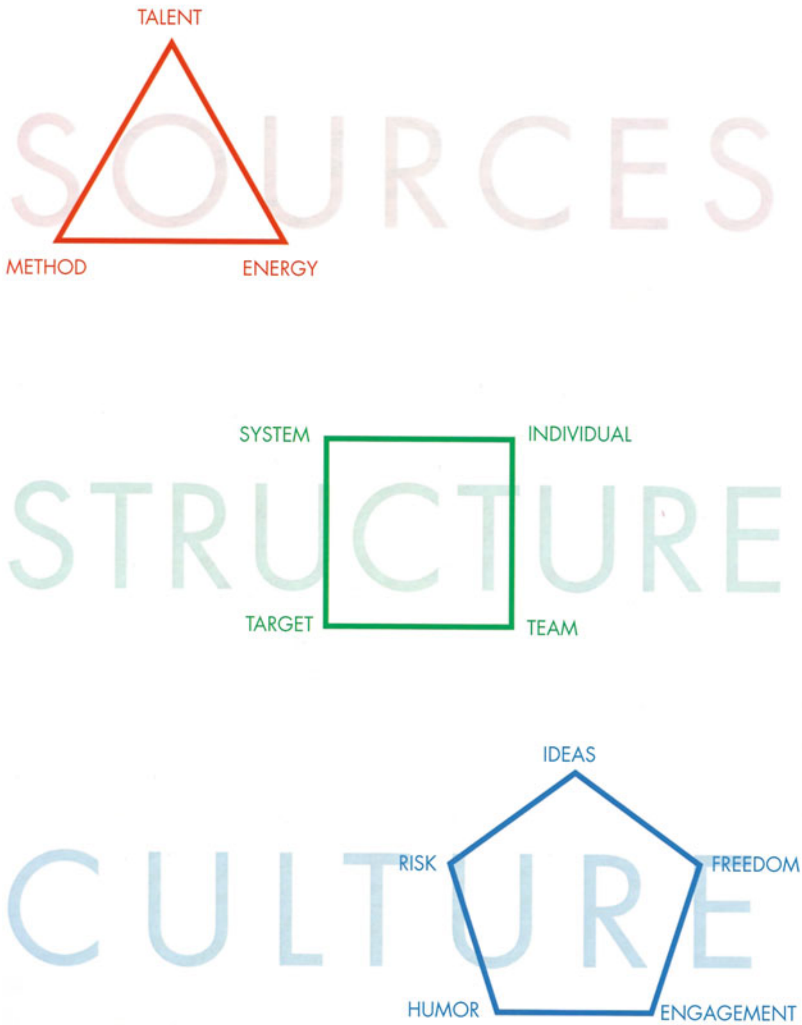
The Art of Innovation recognizes that innovation in organizations is a multidimensional affair whose achievement requires substantially engaging the creativity of all the people of the organization, as well as designing formal strategies and processes.

The Art of Innovation is schematically summarized by a triangle, a square, and a pentagon (see Fig. 1). The cornerstones of each shape consist of three, four, or five innovation drivers. The triangle represents the "sources" of creativity (talent, energy, method), the square represents the "structure" required to deliver innovation (individual, team, target, system), and the pentagon represents the "culture" that is appropriate to promote innovation (ideas, freedom, engagement, humor, risk).

The sources of creativity are the elements required for any purposeful creative act.

Talent is the set of skills required to imagine new things and make them happen. In this model, talent does not take on the conventional meaning, that is, an extraordinary ability or an exceptional "gift" in a particular area. In this definition, there is less concentration on Leonardos and Einsteins and more on "ordinary" human beings all of whom have creative competencies that can be developed and extended. And it is recognized that people are different, with different styles and preferences in the deployment of their creative faculties.

Energy is the personal resources people devote to an issue that is open to creative exploration and resolution. The definition of energy here is not Einsteinian nor is it metaphysical. Energy is a function of the determination to



Art of Innovation: A Model for Organizational Creativity, Fig. 1 The art of innovation

achieve a certain outcome and time. It is highly personal, varying with what each individual is passionate about, and at the same time quite social, varying with the social context and the people involved.

Method is the purposeful approach to creatively addressing challenges. It is the box that gets us out of the box, a call for open imagination and design as well as a call for reason and judgment. It involves destructuring and restructuring challenges to discover their essence and to see problems from many different points of view. It involves active idea generation and stretching the mind. And it requires regrouping and retrenching so that the best solutions can be appraised in depth and turned into concrete action plans. A number of creative methods have been put forth over the years, most importantly the Osborn-Parnes model which divides the problem-solving process into sequential stages and argues for the systematic practice of divergence (creative thinking) and convergence (critical thinking) at each stage (Parnes 1992; Osborn 1964).

The structure of innovation is the organized context in which creativity happens (Fig. 2).

Art of Innovation: A Model for Organizational Creativity, Fig. 2 The art of innovation overview: 3 categories, 12 elements

SOURCES	**The elements required for any purposeful creative act**
▲ Talent	The set of skills required to imagine new things and make them happen
▲ Energy	The attention or personal resources we devote to an issue
▲ Method	An efficient way to creatively confront challenges
STRUCTURE	**The organized context in which innovation happens**
■ Individual	A person separate from other persons and possessing his/her own needs, goals and desires
■ Team	A group of human beings interacting at a high level of maturity to create novel and useful solutions to challenging problems
■ Target	Clearly defined organizational, team and individual objectives
■ System	The mechanism by which new ideas are collected and exploited
CULTURE	**The behaviors, values and norms that favor the generation and implementation of valuable new things in an organization**
⬟ Ideas	Thoughts, concepts, insights, new ways of understanding - the foundation upon which creative cultures are built
⬟ Freedom	Open debate, minimal rules and regulations, empowering jobs
⬟ Engagement	The unwritten contract between the employer and employee to help each other grow
⬟ Humor	The magic ingredient which enables seeing things from different viewpoints
⬟ Risk	Encouraging action, accepting and learning from mistakes

The *individual* is the being distinct from all others from which creative thinking and action emanates. It is most important to understand what drives individuals at work. While many factors are at play, it is quite clear from the work of Amabile and Kramer (2011) and Mihaly Czikszentmihalyi (1990) that creativity thrives when a person is intrinsically motivated by the pleasure and challenge invested in a task or responsibility he or she enjoys for itself. That is, what will most powerfully generate and maintain high levels of creative energy.

Teamwork, in the context of innovation, is more than a set of individuals working efficiently together. Good teams work with trust, have the know-how to resolve conflicts, and are committed, accountable, and centered on well-defined goals. However, it is true that good teams may also indulge in efficient but repetitive behavior with unspectacular outcomes. With the help of an innovative mind-set and creative method, good teams can become innovative teams – that is, groups of people that are outward-looking and ready to invent new things, new ways of doing things, and even to reinvent themselves.

Recognizing and effectively managing the trade-offs and tensions that are inherently present between individuality and teamplay is important. An innovative team needs to work like a good team but must go a step beyond to encourage debate and dissent as opposed to conformism and groupthink. It should also recognize the value of alternating team creativity with stretches of individual creative reflection.

Target is the meaningful purpose given to innovation. Innovation lies on a continuum between radical, game-changing breakthroughs and small but continuous improvements in well known and tested processes. So, a key question people in every organization engaged in innovation must ask is what does innovation mean for our organization? Where do we lie on the continuum? What innovation efforts do we expect from our people – from each department, team, and individual? And what innovation outcomes do we expect to achieve as an organization? The answers to these questions (which are not always easy ones) will determine an explicit incorporation of innovation in the organization's strategy and enable a dialogue on creativity that goes far beyond the oft-repeated (and often useless) exhortation "be more creative." And they will highlight the trade-offs between operational excellence and innovation for the future.

The final structural element is *system* – the organized way by which ideas are collected, appraised, and implemented. Many different types of systems are being practiced in organizations today. Companies like 3M and Google famously offer their employees time to think up new products. Toyota has a very well-run staff suggestion scheme that achieves excellent results. Some companies are reaching beyond organizational boundaries to clients or suppliers and even their families: such has been IBM's Innovation Jam – a global call for ideas – or Procter & Gamble's Connect and Develop – a sophisticated scheme for intelligent outsourcing and value generation for their R&D.

The culture of innovation is the set of values, behaviors, and norms that promote innovation in organizations. Also referred to as "creative climate," those intangible factors promoting innovation have been well researched notably by Teresa Amabile (1996) and Goran Ekval (1996) in recent years. Culture is perhaps the hardest thing to change, especially in old companies with a tradition of success, and clearly, leaders' own attitudes, thoughts, and actions are crucial for setting cultural norms.

Ideas are the first cornerstone of culture. Quite simply, a creative culture is, above all, one that values new ideas, and simple lip-service is not enough. Often, novelty is a source of profound discomfort. Not only because new ideas take people away from familiar territory out of their comfort zones, but also because new ideas are often irrational in their conception (Koestler 1964). A good idea is always logical afterward. Before it is tested however, it may seem unfeasible or even absurd, and irrationality is not a good friend of the analytical business mind. Valuing and loving new ideas means being comfortable with ambiguity and accepting that for one good idea one needs many ideas.

Freedom is also vital for creativity. This does not mean that creativity can only thrive in environments that are free of all constraints (indeed, highly creative acts have been carried out in condition of harsh repression too), and absolute freedom also challenges the very concept of an organized environment and of an organization itself. It means that a reduced rulebook cleansed of absurd regulations and procedures, encouragement of open debate, and job definitions that are open to be stretched all the time are more like to create conditions that are more fertile for innovation to happen.

Engagement is the unwritten contract between the organization and the employee to help each other grow. It is a two-way pact. It need not guarantee lifetime employment, but it does demand very high levels of trust, integrity, and fairness and places responsibilities on both parties. An employee seen as a partner is more likely to be creative than an employee treated as a contractor.

Humor has a funny relationship to creativity. Light heartedness and play are conducive to creativity and have been shown to be highly present in companies with high innovative outcomes (Koestler 1964). In a more profound way, humor has the same logic as creative discovery: it obliges us to see things from new perspectives.

Risk is the bad news and the last important driver of innovation, which is rarely possible with zero risk. Accepting risk does not mean creating a culture of death-defying stunts. Like freedom, risk must be taken in measured doses. There should be zero tolerance for risk when the results can possibly be devastating. In most business situations however, encouraging reasonable risks throughout the organization is a good idea and the downside manageable. This means coming to terms with mistakes and with failure and making every positive effort to learn from mistakes and failures. Innovations have rarely come from environments in which people permanently write memos to cover themselves. At long last, it seems that business orthodoxy is accepting that success comes with the unavoidable company of many failures, and even the Harvard Business Review had an issue on failure this year (HBR 2011).

Sources, structure, and culture are intimately interrelated. In practice, it is often through work on sources and structure that a new culture will be shaped. A *system* that teaches creative *method* and rewards *individuals* and *teams* for generating and implementing new *ideas* and *free*, clear dialogues on innovation *targets* will go a long way to shaping a creative culture.

Conclusions and Future Directions

Innovation in organizations should be seen as a means to an end, not an end in itself. Innovation serves strategy, progress, competitiveness, survival, profitability, well-being, and the achievement of so many other worthy goals, as innovative people add value by imagining and implementing new things. Innovation in organizations can be conceived and experienced in many very different ways.

The Art of Innovation provides a framework for understanding and leading innovation at the organizational level. It is valid for private as well as public organizations (Michaelides 2011). However, life in an organization is more complex than any model can convey, and the 12 innovation drivers of The Art of Innovation model do not manifest themselves in a tidy order. There is no sequential "how to" for an organization trying to become more innovative. Rather, it is the synthesis of the elements of this model that makes an organization innovative. As argued at the beginning, innovation is a multidimensional affair, and leaders must make sure that all the innovation drivers are addressed adequately.

Many leadership challenges arise from this model. Diagnosing the strengths and weaknesses of the organization on each innovation driver is a good starting point. Gauging the relative importance of each innovation driver is then called for, because this may vary significantly depending on the specific circumstances of the organization. And the action plan, while taking into account the model and the diagnosis, will always be unique to each organization.

By promoting understanding and dialogue around the holistic nature of innovation and providing a multiple-level approach to this important subject, *The Art of Innovation* offers a pathway to developing organizational creativity in a substantial way.

Cross-References

▶ Business Creativity
▶ Corporate Creativity
▶ Corporate Entrepreneurship
▶ Creative Behavior
▶ Creative Collaboration
▶ Creative Leadership
▶ Creative Management
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity Management Optimization
▶ Entrepreneurial Organizations
▶ Four Ps in Organizational Creativity
▶ Product Innovation, Process Innovation

References

Amabile T. Creativity in context: update to the social psychology of creativity. Boulder: Westview Press; 1996.

Amabile T, Kramer S. The progress principle: using small wins to ignite joy, engagement, and creativity at work. Boston: Harvard Business Press; 2011.
Bloomberg Businessweek & Boston Consulting Group. 50 most innovative companies 2010, Apr 2011.
Czikszentmihalyi M. Flow: the psychology of optimal experience. New York: Harper & Row; 1990.
Ekval G. Organizational climate for creativity and innovation. Eur J Work Org Psychol. 1996;5(1):105.
Garr D. IBM Redux: Lou Gerstner and the business turnaround of the century. New York: Harper Paperbacks; 2000.
Koestler A. The act of creation. London: Hutchinson; 1964.
Michaelides D. The art of innovation – integrating creativity in organizations. Nicosia: Performa Productions; 2007.
Michaelides D. The art of innovation in the public sector. Int J Innov Sci. 2011;3(3).
Osborn A. Applied imagination: principles and procedures of creative problem solving. Buffalo: Creative Education Foundation; 1964.
Parnes SJ, editor. Source book for creative problem solving: a fifty year digest of proven innovation processes. Buffalo: Creative Education Foundation; 1992.
Snyder NT, Duarte DL. Strategic innovation: embedding innovation as a core competency in your organization. San Francisco: Jossey-Bass Business & Management; 2003.
The failure issue. Harvard Business Review, Apr 2011.

Artificial Intelligence

► State Space Paradox of Computational Research in Creativity

Artistic Research

Alexander Damianisch
Support Art and Research, University of Applied Arts, Vienna, Austria

Arts-based Research, Development of the Arts, Applied Arts, Expanded Research, Implicit Knowledge, Practice Based Research, Research in the Arts, Research through the Arts, Research on the Arts

The aim of this entry is to present basic thoughts regarding practices of artistic research with the objective to describe specific criteria pertaining to this specific process of knowledge production. References to considerations regarding the philosophy of science are possible, but not intended as a demarcation to the further thoughts presented that make up the central element of the entry. Central topics of artistic research are brought into focus, evaluated, and used to generate specific processes for knowledge development. After a brief thematic introduction to the topic and an attempt to a "mapping of artistic research," specific aspects are described in the "setting of artistic research," followed by the thoughts regarding concrete "modes of artistic research," and concluded through execution in the form of a "conclusion and future directions."

Introducing

The following quotation by Cannonball Adderley, introducing *doctor honoris causa* by Joe Zawinul, offers a thematic initiation: "This piece of music is dedicated to Herbie Hancock in honour of his alma mater having awarded him an honorary doctorate degree, which is some other kind of establishment virtue when you dig it, you know, but… Herbie excepted it so under the circumstances who are we to question it. Yeah, his thing you know… so what was this thing in Iowa… Grinell College… come on… Grinell college says that Herbie Hancock was worthy of an award from them by their standards so under this circumstance it must be cool. So this ones is called *doctor honoris causa*."

This passage illustrates the open-ended stance of artistic context, in which insight-oriented actions can unfold, therefore be used in an academic context (Adderley 2012). Standards are developed practically, which also goes for academic considerations and would, as a result, create scope for developments that often unfold themselves if given the necessary disenthrallment. This is also possible for the world of art itself. Thus, in the focus of the orientation of the dOCUMENTA (13) of 2012, which was, for example, stated in a text presented in the entrance hall of the Fridericianum in

Kassel, it said: "dOCUMENTA (13) is dedicated to artistic research and forms of imagination that explore commitment, matter, things, embodiment, and active living in connection with, yet not subordinated to, theory. These are terrains where politics are inseparable from a sensual, energetic, and worldly alliance between current research in various scientific and artistic fields and other knowledges, both ancient and contemporary. dOCUMENTA (13) is driven by a holistic and non-logocentric vision that is skeptical [!] of the persisting belief in economic growth. This vision is shared with, and recognizes, the shapes and practices of knowing of all the animate and inanimate makers of the world, including people (C. Christov-Bakargiev)" (doCUMENTA (13) 2012, p. 2).

Mapping of Artistic Research

Every research practice unfolds itself systematically in front of a specific background. The clarifying of this plays an eminent role for the development of further steps. The number of possibilities of artistic practices – for example, in diverse aesthetics as individual theories of art – is unlimited, with it, the practice framework of potential theory. That theory, per se, can be seen as a practice, and in many cases, it is understood as such – theoretically as well as practically – which goes without saying. In the aforementioned context, theory is understood as the explicit reflection and therefore clarification of the perception and subsequently implementation of the research context to negotiate phenomena. As a theory of the research praxis, it is necessary for the respective team to develop a framework, which subsequently formulates the context for further approach and understanding.

Compared to an exclusive approach, an eclectic-integrative approach is preferable. With recourse to the segment of arts, one could attempt to embed artistic research in the framework of the productively understood aesthetic term. In relation with an epistemological access, which pleases constructive openness, this would be a possibility for theoretical approaches. It is important not to develop something new with the aid of historical forms, but to introduce formally through radical paradigmatic and that in theoretical anticipation. With this theoretical open-endedness, the compatibility within the parameters of artistic approaches is even bigger as compared to the parameters of classical research theories. The reason lies within the idea of disciplining which especially here brings upon motivation, to always overcome this new fact, to work against a static consolidation of knowledge, because it all depends on lively handling, accountability and its description. Endeavors can be assigned to, if an academic approach is followed to the subjects of arts and media, design, architecture, literature, music, or performing arts. This fact also highlights the importance of the preceded quote by Adderley. Especially beautiful is the fact that Herbie Hancock was not only honored but he honoured his college by accepting the price through his doings and his artistic praxis. His standards have prestige, which caused experts like Cannonball Adderley and Joe Zawinul to recognize this connection and – even though in an ironic tone – made it a subject of their work. This shows that the establishment of disciplines and their inner rules and recognition is a question of practical unfolding.

The next adequate step to proceed without maintaining a fixated order is expansion. Accordingly, the discipline is in the best case scenario – as described from the perspective of OECD in the Frascati Manual – only a reactive attempt to justify current developments, but is unable to set a trend-setting standard for concrete activities. That also shows that since 2011, several actors support artistic research, which was however ignored in the given portrayal. Artistic research is not mentioned as a discipline in the Frascati Manual and is explicitly excluded from section 6.3 of the "other humanities," which states: "Other humanities [philosophy (including the history of science and technology), arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S&T activities relating to the subjects in this group]" (Frascati Manual 2002).

Artistic research in this sense has to be considered as undisciplined. Artistic work focuses respectively only on the involved competencies around existing boundaries. Everything else can and must be developed as a means of a purpose. It is noteworthy how classical methodological approaches in when considering new possibilities shift their focus to take upon new liberties and radically shift from research to art. In this context, sensitive points should be identified as the shifts are taking place. Robert Musil is the author of the epochal novel "The Man without Qualities." After an excellent research carrier, he shifted to literary work, which can be interpreted as an example for a consequent critique at research disciplines.

Not reflecting theoretical parameters beforehand would bring upon the danger of making the operation of artistic research ambiguous; the work cannot be understood productively. An effort without detailed orientation would move the framework of comprehension in a direction that was not intended, particularly when it comes to teamwork. As a matter of fact, such a fundamental theoretical positioning does not exclude the possibility for revision; on the contrary, it enables the possibility to change the stance.

Setting of Artistic Research

Artistic research continuously dedicates itself to a present problem and emphasizes on gaining insight; the reason for this presence is individual as is the aiming for insight. The formulation of a question is crucial for any kind of research, often in conjunction with a concrete working hypothesis, whereupon follow-up questions unfold dynamically. Using hypotheses and thereby anticipating a direction can be a necessity, but also poses a problem in the development of further questions. Therefore, the importance and impact of the hypothesis orientation process should be dealt with sensibly. What is often referred to as "blue sky research" in other approaches is actually also the description for the approach of an artistic method. Thereby, artistic research should also be allocated to the range of basic research, or perhaps, even in a more radical sense, as an antecedent to basic research. In this context, one could say that the talk is about applied arts, which also has the possibility in itself to develop in the direction of basic research as well as application-oriented research.

Initially, potential should not be restricted during the development of the research question, in which the selection or definition process narrows down the focus already. A way out of this definitional narrowing could be not to look at the formulation of the hypothesis of the research as a prefixed moment but as a part of the research process. Therefore, the decision regarding the research question would be the subject of the research process making it a disputable step with the possibility of correction.

In a subsequent step after the clarifying of the orientation related to the research question – on the basis of an adequate theoretical foundation, through the use of sufficient competencies and skills, and under the recourse possibility using specific methods – a specific research design is developed. Art does not primarily represent the research subject – even though it is possible – but it presents itself as an orientating factor of the research entity, which is necessary and is to be understood as a definite.

This open-endedness is a prerequisite. It is obviously possible that a work of art turns out to be a part in the research process. The implementation of an artistic work in the research context is no requisite for the aforementioned, but could be possibly necessary. References to such specific examples must be done without. A good presentation – including reflections of examples – is offered by Dombois et al. (2011), or also on the online platform (http://www.research-catalogue.net/), as well as the project data bank of the FWF, an example of national promotional activity (http://www.fwf.ac.at/de/projects/projekt_datenbank.asp) or at the list of research projects supported by the University of applied Arts Vienna (http://www.dieangewandte.at/jart/prj3/angewandte/main.jart?rel=de&content-id=1354136817169&reservemode=active).

In any case, the goal of artistic research is the development of possible forms of insight. This can be shown directly or indirectly. In the second case, it is obviously not the direct formulated and therefore transferable knowledge; in the first case, it is the explicable and, therefore, direct formulated knowledge. It is worth emphasizing that through the knowledge process via artistic research the input is general best described by Novalis as "Idea Paradise." Novalis writes: "In every system – individual group of thoughts – which may either be an aggregate or a product etc. – One idea, one observation, or several such, have especially flourished and stifled the others – or have remained over. We must now gather them together in the system of spiritual Nature – granting each its own specific soil – climate – its particular cultivation – its specific neighbourhood – in order to form a paradise of ideas – this is the true system. /Paradise is the ideal of the earth" (Novalis 2007, p. 165).

It is important to always remember that artistic research does not stake out a claim to be in accordance with rules whose critique since no later than Paul Feyerabend has become subject to continuous struggle in developing new room for knowledge. In a preventive manner, pseudo- or proto-research preliminary tests should not be constructed at the cost of artistic research.

Insight describes itself in extreme modesty as the perception of correlations, which adjust directly or indirectly. The determination of the degree how the correlation can be or should be made more explicit is a deciding factor, through which the distinctiveness of artistic research can be presented. Artistic processes, the way they are implemented in the artistic practice, can, through their follow-up strategies, develop the unclear, thus primarily making the noticing of correlations possible indirectly, and, through such an aporetic process, develop new possibilities.

Similarly, the concept of Zen-Buddhism developed Kōan is a relevant example, especially in the research context: "Masagin juts forth!/ Words are intimate and the mind is even more intimate./He who speaks about right and wrong./ Is a man of right and wrong" (Yamada 2004, p. 89). On the other hand, it could also be possible that artistic work as a subject of a continuous enterprise is unfolded in the following steps. Artistic research should deal with its own historically developed freedom with caution. At the same time, it should stay impartial and continue providing potential as a platform for knowledge.

Modes of Artistic Research

The selection of the methods used for the practical implementation of a specific purpose for artistic research is determined by the actual practice, whereby the preparatory argument along with the theoretical setting provides a strong pillar for the procedure. A research that understands and defines itself artistically demands artistic methods as a crucial component. The disciplinary procedure is not defined by the subject of research, but by the specific method that is applied. Accordingly, it is not the object, but the subject, that determines this allocation. When dealing with a research question that requires methods that are not exclusively artistic, it is questionable whether it can be considered artistic research, even if the research question was developed by an artist or for an artist. But since there are no defined borders, the development of artistic positions can integrate highly diverse practices in the unfolding of knowledge-oriented processes for artistic research.

It is preferable to use an indicative hierarchy as a foundation. The perception of experts is the central orientation point, which is subject to permanent adjustment. In short, those who are concerned understand best what to do and how to do it. However, it is possible for a new methodological practice to develop itself so naturally that it is understood as an artistic method instantaneously. On the other hand, the artistic practice can alter itself in a way that unrelated elements advance into the practice, possibly developing a special "career." This inclusive and exclusive open-endedness should always be a possibility.

Other than the aforementioned terms, infrastructural conditions also contribute to the configuration of the artistic process. It is possible to classify these into static and flexible factors.

Under static factors, space, location, and time are to be considered; under flexible factors, financial resources or material availability is to be considered. Of more significance than infrastructural conditions are actors for the development of specific methods in the case of artistic research. Every actor involved brings forth specific possibilities in a project. This circumstance is particularly relevant when it comes to taking into account indirect competencies. Competencies are a question of skills and abilities as well as a result of knowledge, explicit and embodied (indirectly); albeit the training in the field of arts is always closely related to overcoming the given factor through skills or making ideal use of these given abilities, the development of skills through training in every field is of vital importance. Hence, people use their competencies as the key medium for the generation of actual potential and therefore in the development of knowledge beyond the anticipated output. The question of corporeality with regard to seeking out all competencies plays an important role. The development of practices in this sense for artistic research is a central element, especially in comparison with other disciplines of research practices, highlighting a critical difference.

Whoever is competent for a specific project possesses adequate skills and abilities. The action on the basis of this competence is dependent on different abilities; it is noteworthy that constant objectification takes place and therefore crafting or being crafted can be synonymous. This also corresponds to the circumstance that in the process of artistic research, not only the research subject but also the ongoing research should be viewed as subject matter. This may also be the case in the so-called classical disciplines, but in this particular scenario, it is either about special spectacular cases and not the rule or it is seen differently than in the arts as an unorthodox conduct. The interaction between the research subject and the research object should be taken into account as it provides a fundamental necessity in the establishment of a knowledge-oriented arrangement.

The core of the defining factors of an artistic practice, in addition to the existing resources, comprises of further conditions. Generally, these further contexts can be described as an interrelated web that contains and surrounds the practice. It presents itself on one hand in the form of explicit cooperation and on the other hand, in the form of spontaneous external influences. The former more or less refers to anticipated relevant occurrences, with the latter rather referring to surprising aspects which could become relevant.

Conclusion and Future Directions

Failed research and art without art both can provide new possibilities through artistic research, because it is about new approaches and open-ended results. It is always necessary to use open-endedness through artistic methods in order to unfold creatively. Fact is that artistic research, along with artistic methods, generates work of art; however, it is not obligatory to do so which is an essential differentiation. Just like in other disciplines – in the same sense – failure is always and should be a possibility when it comes to conducting research, as this produces an opportunity to search for a solution in other disciplines. This is therefore an open interplay between structure and flexibility, in which any project is subject to artistic research, and this demands a procedure, which is oriented through flexibility and openness, always striving to reach new grounds to be achieved in such a way that justifies the current research question legitimately. This "legitimacy" does not demand a response through virtuous explicit developed answers, but it provides a horizon that never yields back providing unattainable knowledge. Therefore, besides all competences that can be learned through dexterity, the development of open competences should be encouraged; this is valid for actors as well as the entire associated framework. Artistic research is a research practice, which integrates artistic components as integral parts, taking up integrative competences, and therefore broadens the horizons for insight-oriented praxis and also expands the subjects in possible disciplines. On this subject, direct and indirect forms of knowledge play an equal role, and unclear relations are used productively.

An exclusive approach cannot be an exit strategy or goal for artistic research practice.

The understanding of the connection of art and insight in the sense of artistic research as well as the explicit development of the relations makes it possible that the knowledge circumference covering the art and its application is followed by artistic research practice, and this can therefore serve as the innovation for basic research. The innovation lies therein that if the application is not thought along the lines of the product, art would be mode minus 2 and artistic research mode minus 1, whereby the innovation of artistic research would also be associated to applied arts. This thereby provides an interface to be preserved in its freedom and to be used creatively. It is not about the development of products, designs, or objects, but about effective matting in the broadest sense. In order for this to be possible, it needs a special development of an epistemic governing structure also for artistic research. Shaping this freedom in the sense of a creative present for everyone's purpose is dependent on the future.

Cross-References

▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Cognition of Creativity
▶ Craftsman
▶ Creative Collaboration
▶ Creative Knowledge Environments
▶ Creative Management
▶ Creativity and Innovation: What Is the Difference?
▶ Epistemic Governance and Epistemic Innovation Policy
▶ Interdisciplinarity and Innovation
▶ Interdisciplinary Research (Interdisciplinarity)
▶ Nature of Creativity
▶ Nonlinear Innovations
▶ Open Innovation and entrepreneurship
▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
▶ Research on Creativity
▶ Role of Intuition in Creativity
▶ Science of Creativity
▶ Speaking Pictures: Innovation in Fine Arts
▶ Transdisciplinary Research (Transdisciplinarity)
▶ Translational Research

References

Adderley. vgl. http://en.wikipedia.org/wiki/Herbie_Hancock#cite_ref-7. 2012-07-17.

doCUMENTA (13): Das Begleitbuch/The Guidebook. Katalog/Catalog 3/3. Ostfildern 2012.

Dombois F, Bauer UM, Mareis C, Schwab M, editors. Intellectual birdhouse: artistic practice as research. London: Walther König; 2011.

Novalis DWW. Notes for a Romantic encyclopaedia: Das Allgemeine Brouillon. Albany: Suny Press; 2007.

Organisation for Economic Co-operation and Development: Frascati Manual - Proposed Standard Practice for Surveys on Research and Experimental Development. Paris: OECD; 2002.

Yamada K. The gateless gate: the classic book of Zen Koans. Boston: Wisdom Publications; 2004.

Art-Math

▶ Polynomiography and Innovation

Associationism Worker

▶ Entrepreneur in Utopian Thinking

Asynchrony

▶ Conflict and Creativity

Attention Deficit Disorder

▶ Attention-Deficit/Hyperactivity Disorder and Creativity

Attention Deficit Hyperactivity Disorder

▶ Attention-Deficit/Hyperactivity Disorder and Creativity

Attention-Deficit/Hyperactivity Disorder and Creativity

Jean-Pierre Issa
International Center for Studies in Creativity, Buffalo State College, State University of New York, Buffalo, NY, USA

Synonyms

ADD; Attention deficit disorder; Attention deficit hyperactivity disorder; Hyperkinesis; Hyperkinetic disorders

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a disorder marked by impairing levels of either (1) inattention, (2) hyperactivity and impulsivity, or (3) both combined. Despite these impairments, some clinicians and the authors of some of the most popular ADHD self-help books have asserted that this disorder comes with high levels of creativity. Similarly, giftedness specialists have observed and written about high incidences of ADHD traits in the creatively gifted population. In addition, high-profile entrepreneurs have publicly credited their ADHD for their high creativity and entrepreneurial success in major North American media outlets such as The New York Times and USA Today. Prominent examples have included David Neeleman, founder of JetBlue airlines, and Paul Orfalea, founder of Kinko's (now FedEx Office). However, there has not yet been much empirical research to support these claims of concomitant creativity, and some prominent ADHD researchers fear that this is a detrimental romanticization of a serious disorder.

The purpose of this entry is to describe the state of the research on the creativity of children and adults with ADHD and to touch upon its potential implications for personal creativity, workplace innovation, and entrepreneurship. To understand the context, this will be preceded by (1) a definition of ADHD and creativity, (2) a layout of the heated debates that frame and influence the research, and (3) the hypothetical parallels between ADHD and creativity that remain largely outside empirical investigation.

Key Concepts and Definitions

ADHD

Attention-deficit/hyperactivity disorder is a classification of the American Psychiatric Association (APA) published in its current *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR) (APA 2000) for a condition that affects approximately 3–5% of the global population, according to most estimates. To meet diagnostic criteria, there must be evidence since childhood of inattention and/or hyperactivity and impulsivity that is more frequent and severe than people of comparable age and background – to the point that social, academic, or occupational functioning is significantly impaired. It is divided into three subtypes: (1) primarily inattentive, (2) primarily hyperactive-impulsive, or (3) both combined. Symptoms must be observed before the age of seven (though some clinicians point out that sometimes impairments are not noticed until adolescence, when more self-management is expected). To meet diagnostic criteria, the traits described above must be pervasive enough to cause problems in at least two life settings such as at work, play, school, or home. The following is a breakdown of the three ADHD subtypes.

- ***Predominantly inattentive ADHD type*** is still commonly referred to as simply attention deficit disorder (ADD), which was its formal clinical name until 1987. (Another point of confusion is that some clinicians and manuals still use ADD as an interchangeable umbrella term for all three ADHD types.) Common criteria of inattention in diagnostic manuals include: often having trouble organizing activities and completing tasks, making mistakes at work or school from not paying close attention to detail, being forgetful in daily activities, being easily distracted, having trouble sustaining attention on tasks and following instructions, and often losing things. It is common for people with this ADHD type to be called "daydreamers," "absentminded professors," or even "space cadets" by others.

- ***Predominantly hyperactive-impulsive ADHD type*** includes as its criteria: excessive talking, often being "on the go" or acting as if "driven by a motor," having trouble enjoying leisure activities quietly, running or climbing about when not appropriate (or in adulthood, feeling very restless), fidgety hands or feet, and often getting up when seating is expected (or in adulthood, a feeling of inner jitteriness). Impulsivity is described as often interrupting or intruding on others (such as in conversations or games), having trouble waiting one's turn, or blurting out answers before questions have been finished. As children, these individuals may have been seen as the "class clown," often getting in trouble with teachers, parents, and peers because of their impulsive behaviors. These symptoms can lead to breaking rules at school, at home, and among peers, and often they are seen as tactless in social interactions. There is considerable overlap between hyperactive-impulsive types and both conduct disorders and oppositional defiant disorders, with up to half of these children also getting diagnosed with one of those disorders. This can continue into adulthood, and some even estimate that about half of the US prison population struggles with this disorder.
- ***Combined inattentive ADHD and hyperactive-impulsive ADHD type*** is a combination of the two above types. It roughly corresponds to what the World Health Organization (WHO) classifies as *hyperkinetic disorder (HKD)*. This is published in its International Classification of Disease (ICD-10), which is more widely used outside North America.

Because there is so much diversity in how the varieties of ADHD manifest, describing typical ADHD traits and behaviors can seem like an exercise in contradictions. This sometimes poses difficulties both for conducting research and for public understanding and acceptance of the disorder. Compounding this challenge is the - growing understanding that the *primarily inattentive* ADHD type may be a different neurobiological phenomenon altogether from the other two types.

Though the root causes of ADHD are still not fully understood, the most common form of treatment is the administration of stimulant drugs that are thought to work by activating the executive functioning parts of the brain that regulate attention and control impulsive behavior. Therapy and coaching are also recommended in order to put in place healthy coping habits and to deal with maladaptive psychological and emotional patterns that often accumulate before diagnosis. These can run deep – until diagnosis, the chronic underachievement and social rejection that is often experienced by the sufferer is frequently attributed by his or her social circles to low intelligence or to perceived moral failings such as laziness or intentional misbehavior. These perceptions are often internalized by the sufferer, leading to problems of self-esteem.

There is widespread misunderstanding of ADHD due to its somewhat misleading name. It is often said that ADHD is more accurately a problem of *attention control* or *attention inconsistency* than an *attention deficit*. People unfamiliar with this disorder may be surprised to learn that people with ADHD can usually pay great attention to things that interest them. For this reason, the APA's diagnostic manual advises clinicians to be conscious of situational factors in making a diagnosis because ADHD symptoms worsen in situations that lack intrinsic appeal or novelty, as well as those that require sustained attention or mental effort. On the other hand, symptoms may decrease or disappear altogether when engaged in especially interesting activities, in one-to-one situations, when under close supervision, when frequently rewarded for appropriate behavior, and when in novel settings.

What may be especially significant here are the roles of intrinsic appeal and novelty – also found to be important motivating factors for the highly creative. However, sustained attention and mental effort are also important in following through on potentially creative ideas. A reduction in this capacity – if present even in areas of intrinsic interest or novelty – could be a factor that may hamper creativity in those with ADHD.

Creativity

Though creativity is complex and difficult to define, researchers have come to a consensus that for something to be considered creative, it must have at least two essential elements: (1) *originality (novelty, newness)* and (2) *effectiveness* (*value, usefulness, meaningfulness*). Despite an ongoing popular bias to associate it principally with the arts, creativity – *originality* that has *effectiveness* – can happen in every conceivable domain, whether it be in social interactions, machinery design, starting a business, developing mathematical theorems, cooking, composing music, or leading political movements, to name a few diverse examples.

Studies of creativity are often classified as either studies of *creative person*, *creative process*, *creative product*, or *creative environment*. Because most claims of high creativity in people with ADHD fall under the first category of *creative person*, it is important to examine what this means. Although everyone is capable of creative behavior, what usually earns someone the designation of *creative person* both in and outside of the field of creativity is a matter of degree, i.e., significantly higher than average levels of creative behavior in frequency and/or in caliber. Creativity researcher Gregory Feist proposed an operational definition that is in line with much of the field of creativity by describing a creative person as *one who has personality dispositions that makes creative thought and behavior more likely*.

One last concept to keep in mind when pondering creativity in ADHD is what Mark Runco and others have called *pseudo-creativity*, described as potentially original behavior, but arising mainly from lack of inhibition, luck, or contrarianism for the sake of being different. Although this may seem like creative behavior to a casual observer, if this potentially original behavior has no effectiveness in self-expression or problem solving, it cannot be called truly creative.

Current Debate and Cultural Context

Creative Because of ADHD

One side of the debate contends that most people with ADHD are highly creative largely *because* of their ADHD. Clinicians and ADHD self-help book authors often see this high creativity as a boon for strengths-based therapy – providing patients with increased self-esteem and hope. This notion entered mainstream awareness with the bestselling 1994 publication of *Driven to Distraction: Recognizing and Coping with Attention Deficit Disorder from Childhood Through Adulthood* by Harvard psychiatrists, Edward Hallowell and John Ratey (1995). There has also been a related concern since the 1970s that the misdiagnosis of creative people with ADHD and the ensuing treatment may hamper an inherent creativity. It is also common to hear speculation among giftedness specialists that many of humanity's creative geniuses (e.g., Leonardo da Vinci, Thomas Edison) might have met today's diagnostic criteria for ADHD – and that we should therefore be especially careful when diagnosing gifted children, many of whom tend to display ADHD characteristics.

Creative Despite ADHD

The other side of the debate contends that if some people with ADHD are creative, it is *despite* their ADHD. Some ADHD researchers and clinicians, most prominently Russell Barkley (see Barkley et al. 2008), oppose the notion that people with ADHD are inherently more creative for the following reasons: (1) The notion that those with ADHD are highly creative is based on potentially biased clinical observations. (2) Empirical research on this topic has been historically inconclusive. (3) The idea that ADHD includes high creativity may discourage those who suffer from ADHD from seeking treatment for their disorder, which many studies have shown can have devastating and even tragic effects if left untreated. (4) There is also concern that if the public believes that people with ADHD have an inherent creative advantage, it may discourage societal support for therapeutic research funding as well as legislation for the academic and occupational accommodations that ADHD children and adults often need.

Theoretical Parallels Between ADHD and Creativity

Most theoretical parallels that have been observed between highly creative people and the ADHD population fall under the categories of neurocognition, personality, and entrepreneurial temperament. Though some of these suggest possible overlapping etiologies – perhaps even at the gene level – there is almost no *direct* empirical research comparing these parallels between the two populations, except for budding research that has begun to assess certain dimensions of personality.

Neurocognitive Parallels

The three principal neurocognitive parallels have been related to (1) wide attention and decreased latent inhibition, (2) underarousal and novelty seeking, and (3) atypical brain asymmetry. (These have also been found to have some parallels with other disorders such as schizophrenia and bipolar disorder.)

- **Wide Attention and Decreased Latent Inhibition.** Highly creative people have been found to have a wide attention or an overinclusive mode of thinking that absorbs relatively higher amounts of surrounding information (that could be considered irrelevant to less creative people). This is usually measured through tests of latent inhibition, which is a healthy brain's capacity to keep irrelevant stimuli out of conscious awareness, preventing information overload. This allows one's attention to remain focused on elements relevant to a task at hand. Highly creative people have been found to have a decrease in latent inhibition. It is thought that this allows more information to be considered for recombination during the formation of new ideas – leading to higher rates of original ideas, and making creativity more statistically likely. This also seems to allow one to not be as constrained by previous cognitive structures when generating new ideas. Psychologists such as Hans Eysenck and Colin Martindale have even described creativity as a cognitive and behavioral disinhibition syndrome. It has been thought that a similarly decreased latent inhibition and widened attention could help account for the distraction from internal and external stimuli associated with ADHD and to the lowered behavioral inhibitions associated with impulsive ADHD behavior. Higher intelligence has been speculated to play a role in veering decreased latent inhibition more towards creativity than disorder.
- **Underarousal and Novelty Seeking**. Decreased latent inhibition has been associated with underarousal, characterized by decreased activity in the brain's frontal lobe, which has also been found both in ADHD and in highly creative individuals. This underarousal has been theorized to be behind the motivation of both populations to seek novelty – which is a form of sensation-seeking that stimulates dopamine reward pathways and "awakens" the frontal lobe. This propensity could be related to the high rates of addiction found among both the highly creative and those with ADHD. The highly creative have also been observed to sometimes have an addiction-like obsessive relationship to creative endeavors with long periods of perseveration. In ADHD, perseveration is also common – however, it is usually seen as a maladaptive repetition of certain inappropriate behaviors or cognitive patterns.
- **Atypical Brain Asymmetry.** Both the highly creative and those with ADHD have been shown to be atypical in their brain asymmetry (also called lateralization). This refers to the specialization of the right and left hemispheres of the brain and how they interact during

certain modes of thinking. This is related to popular lay notions of "right-brained thinking" – associated with creative, holistic, fantasy-based thinking, versus "left-brained thinking" – associated with logical, analytical, and sequential thinking. Popular literature often associates both ADHD and creativity to "right-brained thinking," though research is not yet clear on how their asymmetries compare. Increased right hemisphere activity has been found among those who are good at generating new ideas – however, creativity is more complex than this, involving interactions between both hemispheres of the brain at various stages of the creative thinking process.

Personality Parallels

The apparent personality parallels have been the most written about, particularly in popular ADHD self-help books and in the giftedness literature. In the creativity literature, Gary Davis compiled what are generally considered negative traits of creative individuals found in the work of E. Paul Torrance and other creativity scholars. Seven categories emerged: *egotistical, impulsive, argumentative, childish, absentminded, neurotic, and hyperactive*. Although the parallels to ADHD could be due to a number of reasons apart from a common etiology, many have found these kinds of similarities striking nevertheless. *Impulsive, absentminded* (inattentive), and *hyperactive* are the very descriptors of ADHD. Also, given the high rates of oppositional defiant disorder – which again is prevalent among those with hyperactive-impulsive ADHD – *argumentative* is a common characteristic. And finally, *childish* immaturity and *egotistical* behavior are also often used to describe those with ADHD and are often attributed to delayed brain maturation.

Entrepreneurial Temperament Parallels

Although entrepreneurship and creativity are not the same thing, entrepreneurship does require creativity. It is common to read in the popular ADHD self-help literature that those with ADHD are inherently wired for entrepreneurship. Not only has this literature often noted that many of the most successful entrepreneurs seem to have ADHD, but it is even sometimes implied that entrepreneurship could be a wise career choice for those with ADHD to consider. Some of the characteristics of ADHD that are cited in this literature as providing an advantage for entrepreneurship – but that are not in official diagnostic manuals – are curiosity, big-picture thinking, high energy, intuitiveness, an ability to generate ideas, a propensity for risk-taking, and an increased sensitivity to the environment and thus a higher ability to detect opportunities. These nonempirical observations parallel the characteristic of highly creative people found in the creativity research literature.

Empirical Studies That Have Directly Assessed Creativity in the ADHD Population

Just over a dozen small studies have been conducted in the last couple of decades that *directly* assess creativity in the ADHD population. Only one recent study by White and Shah (2011) has demonstrated higher levels of real-world creativity. This was conducted among 30 ADHD college students (matched against 30 non-ADHD controls) using Carson, Peterson, and Higgins' *Creative Achievement Questionnaire*, which measures lifetime creative achievement across 10 domains. Real-world creative achievement is often considered the gold standard of creativity assessment – other forms of assessment usually measure elements related to various aspects of the creative process and creative potentials but not actual creativity.

Until this study, previous research had largely assessed creative levels through divergent thinking tests, which commonly ask participants to generate as many ideas or solutions as they can in response to open-ended questions (such as finding alternative uses for common household objects) or to come up with as many solutions as they can to problems, either through written words (verbal) or by drawing figures (figural). The number of ideas generated, originality of responses, and flexibility of perspective usually determines level of divergent thinking. One of the earliest of such studies was conducted by Cramond (1994). In addition to finding elevated ADHD-related characteristics among highly creative children, she found higher scores among ADHD children on figural divergent thinking tests using the classic *Torrance Test of Creative Thinking*. Others, such as Healey and Rucklidge (2005), conducted similar figural divergent thinking studies but could not replicate these findings. On verbal divergent thinking tests, some studies found higher scores among those with ADHD, but here too, others found no differences.

It is hard to know what accounts for these mixed results, but a few potential issues come up. Though the legitimacy of using divergent thinking tests as measures of creativity has long been an issue of debate for many reasons – for example, perhaps these tests attempt to assess a general creative ability and would not detect domain-specific abilities such as musical creativity – divergent thinking has been generally accepted as an important area of assessment that is strongly related to original thinking. However, some scholars, such as Howard Gruber, have reminded us that the most highly creative people rarely use divergent thinking. This could be a potential blind spot for divergent thinking tests if it turns out that the highly creative and those with ADHD share certain cognitive mechanisms in relation to creativity. Second, divergent test administration methods have been found to have an influence on scores. For example, if they are administered in a test-like manner rather than playfully – something that was not indicated in most of these studies – this could lower scores and account for discrepancies in the results. Finally, it has been found that timed tests – as all of these were – produce less creative responses. This could be especially salient given the fact that one of the main academic accommodations given to ADHD students is to allow more time to take tests at school. Thus, it is possible that current divergent thinking test administration procedures would have to be modified to be valid for the ADHD population.

A smaller line of research has examined the creative cognitive style and personality of those with ADHD (rather than their level of creativity). Style is a personality dimension that deals with the way people process information and their preferences for certain modes of thinking and behaving. In creativity research, it is often described as examining *how people are creative* versus *how creative they are*. Two studies with practical implications used assessments that are widely used to manage creativity in organizations. The first was part of the above-mentioned White and Shah study using Puccio's *FourSight*, an instrument that identifies a person's style preference among four categorized stages of the creative problem-solving process: (1) *clarification* of the problem, (2) *ideation* of solutions through the generation of new ideas, (3) *development* and refinement of solutions, and (4) *implementation* of solutions. Adults with ADHD showed a higher preference for *ideation* compared to controls. In a second study, Issa (in press) also found a preference for *FourSight ideation* among ADHD adults. In this study, they were also found to have a strong *innovator* preference on the *Kirton Adaption-Innovation Inventory* (KAI). This assessment places people on a continuum from *adaptors*, who prefer to "do things better" within a prevailing paradigm, to *innovators*, who prefer to "do things differently," sometimes by radically stretching or disregarding the prevailing paradigm. The KAI has been used in hundreds of studies, some of which have found that a strong *innovator* preference is a good identifier of people with entrepreneurial dispositions. A third study by Alt (1999) used the *Myers-Briggs Type Indicator* to assess how respondents make decisions and interact with the world. ADHD adults had a higher preference for *intuition* (preferring the abstract general meaning of information patterns over more concrete detailed information gathered from the five senses) and *perception* (preferring situations and environments that are more open-ended, spontaneous, and flexible over those that are more structured). These two preferences have most been associated with highly creative personalities in other studies. Finally, a study by a team at Stanford (Simeonova et al. 2005) used the *Barron-Welch Art Scale*. This is a well-established creativity assessment that is based on findings that when highly creative people are shown various figures, they tend to dislike simple symmetrical figures and prefer more complex asymmetrical figures. The study was intended to assess creativity in bipolar disorder (BD) families (whose children are sometimes found to have ADHD as a precursor to BD). This assessment found higher preference for complexity and asymmetry in children with ADHD (and even higher preference in those with BD) compared to control children.

In the area of entrepreneurship and ADHD, at least one study provides interesting evidence. A team lead by Mannuzza et al. (1993) conducted a 20-year longitudinal study of 91 ADHD boys. In addition to higher rates of substance abuse and criminality than controls, a higher percentage (18%) had started their own businesses than non-ADHD controls (5%). Though this can be seen a propensity for entrepreneurship, it could also be interpreted that those with ADHD are more likely to start their own businesses because they have trouble holding down a more conventional job that requires complying with expectations set by employers.

Conclusion and Future Directions

Regardless of whether future research will show that those with ADHD are more creative in level, it may continue to show associations between ADHD and certain creative style tendencies. Becoming aware of style could benefit the creativity of a person with ADHD and the ultimate innovation of the groups or organizations in which he or she may work. For example, it could be that ADHD provides advantages for originality but disadvantages for the effectiveness that would lead to full-fledged creativity. Understanding creativity in this way could allow a person with only high originality to strategize how to best harness their strength, possibly through collaboration with others who have high levels of effectiveness. It could also help in developing more effective educational strategies for ADHD children.

ADHD has clearly been shown to lead to negative outcomes at work, both alone and in teams. Though understanding and working to one's creative style would probably not eliminate the challenges of ADHD (particularly in more severe cases), it could reduce problems. Some ADHD clinicians recommend choosing occupations that match one's style, even as a parallel therapeutic strategy for ADHD. Entrepreneurship seems a potentially fruitful area of research to explore such occupational matching for some ADHD types.

Future studies will no doubt continue to stretch beyond divergent thinking tests and give us a more holistic look at creativity among those with ADHD. Neurocognitive and genetic sciences may soon advance enough that we can begin to make quality comparisons between ADHD and creativity at these levels. All this could move the heated public debates beyond a creative/not-creative paradigm to a more nuanced and useful understanding.

Cross-References

- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Convergent Versus Divergent Thinking
- ▶ Creative Brain
- ▶ Creative Management
- ▶ Creative Mind: Myths and Facts
- ▶ Creative Personality
- ▶ Creative Styles
- ▶ Creativity Management
- ▶ Creativity Optimization
- ▶ Creativity Tests
- ▶ Creativity, Intelligence, and Culture
- ▶ Divergent Thinking
- ▶ Divergent Versus Convergent Thinking
- ▶ Entrepreneur
- ▶ Health of Entrepreneurs
- ▶ Innovator
- ▶ Measurement of Creativity
- ▶ Nature of Creativity
- ▶ Psychology of Creativity
- ▶ Research on Creativity

References

Alt CA. The relationship among attention-deficit/hyperactivity disorder (ADHD), personality type and creativity in adults using the Myers-Briggs type indicator (MBTI) and the Torrence tests of creative thinking (TTCT) [doctoral dissertation]. Saint Louis University; 1999.

American Psychiatric Association (APA). Diagnostic and statistical manual of mental disorders: DSM-IV-TR. 4th ed. Washington, DC: American Psychiatric Association (APA); 2000.

Barkley RA, Murphy KR, Fischer M. ADHD in adults: what the science says. New York: Guilford Press; 2008.

Cramond B. The relationship between attention-deficit disorder and creativity. Paper presented at the meeting of the American Educational Research Association; 1994; New Orleans.

Hallowell EM, Ratey JJ. Driven to distraction: recognizing and coping with attention deficit disorder from childhood through adulthood. New York: Simon & Schuster; 1995.

Healey D, Rucklidge JJ. An exploration into the creative abilities of children with ADHD. J Atten Disord. 2005;8(3):88–95.

Issa JJ. The creative style of ADHD: evidence of cognitive style preference for KAI innovation and FourSight ideation in adult attention deficit hyperactivity disorder creativity [ProQuest dissertations and theses database]. Buffalo: State University of New York College. In press.

Mannuzza S, Klein RG, Bessler A, Malloy P, LaPadula M. Adult outcomes of hyperactive boys: educational achievement, occupational rank, and psychiatric status. Arch Gen Psychiatry. 1993;50:565–76.

Simeonova DI, Chang KD, Strong C, Ketter TA. Creativity in familial bipolar disorder. J Psychiatr Res. 2005;39:623–31.

White HA, Shah P. Creative style and achievement in adults with attention-deficit/hyperactivity disorder. Pers Indiv Differ. 2011;50:673–7.

Augmented Cities

► Entrepreneurship in Creative Economy

Autodidact

► Self-made Man

Autonomous Bootstrapping of Useful Information (DABUI), Device

► Creativity Machine® Paradigm

Autonomous Generation of Useful Information (DAGUI), Device

► Creativity Machine® Paradigm

B

Balanced Organizational Learning

▶ Ambidexterity

Bankruptcy

▶ Firm Failure and Exit

Basic Dimensions of Democracy

▶ Quality of Democracy and Innovation

Basic Science

▶ Translational Medicine and the Transformation of the Drug Development Process

Bench to Bedside

▶ Translational Medicine and the Transformation of the Drug Development Process

Benchmarking

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Biblical Principles of Business

▶ Church and Entrepreneurship

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▶ Translational Medicine and the Transformation of the Drug Development Process

Black Belts

▶ Six Sigma

Blind-Variation and Selective-Retention Theories of Scientific Discovery

▶ Scientific Creativity as Combinatorial Process

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Boom and Bust

▶ Business Cycles

Bootstrap Transaction

▶ Entrepreneurship and Financial Markets

Brain Science

▶ In Search of Cognitive Foundations of Creativity

Brainstorming

▶ Ideas and Ideation

Brainstorming and Invention

Aytac Gogus
BAGEM, Center for Individual and Academic Development, Sabanci University, Istanbul, Turkey

Synonyms

Idea generation

Definitions

Brainstorming means using the *brain* to *storm* a creative explanation for an issue (Gogus 2012). Brainstorming is a method of generating ideas, clarifications, and solutions; therefore, there is a strong connection between brainstorming productivity and domain learning (Gogus 2012). Brainstorming is a group activity to propose ideas and then discuss them as a brainstorming session. There are three kinds of brainstorming: verbal brainstorming, nominal brainstorming, and electronic brainstorming. Verbal brainstorming refers to brainstorming sessions where group members verbally express ideas one at a time. Nominal brainstorming refers to brainstorming sessions where group members generate ideas individually without communicating with other members of the group. Electronic brainstorming refers to brainstorming sessions where group members generate ideas simultaneously. An invention means highly advanced creation of ideas utilizing the principles of the domain subject. Brainstorming is one of the creativity techniques for idea generations and an invention such as a better product, a new process, or a useful cultural innovation. A joint invention can be obtained through brainstorming sessions. A joint invention is an invention which is made cooperatively by two or more people who provided activities necessary to form the invention.

Theoretical Background and Open-Ended Issues

Brainstorming as a Method for Improving the Creativity of Groups

According to Baruah and Paulus (2008), "the brainstorming technique was first popularized by Alex Osborn (1953, rev. 1957, rev. 1963), an advertising executive, who suggested brainstorming as a technique with the following four specific components to creative ideas:

1. *Criticism is ruled out*. Adverse judgment of ideas must be withheld until later.
2. *"Free-wheeling" is welcomed*. The wilder the idea, the better; it is easier to tame down than to think up.
3. *Quantity is wanted*. The greater the number of ideas, the more the likelihood of useful ideas (generated).
4. *Combination and improvement are sought*. In addition to contributing ideas of their own, participants should suggest how ideas of others can be turned into *better* ideas; or how two or more ideas can be joined into still another idea" (Osborn 1963, p.156).

Osborn (1963) claimed that face-to-face groups that verbally exchange ideas should perform better than same number of individual brainstormers who work alone on the same problem since face-to-face group should be able to benefit from the diverse perspectives and abilities of their group members by cognitively stimulating each other to generate many ideas (Baruah and Paulus 2008; Osborn 1963). In addition, there are social and cognitive factors that lead to increased production gains in group brainstorming such as increased accountability, competition, upward comparison, and social and cognitive stimulation (Baruah and Paulus 2008; Dugosh and Paulus 2005).

Brainstorming as an Approach to Creative Idea Generation and Invention of Ideas

Brainstorming is an approach to creative idea generation and invention of ideas and technologies. On creative idea generation literature, idea quality is usually defined as a combination of originality (new or unusual) and feasibility (useful or practicability in implementation). Brainstorming allows generating ideas, sharing ideas, and establishing connections between ideas by analyzing, synthesizing, and evaluating, and thus participating in formation of an invention. A joint invention can be obtained through brainstorming sessions. Brainstorming groups may form an invention by using objective aspects of a joint invention through subjective engagement among participants (Kageyama 2010).

Inventor and Formation of an Invention

The person who was involved in distinctive structural elements and contributed to either "establishment of a model" or "the conception based on a principle" should be recognized as the inventor (Kageyama 2010). The purpose of invention is commonly referred to as the problem to be solved and stages of formation of an invention are (Kageyama 2010):

1. Conception
    - 1.1. Mere intuition
    - 1.2. Conception based on a principle
2. Embodiment of conception
    - 2.1. Establishment of a model
    - 2.2. Experiments/calculation
    - 2.3. Modification of model
    - 2.4. Completion by repeating process from 2.1 to 2.3

Invention as Knowledge Transformers

Some of the discoveries and inventions may be explained in terms of knowledge transformers. The knowledge transformers, like the knowledge generation transmutations, change the logical content of the input knowledge through the inference process of deduction, induction, or analogy (Sim and Duffy 2004). Sim and Duffy (2004) argued that it is reasonable to suggest that these knowledge transformers provide the basis to model the types of learning in design. The seven pairs of knowledge transformers are:

1. Abstraction/detailing
2. Association/disassociation
3. Derivations/reformulation/randomization
4. Explanation/discovery
5. Group rationalization/or clustering/decomposition/ungroup
6. Generalization/specialization
7. Similarity comparison/dissimilarity comparison

The investigation shows that there is some evidence to show that the creative process can be explained through knowledge transformers (Sim and Duffy 2004).

Nominal Brainstorming Versus Verbal Brainstorming

Evidence from numerous studies in social psychology and group psychology has shown that groups generate better ideas and higher quality with nominal brainstorming than with verbal brainstorming (Barki and Pinsonneault 2001). Three major categories of barriers explain the improved performance of nominal brainstorming groups over verbal brainstorming groups as below:

- The emergence of judgments during generation
- Members giving up on the group
- An inadequate structure of the interaction (Isaksen and Gaulin 2005)

Two promising areas for overcoming the barriers include:

- The use of technology such as Electronic Brainstorming (EBS), Group Support Systems (GSS), Group Decision Support Systems (GDSS)
- The use of trained facilitator (Isaksen and Gaulin 2005)

Electronic Brainstorming (EBS)

Electronic brainstorming (EBS) has been proposed as an approach that promotes group synergy and stimulation while facilitating the construction of chains of thought to build on good ideas and to think in novel directions, thus spurring new ideas and improving creativity and originality (Barki and Pinsonneault 2001). However, there is not strong empirical evidence supporting such a stimulation effect on idea quality. The theoretical explanations that suggest that EBS groups ought to generate ideas of higher quality than nominal brainstorming groups have received mixed empirical support (Barki and Pinsonneault 2001). Barki and Pinsonneault (2001) compared the effectiveness of four small group brainstorming methods (nominal brainstorming, verbal brainstorming, EBS-anonymous, and EBS-non-anonymous) in terms of three indices of idea quality (total quality, mean quality, and number of good ideas). The results indicated that nominal small group brainstorming was found to be the most effective for total quality and for number of good ideas (Barki and Pinsonneault 2001). EBS groups were more productive and more satisfied with the interaction process than FTF groups and large EBS groups outperformed nominal groups, whereas small nominal groups outperformed EBS groups (Barki and Pinsonneault 2001). In addition, the three factors manipulated in the experiment (i.e., Group History, Contextual Cues, and Topic Sensitivity) did not significantly improve the quality of the ideas generated by EBS groups (Barki and Pinsonneault 2001). As a result, how to improve the efficiency and effectiveness of EBS is an issue to discover to be able to provide the most effective way to brainstorm while EBS has important implications for electronic collaboration and virtual teamwork in both academic and organizational settings.

Implications for Theory, Policy, and Practice

A cognitive perspective suggests that group brainstorming can be an effective technique for generating creative ideas:

> A cognitive perspective points to methods that can be used so that group exchange of ideas enhances idea generation. Groups of individuals with diverse sets of knowledge are most likely to benefit from the social exchange of ideas. Although face-to-face interaction is seen as a natural modality for group interaction, using writing or computers can enhance the exchange of ideas. The interaction should be structured to ensure careful attention to the shared ideas. Alternating between individual and group ideation is helpful because it allows for careful reflection on and processing of shared ideas. (Brown and Paulus 2002, p. 211).

On the other hand, empirical findings gained from brainstorming research suggest that lose coordination and motivation in a team can hinder the effectiveness of brainstorming (McGlynn et al. 2004). In addition, brainstorming in interdisciplinary team and social interaction may not always assist the generation of creative ideas (McGlynn et al. 2004). Rossiter and Lilien (1994) present six principles of high-quality creative ideas by “brainstorming” as stated below:

1. Brainstorming instructions are essential and should emphasize, paradoxically, number and not quality of ideas.
2. A specific, difficult target should be set for the number of ideas.
3. Individuals, not groups, should generate the initial ideas.
4. Groups should then be used to amalgamate and refine the ideas.
5. Individuals should provide the final ratings to select the best ideas, which will increase commitment to the ideas selected.
6. The time required for successful brainstorming should be kept remarkably short (Rossiter and Lilien 1994, p. 61).

Rossiter and Lilien (1994) suggest using the I-G-I (Individual-Group-Individual) procedure by following six steps:

1. Chairperson announces the problem and gives brainstorming instructions to five to seven individuals seated around a table in the same room. (*Rationale*: This "silent groups" format preserves individuality but introduces a possible social facilitation effect from the presence of others.)
2. Individuals, without talking, write down or key into personal computers as many ideas as they can in the specified time period, usually 15 min. (*Rationale*: Immediate recording of ideas helps to remove the "production blocking" problem whereby mental rehearsal of initial ideas blocks the production of further ideas.)
3. Chairperson records individuals' ideas, in rotation, one idea for per person per rotation, on a group-visible flip chart or electronic screen. (*Rationale*: The rotation procedure removes some of the anonymity of a "talk in any order" group while at the same time producing a list of ideas that are recorded without authorship.)
4. Group clarifies and discusses ideas, combining or refining them as it seems fit. Ideas are taken one at a time, and each individual is asked for reasons of agreement or disagreement as well as to make constructive suggestions for improvement. (*Rationale*: Groups are efficient and usually superior for combining and refining ideas.)
5. The revised ideas are then recorded by the chairperson in a group-visible final list. (*Rationale*: Memory reliance is again minimized and also a degree of democratic anonymity is reinstated.)
6. Revised ideas are rated or ranked by individuals privately, with no discussion. Best idea or ideas chosen by pooled individual votes. (*Rationale*: Democratic voting increases commitment and pooled individuals' judgments usually provide more accurate prediction.) (Rossiter and Lilien 1994, p. 67).

Conclusion and Future Directions

During group brainstorming, group members should generate many ideas, think of uncommon ideas, combine, evaluate, and improve ideas, and avoid from untimely and inappropriate criticism. Learning may result from the brainstorming process, as it provides a momentum to engage in constructing ideas and self-explanations. Osborn (1953) provided detailed suggestions for best practice before, during, and after a brainstorming session as summarized below:

- Before Brainstorming
  - Prepare the group
  - Prepare the task
  - Prepare the environment
- During Brainstorming
  - Dealing with judgment
  - Maintaining group commitment
  - Enhancing the process structure
- After Brainstorming
  - Follow-through
  - Evaluation
  - Implementation

As the best-known tool for group idea generation, brainstorming has become the most widely used method with creativity, productive thinking, and creative problem solving abilities that are stated goals of most programs designed for the gifted and talented (Isaksen and Gaulin 2005). Brainstorming is widely taught in gifted and talented programs (Isaksen and Gaulin 2005).

There are three main concerns regarding the previous researches. First, some previous research about the comparison between verbal brainstorming and nominal brainstorming had an unnecessary focus since individual and group idea-generating approaches should not replace each other, but should supplement each other (Isaksen and Gaulin 2005; Osborn 1953). Second, the leadership role and responsibilities of a trained facilitator is essential for managing a successful brainstorming session (Isaksen and Gaulin 2005; Osborn 1953). Third, brainstorming has not been treated as an isolated event, rather than as a part of a larger process since brainstorming was introduced as one idea-generating tool within the entire creative problem solving process (Isaksen and Gaulin 2005; Osborn 1953).

Cross-References

- ▶ Creative Problem Solving
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity in Invention, Theories
- ▶ Ideas and Ideation
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Invention Versus Discovery
- ▶ Inventive Problem Solving (TRIZ), Theory
- ▶ Levels of Invention
- ▶ Models for Creative Inventions

References

Barki H, Pinsonneault A. Small group brainstorming and idea quality: is electronic brainstorming the most effective approach? Small Group Res. 2001;32:158–205.

Baruah J, Paulus PB. Effects of training on idea-generation in groups. Small Group Res. 2008;39:523–41.

Brown VR, Paulus PB. Making group brainstorming more effective: recommendations from an associative memory perspective. Curr Dir Psychol Sci. 2002;11:208–12.

Dugosh KL, Paulus PB. Cognitive and social comparison processes in brainstorming. J Exp Soc Psychol. 2005;41:313–20.

Gogus A. Brainstorming and learning. In: Seel NM, editor. Encyclopedia of the Sciences of Learning. Springer; 2012;1:484–88.

Isaksen SG, Gaulin JP. A reexamination of brainstorming research: implications for research and practice. Gifted Child Q. 2005;49(4):315–29.

Kageyama K. Formation of invention/joint invention and recognition of inventor/joint inventor. J Intellect Prop Law Pract. 2010;5(10):699–712.

McGlynn RP, McGurk D, Effland VS, Johll NJ, Harding DJ. Brainstorming and task performance in groups constrained by evidence. Organ Behav Hum Decis Process. 2004;93:75–87.

Osborn AF. Applied imagination: principles and procedures of creative problem-solving. New York: Charles Scribner's Sons; 1953, rev. 1957, 1963.

Rossiter JR, Lilien GL. New "brainstorming" principles. Aust J Manag. 1994;19(1):61–72.

Sim SK, Duffy AHB. Knowledge transformers: a link between learning and creativity. Artif Intell Eng Des Anal Manuf. 2004;18:271–9.

Brainstorming Teams

▶ Conflict and Creativity

Brain-Writing

▶ Idea-Marathon System (IMS)

Breakthrough Technology

▶ Innovation and Entrepreneurship

Bridging Knowledge Management to Wisdom Management

▶ Method for Creating Wisdom from Knowledge

Brilliance

▶ Genius

BtoBtoU

▶ Co-Conception and Entrepreneurial Strategies

Business

- ▶ Entrepreneur: Etymological Bases
- ▶ Heroic Entrepreneur, Theories

Business Angels

▶ Angel Investors

Business Climate and Entrepreneurialism

Dimitri Uzunidis
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Business relations; Embeddedness; Entrepreneurial opportunities; Externalities; Industrial atmosphere; Organization; Territory

The definition of the business climate is not simple and homogeneous. There exists no official definition. We can distinguish three kinds of definition. (1) The first is based on the ***opinion of entrepreneurs over the short term***. National statistical offices question, for example every 3 months, entrepreneurs to know their opinion about the economic short-term period (evolution of demand, of production, of stocks, of prices, orders, their workforce, and so on). It is a qualitative indicator based on the personal opinion of domestic entrepreneurs. (2) The second definition consists of ***measuring macroeconomic indicators*** also for a short-term period. For example, trend of the Gross Domestic Product (GDP), of domestic consumption, of exports, of domestic investments and of the public sector balance, and so on. This information is intended for foreign investors who have business projects in a given country. So for a short-term period, we have an objective macroeconomic indicator. It is not based on entrepreneurs' personal opinions, but on objective information. In general, the national office for foreign investment is linked to the department of foreign affairs. (3) The last definition is the indicator developed by the World Bank, «*Doing business*», which provides ***measurements of business regulation for local firms***. A large range of indicators have been defined: starting a business, dealing with construction permits, the supply of electricity, registering property, obtaining credit, prospecting investors, paying taxes, trading across borders, enforcing contracts, and resolving insolvency. So to synthesize, we will define the business climate as follows: a set of macroeconomic indicators which give information about the economy (rate of economic growth, demand, investment, and so on); social (evolution of the workforce); and legal (ownership, business law,. . .) conditions in a given country, and finally a set of individual entrepreneurs' opinions about the economic and social situations over the short term.

But, to be exhaustive, we have also to consider the nature of business networks between entrepreneurs and businesses (large and small), and between entrepreneurs and a large range of institutions (units of research, departments, banks, administrations, and so on), because global or qualitative indicators are inadequate for measuring by themselves the business climate. These networks are constituted of financial and information flows and also transfers of workforce (high-skilled and low-skilled workers), on a national or local level. They can be the product of a political decision, but also of informal practices over a long time period. The main condition for the existence of a social network is its stability in the short term, even if its composition can change in the long term.

The main characteristic of the business climate today is its great instability, for three important reasons: (1) for a ***structural reason***: the capitalist economy is based on permanent (technological, economic, and social) change (Schumpeter 1982, 2008); (2) for a ***medium-term reason***: since the 1980s governments have developed policies of deregulation to encourage market synergies. The weight of the public sector is less important, whereas market regulation is more developed; (3) for a ***short-term reason*** (and as a consequence of the two previous reasons): the short-term economic situation is more and more unstable. Since the 1990s, the number of economic crises is higher in developing and in developed economies in a world context where the interdependencies between economies are more complex.

Business Climate and Entrepreneurialism, Table 1 Three levels of business relations

Business relations at the level of the:	Parameters	Field of action and challenge
Territory (as a geographical area)	Distance versus speed	Transfer: flow
		Relations of competition/ cooperation
Organization (intra- and inter-organization)	Hierarchy versus market	Coordination strategies, actions, routines
	Intra-firm versus inter-firm	
	Vertical versus horizontal	
	Supervision versus contract	
Individual (entrepreneur)	Code versus contents	Communication concept, ideas, knowledge
	Context versus understanding (awareness + interpretation)	

Source: The author

What are the resources and socioeconomic elements which have defined the business climate where individual entrepreneurs, enterprises, and institutions function? How do business relations emerge from the business climate? And, (in a synergic relation) how does the business climate build business relations? In the first part of this entry, we will show that for the entrepreneur the business climate is determined by his business relations resulting from the nature of the business system in which he is integrated (Granovetter's concept of embeddedness). In the second part, we will analyze how the business climate promotes entrepreneurship. We have constructed our demonstration on a certain number of authors (economists, sociologists, and historians) that we consider as the key writers on our subject: Marshall and Pigou (Pigou 2001) for the analysis of the territory; Coase and Williamson for the analysis of the organization; Menger and Simon for the analysis of the individual entrepreneur; Braudel, Wallerstein, Nelson and S. Winter (Nelson and Winter 1985) (for historical analysis) and Granovetter (for the analysis of social networks).

The Business Climate and Business Relations

Business relations influence the creation of a business climate which can be positive for business growth. These business relations are linked to externalities which facilitate cooperation between enterprises and public institutions, between banks and firms, and between these organizations and markets. These relations can be also highly competitive when a new market appears as a result of creation of a new activity or following an innovation. Business relations are developed at three different levels (territory, organization, and institution), and they are based on flows of information, learning, knowledge, technology, and so on (see Table 1).

1. ***Business relations are developed at a territory level***, by definition according to geographic borders. The business relations in this geographic area have been built over a long-term historical period (Braudel 1992; Wallestrein 2004). This is the result of a long historical tradition based on dialectical relations between competition and cooperation.
2. ***Business relations are also developed inside an organization and between organizations:*** In our case, an organization can be an enterprise, a bank, a nonprofit organization, a unit of research, a ministry, and so on. To find resources, enterprises develop relations with other, different organizations and institutions (banks, ministries, and so on). In a general sense, firms' strategies are built on two types of model: the hierarchical model (organization) or the horizontal model (market). According to the level of transaction costs (Coase 1937), the enterprise is structured on one or another model: either the scheme of the large (and concentrated) firm, or of the small (and decentralized) firm.

Business Climate and Entrepreneurialism, Table 2 Business climate and business relations

Business climate According to indicators: ***Objective***: Macroeconomic indicators and measurement by institutional indicators (as for example «Doing business») ***Subjective***: Entrepreneurs' personal opinions		
Business relations		
Territory (geographic)	***Organizations*** Enterprises (interrelations/ intra-relations)	***Individual entrepreneur*** Own resources of the entrepreneur Business opportunities Limited economic rationality

Source: The author

3. ***Individual entrepreneur:*** The entrepreneur is an economic and social performer. He takes decisions according to a set of information and resources to achieve a given objective (e.g., to develop a new business, to obtain a loan, to develop cooperation with another partner, and so on). This individual entrepreneur plays his part in a given society which has given values, roles, and codes of practice. According to this social environment, he is a rational individual. It means that he takes decisions based on the information and resources available to him. His rationality is limited, though, because he takes decisions in a given social context (Menger 2007; Simon 1997).

The concept of business relations is the result of new area of research in social sciences characterized by the emergence of the concept of social capital (see the entry on social capital). In a general sense, social capital is a set of social relationships owned by an individual, and which are valorized to give access to new resources. In this way, individuals can find a new job or a business opportunity, apply for a loan, and so on. But the theory (or the theories) of social capital has (or have) been developed in different ways. For our subject, according to Mark Granovetter (1985) analysis is fundamental, because he shows that business activities are supported by both formal and informal social relations. The formal relationships are constituted by relations with other enterprises and entrepreneurs, financial institutions, departments, nonprofit enterprises, and so on. On the other hand, informal relationships are formed by family, friends, neighbors, etc. Thus, Granovetter shows that business relations (in other words market relations) are embedded in the social framework. In the Granovetter analysis, the rational individual (in a traditional neoclassical sense) does not exist, because his behavior is partly determined by the social context where he operates. The behavior of individuals is determined by the social context.

Business relations are inserted in the business climate, which is defined objectively (macroeconomic indicators and so on) and also by subjective indicators (entrepreneurs' personal opinions). Business relations are developed simultaneously at three different levels: territory, organization, and individual entrepreneur (see Table 2).

Business Climate and Entrepreneurship

The key elements of the business climate are the business relations that are developed at three different levels (geographic area, organization, and individual entrepreneurs). In this following part, we will explain these three elements according to the given economic theories. Our objective is not to do an exhaustive account, but to bring to light some key authors, as we wrote above.

The territory was introduced into economic theory at the end of the nineteenth century by A. Marshall (and before that by Von Thünen). Marshall (1919) argues to show the influence of the territory on economic analysis, that there is an «industrial atmosphere» which influences the development of the local labor market. This phenomenon is linked with competencies and professional experience of workers, and also with the location of firms in a given territory. According to Marshall, an «industrial district» merges skilled workers, a set of players (entrepreneurs, bankers, public authorities), and know-how belonging to the particular industrial district. Firms in this territory have developed between them relations of cooperation. Entrepreneurs have a long history in the territory where they live. They share the same values, codes, and social behavior. Business relations develop in this geographic area in both formal and informal ways.

The Marshallian analysis has given us a large range of studies during the twentieth century, and especially since the 1980s, with for example the concept of «innovative milieu». "Evolutionary Economics" developed the concept of «path dependency» to explain the interactions between firms, institutions, and workforce which are the product of an historical evolution. Braudel and Wallerstein underline the historical dimension of social and economic evolution. The transformation of economic and social behavior is very slow. Routines map out a given path of evolution. These interactions between enterprises, institutions, and workforce are the product of mutual synergies between local players (public and private) over a long-term period. These business relations are developed, thanks to defined conditions: basic resources, workforce skills, financial, technological, information resources, and so on. The existence of common social values and social practices are the engine that synergizes these resources. The innovative capacity of the firm is not only influenced by its own resources, but also by its environment. A strong synergic relation is built up in this way between local players, but if the path dependency is very strong, firms which compose this innovative milieu can collapse if they become too heavily dependent on these initial resources.

Firms are located in the given territories. They were attracted by different types of resources, as noted above. But the firm, as an organization, is not static. It changes according to its strategy, which is partly built under pressure due to the competition. In the traditional neoclassical theory, the market is always more efficient than the organization. Coase shows that the market is not always cheaper, because there are a number of transaction costs entailed in using the market: for instance, costs of obtaining goods or information. Coase shows that firms will grow when they can arrange to produce what they need internally and somehow avoid these coats. Thus, firms can by their strategy transform the market and the territory where they function. Even information is not free. The cost of information can be high, and the entrepreneurial function is, according to (Kirzner 1997), to discover opportunities for investment or profit based on information they already own.

The traditional neoclassical theory argues that entrepreneurs have to maximize their profit as a function of their own resources and the market price. Simon underlines that the entrepreneur, as a given individual and rational player, does not own all the information that he needs, and consequently targets his objectives according to a set of social factors. Thus, the entrepreneur is influenced by the social and economic context where he operates. In consequence, and according to Granovetter, the entrepreneur as an individual performer is embedded in a given social context. Individuals define their objectives (e.g., to set up a firm, develop an innovation, get a loan, find a better job, and so on), according to their own resources (financial, knowledge, information) and their personal ambitions (to become rich, to be an important person, to develop a social enterprise, and so on). They are embedded in a given social context. So, there are differences among individuals (and of course among entrepreneurs). Everyone has not the same behavior in front of the market. Entrepreneurs play their part in business relations which create (and of which they are the product) trust, solidarity, competition, cooperation, cunningness (according to the theory of opportunism of Williamson), and so on (Table 3).

Business Climate and Entrepreneurialism, Table 3 Business climate and entrepreneurship: a synthesis

Business relations	Key authors	Key concepts or ideas
Territory	A. Marshall	Industrial atmosphere
	A. C. Pigou	Externalities
Organization	R. Coase	Dialectical relation
	O. Williamson	Market/organization
Individual entrepreneur	C. Menger	Individualism, methodology
	H. Simon	Limited rationality
	I. Kirzner	Entrepreneurial opportunity
	O. Williamson	Opportunistic behavior
History	F. Braudel	Long-term period
	I. Wallerstein	Historical change
	R. Nelson and S. Winter	Path dependence
Social	M. Granovetter	Social network
		Embeddedness
		Formal/informal relations

Source: The author

Conclusion and Future Directions

The business climate is defined by macroeconomic indicators and entrepreneurs' individual opinions over the short term. It is the product of business relations which are developed in a synergic process in a given territory or economic milieu geographically localized (which is defined as a set of resources within given geographic borders). Business relations are developed in a given social context. Over a long-term period, entrepreneurs build relationships between them, which are the result of socioeconomic practices. These practices feed social behavior based on cooperation, competition, and common or divergent interests. However, taking into account that entrepreneurship is historically developed from a given socioeconomic and geographical milieu, in contrast the logic of capitalist dynamics resides in going beyond geographical borders. The development of information technologies, in an informational space, has become the background for the development of new business relations.

Indeed, the systemic nature of the relationships which characterize an economic and social milieu explains what gives (or does not give) incentives to business creation. However, ought we to reduce entrepreneurship and innovation, products of the milieu, only to inter-individual exchanges, resulting in a new productive combination? Is entrepreneurship only the result of a specific organization of economic relations? Current research takes into account the fact that the business climate does not refer only to economic and financial interactions but also to the social structures which are at the origin of innovative and entrepreneurial behavior. In addition, institutions (such as State and local authorities) play an important role in the organization and the evolution of socioeconomic structures. In turn, the business climate contributes to entrepreneurship, thanks to the supply management of specific (cognitive, technological, financial, etc.) resources.

Cross-References

▶ Clusters
▶ Entrepreneur
▶ Entrepreneurship Policies
▶ Entrepreneurship Policy
▶ Environmental Determinants of Entrepreneurship
▶ Industrial Atmosphere
▶ Innovation and Entrepreneurship
▶ Network and Entrepreneurship

References

Braudel F. Civilization and capitalism, 15th–18th century, vol. 1–3. 1st ed. Berkeley: University of California Press; 1992. 1979.

Coase R. The nature of the firm. Economica. 1937; 4:386–405.

Granovetter M. Economic action and social structures. The problem of embeddedness. Am J Sociol. 1985;91(3):481–510.

Kirzner I. Entrepreneurial discovery and the competitive market process. An Austrian approach. J Econ Lit. 1997;35(March):60–85.
Marshall A. Industry and trade. London: Macmillan; 1919.
Menger C. Principles of economics. 1st ed. Auburn: Ludwig von Mises Institute; 2007. 1871.
Nelson N, Winter S. An evolutionary theory of economic change. Cambridge, MA: Belknap Press of Harvard University Press; 1985.
Pigou AC. The economy of welfare. 1st ed. Piscataway: Transaction Publishers; 2001. 1920.
Schumpeter JA. The theory of economic development. 1st ed. Piscataway: Transaction Publishers; 1982. 1911.
Schumpeter JA. Capitalism, socialism and democracy. 1st ed. New York: Harper Perennial Modern Classics; 2008. 1942.
Simon H. Administrative behavior. A study of decision-making in administrative organizations. 1st ed. New York: The Free Press; 1997. 1947.
Wallestrein I. World-systems analysis. An introduction. Durham: Duke University Press Books; 2004.

Business Climate and Entrepreneurship

► Socialized Entrepreneur, Theories

Business Creation

► New Forms of Entrepreneurship in a Sustainable Knowledge-Based Service Economy

Business Creativity

Igor N. Dubina
Economic Information Systems, Altai State University, Barnaul, Russia

Synonyms

Corporate creativity; Everyday creativity; Organizational creativity

Definition

Business creativity is (1) producing ideas which are new and potentially useful for an organization, (2) solving nonstandard business problem, (3) finding and developing new opportunities for business, and (4) a measurable resource that needs to be effectively organized and monitored.

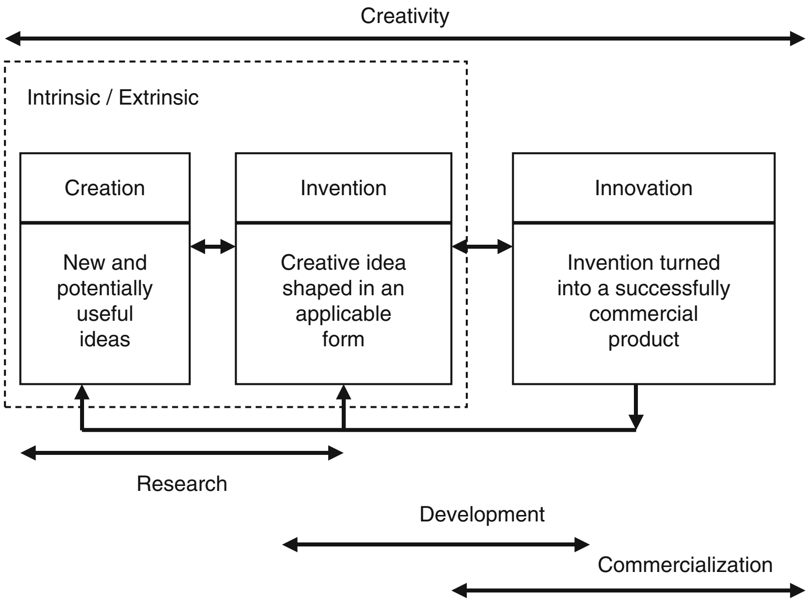
In the current literature, there are many discourses about business creativity as one of the key factors of competitiveness in this dynamic "creative age." From the second half of the twentieth century, alongside with the shift from "Fordist" to "post-Fordist" economies and the increasing role of creativity in business, the "romantic" understanding of creativity as a manifestation of individual genius has been replaced by pragmatic understanding of creativity as an "everyday" and "everyone" natural phenomenon.

In the business context, creativity is understood as a nonstandard problem-solving process, the production of new and useful ideas, or generating and developing new opportunities for business. Any definition of business creativity is based on the combination of novelty and effectiveness. For example, creativity, considered in an organizational context, is often understood as generating ideas which are simultaneously new and appropriate (potentially useful) for an organization. According to this point of view, creativity is defined in a system with the following elements:

- A creative employee(s) generating ideas and introducing variations
- A domain (a set of available ideas, rules, organizational routines, and patterns of behavior)
- An expert(s) evaluating suggested ideas and selecting the variations

If an idea, suggested by the employee, is deemed by the experts as new and useful, it is then included in the set of rules, and the domain subsequently is changed. The "new rules" of the domain communicate back to the subject, and the cycle continues. In other words, creativity

Business Creativity, Fig. 1 Business creativity in an innovation process (Source: The author's own conceptualization)



may be defined as engendering original solutions for nonstandard problems or more effective solutions for existing problems, and these solutions (ways, methods, and techniques) are accepted in the organization as *the rules of future activities*.

Business creativity is a much broader concept than merely generating new ideas for future invention and innovation (Fig. 1). Rather, creativity and innovation are more complementary than consecutive business phenomena. Consequently, managing creativity requires a broader conceptualization than merely managing the process of generating new ideas for further implementation into innovation.

Cross-References

- ▶ Corporate Creativity
- ▶ Creative Management
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity Management Optimization
- ▶ Four Ps in Organizational Creativity
- ▶ Simplexity Thinking

Business Cycles

Jerry Courvisanos
The Business School, University of Ballarat, Ballarat, Victoria, Australia

Synonyms

Boom and bust; Fluctuations in economic activity; Trade cycles

Introduction

The first rigorous attempt to link the innovation role of the "pioneering entrepreneur" with the boom and bust of business cycles was by Joseph Schumpeter in his two-volume *Business Cycles* (Schumpeter 1939). This linkage is fraught with danger as it attempts to examine innovative entrepreneurship – which occurs at the individual firm level – with the aggregate pattern on economic cycles at an economy-wide level. Much has been researched and written since then in an effort to overcome the pitfalls of this dilemma, while preserving the dynamic power of an endogenous entrepreneurial-driven cyclical process. This entry will examine the various mechanisms that have been proposed on how the action of innovative entrepreneurs can lead to prosperity and recession. The analysis begins with a first "simple" approximation of the dynamics of entrepreneurs and cycles, and builds dynamic complexity with further steps into this explanation.

Five Approximations to a Cycle

The base proposition outlined by Schumpeter is the static full employment system where the only business activity is being conducted under "competitive capitalism" by managers, and not entrepreneurs, who merely compete using the existing technological knowledge. Schumpeter calls this the "circular flow" mechanism and it only applies to a stationary state economy that has no macroeconomic cyclical activity. Once innovation is introduced a discontinuity occurs, leading to cycles, with an array of mechanisms to explain this dynamic. The first run-through of this discontinuity can begin with Schumpeter's 1928 handbook entry on the entrepreneur in which he alters the focus from the gifts of a few individuals at the fringes of the economy, to entrepreneurs conducting selection processes and combining production factors that situate them "at the heart of the market economy" (Becker and Knudsen 2003, p. 213). This necessitates the entrepreneur to be aware of actual and potential demand for "new combinations" and that these combinations come from learning through experience which results from selecting and adapting ideas already implemented in the field and then learning and further adapting from those selected. The failures and successes in this cumulative evolutionary process determine eventually the result of innovations. The aggregate outcome of this cumulative innovative activity results in investment and production that produces business cycle patterns. It ensures that the innovation process in theory does not become locked into an "administrative" steady state, requiring some exogenous force to release novelty into the dynamic real world.

This dynamic role between entrepreneurship and the business cycle can be described as a "kaleidic mechanism." Shackle (1972, p. 433) defines the kaleidic mechanism as an ephemeral pseudo-equilibrium (or stationary state) based on accepted practices which are subject to sudden readjustment. This leads to a new precarious pseudo-equilibrium based on "delicately stacked" conjectures which give way to these "sudden landslides of readjustment." Thus, the methodological shift is away from a deterministic method in which history is based on a linear view of the past. Instead, the kaleidic mechanism is sensitive to the short period agency behavioral relations that build up and break down over time with the innovation-investment decision-making processes.

With the role of the entrepreneur harnessing productive forces in innovation specified, the second step (or approximation) in this kaleidic mechanism is to provide a clear conceptual notion of the induced endogenous novelty inherent in the entrepreneur. Schumpeter's productive forces of entrepreneurship are too coarse-grained to grasp a clear picture of the entrepreneur. There needs to be some fine-tuning so that entrepreneurship as a concept can become realized within the macroeconomic picture of the business cycle. This can be achieved through the work of Michał Kalecki, when in Kalecki ([1968] 1991) innovation is specifically identified as endogenous to the investment process, thus integrating the cyclical short period with the long-run growth trend. In this way, the trend and cycle are not considered separately. In this model, inventions that are commercialized through investment "...add to profit expectations over and above those generated by the movement of demand in the course of the cycle" (White 1999, p. 347), leading to a cumulative process of cyclical growth. White (1999) identifies two reasons in Kalecki ([1968] 1991) to account for this. One of the reasons is increased productivity in the form of process innovation that incorporates technical progress in new capital equipment, making the previous capital stock technologically obsolete and enabling market demand to be met more effectively. The other is product innovation coming from the stimulus to investment arising from entrepreneurs wanting to be the "…first to avail themselves of the technical novelties" and thus, adding a new level of demand (Kalecki [1968] 1991, p. 442).

At this third approximation of the dynamics of entrepreneurs and the business cycle, the point of the analysis is the effective demand that is incorporated in the innovation process. White (1999, 350) recognizes "…the stream of inventions underlying the process of innovation could be sufficiently erratic to provide the irregularity in economic behavior necessary to produce deviations in demand and output from those anticipated by producers." With the diffusion of successful innovations, Courvisanos (1996, pp. 114–39) shows that these deviations can be seen as triggers for cyclical investment turnarounds in periods when commitment of orders to investment is highly vulnerable to sharp change, either as too high (over-commitment at expansion peak) or too low (under-commitment at the contraction trough). There can be reinforcement of this process by the inventory mechanism, in which even a small upswing of an inventory cycle at the trough of a business (or Juglar) cycle provides a favorable climate for the spread of investment embodying innovation. This is particularly helpful for explaining the most difficult aspect of any cycle, which is the rise out of a contraction. In this respect, bunching of investment occurs as per Kalecki, with the stimulus from clusters of "basic" innovations as per Schumpeter. Empirical work by Courvisanos and Verspagen (2002) using long-run patent data supports the bunching effect of investment (*á la* Kalecki) while identifying the clustering of innovation (*á la* Schumpeter). All this cluster cycle research is distinctly different from the neoclassical real business cycle research agenda in which clusters occur only due to expectational errors as deviations from the natural (equilibrium) rate, and are empirically inadequate in explaining business cycles.

The fourth approximation relates to the situation in which when a trigger for expansion occurs, then the investment dynamics become the crucial aspect of the diffusion of innovation. Kalecki identified three dynamics. Time lags in investment are seen as critical by Kalecki in the innovation process, an aspect that Schumpeter rejects. There are two time lags. One is the *ex ante* decision (orders) lag, which identifies the time taken to make the decision to order the means of production (plant and/or equipment). This is due to the need to work out the actual design of the capital stock required and find sources for supplying this capital stock. The other is the *ex post* implementation, which identifies the gestation period for the expenditure, or the time taken by the capital-supplying industries to produce and deliver the capital stock, and the time taken for the innovating firm to learn how to operate the plant and equipment in an efficient manner.

The second dynamic relates to the two-sided feedback loop between profits and investment, which also was famously expounded by Joan Robinson in her "banana diagram." Retained earnings out of profits provide the wherewithal to invest, and also allow the firm to borrow for investment on the basis of the profits achieved. Of course, the original investment is made with the expectation of future profits out of the innovation that underscores the investment decision. This seems a very intimate two-sided relationship in which one loop supports the other.

Here, Kalecki identifies the third dynamic which undermines the strength of this two-sided loop. This is the inherent instability of capitalism as firms' innovation and investment decisions are exposed to increasing risk and fundamental uncertainty. By raising external funds from loans or equity for investment, Kalecki ([1954] 1991, pp. 277–81) argues that firms suffer from "increasing risk," which is the marginal risk that increases with the amount of funds obtained externally. External funding is a major issue when commercializing innovation as a start-up venture with no prior profit reserves from the enterprise, thus often requiring venture capital equity funding. Also, for the existing firms, radical innovation in corporate venturing would require large commitment to new means of production, thus requiring external funding on top of any retained earnings funding available.

From this financial perspective, Kalecki identifies three forms of increasing risk: One is share issue risk, when a large issue of new shares creates the risk of reducing the proportion of the controlling group's shareholding, thus diluting its voting power in relation to the existing and potential shareholders. Second form of increasing risk is borrower's risk. Increasing levels of borrowed funds involve higher future interest payment commitments, which are negotiated on the basis of regular payment irrespective of cyclical events and their effects on gross profits. The larger the amount a firm borrows, the greater the increasing cash-flow problem that could arise. The final form is lenders' risk which increases (in terms of higher interest rate) as lenders extend more funds to a firm, which leads to the increasing possibility of the lender suffering bad debts from the borrowing firm's cash-flow problems which may even lead to bankruptcy.

The role of uncertainty in Kalecki is an institutional factor that creates instability. Incomplete knowledge about future outcomes is significant for innovations other than for merely new product developments or "necessity entrepreneurship." Such lack of knowledge leads to setting levels of desired excess capacity well above normal engineering-based excess capacity requirements, and to accepting increased transaction costs as the level of financing rises. In this way uncertainty is accounted for and managed in a pragmatic way. It is for this reason that Kalecki rarely mentions uncertainty. As increasing risk originates from incomplete knowledge of the future outcomes of investment, then uncertainty becomes institutionalized as an instability factor when such risk is locked into rising transaction costs, or alternatively, to what is known in the finance literature as "informational asymmetries." Such efforts can mitigate risk, but not uncertainty.

As aggregate profits are the base for the funding of innovation, the fifth approximation introduces the dynamics of the circular flow created by the two-sided feedback loop which exhibits both virtuous and vicious circles. The virtuous circle can be seen in aggregate when an increase in aggregate profits supports knowledge capital through enhanced R&D investment as well as large venture capital funding available to support invention by new start firms in industries that have a successful track record (e.g., pharmaceuticals, biotechnology, ICT), which encourages expansion of investment. Success in this investment has a direct positive impact on aggregate demand, pushing up the expansion path of the business cycle and consequently even higher aggregate profits. This is the "accelerationist" effect of investment, flowing through greater economic activity, higher profits and even further investment in the same new innovations. This builds the expansion phase of the investment cycle. An endogenous innovation-based reinforcement of this virtuous circle is the increased innovation intensity through further R&D and venture capital funding, pushing the expansion phase further into a strong boom. This dynamic circle exhibits innovation intensity deriving from the growth industries of the endogenous innovation effects of a powerful transformative technological paradigm. This results in strong economic development of successfully innovative firms/industries/sectors/regions and provides the bulwark for cyclically rising gross domestic product (GDP).

The vicious circle appears in the contraction phase of the investment cycle, when there is a relatively low level of build-up in knowledge capital through R&D and invention. Here replication of the dominant technology takes place with the emerging technologies at too early a life-cycle stage for them to be contenders for structural change. The uneven development here is skewed on the negative side. This leads to a decrease in innovative activity, which discourages investment as well. This has a negative impact on aggregate demand, GDP and consequently on aggregate profits. This is the negative "accelerationist" effect on investment flowing through lower economic activity and the contraction phase of the investment cycle. An endogenous innovation-based reinforcement of this vicious circle is the decreased innovation intensity adding another fall in innovative activity to push the contraction phase further into a strong recession. This vicious circle exhibits innovation intensity that is very weak, deriving from the mature industries of the long-established innovation effects of a monopoly controlled "old" technological paradigm and preventing the expansion of new innovative firms and industries.

The extent of the upswing in the next expansion phase of the business cycle depends on how much it is dependent on the older more mature industries attempting to maintain their market power, compared to the ability of the new technology–based industries to take advantage of any new opportunities that have arisen during the downturn and trough. As knowledge capital continues its endogenous innovation push, there is tension with the development of greater economic uncertainty for investment in "new" products and processes. This is Schumpeter's "creative destruction," where new innovations take over from older established industries which have had strong market (or monopoly) control, creating uneven structural change as some industries shift technologically while others remain old and mature. Depending on the National Innovation System that exists in the country, this problematic tension to the next virtuous circle will appear as a negative influence at different intensities of the endogenous innovation-based expansion phase in the investment cycle. The extent of this negative influence affects the strength (or lack thereof) of the new expansion phase and the trajectory of the long wave.

The five steps of complexity in the dynamics of entrepreneurship and business cycles outlined above are based on the classic proposition of the dynamic investment model with innovation at its center. This comes from Schumpeter, who reasoned that the investment function responds to waves of optimism and pessimism that create clusters of innovation outcomes and then "bunching" of investment. Schumpeter saw these two phenomena of innovation outcomes and investment in such innovations as cyclically linked, thus creating business cycles. Despite the empirical evidence described earlier, there is a logical flaw in this approach because one must question the origin of these waves of optimism and pessimism. These entrepreneurial waves would be influenced by aggregate economic activity arising from business cycles in the first place. Thus, a tautology exists if the linkage is tightly held between clustering of innovation outcomes ("clust-") and bunching of investment ("-bun") to commercialize them. Empirical evidence from a positivist methodology is unable to resolve this tautology.

Following the same classic proposition to Schumpeter, Kalecki in his analysis diverges by decoupling the linkage between clustering and bunching. Kalecki sees bunching arising from investment decisions on commercializing innovations as a distinct business process that reflects on uncertainty and susceptibility to cyclical volatility. This is distinct from the clustering that is shaped by the type and extent of innovation. Rothbarth in his critique of Schumpeter's closely tied "clust-bun effect" makes this distinction clear as follows:

> Professor Schumpeter, in my view, is right in maintaining that there would be no trade cycle in a system subject to small random shocks only. He is right in the sense that it would be unrealistic under those conditions to postulate such strong dependence of investment on existing profits as would produce a cycle. It does not follow at all that the process of innovation needs to be cyclical to produce the trade cycle. It suffices that innovation brings about that uncertainty, that strong dependence of investment on current profits on which Mr. Kalecki, Mr. Kaldor, and Mr. Harrod rely. It may well be that the process of innovation itself is cyclical, but the trade cycle would be explicable even if that were not so. (Rothbarth 1942, p. 226)

The investment decision to commercialize various innovations that exist in the form of patents, other intellectual property rights, and market-based benefits (e.g., first-mover advantage) is a separate business process, but it is crucial to recognize that without the innovation, the investment decision would be purely a replacement ("circular flow") investment decision based on rate of depreciation and past demand for the output. This limits considerably the uncertainty attached to investment decision-making. Without innovation, uncertainty is contained and the fluctuations of investment would move around a constant trend growth line with no economic growth.

Taking Kalecki's investment approach and limiting the analysis at this stage to industry-level investment cycles, Courvisanos (1996) shows how this extended uncertainty is due to the commercializing of innovations. This results in significantly high levels of susceptibility that leads to enhanced instability in investment cycles and the development of a trigger mechanism to initiate fundamentally new innovations that produce structural change in the trend of "long wave" implications, as basic innovations are diffused and adapted through incremental innovation, thereby producing a bunching effect. In his final attempt at modeling investment, Kalecki ([1968] 1991) identifies that the cycle-trend pattern that innovation has on the investment function is due to higher profitability of more advanced means of production based on new innovations. Thus, the intensity of innovation, in terms of the extent to which high profits from investment could potentially be generated, impacts on the amplitude of investment cycles and shifts the trend path – or trajectory – of investment growth.

The intensity in investment of particular innovations that are significant enough to structurally change the operating innovation systems has "virtuous circle effect." This occurs as innovation intensity rises, increasing the amplitude of the upper turning point of the investment cycle and shifting the trend path upward. However, there is also the "vicious circle effect." This occurs as investment decisions are made during cyclical contractions to shelf (or modify downward) the commercialization plans of any significantly new innovations, and instead only invest in new capital stock that is absolutely necessary due to depreciation and maintaining market position. This increases the amplitude of the lower turning point of the investment cycle and shifts the trend downward. Thus, the pace of innovation is a shift parameter in the Kaleckian investment function.

This shift parameter has been seen to evoke structural change, with extensive economic history of swarm effects created by clustering of basic innovations and their sequential bunching through investment as new innovation systems are diffused to maturity. Courvisanos and Verspagen (2002), by identifying empirically the "clust-bun effect" and cycle-trend patterns, see investment in incremental innovation propelling the investment cycle during the diffusion of basic innovations through the industry and then related industries. Success in activating basic (or transformative) innovation provides the impetus for the initial investment in new technology or product configurations, followed by bunching of investment based around this new technology. Thus, success in commercializing of transformative innovation is the shift parameter for the trend line in industry investment cycles.

Schohl (1999) adopts a disaggregative explanation of industry investment in implementing innovation to macro business cycles, using the same kaleidic principle. Rather than aggregative variance of investment in implementing innovation used above, Schohl adopts a heterogeneous agent model in which firms are "innovative" agents all the time but at varying degrees of intensity. Schohl never specifies what "innovative" means, yet it can be assumed that he is referring to investment in implementing innovation when he sets up the "variance of the offer changes." A firm can only change the "offer" if investment is made into producing the offer of a good or service. The other variance is that of "the profitability changes," which provides the ability and willingness to invest, *a là* Kalecki. As more agents "buck the system" and adopt the variant activity, then in macroeconomic terms the system gets closer to the turning point of the cycle. In this way a discontinuity occurs at both the top and bottom turning points when the proportion that adopts the variant activity becomes the majority. Thus, Schohl devises a clear-cut spread model that shows how tightening and widening of the spreads of the two variances results in an aggregate business cycle.

Coming from the Austrian economics tradition, Schohl (1999) has a supply-driven philosophy with demand only following the innovative agents along the cycle path. The role of effective demand in the investment in implementing innovation is "hidden" in the "offer change." What this creates is an automatic *deuxs exs machina*, where the turning points are symmetrical. The agent model drives the cycle without any behavioral decisions of agents explained; it is merely a "numbers game." The more agents change to the variant activity, the closer the cycle comes to surmounting the turning point. This approach does not allow for any examination of the dynamics at the trough to see if the lack of profit distribution and finance fragility can be overcome by enough agents so as to generate a strong enough variant activity. In the Kaleckian approach, the profits variant is the driver, but in the Great Depression the lack of both profits and investing finance limited the number of agents switching to the variant activity. It is in such cases that the government is needed to change the dynamics of the turning point. This problem at the trough can be linked to what Rothbarth (1942) identifies as the Kaleckian approach, when the decline of profits during the slump is also the stimulus for change for innovative agents. This stimulus can only translate into investment *if* the reduced susceptibility is unconstrained. The excess capacity constraint needs to be removed, the gearing ratio constraint needs to fall to low and manageable levels, and the strong demand in niche markets need to be established (Courvisanos 1996). This is the effective demand story missing in the Schohl (1999) model.

Conclusion and Future Directions

Essentially, any discussion of business cycles in the context of entrepreneurship needs to distinguish between basic transformative (or radical) innovation and incremental innovation. The investment implications of commercializing innovation are very different in both. Business cycles are greatly exacerbated with investment in basic innovation. The reason for this difference is the effective demand story that is integrated into the uncertainty of investment (from Kalecki), that is missing in the purely supply-side story (from Schumpeter). The linked by distinct two-sided model of innovation and investment outlined in this entry provides the only sound basis of researching the dynamics of entrepreneurship and business cycles.

Note: The concepts, appraisal, and some major sections of the above entry are taken from a more detailed account of these issues in Courvisanos (2012).

Cross-References

- ▶ Bankruptcy
- ▶ Business Climate and Entrepreneurship
- ▶ Creative Destruction
- ▶ Financing
- ▶ Innovation
- ▶ Research and Development
- ▶ Risk

References

Becker M, Knudsen T. The entrepreneur at a crucial juncture in Schumpeter's work: Schumpeter's 1928 handbook entry *Entrepreneur*. In: Koppl R, editor. Austrian economics and entrepreneurial studies: advances in Austrian economics, vol. 6. Oxford: Elsevier Science; 2003. p. 199–233.

Courvisanos J. Cycles, crises and innovation: path to sustainable development – a Kaleckian-Schumpeterian synthesis. Cheltenham/Northampton: Edward Elgar; 2012.

Courvisanos J. Investment cycles in capitalist economies: a Kaleckian behavioral contribution. Cheltenham/Brookfield: Edward Elgar; 1996.

Courvisanos J, Verspagen B. Innovation and investment in capitalist economies 1870–2000: Kaleckian dynamics and evolutionary life cycles. Invest Econ. 2002;LXII (242):33–80.

Kalecki M. Theory of economic dynamics. In: Osiatyński J, editor. Collected works of Michał Kalecki, volume II capitalism: economic dynamics. Oxford: Clarendon; [1954] 1991. p. 205–348 [Original book published 1954, London: George Allen and Unwin].

Kalecki M. Trend and business cycle. In Osiatyński J, editor. Collected works of Michał Kalecki, volume II capitalism: economic dynamics (pp. 435–50). Oxford: Clarendon Press [Original published 1968 as Trend and business cycle reconsidered. Econ J. ([1968] 1991); 78(2): 263–76].

Rothbarth E. Review of business cycles. In Schumpeter JA, editor. Econ J. (1942); 52(206/207): 223–29.

Schohl F. A Schumpeterian heterogeneous agent model of the business cycle. Quarter J Aus Econ. 1999;2(1):1–20.

Schumpeter J. Business cycles: a theoretical, historical and statistical analysis of the capitalist process, vol. 2. New York: McGraw-Hill; 1939.

Shackle G. Epistemics and economics: a critique of economic doctrines. Cambridge: Cambridge University Press; 1972.

White G. Rethinking Kalecki on the trend and cycle. Rev Polit Econ. 1999;11(3):341–53.

Business Discourse

► Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Business Emergence

Kathleen Randerson[1] and Alain Fayolle[2]
[1]University of Grenoble IUT2-CERAG, Grenoble, France
[2]EM Lyon Business School, Grenoble, France

Synonyms

Effectual decision making; Effectuation; Emerging organizations; Market creation; Opportunity creation

Definition

An opportunity (product, organization, market) can come to be in the absence of deliberate planning. The Cambridge dictionary defines "emergence" as when "something becomes known or starts to exist."

Pioneer strategic management scholars (Mintzberg and Waters 1985) and entrepreneurship scholars (Katz and Gartner 1988; Gartner, 1993) had identified the importance of "emergentness" (Mintzberg and Waters 1985). Mintzberg and Waters set emergentness (when the order, or consistency in action over time, occurs in the absence of intention about it) and deliberateness (when the realized strategy, or patterns in action, forms exactly as intended) on the polar end of a continuum and propose a variety of types of strategies that fall along this continuum. Gartner (1993, p. 232, from Webster 1988) notes the definition "emerge" (1) to become manifest; (2) to rise from or as if from an enveloping fluid: come out into view; (3) to rise from an obscure or inferior condition; and (4) to come into being through evolution. He (Katz and Gartner 1988) identified the four characteristics of emerging organizations, defined as "organizations-in-creation, that is, organizations at the stage in which all properties necessary to be an organization come together" (1988, p. 429).

This entry reflects a second mind-set of entrepreneurship. The entry "► Business Project" is set in the paradigm where entrepreneurial opportunities, once found or discovered, lead to the analysis of the idea (business plan) and ultimately to new venture creation via efforts of formal planning and implementation. Business emergence stresses the importance of the entrepreneurial process as a set of actions or behaviors, where entrepreneurial behaviors ("enactment") lead to creation ("emergence") of an organization (where the verb "organize" means "to assemble ongoing interdependent actions into sensible sequences that generate sensible outcomes" (Weick 1979, p. 3, cited by Gartner 1993). If the first mind-set, often seen as dominant or historical, is a pertinent lens to analyze and act in stable environments, the idea of emergence is particularly useful in those of uncertainty.

Opportunity emergence (creation), organizational emergence, and the conditions and principles of emergence in uncertainty will be developed in this entry.

Opportunity as Social Construction

Entrepreneurial opportunities can be seen as objective realities that appear to alert entrepreneurs or are discovered through an asymmetry of information. They can also be seen as a social construction: They exist through the interpretation of the individuals present. Each entrepreneurial situation relies on distinct information processing capabilities. Opportunity discovery, according to cognitive psychologists, implies the use of formal models or algorithms; information processing is characterized by information which shapes the representation of reality. Social construction of opportunity, according to social or cognitive or social constructionists, will use interpretative or heuristic models to construct their reality by using information from their environment (Vaghely and Julien 2010). Recent research shows that information processing models (analytical versus intuitive) are not exclusive, and an individual can rely on one or the other according to the context or phase of new venture formation.

Wood and McKinley (2010) offer a multistage process theory in which they assume that opportunity creation implies several stages, including the conceptualization of the idea by an individual, the objectification of the idea-opportunity, and the enactment of the opportunity into a new venture. They note that not all ideas survive through enactment and identify variables that may influence the passage (or not) from one stage to the next.

Emerging Organizations

Katz and Gartner (1988) identified a selection bias in most studies of the entrepreneurial phenomenon: Most research was (is) done on firms that had (have) come to be formal. This excludes from scientific study the phases of gestation, prebirth, and birth – even though important decisions (including continuation or termination) are taken at this stage. In order to capture important information occurring during the phase of emergence, he suggests qualifying an emerging organization according to four characteristics: intentionality, resources, boundary, and exchange:

1. Organizational intentionality here refers to the search for information of the potential entrepreneur, in the aim of creating a new organization and, reflecting the vision of the entrepreneur but also that of the various environmental sectors (e.g., capital, technological, and legal). It is to note that organizational intentionality is not synonymous with entrepreneurial intention.
2. Resources refer to the material components that combine to form an organization, for example, human and financial capital, property, credit, and social capital (see entry ► Social Capital). The ease and means of marshaling such resources will strongly influence the future organization and its strategy.
3. Boundary marks the passage from "individual as organization from individual as worker" – establishing a boundary establishes the organization's identity beyond that of the individual. Examples of organizational boundary-identifying conditions include obtaining and identifying symbols such as organization name, mailing address, Internet domain, telephone number, and tax identification or tax exemption number.
4. Exchange refers to cycles of transactions that are cyclic and repetitive. They can occur across border of subsystems within an organization and, across organizational boundaries with individuals, the environment, or other organizations. Katz and Gartner (1988) notes that the exchange should be beneficial to the organization (without exchange, the organization will cease to exist), yet they may be inefficient during the early stages (e.g., selling below cost to establish market share).

Gartner's properties of emerging organizations give indications on when to observe the entrepreneurial phenomenon; below are the conditions and principles of emergence in uncertainty.

Conditions and Principles of Emergence in Uncertainty

The entrepreneurial logic, causal or effectual, is another domain where this distinction is salient. "Effectuation processes take a set of means as given, and focus on selecting between possible effects that can be created with that set of means" (Sarasvathy 2001, p. 245). Here, the individual (entrepreneur) will focus on the means he/she has at disposition and imagine the different outcomes (opportunities). His/her actions will give rise to the opportunity, or business. On the opposite, "causation processes take a particular effect as given and focus on selecting between means to create that effect" (Sarasvathy 2001, p. 245), where the new venture is the effect, and focus is set on identifying the optimum means to achieve that effect. On the individual level, the effectuator's given set of means are the responses to three questions: "Who am I?" – my traits, tastes, and abilities; "What do I know?" – my knowledge corridors; and "Who do I know?" – my social networks. This has since come to be known as the "bird-in-hand" principle. The causation model is static, assumes that the decision makers are independent, and focuses on analysis and prediction; effectuation takes place in a dynamic decision-making environment, involves multiple decision-makers, synthesis, and actions.

Both of these logics are viable, and they can "occur simultaneously, overlapping and intertwining over different contexts of decisions and actions" (Sarasvathy 2001, p. 245).

Initially, effectual decision making had been embodied in four principles:

1. *Set affordable loss*: the effectual entrepreneur will identify how much loss is affordable and will focus on experimenting as many strategies as possible with the given limited set of means (as opposed to the model of maximization of potential returns in the causal model). Thus, the idea of risk becomes irrelevant inasmuch as the entrepreneur has accepted the worst possible downside as being acceptable.
2. *Form strategic alliances* or the "crazy quilt principle": the effectuation model relies on strategic alliances and pre-commitments from stakeholders to reduce and/or eliminate uncertainty (as opposed to detailed competitive analysis). Each stakeholder will bring new means to the venture, striving to bring only what he/she considers as affordable loss and, allowing contingencies to influence the venture as possible sources of value. With self-selected stakeholders, no need to worry about trust and opportunism, focus on the commitments they make.
3. *Leverage contingencies* or the "lemonade principle": effectuation is more appropriate when exploiting unexpected contingencies (when life gives you lemons, make lemonade); whereas when exploiting preexisting knowledge (e.g., a new technology) causal models may be preferable.
4. *Control an unpredictable future* or the "pilot on the plane" principle: effectuation focuses on the controllable aspects of an unpredictable future, and expresses the logic "To the extent that we can control the future, we do not need to predict it"; whereas causation focuses on the predictable aspects of an uncertain future, expressing the logic "To the extent that we can predict the future, we can control it."

Two other principle have been formalized since: the *co-creation of the opportunity* (Sarasvathy and Venkatraman 2011, p. 118), that is, the opportunity is the fruit of the actions of the effectuator and of his/her self-selected stakeholders, and the importance of *failure as a learning experience*.

In the effectual mindset, ideas can come from transforming situations into opportunities (Read et al. 2011). The four most common transformation types are deleting/supplementing (any form of (re)-combination of elements related to the original product or service, or from unrelated domains), composing/decomposing (reorganizing material that is already there, that is, taking stock in what you have to offer and pulling it apart to recombine it in a new way), exaptation (employing existing technologies, products, services, or elements thereof for a use they were not intended to serve), and reweighing (increasing and decreasing the relative emphasis of features or attributes of a product or a market, that is, changing the emphasis of a feature so that it carries a lesser or greater emphasis on a new and differentiated offering).

Markets can also emerge in an effectual manner. As noted previously, if causal decision making processes are more appropriate in stable markets, effectual modes are more appropriate when the market does not yet exist: new markets are surprises – highly improbable and thus difficult to predict before they actually come to exist (Sarasvathy and Dew 2005). Sarasvathy and Venkatraman (2011) show as examples failed predictions (radio, "Gone with the Wind," US market for Japanese cars, computers, and personal computers) and successful market creations (Starbucks, metal ploughs, the light bulb, uncollateralized loans) (Sarasvathy and Venkatraman 2011, p. 119). They note that successful entrepreneurs appear as visionaries after the fact, but a close look at their early day stories shows the action of pulling together "a variety of stakeholder commitments, in returns for a shot at shaping the vision; co-creation of a vision that concurrently gets embodied into the components of the new market emerging from the process that is the primary result of the entrepreneurial process. Here, the familiar story of uncommitted prospects haggling over a mouthwatering pie is replaced by the reality of self-selected stakeholders actively engaged in shaping committed ingredients into unanticipated new confections" (Sarasvathy and Venkatraman 2011, p. 120).

Conclusion and Future Directions

In times and/or economies of high uncertainty, the causal, planning decision-making method is at odds to serve its intended purposes: reduce risk, exploit a preexisting opportunity, and maximize returns. Research has linked effectuation to firm performance (Read et al. 2009).

Entrepreneurship is still seeking its identity: Research has shown "mixed results" (Sarasvathy and Venkatraman 2011), and scholars evolve in micro-communities, for example, conceptions of entrepreneurial processes, psychological characteristics of entrepreneurs, alertness-opportunity creation-creative destruction, entrepreneurial networks and resource accumulation, and corporate entrepreneurship and venturing, among others (Schildt et al. 2006; Gartner et al. 2006). A new and exciting avenue of research consists of viewing entrepreneurship not as a discipline, but as a *method* (Sarasvathy and Venkatraman 2011), where it can be opposed to the scientific method.

Cross-References

► Business Project
► Social Capital

References

Gartner WB. Words lead to deeds: Towards an organizational emergence vocabulary. Journal of Business Venturing. 1993;8(3):231–240.
Gartner WB, Davidsson P, Zahra SA. Are you talking to me? The nature of community in entrepreneurship scholarship. Entrepreneurship Theory and Practice. 2006;30(3):321–331.
Katz J, Gartner WB. Properties of emerging organizations. Acad Manage Rev. 1988;13(3):429–41.
Mintzberg H, Waters JA. Of strategies, deliberate and emergent. Strategic Manage J. 1985;6(3):257–272.
Read S, Song M, Smit W. A meta-analytical view of effectuation and firm performance. J Bus Venturing. 2009;24:573–87.
Read S, Sarasvathy S, Dew N, Wiltbank R, Ohlsson AV. Effectual entrepreneurship. New York/Oxon: Roteledge; 2011.
Sarasvathy S. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. Acad Manage Rev. 2001;26(2): 243–63.
Sarasvathy S, Dew N. New market creation through transformation. J Evol Econ. 2005;2005(15):533–65.
Sarasvathy S, Venkatraman S. Entrepreneurship as method: open questions for an entrepreneurial future. Entrepreneurship Theory Pract. 2011;35:113–135.
Schildt HA, Zahra SA, Sillanpää A. Scholarly communities in entrepreneurship research: a co-citation analysis. Entrepreneurship Theory Pract. 2006;30:399–415.
Vaghely IP, Julien PA. Are opportunities recognized or constructed? An information perspective on entrepreneurial opportunity identification. J Bus Venturing. 2010;25(2010):73–86.
Webster's Ninth new collegiate dictionary. Springfield, MA: Merriam-Webster Inc; 1988.
Weick, K. The sociat psychotogy of organizing (2nd ed.) Reading. MA: Addison Wesley; 1979.
Wood MS, McKinley W. The production of entrepreneurial opportunity: a constructivist perspective. Strategic Entrepreneurship J. 2010;4:66–84.

Business Environment

► SME Growth and Influence of Internal and External Environmental Factors

Business Incubator

Karim Messeghem[1], Sylvie Sammut[2] and Chaffik Bakkali[2]
[1]University of Montpellier 1, Montpellier Recherche Management, AES, Montpellier, France
[2]University of Montpellier 1, Montpellier Recherche Management, ISEM, Montpellier, France

The concept of business incubator first developed in the United States in the late 1950s (Lewis 2002). It has become more widespread at the international level since the 1980s (Hackett and Dilts 2004; Bergek and Norrman 2008). Entrepreneurial accompaniment is an activity that tends to develop when an entrepreneurial society emerges (Audretsch 2007). Support for entrepreneurial initiatives comes in the form of accompaniment structures promoted by the state, local groups, businesses, or training and research organizations.

Although initially these structures were used to support creators with restrictions, in a context of deindustrialization, they rapidly transformed into a springboard for ambitious, innovative projects with high added value. The practice of incubation is therefore nothing new, but it is tending to increase in specialization. This evolution has given rise to a wide variety of incubators.

In parallel, abundant literature has developed to include a number of trends (Hackett and Dilts 2004). However, as stressed by Hackett and Dilts (2004), "most of this research is atheoretical" (p. 74). The research tends to be highly descriptive and normative, leaving to one side the incubation process. It is thus necessary now to shed light on the "black box" that is the incubation process (Hackett and Dilts 2008; Schwartz and Gothner 2009). This chapter aims to do just that. The specific aim is to develop a better understanding of incubators and of their diversity. To do this, two focuses will be made: one on the groups of incubator and another on the skills required by the accompaniers.

Taxonomies of Incubator

There is a considerable amount of literature in English dealing with the concept of incubator (Aaboen 2009; Aernoudt 2004; Bergek and Norrman 2008).

According to these authors, business incubation has developed in a context that is favorable for entrepreneurship, offering a reassuring environment for people with projects, providing them with a certain number of services (premises, advice, etc.), making it easier for them to make contact with other entrepreneurs, participating in the discovery process – taking advantage of opportunities, contributing to the development of their legitimation strategy, and, of course, increasing their levels of knowledge and skill. Business incubators must therefore adopt an overall approach, based on their environment, so as to identify and make use of the resources available locally (Autio and Klofsten 1998).

As the needs of businesses today are heterogeneous, in addition to the general missions presented above, the incubators try to specialize (Grimaldi and Grandi 2005). Given this diversity, several authors have tried to classify accompaniment structures by proposing taxonomies of incubator (Aernoudt 2004; Albert et al. 2003; von Zedtwitz 2003). The term "incubator" is used in the English sense, that is, including structures whose support is targeted at the pre-creation stage ("incubators" in the strictest sense of the term) and those whose support focuses on post-creation follow-up ("incubator" in the looser sense of the term). The taxonomy developed by Albert et al. (2003) synthesizes all the main groups of incubator. It is only necessary to add social incubators identified by Aernoudt (2004). Table 1 presents finality, dominant activities, objectives, and targets of the different groups of incubator.

Economic development incubators are set up locally and are thus not standardized. They are

Business Incubator, Table 1 The main characteristics of the different groups of incubator

	Economic development incubators	Academic and scientific incubators	Social incubators	Business incubators	Private investor incubators
Finality	Nonprofit	Nonprofit	Nonprofit	Profit	Profit
Dominant activities	Generalist	High tech	Social	High tech	High tech
Objectives	Job creation	Promotion of technologies	Job creation	Development of the business spirit among employees	Profit through the resale of shares from a portfolio of businesses making it possible to spread out risks
	Reconversion/ revitalization	Development of the business spirit	Economic development	Holding on to talents	Cooperation between the businesses in the portfolio
	Economic development	Citizenship	Creation of social wealth	Intelligence	
	Support for specific populations or industries	Image	Integration of certain social categories	Access to new technologies and new markets	
	Development of SMEs and networks (clusters)	Financial resources		Profits	
Targets	Small craft, commercial or service companies	Projects internal to institutions prior to creation	Projects of a highly social nature	Internal and external projects, in general in relation with the professions of the business	Technological start-ups
	In certain cases, high-tech businesses	External projects			

Source: Adapted from Albert et al. (2003) and Aernoudt (2004)

generally inserted into local economic development programs.

Academic and scientific incubators benefit from state subsidies. They make technology transfer easier and promote the development of business culture in universities. They are at the crossroads of three cultures that have everything to be gained from being preserved: academic, scientific, and industrial.

Social incubators have the particularity of generally pursuing a dual objective: developing economic activity while preserving social logic. They also benefit from local and/or national subsidies.

Business incubators are set up in large companies, one of the ambitions of which is to develop their potential for innovation by giving the employees the opportunity to express their entrepreneurial talent.

Private investor incubators are the expression of venture-capital companies or *business angels*. By creating incubators, the latter aim to reduce the distance separating them from the businesses they finance, thus reducing the asymmetry of information that disadvantages them.

To illustrate these groups of incubator, Insert 1 gives an example of a scientific incubator: the BIC in Montpellier, in the south of France.

Incubators are organizations which mobilize human resources to carry out their activities. The quality of the accompaniment service depends on the skills of the accompaniers (Hannon 2005). The second part of this chapter will be devoted to this aspect.

Insert 1 Presentation of the BIC in Montpellier

The BIC (Business Innovation Centre) was set up in 1987 in the form of an ECEI. It accompanies innovative business creators in the Greater Montpellier area. It supports businesses with a considerable potential for development in the following sectors of excellence: health, biotechnology, information and communication technology, and higher tertiary. In 2007, it received the prize for best world incubator awarded by the NBIA (National Business Incubation Association).

Three key missions have been developed: accompaniment, training, and accommodation. Out of a total of 12 employees, 6 use their talents as project manager 50% of the time in the pre-creation phase, and 50% in the post-creation follow-up phase. These accompaniers are highly qualified engineers or commercial specialists who master all the skills associated with developing a business plan, financial engineering, marketing, and organizational management.

The businesses are housed either within the BIC itself, or in Greater Montpellier. Within the BIC, there are two sites that can be used: Cap Alpha (specialized in biopharmacy, biotechnology, and renewable energy) and Cap Omega (specialized in information and communication technologies). Regardless of the structure chosen (onsite or outside these two incubators, but within Greater Montpellier), the BIC must be familiar with all the activities of the businesses in order to better accompany them.

The training courses proposed by the BIC are in line with the phases of development of the innovative business.

In the pre-creation phase, the BIC proposes three standard training courses:

- *"Etincelle," which makes it possible, over 2 h, to raise awareness of the various stages in the business creation process thanks to accounts from creators themselves.*
- *"Trajectoire," a 2-day training module, allows participants to acquire the basics of methodology before actually creating their business.*
- *"Création d'entreprise innovante" is an extended training course over 20 days. It allows participants to reflect in depth on the feasibility of their projects.*

In the post-creation phase, two training courses are proposed for business directors wishing to create their own businesses:

- *"Focus," which, on the basis of themed training courses (half day or one full day), allows participants to reflect on the management issues involved in an innovative business.*
- *"Décollage," which makes exchanges easier by organizing group or individual training courses on site – that is, within the newly created business. The theme is defined* ex ante, *and the accompaniment takes place over a period of 10 months.*

The Skills Required Within Incubators

The theory set out in this chapter is that there are two categories of skill. Generic skills are those that all accompaniers (incubator managers) have, regardless of the type of structure. There are also skills specific to each type of incubator.

Generic Skills

The trio of knowledge, know-how, and life skills allows to analyze generic skills. Although this trio has its own limitations, based essentially on the fact that the boundaries can seem rather blurred between the three, it is nevertheless relatively practical and this explains why it is used so widely.

Knowledge is all that the project manager must master, regardless of the project accompanied. This knowledge can be analyzed on the basis of the three phases in the model developed by Shane and Venkataraman (2000): detection, evaluation, and seizing opportunities. This knowledge first of all concerns the phase upstream of the creation or detection of opportunity. Creativity methods and intellectual protection law are essential tools for helping the creator develop new ideas and protect them.

Following this phase of entrepreneurial maieutics, it is possible to start evaluating the opportunity, in other words, analyzing the feasibility of the project, based on a concept such as the business model. Knowledge of this tool is essential for helping the creator to develop a management system that makes it possible to appropriate entrepreneurial income. Evaluating the opportunity also supposes knowledge of the environment and, in particular, the specific sector of activity. The accompanier must be aware of the specificities of the sector, its perspectives for evolution, the rules of the competition game, the legal restrictions, etc.

In the exploitation phase, the accompanier must be capable of providing assistance in putting together the business creation dossier and in particular in developing the business plan. This instrumental knowledge is a necessary condition, but not sufficient for the success of the project. The accompanier must also master the specificities of SMEs and, more precisely, the organizational emergence process. It may be possible to understand this process by using grids such as the Gartner model (1985), which focuses on systematic and processual reading. The accompanier must help the creator to manage the young company in its creation and post-creation phases. The knowledge that needs to be mastered can be approached via the key fields in management, such as strategy, marketing, finance, HR, accounting, law, and taxation.

Business Incubator, Table 2 The knowledge needed to accompany the entrepreneurial process

Phases	Detecting/creating opportunity	Evaluating the opportunity	Seizing opportunity
Mobilized knowledge	Creativity techniques	Business model	Management techniques
	Propriety law	Sectors of activity	Business plan Networking

Source: Authors (2011)

Incubators must provide business creators with assistance to help them to immerse themselves in business networks. Accompaniers must therefore have excellent knowledge of the players liable to be of help, to provide advice or funding.

Table 2 groups together all the different types of knowledge using the three phases in the model by Shane and Venkataraman (2000): detection, evaluation, and seizing opportunity.

The second aspect of generic skills is composed of the accompanier's know-how. In order to explain how incubators function, Aaboen (2009) makes an analogy with businesses that offer services for professionals. This type of business deals with customer relation management processes that are based on qualified personnel composed of "knowledge workers." From this analogy, two levels of know-how appear: in management of the structure and in management of the relations with those accompanied.

The first level becomes essential from the professionalism perspective. An incubator is an organization that must use a management system. Its small size may lead it to prefer project logic. It is vital that project management tools and techniques be mastered. Follow-up of a creation project supposes that objectives be defined, the different resources from the structure and its environment be obtained, and that time be mastered. Incubators rely more often than not on public funding. The managers of these structures must negotiate their budget and justify their choices. They must guarantee the follow-up of their activities and can for this reason be called on to set up a system for evaluating their performances. It is important for the running of their activities that a system also be set up to exchange good practices between accompaniers. This system can be inspired by the principles of *knowledge management*.

The second level refers to the relationship with the incubatees. When providing follow-up for a creator, mastery of accompaniment techniques, such as interview techniques or coaching, is essential. The accompanier's aptitude for transferring knowledge to the person with the project is also a key form of know-how (Sammut 2003). This skill requires in particular the transformation of tacit knowledge into explicit knowledge, and vice versa. These different forms of knowledge can create dependency in decision-making, which can prove to be detrimental, particularly in the post-creation phase. Making the creator autonomous is thus an essential skill that the accompanier must absolutely master (Sammut 2003). It allows the creator to find solutions on his own to any future problems that he may encounter as the director of a business. Finally, there are two other forms of know-how. The first is knowing how to respond to a particular problem with a solution that is not generic, but that takes into consideration the specificities of the project – a made-to-measure response, in other words. The second is the ability to bring the person with the project into contact with external partners in such a way as to make up for the lack of integration into networks that is so characteristic of creators.

Life skills are the last aspect of this type of skill. The concept is vaguer than the previous aspects and has been criticized given that it does not correspond to a definition of the skill in its context. It is nevertheless very much present in the skill referentials and is of interest from a managerial point of view for this reason. Life skills can be defined as a set of relational skills. Goleman (2006) distinguishes two types of life skills: social conscience and social skill.

The accompanier's empathy and open-mindedness are the key elements in his social conscience. These two types of life skill were identified by Fayolle (2004) as skills that make easier the relationship between the accompanied and the accompanier. They make it possible to reduce the distance between both parties' mental representations. The accompanier's involvement in the mission is another element that forms part of this social conscience and is represented by considerable availability.

Social skills refer to the accompanier's relational qualities. These qualities allow the accompaniment to take place in good conditions. Respecting decisions and psychological support are the key elements. Respect effectively makes it possible to obtain and conserve the creator's trust, while psychological support helps the creator to go beyond his periods of doubt, thus preventing any deterioration in the accompaniment relationship. Pedagogy also makes it possible for the accompanier to transmit knowledge more easily to the person with the project (Fayolle 2004).

Specific Skills

Generic skills are the common foundation of the accompaniment profession. The second category of skills can be qualified as specific skills. Their specificity lies in the fact that they depend on the nature of the accompaniment structure. On the basis of the taxonomy of incubator presented in the first part of this chapter, five categories of specific skills are identified.

Economic Development Incubators and Territorial Skill

The aim of economic development incubators is to promote economic initiative in a given area by creating conditions for the emergence and development of new localized activities. Since the 1980s, geographical areas have been committed to a competitive dynamic by trying to reinforce their attractiveness. Incubators were designed to encourage and attract new businesses, who were in turn supposed to play a part in the creation of value and job creation. The specificity of these incubators lies in the large number of key players involved in their funding. The accompanier must therefore be able to find his marks in this multidimensional area. To do so, it is necessary for the accompanier to develop good understanding of the role played by each key player so as to be able to integrate into the local networks. Political skills are also needed to negotiate with key players with sometimes opposing forms of logic.

Academic and Scientific Incubators and Technological Skill

The aim of academic incubators is to bring together two universes that are sometimes unfamiliar with each other: academia and industry. This is because successful projects developed by incubatees will find an opening in the industrial sphere. The accompanier must therefore have a scientific culture and good knowledge of the world of business. One major characteristic of these projects lies in the significance of the funds involved, implying that the accompanier must also have good knowledge of funding channels (banks, business angels, venture-capital businesses, and so on). The accompanier must master the various mechanisms associated with technology transfer and the protection of intellectual property.

Social Incubators and Social Skill

By definition, social incubators support projects with a social vocation. These projects can be trade-oriented or not, and concern a wide variety of sectors of activity in the field of social economy, such as culture, sustainable development, ecology, insertion, etc. Adherence to the field of social economy is determined by certain characteristics such as a particular status (e.g., a cooperative or association), as well as a dynamic based on solidarity and reciprocity with regard to the interface with the market, civil society, and the state or its local representatives. Here, the specific skill thus lies in perfect knowledge of social economy, law, and the various statuses possible within a social economy (e.g., in France, the SCOP status – a worker's cooperative).

Business Incubators and Intrapreneurial Skill

Business incubators provide support for projects developed by existing companies. This intrapreneurial mode of organization involves implementing autonomy factors so as to allow certain selected employees to bring their project to fruition thanks to their entrepreneurial skills. Accompaniers in business incubators must enable and/or enhance (1) the creativity of the incubated intrapreneurs, (2) their managerial capacities, and (3) their socialization.

Private Investor Incubators and Financial Skill

The last type of incubator corresponds to private investor incubators. Venture-capital companies and business angels are often behind the creation and funding of this type of accompaniment structure. The typical activities of these private investors consist in financing projects that they consider to be potentially profitable. Private investor incubators make it possible to reduce the asymmetry that investors are subject to in their relationships with entrepreneurs. The latter try in this way to benefit from physical proximity with the businesses that they finance (Barrow 2001). This proximity thus allows them to detect businesses that may not turn out to be profitable, but also those that have a greater potential for growth than initially predicted, so as to be able to adjust their level of participation. The main specific skill here lies in the accompanier's capacity to perpetually assess the potential of the accompanied businesses to create value. It is this capacity that we refer to as financial skill. This supposes that the accompanier masters the various methods of evaluation.

Conclusions and Future Directions

The development of incubators results in questions being raised regarding their management practices and the skills of their accompaniers. The quality of the service provided effectively depends greatly on the skills of those who accompany the incubatees.

Two categories of skill have been identified. The core is composed of the generic skills that are essential, regardless of the type of project accompanied. These generic skills are based on the trio of knowledge, know-how, and life skills which is widely used in incubators. In order to take into account the wide range of incubators, a taxonomy based on five categories of incubator has been proposed. Thus, five types of specific skills have been identified.

The configurational approach seems to be an interesting future direction to conceptualize the management of incubators. By adopting this approach, it could be possible to propose a specific HR management model for each group of incubator. For example, specific model of remuneration or specific model of recruitment could be envisaged.

Cross-References

- ▶ Accompaniment of Business Creation
- ▶ Business Start-up: From Emergence to Development

References

Aaboen L. Explaining incubators using firm analogy. Technovation. 2009;29(10):657–70.

Aernoudt R. Incubators: tool for entrepreneurship? Small Bus Econ. 2004;23(2):127–35.

Albert P, Bernasconi M, Gaynor G. Incubateurs et pépinières d'entreprises: un panorama international. Paris: L'Harmattan; 2003.

Audretsch DB. The entrepreneurial society. New York: Oxford University Press; 2007.

Autio E, Klofsten M. A comparative study of two European business incubators. J Small Bus Manag. 1998;36(1):30–43.

Barrow C. Incubators: a realist's guide to the world's new business accelerators. New York: Wiley; 2001.

Bergek A, Norrman C. Incubator best practice: a framework. Technovation. 2008;28(1–2):20–8.

Fayolle A. Compréhension mutuelle entre les créateurs d'entreprise et les accompagnateurs: une recherche exploratoire sur les différences de perception. Manag Int. 2004;8(2):1–14.

Gartner WB. A conceptual framework for describing the phenomenon of new venture creation. Acad Manage Rev. 1985;10(4):696–706.

Goleman D. Social intelligence: the new science of human relationships. New York: Bantam Book; 2006.

Grimaldi R, Grandi A. Business incubators and new venture creation: an assessment of incubating models. Technovation. 2005;25(2):111–21.

Hackett SM, Dilts DM. A systematic review of business incubation research. J Technol Transf. 2004;29(1): 55–82.

Hackett SM, Dilts DM. Inside the black box of business incubation: study B—scale assessment, model refinement, and incubation outcomes. J Technol Transf. 2008;33(5):439–71.

Hannon PD. Incubation policy and practice: building practitioner and professional capability. J Small Bus Enterp Dev. 2005;12(1):57–78.

Lewis DA. Does technology incubation work? A critical review of the evidence. Athens: National Business Incubation Association; 2002.

Sammut S. L'accompagnement de la jeune entreprise. Revue Française de Gestion. 2003; 3(144):153–64.

Schwartz M, Gothner M. A multidimensional evaluation of the effectiveness of business incubators: an application of the Promethee outranking method. Environ Plan Gov Policy. 2009;27(6):1072–87.

Shane S, Venkataraman S. The promise field of entrepreneurship as a field of research. Acad Manage Rev. 2000;25(1):217–26.

von Zedtwitz M. Classification and management of incubators: aligning strategic objectives and competitive scope for new business facilitation. Int J Innov Manag. 2003;3(1–2):176–96.

Business Intelligence

▶ Information Monitoring and Business Creation

Business Model

Robert H. Desmarteau[1], Anne-Laure Saives[2] and W. David Holford[2]

[1]Department of Strategy, Social and Environmental Responsabilities, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

[2]Department of Management and Technology, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

Synonyms

Economic model; Strategic system

Definition

A business model is the representation of a given firm's competitive strategy which, in the image of a sketch, determines how the firm organizes its human, physical, and financial resources to create, capture, and share value. As to the "how to's" of organizing, a consensus emerges toward identifying four elements or specific logics to be considered: "customers," "expertise," "network," and "revenues, economic value-added."

The Concept

During the financial bubble of 2000, a proliferation of the term "business model" as symbolized by "start-ups.com" first found its origins within an accounting dissertation published by Bellman in 1957 (Bellman et al. 1957). This up-until-recently forgotten or orphaned notion is best characterized by its conspicuous absence within the classical literature, or as Teece (2010) recently stated, "*The concept of Business Model has no established theoretical grounding in economics or in business studies*." In parallel to this epistemological vacuum, one single click on the Google search engine generates 300 million plus listings. In short, one is faced with the flagrant academic obligation to examine both the significance and scope of the concept of business model. What utility does the concept provide? How does one represent the concept? What is its relationship to competitive strategy?

According to Magretta (2002), a good business model is above all a good narrative tool (*good story*) on how a firm functions (e.g., Wal-Mart founder Sam Walton (in his words) "*Put good sized stores into little one-horse towns which everybody else was ignoring*" (Magretta, in Teece (2010))), a good story from which one can then judge its capacity to respond to Peter Drucker's age-old questions (Magretta 2002): (1) Who is the customer? (2) What does the customer value? (3) How does one make money in this activity? (4) What is the underlying economic reasoning that justifies the firm's ability to provide value for its customers in a cost-effective manner? For many, it is the art of design, or again, the architecture as proposed by Teece (2010) to describe the explicit or implicit concept of the business model: "*Whenever a business enterprise is established, it either explicitly or implicitly employs a particular business model that describes the design or architecture of the value creation, delivery, and capture mechanisms it employs. [...] In essence, a business model embodies nothing less than the organizational and financial architecture of a business*." In other words, the "blueprint" image ingeniously proposed by Osterwalder (2004) captures the essential concept of business model.

A History of the Concept of Business Models

Circumscribing the historical origins of the concept of business models is an audacious exercise which emphasizes a filiation of principal ideas so as to generate new understandings across the proposal of sensible linkages which are more or less expected. The first point of reference among the historical foundations of business model concepts can be revealed across Ansoff's (1965) bidimensional conceptualization of corporate strategy whereby the product and the market are combined: "*the product-market scope, the grow vector, and the competitive advantage – describes the firm's product-market path in the external environment*" (p. 99). This resolutely deterministic approach was to guide the development of several instruments to strategically "position" firms. Among the most well known are (1) "Portfolio Analysis" from the Boston Consulting Group Perspective created by Bruce Henderson in 1968, (2) "Profit Impact of Market Strategy Project" (PIMS) (Schoeffler et al. 1974), (3) Market Attractiveness/Business Position Assessment (Rothschild 1976), and (4) General Electric's Strategic Business Unit (SBU) (1971; Hall 1978). The years which followed this effervescence led toward a third dimension – of a voluntary nature – embodied within competencies related to organizational strategic practice (Normann, 1977, 1983). "*We want a concept which includes not only ideas about the market and the role of the company in the external environment* (i.e. *what is to be dominated*), *but also what is to be done to transform these ideas into* *concrete arrangements. [. . .] The business idea expresses the unifying principle of such a system. [. . .] A description of the business idea involves description of: the niche in the environment dominated by the company, in other words the company territory; the products of the 'system' that are supplied to the territory; the resources and internal conditions in the company by means of which dominance is acquired*" (Normann 1977, p. 34, 37, and 38).

Closely following the pronouncement of this new paradigm, the tridimensional representation of strategic practice took shape across the work of Buzzell (1975, 1978) involving the definition of the notion of the market, and materialized itself at the level of the firm across Abell's (1980) reflections: "*I shall make the working assumption that the market will be redefined in terms of customers groups, customers functions, and technologies as individual businesses are redefined in these dimensions*" (Abell 1980, p. 25). During the 1980s, the "function, client, and technology" tridimensional representation of corporate strategy became an epistemological rallying point. As an example, (Thompson and Strickland's 1983) understanding can be mentioned: *"The three dimensions of defining 'What Is Our Business?' Derek Abell has expanded on the importance of a customer-focused concept and suggests defining a business in terms of three dimensions: (1) customers groups, or who is being satisfied, (2) customers needs, or what is being satisfied, and (3) technologies, or how customer's needs are satisfied*" (Thompson and Strickland 1983, p. 62). Finally, in a convincing and concluding manner, Ansoff, in 1987, recognizes the advantage of the tridimensional model: "*Instead of the two dimensions of the original matrix it is more realistic to describe the geographic growth vector along the three dimensions which the firm can use to define the thrust and the ultimate future scope of the business: dimension of the market need, dimension of product technology, and the market geography which defines the regions or nations states in which the firm intends to do business*" (Ansoff 1987, p. 84). Since the beginning of the 1980s, the conceptualization of corporate strategic practice has multiplied the tridimensional representation. Examples such as Johnson et al. (2008b) SAD (strategic activity domain) and Allaire and Firsirotu's (1993, 2004) "strategic system" both combine the "market need, market geography, technology" triad, and by integrating the "value network" dimension, pave the way toward the notion of business models.

To materialize the transition from the tridimensional vision of corporate strategic practice to the representation of the business model concept, one must recognize Chesbrough's (2003) emblematic contribution which represents the concept of business model within a construct which breaks down the value creation process into six key functions: (1) define a customer proposition based on specific value-carrying benefits; (2) identify a target market encompassing the given customers; (3) define a value chain based on necessary complementary assets; (4) describe the revenue-generating mechanisms based on cost structure and anticipated production margins; (5) after having identified potential competitors, specify the firm's position within a value network linking suppliers, customers, alliance, and collaboration partners; and (6) formulate a competitive strategy which will allow the innovating firm to gain a competitive advantage over its rivals. In the ensuing years, the literature on business models provided an abundance of contributions whereby diverse epistemologies confronted one another in their attempts at apprehending the object of study. Nevertheless, based on specific dominant contributions, a consensual thread emerges across authors such as Chesbrough (2003, 2006), Johnson et al. (2008), Jouison and Verstraete (2008), Verstraete and Jouison-Lafitte (2011), Osterwalder and Pigneur (2010), and Teece (2010). These authors integrate the definition of the business model within an exercise which eventually translates a firm's strategic choices "into acts of creating, capturing, and sharing value." To fulfill or actualize these "acts of creating, capturing, and sharing value," strategists from IBM's "*Institute for Creation Value"* (Giesen et al. 2009) defend the consensual notion of business model across the aid of four elements which can didactically be associated to articulated and evolving logics (Desmarteau and Saives 2008): (1) "customer" logic in which the firm conceives a value-laden proposal by exceeding their expectations within a framework of sustained relationships; (2) "expertise" logic, in which the firm combines key necessary resources, processes, and competencies to create/capture/share value; (3) "network" logic which relies on a network of partners to seize upon conjoint opportunities of value creation and sharing by exploiting Chesbrough's notion of "*Open Innovation*" ("'*Open Innovation' means that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well*" (Chesbrough 2003, p. 43)); and (4) a "revenues" and "economic value-added" logic (Stewart 1991) whereby the firm conceives revenue-generating mechanisms as well as a cost structure of its resources by relying on capital cost overruns.

The Strategic Energizing of the Concept

The competitive strategy energizes the business model or more specifically its underpinning in action. In other words, the creating, the capturing, and the sharing of value are induced by the driving of one or of all of the logics across energizing properties related to innovation, inimitability, and renewal. Innovation implies access to market. Starting from Schumpeter's (1942) teachings, Baumol (2002) distinguishes innovation from invention in that innovation constitutes an opportunity for change whereby all means and resources are implemented toward the successful introduction of an invention to market. As for periodic renewal, it rests on the firm's capacity to change the dynamics of a business model, this, by reason of time's irreparable erosion of any given competitive advantage and on the need to concretize change so as to construct a lasting advantage and durability of the firm (Demil and Lecocq 2010). Finally, inimitability is based on the firm's capacity to combine rare resources so as to construct its distinct identity and on its capacity to institutionally lock these same resources (Hamel 2002; Teece 2010) by means, among other things, of patents or, again, distinctive partnerships.

Conclusions and Future Directions

In summary, the concept of business model is the representation of a given firm's competitive strategy which, in the image of a "blueprint" (Osterwalder 2004), determines how the firm organizes its human, physical, and financial resources to create, capture, and share value. As to the "how to's" of organizing, a consensus emerges to identify four elements which can be associated with specific logics: "customers," "expertise," "network," and "revenues, economic value-added."

At the praxeological level, certain practitioners call for a census of business models as well as for a classification and inventory of business model elements (Zook and Allen 2011) or a taxonomy of business models envisaged by firms. Others, in front of an infinite number of possibilities as well as the specific context of firms, consider the feat to be unrealizable. At the methodological level, certain researchers attempt to circumscribe the modes of change and evolution associated to business models. At the epistemological level, so as to guide the practice of this subtle art of modeling, the words of Jean-Louis Le Moigne become useful: "*Modeling, is orchestrating! How does one model? By specifying, as much as possible, the why's of these how's*" (Le Moigne 1990–1977, p. 23).

Hence, across the exercise of representation, the concept of business models poses numerous questions which remain unanswered (Saives et al. 2012): at the epistemological level, does the business model require a theory of the firm? And conversely, in a somewhat provocative manner, does the firm require a theory of business models? Does the business model bring in to play the "why," the "what," and the "how" of the collective existence? The business model is a management instrument that is often coupled to the postulate of the market economy. How does one re-utilize and adapt it so that it can become an instrument for organizations (with social finalities) which have a plural conception of the economy? This evidently poses the central question of a plural conception of value. Lastly, can the instrument of the business model successfully inscribe itself within the management system ("*dispositif de gestion*") (Moisdon 1997)? Does this constitute an opportunity to seize and/or an instrument to surpass? Robust anthologies on the concept of business model will soon come forward to satisfy this epistemological void, since here, as in elsewhere, nature abhors vacuums.

Cross-References

- ▶ Business Start-Up: From Emergence to Development
- ▶ Creative Destruction
- ▶ Entrepreneurial Opportunity
- ▶ Entrepreneurship in Creative Economy
- ▶ Innovation Opportunities and Business Start-Up
- ▶ Open innovation and Entrepreneurship
- ▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)
- ▶ Product Development, Business Concept, and Entrepreneurship
- ▶ Schumpeterian Entrepreneur
- ▶ Social Entrepreneurship
- ▶ Spin-off
- ▶ Start-up
- ▶ Strategic Thinking and Creative Invention
- ▶ Venture Capital and Small Business

References

Abell DF. Defining the business: the starting point of strategic planning. Englewood Cliffs: Prentice-Hall; 1980.

Allaire Y, Firsirotu M. L'entreprise stratégique: penser la stratégie. Boucherville: Gaëtan Morin; 1993.

Allaire Y, Firsirotu M. Stratégie et moteurs de performance. Montréal: Chenelière McGraw-Hill; 2004.

Ansoff HI. Corporate strategy. New York: McGraw Hill; 1965.

Ansoff HI. The new corporate strategy. New York: Wiley; 1987.

Baumol W. The free-market innovation machine. Analysing the growth miracle of capitalism. Princeton: Princeton University Press; 2002.

Bellman C, et al. On the construction of a multi-stage, multi-person business game. Oper Res. 1957;5:469–503.

Buzzell RD. Market share: a key to profitability. Harv Bus Rev. 1975;53:97–106.

Buzzell RD. Note as a reference source for the analysis of case studies involving issues of market definition and segmentation, 1978. Copyright, the President and Felloes of Harvard College. 9-579-083 Rev. February 27, 1987 (reprod.).

Chesbrough HW. Open business models: how to thrive in the new innovation landscape. Boston, MA: Harvard Business School Press; 2006.

Chesbrough HW. Open innovation: the new imperative for creating and profiting from technology. Boston, MA: Harvard Business School Press; 2003.

Demil B, Lecocq X. Business model evolution: in search of dynamic consistency. Long Range Plann. 2010;43(2–3):227–46.

Desmarteau RH, Saives AL. Opérationnaliser une définition systémique et dynamique du concept de modèle d'affaires: cas des entreprises de biotechnologie au Québec. In Actes de la XVII^{e} conférence internationale de management stratégique, AIMS, Nice, juin, 2008.

Giesen E, Riddleberger E, Christner R, Bell R. Seizing the advantage. When and how to innovate your business model, IBM Institute for Business Value, 2009.

Hall WK. SBUs: hot new topic in the management of diversification. Bus Horiz. 1978;21(1):17–25.

Hamel G. Leading the revolution: how to thrive in turbulent times by making innovation a way of life. Rev. and updated. Boston, MA: Harvard Business School Press; 2002

Johnson MW, Christensen CM, Kagermann H. Reinventing you business model. Harv Bus Rev. 2008a;86(12):51–9.

Johnson G, Scholes K, Whittington R, Fréry F. Stratégique. 8ème éd. Pearson Education; 2008b.

Jouison E, Verstraete T. Business model et création d'entreprise. Revue Française de Gestion Février. 2008;34(181):175–97.

Le Moigne J-L. La théorie du système général, théorie de modélisation. 3^{e} éd. rev. Paris: Presses universitaires de France; 1977–1990.

Magretta J. Why business models matter. Harv Bus Rev. 2002;80(5):86–92.

Moisdon J-C. (dir). Du Mode d'existence des outils de gestion, collectif, Seli Arslan, 1997.

Normann R. Management for growth. Chischester/New York: Wiley; 1977. Traduction of *Skapande foretagsledning*, Stockholm, Aldus, (1975).

Normann R. Reframing business: when the map changes the landscape. Chichester: Wiley; 1983.

Osterwalder A. The business model ontology: a proposition in a design science approach, Doctoral Dissertation HEC Lausanne, 2004, p. 172.

Osterwalder A, Pigneur Y. Business model generation. Self Published, BusinessModelGeneration.com; 2010. ISBN 978-8399-0617-3.
Rothschild WE. Putting it all together: a guide to strategic thinking. New York: Amacom; 1976.
Saives A-L, Desmarteau RH, Schieb-Bienfait N. Après une décennie de Buzz, quelle pertinence pour le concept de modèle d'affaires en stratégie ? Montréal: JFD Éditions; 2012.
Schoeffler S, Buzzell RD, Heany DF. Impact of strategic planning on profit performance. Harv Bus Rev. 1974;52:137–45.
Schumpeter JA. Capitalism, socialism, and democracy. New York/London: Harper & Brothers; 1942.
Stewart III GB. The quest for value. New York: HarperCollins; 1991.
Teece JD. Business models, business strategy and innovation. Long Range Plann. 2010;43:172–94.
Thompson Jr AA, Stickland III AJ. Strategy formulation and implementation tasks of the general manager. Plano: Business; 1983.
Verstraete T, Jouison-Laffite E. A conventionalist theory of the business model in the context of business creation for understanding organizational impetus. Manag Int. 2011;15(2):109–23.
Zook C, Allen J. The great repeatable business model. Harv Bus Rev. 2011;89(11):106–14.

Business of Church

► Church and Entrepreneurship

Business Plan

► Business Project

Business Project

Kathleen Randerson[1] and Alain Fayolle[2]
[1]University of Grenoble IUT2-CERAG, Grenoble, France
[2]EM Lyon Business School, Grenoble, France

Synonyms

Business plan; Corporate venture, internal; Intrapreneurial project

Definition

An identified opportunity can be pursued in a systematic, planned manner.

The Cambridge dictionary defines "project" as "a piece of planned work or an activity which is finished over a period of time and intended to achieve a particular aim" and business as "the activity of buying and selling goods and services, or a particular company that does this, or work you do to earn money." In a first acceptation, a business project is the planned work intended to assess the pertinence of pursuing a business opportunity, the resources and means required to do so, and how to get access to these means and resources (business plan). More recently, entrepreneurship and business practices have been adopted in the social sector (social entrepreneurship: see other entries in this volume); a business plan can be drafted in this case. Moreover, pursuing an opportunity can be the aim of an individual in an organizational setting: This is an intrapreneurial project (related entries in this volume: ► Corporate Entrepreneurship, ► Entrepreneurial Organizations).

The Business Project as a Start-up

When the opportunity is exploited by an individual, or group of people brought together for the specific purpose of exploiting the project, the project will be ad hoc and be translated by the production and diffusion of a business plan. The entrepreneur (individual or team) has identified an opportunity. The opportunity can be related to business or to a social need: new product or service, a technological innovation, a novel application of a known technology, and a new means to create value (see entry "► Business Model"). To exploit this opportunity, the entrepreneur must round up resources such as people/competencies, funds, or physical assets in order to transform the opportunity to reality.

Drafting a business plan responds to several objectives. It is useful to support decision-making (for the entrepreneur(s) and external stakeholders) and to communicate the project. Different drafts of the plan will reflect the evolution of the project and be addressed to a specific interlocutor for a given request (potential partner, shareholder, bank, etc.). Above all, it is important that the document reflects a fit between the opportunity, the market, the entrepreneur(s), and the new organization.

Generally speaking, a business plan includes the following chapters:

Executive summary: found directly after the title page, the executive summary should concisely resume the entire business plan in one page or less. Essential information that should clearly appear: what the entrepreneur wants (loan, buy-in, grant, etc.), the business concept, financial information, current business position, and main achievements. It can also comprise a description of:

- The future enterprise (creation, development, takeover)
- The top management team and their competencies in relation to the opportunity
- The opportunity itself and the strategy to exploit it
- The market and its potential
- The competitive advantages of the good or service
- The financial return and the interest for the potential investor or partner
- The funding needed, what the enterprise can give in exchange for that funding, and how the funds will be used or the aim of the partnership

Team members: the names of the team members and the specific resources (skills, competencies, network, funding) they bring, in relation to the project.

Business description: first a landscape view (the industry), then a description of the target market, and finally a view of how future activity will create value in this environment.

Business concept: will describe the goods or services, their uniqueness for the market, and the business model (see this word). The description of the offer will include the technical characteristics, eventually illustrated by a photography or blueprint. The aim is to show how the offer responds to a demand, the specific advantages of the offer, and possible further evolution, as well as identified risks. The life cycle, the protection of the idea (IP), and R&D activities needed to renew the offer may be interesting to develop.

General strategy: this chapter should clearly demonstrate that the suggested business is the response to pursue the identified opportunity. It will include the enterprise's mission statement, how it differentiates from existing firms, the qualifiers of success and how they will be leveraged upon, and eventually further stages of development. It should show the fit between the conclusions of the market study and the offer, the pertinence of the planned strategy.

Market strategies: first demonstrate that there is a solvable market to exploit the opportunity. The data presented is generally collected through a market study, leaning on reliable, operational, and prospective information. It is important to show that the target and distribution channels are clearly identified. The following items can be developed: the industry and its characteristics, the segments targeted, how the goods or services will be introduced onto the market, the qualifiers compared to existing offers, the potential customers and their purchasing habits, and the perspectives of the market. A scan of the competition will cover identifying the main competitors, their position, and their strategy.

Sales and marketing strategy: will define the distribution circuits, how the price was determined, and how the offer will be advertised, considering factors such as quality, accessibility, price, advertisement, and customer service. Data can include a description of the duo product/market, sales forecast, prices and margins, previsions, and communication.

The means and organization (design and development): this section will describe how the future organization will be operated, on the practical and legal levels. The entrepreneur will show that he/she can manage the constraints inherent to production and describe the buildings, equipment or material required, the raw matter and its provenance, the possible extensions and evolutions. The production process will be described in detail; the subcontracted phases will be described separately and include the name of the subcontractor, the conditions of the contract, and why this solution has been adopted.

Legal matters: include the legal structure of the enterprise but also IP matters, partnerships, tax, and contracts (e.g., labor, rental, loans, insurance).

The financial previsions: present an evaluation of the financial needs and their structure. The coherence between the financial previsions and the rest of the business plan should appear clearly and include first a presentation of the main hypothesis that found the previsions but also the financial projections over 3–5 years. Three documents should be included: balance sheet, income statement, and cash flow statement, monthly for the first year and quarterly for the following. It is important that the reader identify easily the realism of the hypothesis and measure the level of robustness of the financial structure facing the risks. Including the exit options for investors will increase chances of buy-in.

The Business Project as a Corporate New Venture

When the opportunity is exploited for an organization, the undertaking will generally take the form of an intrapreneurial project. This entry will draw the portrait of the intrapreneur, review the types of intrapreneurial projects and the differences with entrepreneurial projects, and finally exhibit the outcomes. These projects are often the means for organizations to bring innovations to market.

Pinchot and Pinchot (1978) coined the expression "intra-corporate entrepreneur" as "intrapreneur," referring to an individual who pursues an identified opportunity in an organizational setting. He suggested eight principles that enable to identify an intrapreneur and his/her contract with the organization:

1. To become an intrapreneur, an individual must risk something of value to himself, for example, time or a delayed salary raise.
2. The rewards of success in an intrapreneurial project must be shared between the corporation and the intrapreneur in a well-defined and equitable way.
3. The intrapreneur should have the opportunity to build up something akin to capital (e.g., a cash bonus, additional R&D funds, or "intra-capital").
4. The corporation must let the employee entrepreneur who has earned his independence have it as well as the right to fail.
5. To start a new venture, the would-be intrapreneur who has not built up "capital" must seek funding, present and defend a business plan, and agree on a method of sharing the venture's profit.
6. After a number of players have built up sizable intra-capital, some may become "venture capitalists" within the corporation, investing in the projects of other employees who cannot get corporate backing on agreeable terms and who lack adequate intra-capital.
7. If a new product or service developed by an intrapreneur cannot be sold advantageously to another division of the company, he should have the option of raising intra-capital from the venture capital committee and/or from other successful intrapreneurs, to manufacture and market the new product. The new venture could be organized as a new corporate division, or even as a new corporation largely owned by the parent corporation.
8. As the intrapreneurship system matures, intrapreneurs will be found throughout the company enthusiastically performing many services that are now performed in a less-efficient and inspired manner by corporate employees.

Currently, intrapreneurship refers to the intracorporate entrepreneur (Pinchot and Pinchot 1978), or innovation initiated and implemented by employees (Carrier 1996). Internal corporate venturing relates to the creation of new activities inside an existing organization through product or market innovation (Block and McMillan 1993), focusing on the exploitation of the firm's talents and resources. Corporate entrepreneurship can be defined as a formal or informal activity aiming at the creation of new activities through product or process innovation and the development of new markets (Zahra 1991). The outcomes are similar: innovation (product, market, process) and the development of new markets (e.g., internationalization).

As suggested above, a business plan will usually support the intrapreneurial effort to transform the opportunity into organization; the same attention will be devoted to communicate the fit between the opportunity, the market, and the new enterprise. Buy-in may be particularly difficult to gain in the corporate setting, as the suggested innovation may perturb the corporate strategy, well-engrained processes and habits, or the organizational culture; the intrapreneur will need to double his/her efforts.

Innovation through intrapreneurship carries specific traits: The project finds its legitimacy through the process, funding is conditional and uncertain, and the innovation can take place anywhere in the company and relies mainly on informal networks and specific procedures. The process is heavily dependent on the personality of the intrapreneur, who will benefit strongly and directly from the project's success.

The intrapreneurial process can take several forms: platform, cell, division, or be spontaneous. Spontaneous intrapreneurship is the result of an individual initiative that germed in an organizational context; in this case, the project will need to be sufficiently developed before the intrapreneur will be able to officially take responsibility for it. Intrapreneurial activity can also be induced by the organization. Intrapreneurial units, or small teams, can be appointed by the firm's direction to develop a specific opportunity. Named "task force," "team," and "unit," this group of people is united for the specific project and will disband once the project comes to term, returning to their initial post or are affected to the newly created activity. The intrapreneurial platform is a device, often sophisticated, set up by the firm to encourage, select, and implement intrapreneurial projects. This platform is not an entity per se, but a set of systems and procedures aiming at encouraging a flow of intrapreneurial ideas. The employees involved in these platforms do this activity in addition to their usual responsibilities. The intrapreneurial division is an independent unit with its own objectives; financial, human, and technical resources; and management system. It has the same purpose as the intrapreneurial platform, but it is autonomous. The employees are involved in this activity full-time, and this implication is reinforced through a specific system of compensation/sanction.

Conclusion and Future Directions

The business project, be it in an organizational setting or not, is the act of planning a future business. This can be supported by drafting the business plan, a document that will show that the proposed organization is a pertinent way to pursue an identified opportunity, on a given market. The document will also support decision making (go or no-go) for the entrepreneur(s) as well as external shareholders (potential investors) or stakeholders (e.g., suppliers) and be a valuable communication tool. However, the predictive value of the business plan is controversed: A business plan rarely correctly predicts the financial return of the new business. In many cases, the preponderance of the business plan (document) occults the importance of the project (process). In uncertain contexts, business emergence (see entry ▶ Business Emergence) plays an ever increasing role.

Cross-References

- ▶ Business Model
- ▶ Corporate Entrepreneurship
- ▶ Entrepreneurial Organizations
- ▶ Intellectual Property Rights
- ▶ Social Entrepreneurship
- ▶ Start-Up

References

Block Z, McMillan IC. Corporate venturing: creating new businesses within the firm. Boston: Harvard Business School Press; 1993.

Carrier C. Intrapreneurship in small businesses: an exploratory study. Entrepreneurship Theory Pract. 1996;1:5–20.

Pinchot G, & Pinchot E. Intra-Corporate Entrepreneurship Tarrytown School for Entrepreneurs. 1978. http://www.intrapreneur.com/MainPages/History/IntraCorp.html. Accessed 5 June 2012.

Zahra SA. Predictors of financial outcomes of corporate entrepreneurship: an exploratory study. J Bus Venturing. 1991;6:259–85.

Business Relations

► Business Climate and Entrepreneurialism

Business Start-Up: From Emergence to Development

Michel Marchesnay
ERFI, Université de Montpellier, Montpelier, France

Synonyms

Accompaniment; Creation; Growth

Entrepreneurship, viewed as either an academic or a practical field, is primarily made up of three interwoven mainstreams:

- "Individual traits" of entrepreneur, typified as either a cautious owner-manager (J-B Say), or an audacious risk-taker (J-A Schumpeter 1943)
- Global "spirit of enterprising" of Society, typified as either a positive attitude toward risk and innovation (Drucker 1985) or a free market ideology (Williamson 1985)
- Last but not least, business creation, start-up and development

Academic research on this latter topic started during the sixties. It sharply increased with the industrial world crisis of the mid-seventies, requiring new public policies. By supporting new firms, Governments tried to reduce unemployment of either salaried workers, fired from big industrial concerns, or "disabled minorities" (Small Business Act). But they also designed to promote and develop new technologies, in activity parks, nurseries, clusters, and so on.

Ten years later, the emerging worldwide capitalism, usually named "postindustrial," also "entrepreneurial" (Audretsch 2007), entailed a deep "reengineering" of economic activities, implying to promote their own business creation by new generations. Some countries were revealed to be more flexible and entrepreneurial, as in North America, with a high rate of new ventures (partly due to foreign newcomers). However, creation of small business firms appears everywhere as a major trait of the new capitalism. Moreover, most part of creations is not registered, those organizations being embedded in either black economy, or the nonprofit and social sectors.

Another main feature of "neo managerial capitalism" is its strategic propensity to replace inner recruitment by outsourcing, leading to the development of very small firms and even to self-managed units, occupying one or two persons (for instance, a couple). Doing so, some management problems of nascent micro-firms may be paradoxically similar, whatever the nature and level of skill, from one tiny stall of an African woman on her local market to one notorious counselor in international finance!

During the last 30 years, academic literature relative to small business creation and creators hugely expanded, as revealed by an increasing amount of specialized reviews, books for the general public, students and scholars, academic papers, workshops, seminar, congresses, and so on. As a result, researchers are faced with a wide span of theories about business creation, dealing with every specific problem, such as entrepreneur profile, management competences, organizational resources, market opportunities, financial needs, innovation perspectives, etc. The topics of academic research are inspired, or even dictated by "social demand," as a need for accurate information and tools for local development, counseling, entrepreneurship training and education, and so on. Furthermore, a lot of news magazines and popular works deal, for instance, with "how to make your creation successful," "the heroes of economy."

Three Contrasted Models: Theoretical, Pragmatic, and Systemic

The Life Cycle Model: A Theoretical Approach

The LCM is more deductive (logical, rational) than inductive (based on factual observations of sampled firms). This model is based on a biological analogy with living human and creature. Theoretically, every firm may be typified as getting over several stages, from birth and childhood to old age and death. The LCM deduces that, at each stages, the entrepreneur copes with specific management problems, each ones requiring specific skills, as creativity (stage 1), risk taking (2), managerial skills (3), leadership (4), marketing (5), and so on. Some researchers designed until many as 11 "hurdles" to be jumped during the whole life of the firm! But the best known model, published by Neil Churchill and Virginia Lewis (1983), comprises only five stages.

The LCM aims to describe what specialists on management research and education call "success stories." It intends to demonstrate that, during the early stages, the "boss" must behave as an entrepreneur (a risk-taker), but, during the following ones, as an organization man (a risk manager), in such a way that the founder is frequently replaced by a salaried person as top manager. He/she is most often assumed to maximize growth, willing to build an "empire" and what Schumpeter (1943) called a "dynasty," as described, among many other "exemplary" cases, with those two following groups.

In 1928, Joseph Rapp, both a craft carpenter and a farmer, creates a small joiner workshop in a small village of Eastern France (Alsace), in order to craft and sell furniture. His two sons create, in 1959, the first store, in the nearest city (Mulhouse), and, in 1964, the first super market of furniture (Sumara, changed to Atlas in 1973). In 1978, they start the store chain Fly, and merged the chain Crozatier after its failure. In 2003, the two sons become co presidents. In 2010, this family group is the fourth French furniture retailer, with 261 stores. But they are now at the cross roads, being faced with the third generation. Indeed, the two presidents have 20 thirty years' old little children (and stock owners). Now, some of them firmly intend to work inside the group, and to hold managerial responsibilities. Thus, the two presidents have to choose between a managerial organization, governed by salaried executives, and a family business structure. At the cross roads, they decide to design a chart, in order to maintain cohesion between heirs, and so avoid stock sales to "intruders".

The first French chocolate factory was created in 1814 in the South of France (near the Spanish border), by Mr Cantaloup, who inspired the name of the firm, in 1884. The firm grew, after its buy –out in 1962, by Mr G. Poirrier. This entrepreneur first used the brand Cantalou as a subcontractor of big retailing. In 1982, he merged the firm Cémoi, using that well known brand as an umbrella. The two sons of Mr Poirrier are respectively president of the group and general manager of the subsidiary Sucralliance. In spite of risks, they build factories in Africa (Ivory Coast 1996), and in Spain (2008) in order to make stocking more secure. Nowadays, the Cémoi group employs 3,000 people and corners 3 % of the world production of cacao.

However, it is commonly said that "too simple is wrong, but too complex is unusable." If the LCM is an appealing tool for early "management" teaching, it appears far from the actual problems of new venturing, as taught in "entrepreneurship." Indeed, new starting businesses are mostly micro-firms, employing one or two people. Furthermore, a host of inquiries (for instance, Sue Birley 1999) confirm that not only more than half of SME entrepreneurs are unwilling to grow, but that growth reluctance increases as the firms are smaller. Besides the argument of a lack of resources and skills, SME entrepreneurs declare to prefer a "perennial" (and quiet) life, rather than suffer risks inherent in coping with growth uncertainties. The above firm is a good example of strategy of niche.

The firm Minilamp, created in 1951, employing 28 people, is the world leader (one competitor in Europe, two in the United States) in the niche markets of both design and manufacturing incandescent lamps. They reinforced this, in 2001, by acquiring a laboratory working on special lamps used in research (10 employees). They achieved small *and overspecialised orders for 300 clients in the world, mostly big companies working in the transportation industries (railway, airway, and so on).*

The Business Model: A Pragmatic Approach

The "Business Model" is primarily a pragmatic tool, designed to help anyone willing to start his/her own business to detect, expect, avoid, prevent, and deal with "common" problems in the designing and achievement of their project. However, two different visions of the BM may be observed, focusing either on processes or on procedures.

The "process approach" is primarily used by counselors. They help applicant to identify the nature and level of problems linked to his/her project. For instance, as seen later, he/she has to precise motives (and motivation), expectations (economic, social), supports (family, friends, social networks), and so on. Most often, this first stage helps to reveal contradictory and unrealistic designs, even some psychological refusals to take obstacles into account. During the following "constructivist" stage, the counselor helps the creator to build and develop his/her project, but in such a way that it looks unfinished, as a sketch. Indeed the "training process" ever requires more precise, factual, and accurate information, more realistic visions, and so on. That pragmatic approach is primarily aimed to help the creator to "discover" key problems, rather than to apply some "best," unique, solutions. That methodology is based on uncertainty, inherent to strategic decisions, as underlined by Igor Ansoff (1988). For instance, a lot of future events, often unpredictable (as the arrival of competitors, disruptive innovations, etc.), may require a change in depth of the whole structure of the business model.

The "procedural approach" is primarily used by, and for institutions, banks and credit organizations, public agencies, agreement committees, and so on. Those institutions require formal information fitting into their own procedures. Thus, request for some credit must be made as if the whole set of future decisions concerning resources needs, market definition, technology-products designs, and so on were definitively and precisely taken and forecasted. It refers to the so-called heuristic decision: assuming that the "solution" is given, it "just" remains to detect how to resolve some technical problems, by using the one best way (for instance, in matter of finance, the "optimal" leverage ratio). Strategic choices are seen as deliberate, not emergent, as typified in the case of big corporations. For instance, the applicant is assumed to be able to forecast expected sales for several years, workforce, current expenditures receipts, margins, future net cash positions, and so on. Thus, most of innovative creators are deterred from presenting their business models to banks or financial institutions, due to the high uncertainty prevailing for their expected businesses. Fortunately, agencies in charge of those innovating ventures (for instance, hosting inside a Nursery, an Innovation Center, or institutions allowing financial supports) use, inside their committees, a B.M. methodology close to the process approach. Furthermore, more extensively, decision criteria take into account informal data, such as those collected during interviews with applicants.

The "Seven W Model": A Systemic Approach

Project evaluations encompass several "unavoidable" topics. Therefore, global appreciation, as a "systemic" approach, results from a "mix" of formal and informal data. Each theme is below identified by its initial W, knowing that it is embedded in a global evaluation of the whole project, viewed as a system. That methodology implies several face-to-face encounters, dialogues, trial and error processes, between the applicant and every protagonist (counselor, colleague, friend, stakeholders. . .). Of course, both the following list and the content of themes are not limited.

1. "Who?"

   "Who" refers to identity of "nascent" entrepreneurs, including life story (origins, education, career, family, etc.), traits of character (energy, adaptability, tenacity, open-mindedness, sociability, etc.). Academic research leaves questionable the link between individual identity and entrepreneurial skills.

2. "Why?"

   "Why" first refers to the factual reasons inducing an entrepreneur to create his/her own business, such as being fired, willing to be his/her own boss, or seizing a technical or market opportunity. Moreover, it refers to more deeply precise goals and intents. For instance, is applicant primarily motivated by searching for either a "survival income," or a "satisfying return" on his/her investment, or, even more, "highest growth as possible"? Does he/she intend to stay on a long run in this expected job, or does he/she will sell his/her business to a big company, or take another business, once past the highest rate of growth of the targeted market?

3. "When?"

   It refers to the both forecasting and programming processes. Short seeing applicants prioritize building a business model in accordance with data, ratios, values required by supporting institutions. They postpone underlying problems, hoping to solve them later, once they have obtained agreements. Too often, those creators either create in a hurry, without training, or lack of learning in matter of entrepreneurial skill. It primarily explains the high rate of failures during the early years.

   Mr Coste, an engineer employed in a giant computer company, is a good example of "opportunist entrepreneur", as typified by Norman Smith (1983). Indeed, he noticed that French firms were absent on the world-wide "niche" market of some overspecialized metrology equipment. He seized that opportunity to retire. He got agreements for financial supports, added to his departure premium. Unfortunately, he says that he was "badly counselled" during the 1st year. He had not envisaged "classical" start-up problems, such as the licensing problems, the cost and delay of finding and acquiring business premises, the retaliating reaction of the two (American and German) installed competitors, and so on. Thus, he wasted the most part of his venture capital during the 1st year. Fortunately, the project was promising enough to be further supported by institutions and clients.

4. Where?

   Location is the key factor of most of the craft or retail shops, and, more generally, for all businesses requiring some physical proximity to clients, suppliers, and stakeholders. However, expected benefits due to the so-called best site are frequently overestimated, due to the unexpected high cost of real estate, cut throat competition, imitation, retaliation, and so on. Furthermore, some businesses primarily require immaterial relationships, as website trade, so that the nascent entrepreneur may choose more distant and quiet spaces, as typified with the "lifestyle entrepreneur." Moreover, innovative entrepreneurs are hosted in activity parks, clusters, nurseries, innovation centers, and so on.

   The best location varies according to the content of the "business", and, consequently, the core competence. For instance, a generalist bookshop must be located in a busy street or a commercial centre, while specialised, second-hand or rare bookshop preferably works in a cheap and quiet place. The more the market is specialised, the more the shop must be, either near to clients (for instance, a scholar bookshop, near the university), or distant (for instance, use of website to trade in rare, ancient books with specialists and amateurs), or be located in a city in which all sorts of books and linked craft activities are traded, as in a "cluster", or a "Marshallian" district (for example, the medieval town of Montoulieu, in South of France).

5. What?

   The pronoun "What" deals with both nature and design of business. This one is defined in strategic management by the acronym "T-P-M," i.e., a "basket" of "technology," "product," and "market." Every applicant has to deal with the prevailing question of "fit" between those three grounding "pillars" of project feasibility. The main questions to, respectively, ask, answer, and solve are:

– What are the definitions and components of the designed product? How is it different, and, as much as possible, "better" than those yet installed in the targeted market?
– What are the resources required to get the core competencies to survive (core competencies), and, better, prosper in the targeted market?
– What are the tastes, behaviors, and expectations of the targeted users (consumers, firms, administrations, foreign markets)? To what extent does the proposed "service" improves user's satisfaction, and, more generally, that of stakeholders, including everyone concerned (for instance, more sensitive to ecological problems)?
– What are the main expected trends of the business market evolution? Does the product stay with current mainstream, or is it disruptive, anticipative, and innovative?

For instance, the "hypo" – very small-group (six societies, 35 employees) Sigma Méditerranée works on virtual intelligence. The firm is installed in an activity park, near from the new computer cabled network. The president anticipated that Health Agencies will increasingly have to cope with very old people living at home. The regional rate of growth of old people is around 18 % by year, and the "home solution" is highly promoted by Health Agencies. The firm markets "Logo Box TV, a "domotic" equipment (electronic for home uses. Including TV and Internet, it gives a permanent link between old person at home, and Health and Assistance services. Indeed, it appears to be promising market.

6. Which?

Small business entrepreneurs are commonly viewed as being alone, with no support. In fact, all of them, as all people, are embedded in numerous "social areas," such as family, neighbors, ethnical community, public or professional institutions, and so on. It explains why the creator has to list those various "stakeholders," i.e., every person or organization having some potential relationships and interest with the future entrepreneur and his/her business. The prevailing questions are:

– Which will govern? Indeed, the applicant may be submitted to other owners, as for instance, family members, or venture capitalists. Consequently, in order to avoid conflicts, or "surprising decisions," he/she must carefully examine the content of firm statutes, and forecast consequences of family troubles, as divorce, death. Decision power concerning ownership (profit sharing) and management (financial policy) must be defined, above all in case of comanagement and ownership by associates or family members.
– Which people will trade with the firm workers? It includes suppliers, retailers, clients, and colleagues. Some of them may create a "dependency effect," for instance, big retailers or unique suppliers.
– Which external people will be positively involved in the success of the project? The "first circle" is made of family, the second one of friends and community members, the third one of institutions supporting such projects, such as financial, promoting, and counseling institutions.
– Which external people or organizations are reluctant or hostile to the project? It primarily concerns all firms threatened by new "intruders," by business and even market innovations. "Intruder" may be even rejected when the so-called invader is not well embedded in the local environment. The newcomer will have to learn more about local networks and habits.

7. Whole

Finally, "whole" deals with a global appraisal of all topics mentioned above. Most often, projects are built by using an analytic and procedural view. Thus, each problem is dealt alone, as if it was insulated from the other ones. Every choice actually impacts on the whole system, thus requiring a global overview. Moreover, every scenario is unavoidably prisoner of future events, so that it implies adopting an "evolutionary" attitude. Thus the creator has to pay attention to the successive steps – vision, intention, start-up and development – as described below.

The Genesis Process: From Vision to Intention

From Vision...

Vision is first of all a cognitive process. Somebody, looking at the future, more or less clearly and early, is induced to consider opportunities. A large number of researchers have studied to what extent more or less hidden motives, logics, norms, events, etc., primarily explain how vision works. In fact, a lot of personal factors may be retained as hypothetical, so that the visionary process varies on a case by case basis. Thus, it justifies the need for counselors to have recourse to individual "storytelling" with each applicant.

The well-known two-type dichotomy – "artisan" versus "opportunist" entrepreneurs – by Norman Smith is based on two opposite visionary processes. The so-called artisan has a "limited" vision, as regards space (close environment), time (near future), and business (weak or poor skills). He/she most often makes his/her decision in a hurry. Conversely, the so-called opportunist has an "enlarged" vision, embracing not only stakeholders, but every influential event other than business ones. Thus, he/she waits until his/her project is mature enough (as Mr Coste, described above).

A four type's classification, inspired by the well-known typology by Miles and Snow (1978), is gotten by crossing the two above dimensions, named here "short or long-run vision," and "narrow or broad-minded," It allows giving a more accurate description of the working of vision.

"Short-sighted" and "narrow-minded" applicant is typically a "follower," according to the Miles and Snow typology. His/her vision is usually focused on two quite different businesses: either traditional (for instance, small craft proximity units, service, or retail activities) or fashionable (for instance, video games, snack foods). Both entry and exit barriers are low, so that they cope with many competitors. The shortness of vision may be justified, either by a lack of turbulent events (traditional), or, at the opposite end, by a larger number of unpredictable events (fashion). The exceedingly high rate of turnover (births and deaths) is thus explained by either a too high risk of unprofitability and failure, or a short life expectancy of a fashionable business.

– Both a short-sighted and broad-minded entrepreneur is defined as an "adaptor" by Miles and Snow.

  He/she focuses on one or several business features, such as technical process, consumer or user needs, internal skills, and competencies. He/she incrementally improves his/her business, searching for mastering either a segment or even a niche of an existing market. It implies that his/she has both a good knowledge of current business, and an accurate vision of its evolution, requiring incremental and adaptive changes (often viewed as "innovations" by those creators). A good deal of adaptive creators is previously well trained, as, for instance, an executive chief deciding to create his own restaurant. Other people seize opportunity to transfer their knowledge (know-what or know-how) to different markets. For instance, a well-trained worker in electronics will apply his/her skill to the home security market.

– "Prospector," according to the Miles and Snow typology, may be defined as "narrow-minded," but "long-run seeing."

  They concentrate on their special competencies. Those are due to personal stories, including education, culture, learning, experience, and so on. Moreover, he/she may be a member of some specialized community, such as professional (craft guild), social (ethnic group), local (regional specialty, cluster). The prospector tries to discover opportunities. By appraising the most probable evolutions, and even revolutions in customs, in products, in technology, in world economy and politic, and so on, he/she searches for any developments in existing or emerging markets, by using his/her competences as a lever. The case of Sigma Méditerranée, mentioned above, is a good example of prospector behavior.

– The fourth type is named "innovator."

He/she is assumed to be both long-run sighting and broad-minded, so that he/she is opened to every "message" or "percept" put forward in his/her enlarged environment. It implies very peculiar abilities, so that the innovator, for instance, will be the unique detector of a business opportunity. Indeed, such innovations may often reveal to be highly disruptive. Innovators are described as attaching most importance to future events. They try to encompass as many future contingencies as possible, in every field. For instance, they practice "serendipity," i.e., the aptitude to find opportunities by interpreting (correctly or not) any "signals," as described in semiology. The whole set of collected "signs" are drawn from an unlimited "bundle" (Tilton-Penrose 1959) of hypothetical resources. They actually become "useful" resources as soon as the innovator is able to "catch" them, and decides to create an innovative business.

However, it must be kept in mind that the "pure" innovator, as defined here, is quite exceptional. Indeed, it first implies that the idea is quite original, "risen from nothing." But most researchers, following Kirzner (1973), think that the innovator has just "discovered," "revealed" or "underlined" some discrepancy between "supply" and "demand" in one market, and is able to find the "good way" to fill that gap. It further assumes that innovator must be willing to create his/her business, to achieve a project and bear entrepreneurial risks. It requires that this person possesses, or is able to acquire several and different competencies. Thus, many researchers admit that entrepreneurs are "more or less" innovators, but that many innovators are "more or less" entrepreneurs by creating and managing their own enterprise. In fact, there is a large span of "innovativeness," so that even the less innovative creators contribute to modify the competitive scope in their street or in the market place! Moreover, it must be underlined that most of disruptive innovations are nowadays discovered in research laboratories of big companies, or bought from small innovative firms (as patents in genomics, or software, for instance).

To Intention

Opinion polls show that, instead of an increasingly willingness to create their own business, few of people carry out their "dream." Pragmatic reasons explain that discrepancy, such as low motivation, low entrepreneurial skill and culture, lack of venture capital, excessive risk, and so on. Of course, there is a world of difference between, for example, a micro-firm created by a female worker, poor, unskilled and unemployed in the suburbs of a African megalopolis, and a start-up created by a small team of highly skilled researchers, hosted in an innovation center, and benefiting from venture capital. However, one similar explanation lies in the both psychological and technical difficulties in achieving such a project and writing it in a business plan.

Intent starts as soon as applicant explores avenues to create his own business. He/she visits websites, looks for institutions in charge either of administrative formalities or of counseling, discusses with family members, friends, and colleagues. Countries aiming to promote entrepreneurship have drastically reduced registration formalities (centralized in a unique office, and available on the web). A host of information systems about creation are nowadays easily available. Accompanying activity hugely expanded during the last two decades, as described in other contributions to that encyclopedia.

The second stage of intention starts when an applicant contacts and meets expert people in order to gather information, and starts a review of questionable topics, as described above with the "seven W" model. As frequently observed, those early meetings are used for identifying some key points, such as business (T-P-M) content, available and required resources (tangible and intangible), and, above all for new applicants, information concerning nearby environment (market, competitors, public institutions, and so on).

Both content and development of the following stages primarily depend upon many variables, some of them implying a more advanced formalization, as applications for venture capital, for business center, for bank credit allowance, for counselor monitoring, for micro-credit valuation, and so on. Research shows that, the more the applicant is accompanied during that period, the more he/she increases the probability of success, as revealed by cases and inquiries relative to the failure causes of "young" enterprises (less than 5 years).

An entrepreneurship program for a French public institution, entitled "Institute of Rural Management and Economy" (in French: Institut de Gestion et d'Economie Rurales), was formed and practiced during the early Nineties. It was aimed to train local counsellors of around one hundred Rural Management Centres, in order to get accurate competences for creator's accompaniment in rural areas. It comprised several stages, from idea until actual start-up. During a first informal meeting, untitled "representation", the applicant freely gives some "prima facie" description of his/her vision, primarily based on subjective perceptions. The counsellor centres the "conversation" on the two crucial links between the "why?" and the "what?, the "competences" and the "market expectations", as described above. At this time, counsellors conclude that new applicants are commonly used to focus exceedingly on their hypothetical competitive advantage. The most quoted are either technical skills ("I work very well that product or service"), or commercial competence ("I deeply know that market"). Doing so, they (subconsciously or deliberately?) avoid underlining or encountering any other troublesome problems, or weaknesses, may be expecting that they will be solved during the start-up stage, as seen below. Conversely, mature applicants, those having previously started one or more businesses, tend to be better trained, due to either trial and error learning (including failures) or successful creation(s) (including profitable resale). Inquiries confirm that, the more prior creations, the more clear vision and intents. Financial institutions usually upgrade a credit file when it reveals a high spirit of enterprising, and particularly a high resilience capacity, i.e., *an ability to start again, in spite of previous troubles or failures.*

Otherwise, it must be mentioned that a lot of small business creations, seemingly made by a unique owner-manager, are in fact governed by either big concerns (outsourced or subcontracting small firms), or venture capitalists (start-ups and "gazelles"). Other ones are increasingly created by one person or family governing a (very) small firms network (so-called "hypo group", as seen above, case "Sigma Méditerranée"). In those three cases, the formal business file, meant for various institutions, will probably be built accurately.

The first meetings ("representation") aim at highlighting problems arising from the targeted project. The second set of meetings deals with the so-called "presentation", namely, a formal file offering solutions, according to some basic choices. Ultimately, the applicant must be able to build his/her twofold business plan. The first version, designed for institutional files, is mainly based on definitive, deliberate, available and secure data, in order to convince the institution that the applicant has a clear vision, a firm intent, and attainable objectives. The alternative version is designed for the personal view of the applicant. It is mainly based on evolutionary, emergent, random and unsecured data, in order to hold strategic flexibility, and ability to face with unexpected events during the early years.

The Start-Up Process: From Birth to Development

The start-up period is defined by dated events, as first order by some client, first batch (for manufactured product), official shop opening, and so on. However, the creator must have solved before as many prior start-up problems as possible. Indeed, the early years are crucial and must be carefully prepared. Failures occurring during that period are primarily due to "classical" mistakes, commonly summarized as "bad, or wrong, management" by both researchers and institutions. Observers and practitioners point to a dichotomy between two kinds of problems to be solved. The first ones deal with long-term (strategic) topics being appraised and solved before effective start-up. The second ones concern short-term (operational) problems, occurring more or less sharply during early years.

Avoiding Strategic Troubles

Strategic troubles may be analyzed primarily as "misfits" concerning, respectively, coherence between the logic of creation and the nature of the business, the link between key competences and targeted markets, and, ultimately, between ownership and management power.

1. What logic of action ?

   The mainstream of literature on entrepreneurship defines the spirit of enterprising as a mix of a search for both profit and growth. It thus entails a typology made of four prevailing logics of action.

   – The "survival" logic.

     The entrepreneur (for instance, a craft worker, a small retailer), primarily expects a "satisficing" income, similar to revenues observed in his/her nearby environment. He/she desires a quiet life by targeting stable markets, with well-known habits of clients, suppliers, and competitors. He/she expects no sharp changes. "Profit" is just seen as a "normal" margin, as compared to competitors, or a "cash surplus," used for his/her own (including family) consumption.

   – The "family," "community," or "patrimonial" logic.

     This entrepreneur aims to preserve and accumulate family capital, made of both productive assets (net value of the business) and private capital ("stone and land," financial portfolio). Profit is seen as the best way to enhance patrimony, by practicing self-financing. Internal or external growth appears as just a second best strategy, giving priority to patrimony maximization. Family logic implies both "craft" expertise and market reputation on a long-range perspective. It most often requires a strong common culture between family members, including heirs. For instance, the heirs of the group Rapp (big retailers in the furniture market, mentioned above) are all fervent Catholics. Besides the "nuclear" family, it must increasingly be taken into account a "widened" family, comprising "community" or "ethnic" members.

   – The "managerial" logic.

     The managerial entrepreneur is most often well educated and trained on managerial principles and practices (for instance, as a prior executive). He is clearly searching for both profit and growth, by targeting two business objectives: first, reduce costs and increase productivity; second, enhance market power, by internal growth and mergers, by enlarging and diversifying the business portfolio, and so on. Accordingly with the BCG matrix, the entrepreneur is searching for new promising, turbulent, and risky market, financed by earned profits in mature, stable, and secure ones. Thus, he/she reveals a high propensity to "nomadism."

   – The "entrepreneurial" logic.

     Those entrepreneurs delight in venturing businesses. Searching for opportunities to achieve an innovative and risky business, they are unavoidably embedded in emergent and unstable markets. Apart from the case of R&D as a full-time activity, entrepreneurial entrepreneurs are expecting, during the start-up, and most often the "cruising stage," to hardly need managerial skills. It explains why a lot of them primarily hope that their firm will be acquired by big companies, and that they will be recruited unless they try again to find new venturing opportunities…

2. Who governs?

   Who actually has the decision power remains often an unsolved and sometimes avoided question. However, a distinction must be made between two levels of decision, and consequently, of governance.

   – Governance linked to property rights.

     Apart from the case where the entrepreneur is the unique owner, start-up capital is usually brought and shared between several people or institutions (including family members and friends, with "love capital"). The entrepreneur must ensure that, whatever the future brings, he maintains his/her decision power. Those events comprise, besides economic or financial ones, social situations, as for instance, personal (health) and family (divorce) problems. Concerning venture capital firms, they most often target the majority of rights to vote, while maintaining the creator as the boss. Another "classical" problem frequently occurs when the entrepreneur has just the commercial lease, entailing potential conflicts with the reversionary owner. It is thus required to carefully prepare legal clauses concerning who decides and pays for improvement or repair investments.

   – Governance linked to management power.

     Underlying problems are commonly due to a lack of practical experience, either of technical and organizational problems, or marketing and commercial ones. They crop up when this weakness concerns the "key function," requiring core or even distinctive competences. For instance, if the entrepreneur, previously a salaried executive, intends to create his/her business in a craft activity, requiring special abilities, the recruited foreman may acquire excessive influence, until he opposes to decisions taken by the boss, as described below.

     Twenty years ago, an entrepreneur, Mr Berry, started his business IREB on an activity park, in the suburbs of a French southern city. He manufactured, as a subcontractor, components for Hi Tech big companies, working mostly on French defence and arms markets. Every order requiring original specifications, he recruited highly skilled workers, particularly the foreman. During the 2nd year, in order to get more cash, Mr Berry decided to install an entirely computerized machine, producing large batch pieces, such as screws, bolts, and so on, for factories supplies. The foreman convinced the team to refuse operating the machine, thus putting down the reputations of both workers and enterprise. After 6 months of conflict, the entrepreneur resigned himself to resell the machine. The firm has flourished until today… maybe thanks to this obstinate foreman.

Solving Start-Up Troubles

During the early years, the entrepreneur has to solve "classical" problems, as underlined by both researchers and counselors. They may be classified according their link with strategic choices. Some of them require some reexamination of prior choices, other ones just adaptive reactions. Those troubles are illustrated below by taking several cases of restaurateurs.

1. Reconsidering strategic choices

   The entrepreneur realizes a misfit between his/her expectations and the actual business.

   This creator was an appreciated salaried chief in a high class restaurant located in the commercial street of a famous seaside resort. He started his own restaurant in a cheaper and more quiet place of that touristic town. He intended to benefit from his gastronomic competences to attract clients willing to taste his "innovative" recipes. But he quickly observed that clients were primarily attracted by his previous recipes, simpler and cheaper; moreover, his wife calculated that he would earn a higher margin than with the "innovative" ones. He rapidly changed his mind, in order to cope with market expectations. But he was almost frustrated, and hoped to later convince his clients to taste his more original (and expensive…) recipes…

The entrepreneur seizes opportunities to adapt the fit between his/her competences and market changes. But unforeseen disturbing events may arise, requiring an in-depth strategic change.

Philippe sold his baker's shop – at a good price. He, and his wife, intended to start a less tiring business in the snack food market. However, they had not foreseen the intrusion of so many small shops in the snack market, in the best places, and the rise of the lease cost in town centre. Finally, Philip found a place located in a passer-by road at the town exit. Its attractiveness was enhanced by imminent construction of a new tram line, planned to pass nearby. But, once installed, he learned that people living along that street had protested, so that the city council had changed the lay-out. Now, the tram line was constructed in its own street, with access only for inhabitants, pedestrians, or cyclists. They tried for 1 year to start the business, in spite of those exceedingly disturbing public works, but they were obliged to stop. They just received a" symbolic" indemnity from the authorities.

2. Reacting to start-up problems

   Scholars on start-up research agree on the most frequent problems, including conflicts, arising during early years. For the sake of simplicity, in spite of their systemic impacts, they will be classified as "internal" and "external."

   - Internal problems solving

     While organizing their tasks scheduling, entrepreneurs must take in a hurry a lot of short sighting and time-consuming micro-decisions. Thus, they complain of not having time enough to think about their deliberate strategy. An alternative strategy emerges, based on a host of incremental decisions. This troublesome problem may become more acute in case of dissent between associates or stakeholders.

     Organizational problems may also occur with the workforce. The entrepreneur must define precisely each profile of accurate competences required for the various jobs. Some of them are seen to be crucial, either as a part of core competence, or even of "singular," distinctive ability.

     For instance, somebody who intends to start a pizzeria must primarily recruit a well trained pizzaiolo, and offer him a high wage, a "good" pizzaiolo being very asked for. It explains why so many pizzerias are family or community businesses, members being both trained to work the job, and supported to create their own business, inside a "community" or family network.

     In fact, most part of creations just comprises a very few workers. Thus, according to Mintzberg's classification (1973), a small organization (named "entrepreneurial"), is primarily organized by mutual adjustment. It requires that employees are well integrated, and adhere to the enterprise "culture," knowing that some organizations are viewed as "convivial" and interactive, and other ones "centralized" and hierarchical. The organizational climate is made up of several factors, extensively described in organizational literature, such as: ethics and dominant values of entrepreneur (including his own story); nature of tasks, requiring or not interactions and cooperation; educative and psychological profile of members, and so on. It has been observed that, passed over a given number of employees (around seven people), mutual adjustment must be replaced by hierarchy, the need of tasks differentiation becoming more important than of human integration. For instance, the entrepreneur will have to recruit a foreman for the workshop, or an assistant for the office. Inquiries show that the entrepreneurs are inclined to recruit people in accordance with their own values, increasing the risk of encountering interpersonal and "clan" conflicts, routine, and so on. Thus, they must prove their ability to balance proximity (empathy) against distance (authority).

     The introduction of machine or first product lines also frequently reveal problems, above all when the manufacturing process is innovative. Moreover, the product must be modified and adapted, according to both client reactions and workers' learning curves.

- Reacting to external problems

  The entrepreneur knows only the true market of his product (good, service) when early buyers use it and react. A whole set of critics and customers' satisfactions contribute to product improvement and market targeting.

  For instance, sweeties based on local tradition were welcomed by early consumers. However, they worried about the targeted people (local consumers, tourists, upper or middle class, and so on). The entrepreneur and her team rapidly solved the problem by adapting packaging and prices, in order to better fit with each delivery process (big retailing, sweetshop, tourism office, export, and so on).

  Moreover, the entrepreneur may encounter hostile reactions, not only from installed competitors, but also from nearby environment – for instance, if the workshop is noisy or pollutes. In many cases, he must search for better local embeddedness, including social and community relationships, in order to live in a fitting environment.

  For instance an executive, working in Paris, decided to adopt the so-called "life style entrepreneurship". He resigned from his job in Paris, and installed his upper restaurant in a village embedded in an under populated area. However, in a first time, he neglected to contact inhabitants, entailing hostile reactions against "the stranger". He reacted by both meeting them and participating in the life of the village, to such a point that he was later elected as the mayor. His restaurant, mentioned in gastronomic guides, flourishes. He added a hotel later.

  Other crucial troublesome problems frequently occur with stakeholders, namely, client and suppliers. Entrepreneurs have usually to deal with hard bargaining relative to payments and credit conditions. It particularly concerns transactions with either big companies or their subsidiaries, including lead times conditions. The entrepreneur may encounter similar problems with banks. It means that he/she must anticipate, as much as possible, that situation by trying to get agreements before starting. On the other hand, it has been observed that some partners have some interest in helping the new enterprise, by offering better conditions. Partnership may even include financial and other supports by public institutions. Of course, this problem is less troublesome when the young firm is coming from an incubator.

  To sum up, some researchers suggest some "life cycle model," underlining successive crisis that the nascent firm has to pass over. The most often mentioned and described are the following ones:

  – Cash flow crisis, due to clients falling behind the times or failing, suppliers pressures, and banking credit cuts. Illiquidity is usually seen as the worst signal, because it implies other management problems.
  – Human resources crisis, as the departure of a key worker, strike, conflict between associates, and so on.
  – Environmental turbulences, due, for instance, from external events (from health alerts, diseases attributed to the product, ecological protests, and so on, to public changes concerning norms).
  – Changes in market structure, due to fashions, tastes, sharp intrusions of big competitors (including franchisees), and so on.
  – Technological changes requiring a quite different expertise (for instance, new materials in building industry, computerized machine tools).

  It has been assumed that the start-up period was analogous to the life cycle model. The nascent enterprise would have to necessarily pass over a set of successive crisis. However, empirical observations underline the extreme specificity of each individual story.

The Development Process: From Growth to Networking

The slogan" the enterprise must grow or die" is one major pillar of managerial "*doxa*." Thus, once the entrepreneur has stabilized his business, public institutions encourage growth. Doing so, the small firm is assumed to increase not only its legitimacy, by creating direct employment, or exporting, but also its competitiveness, by enlarging its market and increasing its profits. Actually, a lot of success stories, enlightened by Medias, are based on growth strategies, as showed below with the case of Pro Natura.

Henri de Pazzis, founder of ProNatura, is the prime European example for the retailing of biological fruits and vegetables. Thirty years ago, aged twenty, he starts his bio micro firm with tomatoes. He creates his own brand in 1987, working with specialized retailers. In 2003, he buys out Vita Bio, specialized in bio packaging, in order to work with big retailing. In 2005, he enters into partnership with Activa Capital, and buys out small firms working on the bio market, located in France, Morocco and Africa, in order to enlarge his range of bio products.

Moreover, some entrepreneurs, called "snatchers" by Hicks (mentioned in Penrose, 1959, note p. 40), primarily search for short-term growth and quick profits in rising markets. Once those ones reach maturity, they close their business, or sell it, and start again elsewhere.

However, studies show, as already mentioned, that small entrepreneurs are primarily reluctant to growth. In fact, a lot of them develop their business by other ways than "homogeneous," internal or external growth. Actually, small firms achieve their development among a large span of strategic choices, networking and alliances playing an increasing role.

"To Grow or Not to Grow, That Is the Question"

More precisely, the chosen development path depends upon the very nature of each small firm, empirically classified below, according to typical cases.

1. Most of small firms are quite unable to grow.

   Those small entrepreneurs cannot acquire needed resources, such as financial capital (equity, debt capacity), skills (knowledge, learning), workers, social networks, and markets. This primarily concerns micro-firms and social entrepreneurship in the black economy. However, micro-credit banks may support promising businesses and entrepreneurs by allowing cheaper loans.
2. Many small entrepreneurs are unwilling to grow.

   Entrepreneurs usually give a lot of alternative arguments to refuse growth, as listed below.
   - They make, more or less explicitly, a trade-off between work and leisure. Economists describe that strategy in terms of a rational calculus of compared utility versus disutility for a bigger size. Ethno sociologists underline a weak of spirit of entrepreneurship in various countries or, better, communities. On the contrary, some communities promote entrepreneurial and risk taking values.
   - Both competitiveness and legitimacy are based on proximity links with stakeholders. Growth, entailing more distance would require in-depth strategic changes. For instance, what is strength with a small size, as personal links with stakeholders, would become a weakness, with more "distant" relationships with bureaucratic organizations.
   - Growth is viewed as a risky and uncertain undertaking. Growth is first linked to uncertainty, implying no expectable events. For instance, export strategy has to cope with various turbulences, such as catastrophes, riots, revolutions, and so on, called by Ansoff "strategic surprises." Less

dramatically, export needs a good knowledge of habits, customs, laws, economy, and language of targeted countries. Similarly, diversification by new products requires a deep knowledge of both technological processes and market complexity. Most often, unpredictable events may always occur, such as sharp innovations, or disturbing "accidents." Moreover, the expected synergy of new business portfolio may actually reveal to be dissynergies.

For instance, a small entrepreneur specialized in an upper regional food category (foie gras) decided to diversify towards big retailing, with a lower margin. His brand image was thus damaged, so that sales in luxury shops, and so profitability, sharply decreased.

More generally, the entrepreneur has to make a trade-off between expected growth earnings and evaluated growth costs. Indeed, growth requires new resources, in order to build new capacities. Those that are most often indivisible and irreversible (for instance, a new machine, or a skilled employee). So, they require more other investments to work at full-time.

For instance, recruiting a skilled salesman implies that the productive capacity gives enough products and sales to "make profitable" that human investment.

As a result, the growth of the firm may spiral up, and thus be endangered, until a financial crisis (cash shortage) and bankruptcy occurs. It explains why so many (too) high growth firms are failing or merged with competitors, bigger companies, or venture capitalists.

Alternative Ways for Development

Two alternative strategies of small firm development may be underlined as representative of a new capitalism, sometimes called "entrepreneurial capitalism."

1. "Singularity" strategies

   That strategy is based on the following precept: "the more my business is singular, the better it performs." It means that the entrepreneur tries to center on a quite different, original, specific business. It is based, jointly or alternatively, on three "views":
   - The RBV ("resource-based view") suggests that holding so-called idiosyncratic (external) resources" contribute to singularity. Those are defined as rare, requiring "specific assets" (primarily knowledge), valuable, nontransferable, inimitable.
   - The CBV ("competence-based view") concentrates on (internal) skills, learning, knowledge, craft ability, and so on. Either deliberately developed or incrementally emerging inside the organization, those "singular competences" must be developed, protected, and deepened, as a basis of a permanent competitive advantage.
   - The MBV ("market-based view") defines "singularity" from the point of view of the latent or emerging demand for such business. It concerns as well luxury consumer goods or services, such as hi-tech manufactured products.
2. Networking strategies

   Post-managerial *doxa* promotes outsourcing, as a strategic way of lean management. Doing so, big companies have opened a host of opportunities for small firm creations. Outsourcing refers to either low tech (as, for instance, maintenance, security) or high-tech units (as, for instance, pharmaceutical research laboratories). If the former are outsourced as no contributing to profitability, the latter are outsourced as overspecialized and even singular. Doing so, big companies build hierarchic networks. They hold governance on a whole set of SME, either dependent on orders or partially owned by strategic business units or subsidiaries.

   Conversely, entrepreneurial literature points out interactive networking made of complementary micro and small firms working together. Each one contributes by bringing its distinctive competence, for instance, to achieve complex projects, requiring high skills, from high-tech to art crafts (as in the performance markets). Thus, those enterprises flourish in spite of their reluctance to individual growth. This behavior is inspired by the so-called hypermodern attitude, based on the search for individual achievement, while being embedded in "nomad" networks.

The entrepreneur, as an owner-manager, either alone or supported by his/her family, community, or associates, creates new small firms by "layering," as the "one best way" to develop and grow. Indeed, risks are minimized (in case of one firm failure, the whole group is safe) and the owner(s) hold(s) governance. As already described, those groups made of a network of smaller business firms are called "hypogroups."

Conclusion and Further Reading

As observed above, create his/her own business has a long time been underlined as a too risky business. It explains why, in so many countries and communities, so many people are reluctant to start and install their enterprise. Actually, inside modern countries and societies, to be his/her own "boss" is increasingly becoming a common way to work, enhanced by network relationships. However, ever more-deepening researches and accurate methodologies are required to improve supports and practices concerning the whole creation process.

Cross-References

- ▶ Accompaniment of Business Creation
- ▶ Business Incubator
- ▶ Business Model
- ▶ Business Project
- ▶ Clusters, Networks, and Entrepreneurship
- ▶ Craftsman
- ▶ Entrepreneurial Capability and Leadership
- ▶ Entrepreneurial Opportunity
- ▶ Entrepreneurship and Business Growth
- ▶ Entrepreneurship and Small Business Agility
- ▶ Experiential Learning and Creativity in Entrepreneurship
- ▶ Green Business and Entrepreneurship
- ▶ Individual Determinants of Entrepreneurship
- ▶ Innovation Opportunities and Business Start-Up
- ▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
- ▶ Love Money
- ▶ Microfinance and Entrepreneurship
- ▶ Microfirms
- ▶ Network and Entrepreneurship
- ▶ Networking Entrepreneurship
- ▶ Patents and Entrepreneurship
- ▶ Product Development, Business Concept, and Entrepreneurship
- ▶ Proximity Relationships and Entrepreneurship
- ▶ Risk, Uncertainty, and Business Creation
- ▶ Small Business
- ▶ Small Businesses and Sustainable Development
- ▶ Small Businesses - Value, Transmission, and Recovery
- ▶ Social Capital of the Entrepreneur
- ▶ Start-Up and Small Business Life
- ▶ Territory and Entrepreneurship
- ▶ Venture Capital and Small Business

References

Ansoff I. The new concept of corporate strategy. New York: Wiley; 1988.

Audretsch D. The entrepreneurial society. Oxford: Oxford University Press; 2007.

Birley S, Westhead P. Growth and performance contrasts between "types" of small firms. Strategic Manage J. 1990;11:535–57.

Birley S, Ng D, Godfrey A. The family and the business. Long Range Plann. 1999;32(6):598–608.

Churchill NC, Lewis VL. The five stages of small business growth. Harv Bus Rev. 1983;61:30–50.

Drucker P. Innovation and entrepreneurship. New York: Harper and Row; 1985.

Kirzner IM. Competition and entrepreneurship. Chicago: Chicago University Press; 1973.

Miles R, Snow C. Organizational strategy, structure and process. New York: Mc Graw-Hill; 1978.

Mintzberg H. Strategy-making in three modes. Calif Manage Rev. 1973;XVI(2):44–53.

Schumpeter J. Capitalism, socialism and democracy. New York: Harper and Row; 1943.

Smith NR, Miner JB. Type of entrepreneur, of firm, and managerial motivation: implications for organizational life cycle theory. Strategic Manage J. 1983;4:325–40.

Williamson O. The economic institutions of capitalism. New York: Free Press; 1985.

Further Reading

Chan KF, Lau T. Are small business owner/managers really entrepreneurial? Entrep Reg Dev. 1993;5:359–67.

Dodge RH, Fullerton S, Robbins JE. Stage of the organizational life cycle and competition as mediators of problem perception for small business. Strategic Manage J. 1994;15:121–34.

Filion LJ. Operators and visionaries: differences in the entrepreneurial and managerial systems of two types of entrepreneurs. Int J Entrep Small Bus. 2004;1(1/2):35–55.

Gibb A, Davies L. In pursuit of the frameworks of growth models of the small business. Int Small Bus J. 1990;9(1):15–31.

Hay M, Kamshad K. Small firm growth: intentions, implementation and impediments. Bus Strategy Rev. 1994;5(3):49–68.

Headd B. The characteristics of small-business employees. Mon Labor Rev. 2000;123:13–8.

Marchesnay M, Julien P-A. The small firm, as a transaction space. Entrep Reg Dev. 1990;2(3):267–77.

Perry C. Growth strategies for small firms: principles and case studies. Int Small Bus J. 1987;5(2):17–25.

Russel MG, Sauber MH. Profiles of managerial activities in small firms. Strategic Manage J. 1995;16:551–64.

Business Support

► Accompaniment of Business Creation

C

Capabilities to Change Firm's Trajectory

► Entrepreneurial Behavior and Eco-Innovation

Career Trajectories in Creative Achievement

► Age and Creative Productivity

Carve-Out

► Spin-off

Case-Based Reasoning

► State Space Paradox of Computational Research in Creativity

Change Management

► Creativity in Invention, Theories
► Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

China's National Innovation System

Hefa SONG
Institute of Policy and Management, Chinese Academy of Sciences, Beijing, China

Synonyms

National system of innovation

Introduction

Innovation capacity is one of the fundamental sources of nation's wealth (Antonelli, 2006). China has made great progress in all fields since the reform and opening-up, especially the accession to the World Trade Organization (WTO). The economy has developed rapidly and GDP per capita increased to more than 5,000 US dollars. The scientific and technological innovation capacity is ranked 30th in the world. Science, technology (briefly, S&T), and innovation now play an increasingly important role in economic and social development. Their supporting and leading roles in sustainable economic and social development are becoming increasingly essential. China has set forward the ambitious objective to be an innovative country in 2020. China's national innovation system still has many deficiencies and problems to overcome, however, before reaching that goal.

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DOI 10.1007/978-1-4614-3858-8,

China is the largest developing country in terms of economy and also the largest country with regard to S&T and innovation. China's future development will have an important influence on the world. It is necessary to study the characteristics of China's national innovation system, especially the successes, deficiencies, and problems, and appropriate recommendations are required for its future development. Following is a review of China's national innovation system from participants and sub-systems in a Quintuple Helix model theory, an analysis of problems and challenges faced by China's national innovation system, and some recommendations for reaching the 2020 goal.

Definition of the National Innovation System

Friedrich List (1841) first introduced the concept of a national system and analyzed how it influenced one country's economic development and technological policies. Joseph Schumpeter (1911) first put forward the concept of innovation and defined it to be a procedure introducing a new production function. Christopher Freeman developed the concept of a national innovation system to explain Japan's economic success (Lundvall 2010; Liu 2009). Many researchers have developed the concept of a national innovation system. Lundvall (1992), a well-known researcher of the national innovation system, defined it as the elements and relationships that interact in the production, diffusion, and use of new and economically useful knowledge and that are either located within or rooted inside the borders of a nation state. Nelson (1993) saw it as a set of institutions whose interactions determine the innovative performance of national firms. Patel and Pavitt (1994) defined it as the national institutions, their incentive structures, and their competencies, which determine the rate and direction of technological learning in a country. Freeman (1995) regarded a national innovation system as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies. Metcalfe (1995) defined it as a system of interconnected institutions to create, store, and transfer the knowledge, skills, and artifacts that define new technologies.

The national innovation system is considered a comprehensive analysis framework. Edquist (2005) criticized the notion as diffuse and lacking theoretical foundation, but Lundvall et al. (2009) stressed its theoretical elements to evolutionary economics. From the above concepts, many researchers have studied the national innovation system in terms of learning by interacting (Lundvall 1992), technology learning (Patel and Pavitt 1998), innovation policies (Caracostas 2008), and policy instruments (Metcalfe 2008). Although it is sometimes vague in theory, many recognize that the national innovation system has become an important and useful tool for analysis of a country's innovation and development.

Based on models of knowledge production and application and knowledge-based problem-solving, Carayannis and Campbell (2006) put forward the concept and framework of knowledge production system "Mode 3," which is an innovation ecosystem. Mode 3 includes people, culture, and technology and consists of innovation networks and knowledge clusters focusing on and leveraging higher-order learning processes and dynamics that allow for both top-down and bottom-up systems of governments, universities, industry, civil society, and grassroots organizations to interact toward a more intelligent, effective, and efficient synthesis. Etzkowitz and Leydesdorff (2000) put forward the Triple Helix model of the national innovation system, which includes academia/universities, industry, and state/government. Based on it, Carayannis and Campbell (2009) developed a Quadruple Helix model, the fourth helix of which is media-based and culture-based public and the civil society. Furthermore, Carayannis and Campbell (2010) also developed the Quintuple Helix model, bringing in the fifth helix of the natural environments of society, and pointed out that the Quintuple Helix model is adequate for creating and supporting mid- and long-term sustainable development of society.

Some researchers have studied China's national innovation system (Liu and White 2001; OECD 2008). Xielin Liu and White (2001) studied the structure and dynamic of China's national innovation system from R&D, implementation, end-use, education and linkage. Shulin Gu and Lundvall (2006) studied the current characteristics of China's production and innovation system, especially how they have been shaped by history and the major challenges they face in the future. Rowen (2008) found that China's national innovation system originated from an underdeveloped top-down, centralized, and state-run system. Xielin Liu (2001) highlighted the role of government in China's national innovation system transition, noting that China's innovation capability has not increased quickly. Boeing and Sandner (2011) pointed out that China's national innovation system placed the creation of innovation at a lower value, with public research institutes playing a minor role and universities playing a central role; the universities' strong collaborations with the business sector resulted in high volumes of patent applications. Kroll, Comle, and Schuller (2010) noted that the outstanding features of China's innovation system were the continuous importance of public research, the weak position of domestic enterprises in the innovation system, and little investment in research for new products and processes. Chen and Guan (2011) pointed out that the most important problem with China's national innovation system was the weak linkage among the actors. OECD (2008) suggested that China should adopt more bottom-up decision making and help the private sector to play a more important role.

History and Development of China's National Innovation System

After the foundation of the new China, following the development mode of the former Soviet Union, China began to establish many kinds of scientific research institutions, including the Chinese academy of sciences, industrial institutes, and local institutes, and it issued the 12-year national development plan for S&T. The period from 1950 to 1977 was the formation phase of the national innovation system. In 1978, China adopted policies of reform and opening-up and began to explode the development model of the national innovation system. China set forward a series of national plans of S&T, such as the High-tech Research and Development Program (863), the Torch Program, the Spark Program, the Major Achievement Promote Program, the National Natural Science Foundation, and the Climbing Program. China also reformed the funding system, developed technology markets, promoted the commercialization of S&T achievements, and issued many innovation policies. In 1995, China began to deepen enterprise-centric reform. The national technology system of innovation developed quickly. China reformed the enterprise system and the property rights system and emphasized the innovation functions of enterprises. In 1996, China issued the Strategy of Invigorating the Country through S&T and Education. The Department of S&T began to formulate S&T programs jointly with the Department of Economy. The National Engineering Centers, including the National Engineering Research Centers and National Engineering Technology Research Centers, and the Productivity Promotion Centers were established. The Technological Innovation Project was begun to enhance the innovation capacity of enterprises. During that time, many policies were issued to accelerate the commercialization of S&T achievements.

The year 1998 was the formal starting point for China to construct the national innovation system. In December 1997, the Chinese Academy of Sciences put forward a report which name was "welcoming the era of knowledge economy and constructing the national innovation system" to the central government of China. On June 9, 1998, the central government approved the report and required the Chinese Academy of Sciences to implement the knowledge innovation project as a pilot unit for construction of the national innovation system. In 2006, China issued the National Medium and Long Term Plan for Science and Technology Development (2006–2020) and put forward the guiding principles for S&T

undertakings over the next 15 years, which were "indigenous innovation (should be self-dominant innovation), leapfrogging in priority fields, enabling development, and leading the future," and the general objectives in 2020, which were to "noticeably enhance self-dominant innovation capability" and "join the ranks of innovative countries." In this period, China's main tasks are to construct a technological innovation system such that enterprises could be the main player and industries, universities, and institutes could be linked tightly, to construct a knowledge innovation system wherein scientific research and higher education could be combined together, to construct a national defense science and technology innovation system where the military and civilian sectors could combine their work, to construct a regional innovation systems with respective characteristics and advantages, and to construct an innovation intermediary service system with features of socialization and networking. After more than 10 years of development and especially the entrance of the WTO, China's national innovation system developed quickly and became primarily a system with characteristics and five sub-systems, which are the knowledge innovation system, technology innovation system, regional innovation system, national defense innovation system, and innovation intermediate service systems.

Governmental Institutions and Functions for Innovation

Carayannis and Campbell's Quintuple Helix model is a useful tool for analysis of China's national innovation system. The Quadruple Helix model added the fourth helix to the Triple Helix model, which is the media-based and culture-based public as well as civil society; the Quintuple Helix model added the fifth helix, which is the context of environment for society.

In the Quadruple Helix model, the fourth helix is very important, but this helix is not in the same dimension with the other three helices, and this helix ignored another important element, the innovation policy. The innovation policy has been become an essential tool for promoting development of the national innovation system. In recent years, many countries, such as the United States, members of the EU, Japan, South Korea, China, and England, have issued innovation strategies or innovation policies in response to the financial crisis and to revive their economy. This entry will study China's national innovation system, mainly following Carayannis and Campbell's Quadruple Helix model and the Quintuple Helix model and also considering the element of innovation policy.

The Governmental Organizations of China's National Innovation System

At present, China has adopted a unified and separated administration regime of S&T and innovation. Under the leadership of the Leader Group of S&T and Education of the State Council, the National Development and Reform Commission is responsible for the macro plan and management for all S&T and innovation undertakings, especially planning and budgeting for S&T programs and projects and implementation of high-tech industrialization projects, S&T infrastructure projects, basic operation expenses of research institutes, the knowledge innovation project, and so on. The Ministry of Finance handles budgeting for all S&T plans, programs, and projects and the accounting of the implementation. The Ministry of S&T focused on execution of S&T programs such as the Basic Research Program (973), the High-tech Research and Development Program (863), and the S&T Support Program and Programs supporting small and medium enterprises, agriculture, and industrialization according the budgets. The National Natural Science Foundation committee supports science foundation projects via a new mechanism, in particular, expert peer review. The Ministry of Education is primarily in charge of cultivation of human resources and also supports cooperation between universities and business. The Ministry of Industry and Information and the Ministry of Agriculture are mainly in charge of innovation and development of industry and agriculture. The Ministry of Commerce is committed to establishing a sound, unified, open, competitive, and orderly market system to promote fair foreign and domestic trade favoring innovation. It also strives to improve the structure and competitiveness of China's export products through a program of S&T that promotes trade with the Ministry of S&T. The State Administration of Industry and Commerce regulates the market and enforces anti-monopoly policies to create an innovative environment. The State Intellectual Property Office, the Trademark Office of the State Administration of Industry and Commerce, the Plant Variety Office of Ministry of Agriculture and that of the State Forestry Office provide examination services for intellectual property rights such as patents, utility models, industrial design, topographies of integrated circuits, trademarks, and plant varieties to protect and encourage innovation.

Development of China's National Innovation System

The knowledge innovation system of China has made great progress in the twenty-first century. The Chinese Academy of Sciences now is the highest national academic institution for natural science, the highest advisory body for science and technology, and the R&D center for natural sciences and high-tech. The Chinese Academy of Engineering is the highest honor and advisory academic institution in the engineering and technology field. In 2010, the Chinese Academy of Sciences satisfactorily completed two pilot tasks. A number of major innovative achievements have been achieved in strategic high-tech, major public-welfare innovation, and important basic and cutting-edge research fields such as Godson processors, the Shuguang high-performance computer, manned spaceflight, coal-to-oil technology, and so on, effectively lifting the support capability of China's S&T and innovation to economic and social development, and its international competitiveness and influence. In 2011, the Chinese Academy of Sciences began implementing the phase 3 knowledge innovation engineering. The goal is to lead and drive China's national system of innovation into a new stage, encouraging self-dominant innovation, original scientific innovation, and systematic integration of key technologies; upgrading the ability to solve key S&T problems for current and future economic and social development; heightening the ability to provide the knowledge and technical base for implementing the "scientific development concept"; and raising the ability to safeguard national security and respond to the new world revolution in military affairs. Universities are gradually becoming an important player in the implementation of the knowledge innovation engineering project. In 1995, China began to construct 100 key universities for the twenty-first century through the "211 Project." Currently, the number of the key universities has reached 112, and the amount of investment is near 2.8 billion US dollars. In 1998, China began implementing another project to promote Peking University, Tsinghua University, and others to be world-class and high-level universities, and the number of the universities in the "985 Project" has reached 39.

Enterprises have become the main player in the technology innovation system. In 2007, R&D personnel in enterprise accounted for 68.36 % of the entire country's R&D personnel. The R&D fund expenditure from enterprise accounted for 72.28 % of the whole country's R&D fund expenditure. The proportion of the number of enterprises that had science and technology agencies to the total number increased to 58.87 %. The total number of state-certified enterprise technology centers increased to 575, and that of the provincial-certified enterprise technology centers increased to 4,886. The number of service invention patent applications from domestic enterprise accounted for 69.28 % of the total service invention patent applications. The contract amount from enterprises as the seller accounted for 86 % of the national contract amount of the technology market traded.

The regional innovation systems' characteristics and advantages have formed gradually. On the basis of regional development plans of the Yangtze River Delta and Pearl River Delta, China has issued nearly 20 regional development plans to dates, and each plan has emphasized the innovation capacity construction and development of the regional innovation system. China has established 54 national high-tech industrial development zones and many local high-tech industrial zones. Beginning in 2010, the Zhongguancun (Beijing), Zhangjiang (Shanghai), and East Lake (Wuhan) high-tech zones began to transformed into national self-dominant innovation demonstration zones. These three zones and the Hefei, Wuhu, and Bengbu self-dominant innovation comprehensive reform pilot areas were permitted to adopt new policies, such as permitting the service inventor to own a percentage of stock outright and the net profit dividend right of the company implementing the service invention. On January 6, 2010, the National Development and Reform Commission approved 16 cities, Dalian, Qingdao, Xiamen, Shenyang, Xi'an, Guangzhou, Chengdu, Nanjing, Hangzhou, Jinan, Hefei, Zhengzhou, Changsha, Suzhou, Wuxi, and Yantai, as National Innovative Cities. And on January 10, 2010, the Ministry of Science and Technology named Beijing (Haidian District), Tianjin (Binhai New Area), Tangshan, Baotou, Harbin, Shanghai (Yangpu District), Nanjing, Ningbo, Jiaxing, Hefei, Xiamen, Jinan, Luoyang, Wuhan, Changsha, Guangzhou, Chongqing (Shapingba District), Chengdu, Xi'an, and Lanzhou as National Innovative Cities (districts). Both ministries support the regional innovation system by investment in innovation facilities, R&D projects, industrial innovation, and so on.

The civil-military integrated national defense innovation system has made progress. Over nearly 30 years of construction after the foundation, China has established a relatively complete national defense industry system. In 1978, with the reform and opening-up, and later with the national S&T system reform, China actively introduced market mechanisms and promoted the military and civilian cooperation. A large number of national defense enterprises began to produce civil products or were changed to entirely civil enterprises. In 1992, China implemented the strategy of "combining military and civilian, and integrating the armed forces in civilian" efforts and promoted the construction of the national defense innovation system by comprehensive civil-military integration; the scientific and technological strength of the national defense system has thus been lifted significantly. In 1998, the former National Defense Science, Technology and Industry Committee was incorporated into The Ministry of Industry and Information and became the National Defense industrial Development Bureau of Science and Technology, which strongly supports the construction and development of China's national innovation system.

The innovation intermediary service system also developed rapidly. Currently, there are four main kinds of organizations in China's innovation intermediary service system. The first includes productivity promoting centers, engineering and technology research centers, entrepreneurial service centers, including incubators and accelerators, and R&D and design centers. They mainly provide services for production. The second includes information research centers, technology consulting companies, technology transfer centers, technological training centers, and small and medium enterprises (SME) services centers. They provide services for the whole society. The third is service entities, including high-tech zones, science and technology parks, pioneer parks, and economic and technological development zones. The forth provides market services, including technology markets, talent markets, and so on. China has made great efforts to improve the innovation service environment in the last 30 years. All 54 national-level high-tech industrial zones have their own incubators or accelerators. China has established six national technology transfer centers, including those in the Chinese Academy of Sciences, Tsinghua University, and Peking University. The university parks, such as those at Tsinghua University and Peking University, are called National University Science Parks and the number of them reaches to more than 80. In 2010, along with the development of property exchanges of Guangzhou, Shanghai, and Beijing, China established the China Technology Exchange in Beijing and the Tianjin Intellectual Property Right Trading Center. The number of state patent exhibition and trade centers reached 42, the number of patent agencies was more than 1,000, and the number of the practicing patent attorneys was 7,200. The number of entrepreneurial investment enterprises in 2007 reached 464, the investment volume in 2008 was 22.7 billion US dollars, and the cumulative number of investment projects was 6,796; the cumulative investment volume was 12 billion US dollars.

China's Innovation Policies

In 2006, in order to put the National Medium and Long Term Plan guideline for Science and Technology Development into practice, China issued 60 supplemental policies from 10 parts. The supplemental policies were warmly welcomed by enterprises and the whole society. The policies of investment in science and technology mainly include six aspects. The first is to substantially increase investment volume in S&T, both of public and private. The second is to ensure steady growth of the public financial investment in S&T. The annual growth rate of S&T investment volume shall not be less than that of the government financial expenditure. The third is to earnestly safeguard the smooth implementation of 16 Mega S&T Projects. The forth is to optimize the structure of the financial S&T investment. The fifth is to play a leading role in providing financial funds to encourage enterprise's self-dominant innovation. The sixth is to optimize the S&T investment management mechanism.

New tax laws and policies cancel the threshold of annual 10 % growth rate of research and development expenses and allow enterprises to deduct their actual research and development expenses and amortize the intangible assets in corporate taxable income at 150 %. The actual research and development expenses can be carried forward and deducted in the following 5 years if they are shortfall deductable. The employee education and training funds extracted in less than 2.5 % of the total taxable wages can be deducted before the corporate income taxation. Enterprises are allowed to accelerate the depreciation of the instruments and equipment used in R&D activities. High-tech enterprises' corporate income taxation rate was reduced to 15 % from 25 % since they had a profitable year within 2 years after certification by the government.

Investment and financing policies regulate and strengthen the financial support for self-dominant innovation, to lead commercial financial support for self-dominant innovation, to improve the financial services for SMEs' innovation, to accelerate the development of venture capital, to establish a multi-level capital market supportting for self-dominant innovation, and to improve the insurance services and foreign exchange management policies for high-tech enterprises.

Government procurement policies require to establish a self-dominant innovation product certification system and a certified standard and evaluation system, to improve government procurement assessment method, to give preferential treatment to the products of self-dominant innovation, to establish the first government purchase and ordering system to encourage innovation, to establish a certification system for domestic goods and an audit system to purchase foreign products, and to play the role in national defense procurement to support self-dominant innovation. China issued the concept and standard of the self-dominant innovation product in 2010 that it shall has intellectual property right (actually is patent) or using right licensed from abroad in China, and has trademark right registered or using right licensed from abroad in China according to law. But China abandoned the government policies on self-dominant innovation product in 2011 under international pressure.

In addition, China issued other policies to strengthen the import, digestion, absorption and re-innovation, creation and protection of intellectual property right (IPR), cultivating and utilizing innovative talents, strengthening education and science popularization, and promoting construction of S&T innovation bases and infrastructures.

In order to implement the 60 supplemental policies, the relevant departments of China's central government also formulated and issued 78 policy-implementing rules beginning in 2006. The relationship between the 78 rules and the 60 supplemental policies are described in Table 1.

China's National Innovation System, Table 1 Relationship between the 78 implementing rules and the 60 supplemental policies

Supplementary policies	Implementing rules	2006	2007	Supplementary policies	Implementing rules	2006	2007
S&T Investment	6	6	0	Innovative Talent Team	13	6	7
Tax Deduction	8	2	6	Education and Science Popularization	7	5	2
Investment and Finance Support	9	7	2	S&T Innovation Base and Infrastructure	11	5	6
Government Procurement	6	1	5	Co-Ordination	2	0	2
Import, Digestion, and Absorption Re-Innovation	3	2	1	Others	9	2	4
Intellectual Property Right Creation and Protection	4	3	1	Total	78	38	37

Source: The center for innovation and development, Chinese Academy of Sciences

Deficiencies and Problems of China's National Innovation System

Currently, although China has made great progress in construction of a national innovation system, there are still many deficiencies and problems challenging future development, especially innovative country construction. The first is that the allocation of government organizations and government functions has not wholly met the demand of the national innovation system. Scientific research is out of touch with education, and technology innovation is out of touch with the economy. There are many government departments responsible for innovation. Innovation policies come from many departments and many people consider them too complicated. Innovation activity has mainly been dominated by government; the science and technology community has limited impact on innovation activities. Some of the government functions of innovation are overlapping, co-existing, or even missing. For example, many departments have nearly the same function of industrialization, although they are called S&T achievement industrialization, patent industrialization, high-tech industrialization, and industrial stucture optimization and upgrading. The government of innovation management lacks supervision from the public, and the government's innovation service functions are inadequate.

The second is enterprises as the main player in innovation in the national innovation system. Although it can be said that enterprises have been the main player in innovation basing on data such as R&D investment and patent application number, it can be also found that enterprises are not the real main player from views of the decision-making around innovation themselves, major part of government innovation resource allocation and high-end innovative talents including those who has got master or doctor degree. The existence of the lucrative industries, low-cost, rent-seeking behavior, and inadequate implementation of the innovation policies, together with an innovation culture has not been fully formed, infuluencing the enterprises that are not dynamic enough to undertake innovation. The investment policies, trade policies, and intellectual property protection policies are not coordinated enough with the innovation policies. The intellectual property policies place more stress on international rules and increasing application numbers and less stress on quality and utilization. To date, the appropriate mode and effective measures of commercialization of S&T achievements have not been found.

The third is the allocation of innovation resources. Investment in innovation infrastructure such as large scientific or engineering facilities, laboratories, engineering research databases, and data and information databases is inadequate. Innovation resources, whether S&T infrastructure, innovation bases, or R&D funds, are deployed more to the eastern and coastal regions and major cities and less to the medium-size cities and west regions. The Chinese Academy of Sciences is the largest in the world and its staff numbers is more than nearly 60,000. The proportion for basic research of R&D funding has been lower than 10 % of the total R&D expenditure for many years. Because most R&D investment comes from government, many institutes focus more on industrial generic technologies or critical and key technologies and less on new products and technologies needed by enterprises. In the meantime, the government innovation resources are invested more in research institutions and universities and less in enterprises. The division of the national innovation system into five sub-systems is not optimal but is favorable for some departments and institutions to acquire government innovation resources. This method of division limits the ability of enterprises to be the main player in the whole national innovation system.

The fourth is the management of the S&T and innovation funding. The most important problem is lack of openness to the public and transparency. The expenditure of projects funds isn't enough open and fair. A majority of technology projects are required to apply for funding by sub-projects and compete against each other, and it is difficult to form a cohesive force for innovation. The decision-making, management, and supervision of S&T and innovation fund allocation are executed by only one department, affecting the efficiency of the use of the fund. A small number of administrative officials have the final say on the allocation of for S&T and innovation resources, and participation from expert groups and the public is lack.

The fifth is implementation of the innovation policies. To date, there have been no implementing regulations and supporting policies for the Scientific and Technological Progress Law and the Law on Promoting the Transformation of Scientific and Technological Achievement. Thus, there are not detailed regulations for research institutions, technology transfer, S&T fund management, and service and non-service invention. The low technology transfer rate has been a serious unresolved problem for a long time. The implementation of policies like statutory growth of science and technology funding, deduction of R&D expenses before corporate tax at 150 %, and government procurement for self-dominant innovation products still have encountered many difficulties, but there are less effective measures. There are not preferential value-added tax policies or business tax policies for self-dominant innovation and self-dominant intellectual property right products. There are no quick examination policies on intellectual property rights, which are essential to innovation such as small- and medium-sized and high-tech enterprises. The condition and treatment of enterprise talents are poor in household registration, social security, and other aspects. The implementation of innovative talent introduction, cultivation, and utilization planning and police need to be improved.

The sixth is the construction of the innovation culture. Notable progress has not been made in construction of the innovation culture to date. The bureaucratic, counterfeiting, and impetuous cultures suffocate, harm, and restrict innovation culture construction. The scientific community is far from established, the development of scientific ethics lags behind, and the protection of intellectual property rights has a long way to go. Society overall has only a weak awareness of innovation culture. There are large gaps between the current creative talent nurturing model, curriculum design, teacher configuration, and education conditions and the demand of innovative country. Investment and financing, especially venture capital, are also less developed.

Conclusion and Future Directions

Following the Quadruple Helix model and Quintuple Helix model and considering the elements of innovation policy, this entry reviewed the history of China's national innovation system and found that China was gradually being transformed from a technology innovation system to a national innovation system. The entry also examined the roles and relationship among government, industry, and universities/institutes and found that China's national innovation system was still a top-down system, especially in the formulation of innovation policies that were mainly promoted by the government. Enterprises' position as a main innovation player was still low. China's national innovation system was changing from a plan-oriented system to a market-oriented system. But because of departmental interests, it is still not a system that market functions completely. The sub-system method of division is one way to obtain government innovation resources. In construction of an innovative country, in order to achieve the goal of a national innovation system, China not only needs to optimize the three helix relationships of all the players but also to adopt some new innovation policies.

The first is to optimize government organizations and the innovation functions. It is necessary to establish separated and cooperating governmental organizations for decision-making, implementation, and supervision for S&T and innovation. The decision-making function can be undertaken by a commission and the supervision function can be undertaken by an independent third party or even the public. As in other countries, comprehensive departments combining education with basic research, technology with industry, and innovation and economy need to be established. Similar government functions should be integrated into one department. The excessive market behavior of universities and research institutes should be limited, and gathering of innovation resources in enterprises should be encouraged. Supporting development of the scientific community to support innovation through self-regulation is a good choice.

The second is to promote knowledge production. To keep up with cutting-edge science around the world and to meet major national strategic demands, it is necessary to build up a number of high-level national research bases, research universities, and research institutes. Also necessary are coordination in deployment and accelerated construction of the laboratory system and building up a number of large scientific projects and research experimental bases. A sound modern scientific research institute system must be established. In the meantime, it is necessary to accelerate construction of key disciplines and S&T and innovation infrastructures focusing on original innovation in the field of basic research and frontier technology research.

The third is to strengthen enterprises' position as a main player in innovation. This can be achieved by supporting some leading enterprises to establish cutting-edge technology institutes and to promote them to undertake the forefront industrial and key technology research with universities and research institutes as the leader. It is a task for government to guide enterprise with self-dominant intellectual property rights to actively participate in the formulation of international technical standards. The financial and tax policies shall be improved in favor of SMEs' innovation. Another important policy is to promote technology development institutes transformed on specific technology development according to the needs of enterprises.

The fourth is to promote balanced development of the regional innovation systems with distinctive characteristics and advantages. It is necessary to deploy the construction of regional innovation systems, in which universities, research institutes, and leading industries can be combined together geographically. The national or provincial S&T projects, the industrialization projects, high-tech zones, the innovative cities, and the national self-dominant innovation demonstration zones can integrated to support emergence of a number of regional innovation centers. The policies shall encourage the eastern regions and the regional central cities to develop high-end industries and find an innovation-driven development model. They shall lead more innovation resources to flow to the central and western regions through construction of innovation facilities or infrastructures and development of industries with characteristics and advantages than ever. The policies shall also support construction of regional innovation resource sharing networks and promote rational and efficient resource allocation.

The fifth is to promote the development of the military-civilian integrated national defense S&T

innovation system. The policies shall focus on following points: strengthening the integration of military and civilian technology innovation resources; establishing a sound S&T innovation resource sharing and coordination mechanism thus the military and civilians can mutually transfer high technologies easily; encouraging military research institutes to undertake civilian tasks and open the defense R&D projects to civilian research institutes and enterprises; and expanding the military procurement range to products made by civilian enterprises.

The sixth is to accelerate development of the S&T and innovation intermediary service organizations. It is necessary to issue laws or polices to regulate the development of S&T and innovation intermediary services in S&T Progress Law and the Law on Promoting the Transformation of S&T Achievement. It is necessary to transfer state-owned service originations to civilian ones, to establish a vocational qualification and certification system to avoid deceptive and dishonest behaviors, and to decrease the value-added or business tax rate for the innovation intermediary servicers and to enhance their service capabilities. It is necessary to support a number of universities and research institutes to build technology transfer offices and set up venture capital funds to promote technology transfer. A number of high-level innovation intermediary services introduced talents through all kinds of talent plans should be encouraged.

The seventh is to make great efforts to cultivate the innovation culture. One important measure is to reduce the administrative intervention on S&T and innovation, and most decisions shall be made by scientific communities or enterprises themselves. Another measure is to adopt law enforcement accountability for local governments in IPR laws and to crack down on counterfeiting activities. A third measure is to construct innovation culture facilities, especially propaganda facilities such as film, television, websites, newspapers, and others. A fourth is to add the innovation and intellectual property protection idea and method into the national education system of primary and high school. A final measure is to lift the public's scientific and cultural quality through S&T popularization and freely opening universities, research institutes, the S&T museum, and the science bases to the public.

Cross-References

- ▶ Fostering Creativity Through Science Education
- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovation Systems and Entrepreneurship
- ▶ Institutional Entrepreneurship, Innovation Systems, and Innovation Policy
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Mode 3
- ▶ National Innovation Systems (NIS)
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Triple Helix of University-Industry-Government Relations

References

Antonelli C et al. Introduction. In: Antonelli C, Foray D, Hall BH, Steinmueller WE, editors. New frontiers in the economics of innovation and new technology. Cheltenham\Northampton: Edward Elgar; 2006. p.3–20.

Boeing P, Sandner P. The innovative performance of China's national innovation system. Frankfurt School – working paper. Series No. 158; 2010.

Caracostas P. The Policy-Shaper's anxiety at the innovation kick: how far do innovation theories really help in the world of policy? In: Malerba F, Brusoni S, editors. Perspectives on innovation. Cambridge/New York: Cambridge University Press; 2008. p. 464–89.

Carayannis EG, Campbell DFJ. "Mode 3" and "quadruple helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manag. 2009:201–34.

Carayannis EG, Campbell DFJ. Mode3? Meaning and implications from a knowledge systems perspective. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters a comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006. p. 1–25.

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. Int J Soc Ecol Sustainable Develop. 2010:41–69.
Carayannis EG, Gonzalez E. Creativity and innovation competitiveness? When, how, and why, Chap 8. In: Shavinina LV, editor. The international handbook on innovation, vol. 1. Amsterdam: Pergamon; 2003. p. 587–606.
Chen KH, Guan JC. Mapping the functionality of China's regional innovation systems: a structural approach. China Econ Rev. 2011:11–27.
Edquist C. Systems of innovation: perspectives and challenges. In: Fagerberg J, Mowery DC, Nelson RR, editors. The Oxford handbook of innovation. Oxford \New York: The Oxford University Press; 2005. p. 181–208.
Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and "mode 2" to atriple helix of university-industry-government relations. Res Pol. 2000:109–23.
Freeman C. The national innovation system in historical perspective. Camb J Econ. 1995;19:5–24.
Gu SL, Lundvall B-A. China's innovation system and the move toward harmonious growth and endogenous innovation. DRUID working paper no 06-7. 2006.
Henry E, Leydesdorff L. The dynamics of innovation: from national systems and "mode 2" to a triple helix of University-industry-government relations. Res Pol. 2000;29:109–23.
Kroll H, Cole M, Schulle M. China: innovation system and innovation policy. In: Friestch R, Schuller M, editors. Competing for global innovation leadership: innovation systems and policies in USA, Europe and Asia. Stuttgart: Die Destche Bibliothek; 2010. p. 241–61.
Liu XL, White S. Comparing innovation systems: a framework and application to China's transitional context. Res Pol. 2001:1091–114.
Liu XL. National system of innovations in developing countries: the Chinese national system of innovation in transition. In: Lundvall B-A, Joseph KJ, Chaminade C, Vang J., editors. Handbook of innovation systems and developing countries: building domestic capabilities in a global setting. Cheltenham\Northampton: Edward Elgar; 2009. p. 119–38.
Lundvall B-A, editor. National systems of innovation. Towards a theory of innovation and interactive learning. London: Pinter; 1992. p. 957.
Lundvall B-A. Innovation in system research – where it came from and where it might go. In: Lundvall B-A, editor. National systems of innovation. London/NewYork: Anthem Press; 2010. p. 317–51.
Lundvall B-A., et al. Introduction. In: Lundvall B-A, Joseph KJ, Chaminade C, Vang J., editors. Handbook of innovation systems and developing countries: building domestic capabilities in a global setting. Cheltenham\Northampton: Edward Elgar; 2009.p. 1–30.
Metcalfe S. The economic foundations of technology policy: equilibrium and evolutionary perspectives. In: Stoneman P, editor. Handbook of the economics of innovation and technological change. Oxford (UK)/Cambridge (US): Blackwell; 1995.
Metcalfe S. Innovation systems, innovation policy and restless capitalism. In: Malerba R, Brusoni S, editors. Perspectives on innovation. Cambridge/New York: Cambridge University Press; 2008. p. 441–54.
Nelson R, editor. National systems of innovation: a comparative study. Oxford: Oxford University Press; 1993.
OECD. Innovation in science, technology and industry: OECD reviews of innovation policy: China/Paris: OECD; 2008.
Patel P, Pavitt K. The nature and economic importance of national innovation systems. STI review, NO.14. Paris: OECD; 1994.
Patel P, Pavitt K. Uneven (and divergent) technological accumulation among advanced countries: evidence and a framework of explanation. In: Archibugi D, Michie J, editors. Trade, growth and technical change. Cambridge: Cambridge University Press; 1998.
Rowen H. Introduction. In: Rowen H, Hancock MG, Hall ME, editors. Greater China's quest for innovation. The Brookings Institution; 2008. p. 931–81.
Schumpeter J. Theorie der wirtschaftlichen Entwicklung. Berlin; 1911.

Chronesthesia

▶ Imagination

Church and Entrepreneurship

Hector Ramos
Department of Educational Psychology, College of Education & Human Development, Texas A&M University, Bryan, TX, USA

Synonyms

Biblical principles of business; Business of church; Missions and business; Restoration theology and the church

Topic and Definition

The symbiotic relationship between church and entrepreneurship can be viewed from two fundamental perspectives. It is either men's business of religion or God's business on the Earth. The question is, "what is man or God buying?" For example, men can purchase peace of mind (from men) or obtain the peace of God and from God (for free). This entry focuses on how God and men in the church and through the church can become coworkers with God following His principles and guidance. If it is God's business, we need to find out how He runs His business and whether it is a multinational (from every tribe and race) or just a family business. Is God into corporate social responsibility? And how? Is He interested in sustainable business? Entrepreneurs are always looking for gaps or unmet needs they can satisfy with products or services. What is God's unmet need in the business world? Does He have a vision or mission? How does He want to work through the business of the Church and in the Church to achieve His purposes? How does He define value in business terms? To answer this question from His perspective would be immensely valuable to the Christian and non-Christian reader.

The discussion will focus on (1) different concepts regarding entrepreneurship and the Church and on (2) how God reflects His nature through the entrepreneurial talents of His people in and through the Church.

Definitions of Church and Entrepreneurship from a Biblical Perspective

The Church

According to the Biblical perspective, the inventor of the Church, Jesus Christ, gives a simple but profound account about the nature of the Church in the book of Matthew, Chapter 16:13:

> He asked His disciples, Who do people say that the Son of Man is? And they answered, Some say John the Baptist; others Elijah; and others Jeremiah or one of the prophets. He said to them, But who do you say I am? Simon Peter replied, You are the Christ, the Son of the living God. Then Jesus answered him, Blessed are you, Simon Bar-Jonah, For flesh and blood have not revealed this to you, but My Father Who is in heaven. And I tell you, you are Peter, and on this rock I will build My church, and the gates of Hades shall not overpower it.

There are basically three main elements that constitute the nature of the Church. These are essential to understand the activity and mechanisms of the Church:

(a) Jesus reveals His identity as the Christ (anointed One) through the revelation by Simon Peter. Simon Peter received this revelation by the Father. Simon Peter is then also revealed as Peter (his spiritual identity).
(b) This *revelation* of Jesus as the Christ is the foundation (rock) of the Church. The Greek word used here is Petra (huge rock) compared to Petros (rock) that is the name given to Simon.
(c) *Jesus is the builder* and not men. It is a spiritual entity and not a building. And there will be a struggle between gates of Hades and the Church but the latter will be victorious.

We need to note that in this case, the declaration of that revelation by Simon Peter on Jesus' identity brings another revelation of Simon Peter's true identity in Him. This means that the symbol of the rock used to describe Jesus many times, the huge rock (Church), and small rock (Peter) are all one. There is another simple prayer that Jesus taught that receives its true meaning from this passage. Jesus taught the disciples to pray "Father, Your Name be glorified, Your Kingdom come and Your Will be done on earth as it is in heaven." This translated in this context means let the Name of Your Son Jesus Christ be glorified through the work of the Church in the establishment of Your Kingdom (the realization of Your will, power, dominion, and influence on the earth). In short, "let Jesus build His Church."

This entry is all the more important because both God and men have been at work in the Church from two very different perspectives and approaches, and the biggest issue that has been at stake is the *entrepreneurial nature of the Church*. From God's perspective, He is the CEO of a great business and we are His coworkers. God wants to redeem all things and reconcile all things to Him, and one of them is business and entrepreneurship. It is of value to indicate that the first man, Adam, was given a job to take care of a garden and orchard (gardener) and that Jesus also worked as a carpenter and did not consider it shameful. In fact, He called businessmen (fishermen) to enter into His business. From man's perspective, a church has to be a building. It is mainly because a physical building is something that man can build. And this building welcomes many financial transactions: men give tithes (10 % of their income) and offerings and also volunteer their time and effort. In many cases, men go to church to be encouraged, to listen to a message that will give them some comfort, and also attend Bible classes to know more about God. So the church building can be a center of exchange where men buy their peace of mind and some knowledge and help people on occasions. It has the potential to be the center of man's effort and man's achievement through whatever financial contribution they make. It is like a spiritual club where members can receive some self-help lessons about how God is going to bless them through their prayer, giving, and effort. From man's perspective, the activity of the church is constrained to a building but for God's perspective, it is His activity through His people wherever they are.

Entrepreneurship

Four verses encapsulate the plan of God for business:

Deuteronomy 8:18* "But you shall remember the LORD your God: for it is he that gives you power to get wealth, that he may establish his covenant which he swore to your fathers, as it is this day."

Jeremiah 29:11 "For I know the plans I have for you," declares the LORD, "plans to prosper you and not to harm you, plans to give you hope and a future."

1 Corinthians 10:39 "Whatever you do, do it for the glory of God."

Ephesians 2:10 "For we are God's workmanship, created in Christ Jesus to do good works, which God prepared in advance for us to do."

In these four verses, we can understand God's design. He made us with a purpose in mind. He had a plan for us, works for us to do that would *glorify* His Name. God has a redemptive purpose for everyone's activity on earth. And God also provides the power or means to do it. If we look at the promised land promised by God to the people of Israel, we see "land of milk and honey." This can also be translated as prosperous business. Considering the life of Abraham, Isaac, and Jacob, we see in many ways the financial blessing in business that follows the obedience to the word of God. In the book of Genesis, we read how God gave Abraham the wisdom and power to prosper in a dry land. He also gave Isaac the wisdom to sow in a time of famine, to Jacob the wisdom to help the sheep reproduce in a way that was profitable to him, and to Joseph the wisdom to gather grain for a huge sale to the nations. In only one book, we can see how God glorifies His name through the business success He gives to those who follow Him.

However, entrepreneurship in the Church has also been understood in other different ways.

Businessmen are those who provide finances for the church so that it can continue to run. They pay the staff's salaries so that people can be employed to run the church. For many pastors, business is just something else that people do or "a necessary evil" depending on how they perceive business and money.

The Implications of a Business World Run by God

Regarding business and wealth, Jesus made it very clear when He challenged His followers with this question, "what would give a man for his soul? The entire world?" This is essentially the business proposition that Satan had given Him in the dessert, "If you worship me I will give you ALL these Kingdoms (the earth) and their glory thereof." Finally, Jesus got the best deal by paying the *price* through His death and when He proclaimed after His resurrection that "ALL power and authority has been given to Me in heaven and on earth." If this is really true, then the implications are that Jesus is interested in everything that happens in a place (earth) that belongs to Him. These implications for business and entrepreneurship can be summarized as follows:

1. He wants to restore ALL things and redeem ALL things according to His Father's plans including the motivation, purpose, and consequences of entrepreneurship and business.
2. A business that glorifies God is not necessarily a church or a Christian shop but a place where God's work and power is displayed through His people as part of His redeeming plan. Business activity speaks of Him more than the production of Jesus's stickers or Christian music.
3. A business that glorifies God is run by His grace. This grace or divine favor is based on the revelation of His business principles (excellence, integrity, compassion, providing a product or service that edifies according to biblical principles…) and divine enablement for His children to do the work within that framework.
4. A business that glorifies God is run by Christian who can hear His voice and direction for the business, who overcome obstacles by complete faith and trust in His promises, and who display a nature and character that reflects Him who created, shaped, and redeemed them.
5. Christian entrepreneurship is conducted with eternity in mind. Those who engage in it consider how their actions bless or hinder people around them and become a vehicle where the presence of God resides promoting His message of reconciliation.
6. Christian entrepreneurship and business is only a vehicle for Him to do His will on earth as it is in heaven, to establish His Kingdom and see His Name be glorified.

But how do we see the role of the Church in entrepreneurship or the development of the local economy?

Eldred (2005) gives a profile of kingdom business along these lines that helps us understand the type of influence that the Church can have in the entrepreneurial world. He underlines how kingdom business provides a model for sustainable missions; brings technology, expertise, and capital; provides access to many locations; and builds the local economy. These companies not only act as funders of the local church but promote the gospel through their words and deeds by getting involved in local charity and meeting the needs of the poor.

Rundle and Steffen (2003) also give an account of what makes Great Commission Companies (GCC) (companies that do also the work of the Church) in their research with the following findings:

The most effective GCC are managed by professionals including locals who have had experienced in ministry, partner with local churches or ministries, and have an integrated view of work, business, and ministry.

Seebeck and Stoner (2009) go beyond strategies in their analysis of mission companies working in different countries to state three key truths for successful mission businesses. They are interdependence as we realize how much we depend from each other in a global economy as there is no isolated country. The second is reciprocity as each part gives and receives. Finally, there is mutual respect and humility as we do not impose cultural values from developed nations on developing nations.

Conclusions and Future Directions

Entrepreneurship and business has been the battle ground for the church for a long time. The inability to hear God, to know His plans and purposes, and to obey Him has led many people into a man-made and man-centered religion that is void of the presence, purpose, or sanction from God. It is a safe place for man, a place that requires no faith or sacrifice. However, God is building His Church, and this spiritual entity is also interested in doing business that glorifies God. In terms of physical redefinition, the business office or factory is also "the Church" because that name defines God's activity on earth through Christians (His children). We are about to see what God can do through His Church, His Business on earth.

The interaction between the Church and entrepreneurship not only needs more research but also a different perspective that would consider the basic assumptions of Christianity. We are in a world that God wants get involved in and help run through the beneficial influence of the Church.

The Church as representative of a triune God needs to reflect the characteristics of that God in business through righteousness and generosity. Therefore, future directions of research could look into cities and nations that are being transformed by the gospel. For instance, Hughey and Adams (2010) report how small economies in the Fiji Islands have been impacted by the Church and God's presence. These directions could also take into consideration a broad definition of the Church to include businessmen that are trained and anointed to minister in the marketplace through their business. That type of research based on different assumptions will yield drastically different results.

Cross-References

- ► Business Creativity
- ► Business Emergence
- ► Creativity and Church
- ► Nature of Creativity
- ► Self-Made Man

References

Adams W, Hughey R. Revival: Its present relevance and coming role at the end of the age. 2010. Oasis House.

American King James Bible.

Eldred K. God is at work. In: Transforming people and nations through business. Montrose: Manna Ventures LLC; 2005.

Rundle S, Steffen T. Great commission companies. Downers Grove: Intervarsity Press; 2003.

Seebeck D, Stoner T. My business, my mission. 2009. Partners Worldwide.

Citizen Science in Health Domain

Barbara Prainsack
Department of Sociology and Communications, Brunel University School of Social Sciences, Uxbridge, Middlesex, UK

Synonyms

Open science

What Is Citizen Science?

Democraticization and Openness

In recent years, we have been witnessing increasing evidence that the separation between roles traditionally associated with knowledge production, on the one hand, and roles associated with utilizing and "consuming" knowledge, on the other, have become blurry (see Gibbons et al. 1994; Nowotny et al. 2001). While this is true in many fields of science (Goodchild 2007; Fischer et al. 2012; Nielsen 2011), the health domain is a particularly illustrative example. Patients have started to organize their own medical studies and trials (Wicks et al. 2011); questions that professional scientists have been struggling for years, or even decades, are solved by people playing computer games (e.g., Khatib et al. 2011), and patients facing difficult treatment decisions put their medical information online to invite experts from all over the world to comment (e.g., Albanello 2011). The notion of "crowdsourcing" has been applied by many authors to discuss novel forms of collective knowledge production and collective intelligence.

Although the production of knowledge in the health domain, including the production of scientific knowledge, has always been, to some extent, a collaborative endeavor, the emergence of citizen science as a new paradigm of collective knowledge production has brought the pace and impact of collective knowledge production and innovation to a new level. As the author of this entry has argued elsewhere (Prainsack 2012), the shift we are witnessing goes beyond Ziman's (1996) notion of post-academic science, where knowledge producers were still professional scientists, although their science may serve other than academic purposes primarily. It also goes beyond von Hippel's (2005) diagnosis that users are key drivers of innovation. In contemporary citizen science initiatives, we see nonprofessionally trained people make substantial contributions not only to how scientific findings are applied to "the real world," but they contribute to knowledge production in basic research.

The emergence of citizen science has been partly rendered possible, and definitely catalyzed, by Internet platforms and social media such as Twitter, Facebook, Flickr, and more recently, specific initiatives dedicated to the development of citizen science projects (e.g., http://www.citizensciencealliance.org/). The increasing prominence of citizen science challenges and reconfigures the ways in which knowledge production in the health domain takes place, while at the same time, raising ethical and regulatory questions pertaining, for example, to how contributions from citizens should be attributed in scientific publications; what research ethics procedures should apply to studies that are self-organized by patients; and how new modes of citizen participation in medical and bioscientific knowledge production and decision making can or should be integrated into existing institutional structures (e.g., into existing systems of healthcare delivery). They also raise the question of what can be done to minimize the risk that citizen science initiatives are "hijacked" by actors pursuing primarily commercial interests. Moreover, professional researchers, scientists, and educators are also discussing ways to ensure that the quality and standardization of data are collected, generated, and processed by nonprofessionals (e.g., Cohn 2008; Wiggins et al. 2011; see also the important work led by the Cornell Lab of Ornithology, where the term citizen science seems often seen to have originated: http://www.birds.cornell.edu/citscitoolkit/toolkit/steps). This links to the overarching question of why, and under what circumstances, citizen science works (i.e., it produces "better" results than conventional science; either because the results are produced faster, they are more socially robust, or they solve previously unresolved questions). There are different approaches to answering this question, many of which draw upon the literature on social networks (see also Shirky 2008). James Surowiecki, in his book *The Wisdom of Crowds* (2005), for example, suggested four criteria that need to be met for a crowd to make intelligent decisions: (1) independence of individual opinions from peer or other influences, (2) decentralization of expertise in the crowd, (3) diversity of opinion, and (4) aggregation (i.e., some mechanisms of turning individual opinions into a collective decision). This, of course, leaves open the question of how aggregation should take place in order to maximize the intelligence of the crowd. This is one of the questions that Nielsen starts to unpack in his book on *Reinventing Discovery* (2011). For him, for citizen science to work, initiatives need to provide instant feedback to participants; they need to be modular, and there needs to be some level of coordination. The question of how exactly coordination takes place (e.g., "emerging" from bottom-up or top-down), and how much coordination is too little or too much, will hopefully be answered on the basis of empirical studies of citizen science projects in the coming years.

Citizen science initiatives involve the participation of nonprofessional scientists at any or every stage of the trajectory of scientific knowledge production: at the stage of data collection/generation, data analysis, interpretation, application, dissemination, and evaluation. The following typological grid can help us in the assessment of how coordination and agency is distributed in a particular citizen science project, how "open" it is, and what kind of entrepreneurial and innovative potential it utilizes and/or fosters (see Table 1).

Citizen Science and Open Science

Many practices subsumed under the label of citizen science also fit the definition of open science (e.g., Delfanti 2010). While these two concepts clearly overlap, their focus is different. Open science, as we will see below, focuses on transparency and accessibility of data, results, and often also research infrastructures. Citizen science, in turn, emphasizes the participation of not professionally trained individuals (i.e., at least not in the activity they engage in) within the production of scientific knowledge. In other words, citizen science signifies the production of authoritative knowledge by "amateurs." The term citizen science is rather inclusive with respect to different format and designs of the participation of nonprofessional experts. It is sometimes applied to projects that are conceived, executed, and utilized (also in terms of intellectual property rights) by citizens in a bottom-up way, without

Citizen Science in Health Domain, Table 1 Criteria for the classification of citizen science projects (Source, author)

Coordination: Who has influence in
1. Agenda setting
2. Determining the terms of the execution of the idea/ procedural aspects
3. Deciding what results are (and what "good" results are)
4. Deciding what will be done with results
5. Deciding on intellectual property questions
Participation: Who participates (demographic and social parameters of those who participate)? Why and how do they participate?
6. How much special training or expertise is required to participate in this project?
Evaluation
7. How and by whom is it decided what good outcomes are?
Openness
8. Do participants in the project have access to the core datasets?
9. Can participants in the project edit the core datasets?
10. Is the contribution of participants adequately acknowledged in published materials?
11. Are datasets made publicly accessible (open source/ open access)?
12. Are main findings made publicly accessible (open source/open access)?
Entrepreneurship
13. How is the project funded?
14. What is the role of for-profit entities in this project? Are these small, medium-sized, or large entities, and where are they located?
15. How are for-profit and other interests aligned in this project (and/or do they conflict, and where?)

any involvement of professional scientists; although such projects are rare, they do happen (the example of a group of patients organizing their own study via the platform *Patients Like Me* to explore whether lithium carbonate slows down the progress of motor neuron disease, as suggested by a clinical research study, comes closest to this "pure" citizen model; see also Wicks et al. 2011). Other citizen science projects were either conceived, designed, coordinated, or assessed by professional scientists (see, e.g., the platform for the crowdsourcing of data analysis *Kaggle*; www.kaggle.com) Other projects assign clearly delineated tasks to citizens which do not require any particular experience, training, or familiarity with the subject; an example for this latter type of project would be *Pearl* in China; here, citizens use the infrared device on their mobile phones to record and transfer to a central platform data on human interaction patterns in order to understand better how airborne diseases spread. The project is based on the fact that the range of the infrared device on people's smart phones is the same as the range in which airborne diseases can be caught from an infected person (for more details, see http://bioinfo.ict.ac.cn/pearl/, and Swan et al. 2010). Here, citizens have far less, if any in the designing of the project and the interpretation of the results.

Projects like *Pearl*, where the role of citizens is limited to data collection, have been criticized as using citizens as "brain soldiers," as part of a cognitariat (Toffler 1983); they often volunteer their time to carry out tasks that average human brains happen to do better than computers, namely, the filtering out of "noise." This "bottom-up score" of a citizen science project, which can be assessed on the basis of the criteria listed in Table 1, tells us something about the emancipatory and democratic potential of a citizen science project (e.g., Does the project draw primarily on the creativity of people from outside the academic discipline? Does it empower people who would normally not engage with this field of science and who would normally have no, or very limited, access to datasets?). It does not prejudice, however, how "good" or successful a citizen project is: Some projects in which citizens had very little influence on project design, etc., led to amazing outcomes that had a significant impact on the science in their fields (Khatib et al. 2011). Thus, the overall assessment of the success of a citizen science project will always depend on what the main objective is: the "democratization" of science, the education of citizens (e.g., Bonney et al. 2009), or the solution of a pressing scientific issue.

An additional dimension according to which citizen science projects can be assessed is the degree of their openness. Openness is, as the term suggests, the main focus of the notion of open science. A website devoted to open science (Gezelter 2009) defined open science projects as those meeting four sets of criteria: first, transparency in methodology, observation, and data collection; second, public availability and reusability of scientific data; third, the public accessibility and transparency of scientific communication; and fourth, the availability of Web-based tools to facilitate collaboration. In short, the more publicly accessible every stage of scientific knowledge production process is, the higher the "openness score" (see Table 1) of a project. Whether the project is carried out exclusively by professional scientists, or whether it includes nonprofessional participants, is not a decisive factor in this regard. A project which is carried out by one Nobel Laureate working entirely alone at her lab or at her desk, yet who makes all her data, her lab journals or research notes, and the findings, publicly available, could qualify as an open science project.

The idea of open science is also closely linked to the much older open access (OA) movement in academic publishing. The term OA typically refers to a type of publishing where journals do not charge readers or their institutions for access. In an academic context, OA publishing usually refers to OA journals that are also peer-reviewed and include editorial quality control. In the last decade, OA publishing has become increasingly common in the scientific world. This is partly a result of funding agencies requiring research findings being made publicly available, although they typically allow a period of exclusive use of the data by the researchers who generated them. To date, about 10 % of all peer-reviewed journals wordwide are OA journals (http://www.doaj.org/), and it is estimated that about 30 % of the global research output is available OA (including green OA, or self-archiving; namely, making materials public available which have previously been published in non-OA sources).

Citizen Science: A Mixed Blessing?

Commentators have been both enthusiastic and concerned about the emergence of citizen science. Many authors (e.g., Angrist 2010; Nielsen 2011) welcome citizen science especially also in the health domain as a process of empowerment of patients and citizens. Some people, however, are concerned that the replacing of professionally trained experts, such as clinicians and medical researchers, by "regular" citizens who participate in the production of authoritative knowledge may compromise the quality of both the science and the clinical applications emerging from them. Some authors have also been very skeptical with regard to the political meaning of citizen science. For example, it has been argued that models of participation in citizen science projects – especially those which are "run," or coordinated, by companies, governmental organisations, or other actors which are not primarily acting in their capacity as nonprofessionals and citizens in the first place – bear strong resemblances with many Web 2.0 enterprises. *Google*, for example, famously combined the prioritization of user experience with reliance on user-generated information (*Google*'s algorithms draw on how many times users access particular websites) and now dominates the market (Auletta 2009). Also, the case of the online platform *Napster* (www.napster.com) arguably shows how user "participation," and the reliance on user-generated content, was utilized not only to generate revenue but also to breach copyrights and change an entire industry: *Napster* launched in 1998 to allow users share music files with each other in "real time," and early users played crucial roles as codesigner of the service and shapers of its content. Early adopters thus assumed an important role in challenging the previous dominance of elites – the music industry – as gatekeepers to information (music files; Robinson and Halle 2002). A very similar argument could be made about the ways in which online genetic testing companies involve their consumers in knowledge production facilitated by the company. By creating facts on the ground – namely, by facilitating that thousands of people access genetic information online and allow the company to use their data for the purpose of disease research – the company is in a much stronger bargaining position vis-à-vis regulators who wish for medical professionals to remain gatekeepers to these activities.

According to this more skeptical view of citizen science initiatives, citizens contributing to science in citizen science projects where they will not share the profits engage in value cocreation for the powers to be (Arvidsson 2008; Bonsu and Darmody 2008), whether these are for-profit companies, or traditional academic and scientific institutions who receive the main credit for the discoveries made by citizens.

However, it should not be automatically assumed that all citizens in projects where the influence of participants in project design is very limited are being exploited. For many, being part of something useful, being acknowledged publicly in publications, and/or learning about the scientific area in question is enough of an incentive to participate. While there certainly are initiatives that aim at making profits on the basis of the unpaid labor of people, not every instance of citizens participating in such projects can be automatically read as an instance of "false consciousness."

Conclusion and Future Directions

There is an evident need for systematic empirical and conceptual explorations of the circumstances under which citizen science projects generate good outcomes in the sense that outcomes are academically or scientifically more accurate and better, and more socially robust, than the results of traditional ways of scientific knowledge production in health. Moreover, researchers in the next decade will hopefully also explore according to what parameters the results of citizen science should be evaluated and assessed. Overarching questions include, for example, the following: Is the prominence of citizen science a passing trend, or will it reconfigure the ways in which innovation takes place in a sustainable manner? Is innovation produced by citizens faster, or "better," in any way? And can citizen science be seen as a potential solution for educational needs outside, or both inside and outside, of traditional academic institutions?

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Cross-References

- ▶ Academic Entrepreneurship
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Healthcare and Innovation
- ▶ Higher Education and Innovation
- ▶ Innovation and Democracy
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Social Innovation

References

Albanello L. Lorenzo's brain. 2011. http://lorenzosbrain.blogspot.com/. Accessed 26 Dec 2011.

Angrist M. Here is a human being: at the dawn of personal genomics. New York: Harper Collins Publishers; 2010.

Arvidsson A. The ethical economy of customer coproduction. J Macromark. 2008;28(4):326–38.

Auletta K. Googled. The end of the world as we know it. London: Virgin Books; 2009.

Bonney R, Cooper CB, Dickinson J, Kelling S, Phillips T, Rosenberg KV, et al. Citizen science: a developing tool for expanding science knowledge and scientific literacy. Bioscience. 2009;59(11):977–84.

Bonsu SK, Darmody A. Co-creating second life: market-Consumer cooperation in contemporary economy. J Macromark. 2008;28(4):355–68.

Cohn JP. Citizen science: can volunteers do real research? Bioscience. 2008;58(3):192–7.

Delfanti A. Open science, a complex movement. J Sci Commun. 2010;9(3):1–2.

Fischer DA, Schwamb ME, Schawinski K, Lintott C, Brewer J, Giguere M, et al. Planet hunters: the first two planet candidates identified by the public using the kepler public archive data. Mon Not R Astron Soc. 2012;419:2900–11.

Gezelter D. What, exactly, is open science? 2009. http://www.openscience.org/blog/?p=269. Accessed 26 Dec 2011.

Gibbons M, Limoges C, Nowotny H. The new production of knowledge. London: Sage; 1994.

Goodchild MF. Citizens as sensors: the world of volunteered geography. GeoJ. 2007;69(4):211–21.

Khatib F, DiMaio F, Foldit Contenders Group, et al. Crystal structure of a monomeric retroviral protease solved by protein folding game players. Nat Struct Mol Biol. 2011;18:1175–7.
Nielsen M. Reinventing discovery: the new era of networked science. Princeton: Princeton University Press; 2011.
Nowotny H, Scott P, Gibbons M. Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge, UK: Polity Press; 2001.
Prainsack B. Book review of Elias G. Carayannis and David F. J. Campbell: Mode 3 knowledge production in quadruple helix innovation systems: twenty-first century democracy, innovation, and entrepreneurship for development. New York: Springer, Minerva; In press 2012.
Robinson L, Halle D. Digitization, the Internet, and the Arts: eBay, Napster, SAG, and e-Books. Qual Sociol. 2002;25(3):359–83.
Shirky C. Here comes everybody: the power of organizing without organizations. New York: Penguin; 2008.
Surowiecki J. The wisdom of crowds. New York: Anchor Books; 2005.
Swan M, Hathaway K, Hogg C, McCauley R, Vollrath A. Citizen Science Genomics as a Model for Crowdsourced Preventive Medicine Research. J Particip Med. 2010;2:e20.
Toffler A. Previews and premises. New York: William Morrow; 1983.
von Hippel E. Democratizing innovation. Cambridge, MA: MIT Press; 2005.
Wicks P, Vaughan TE, Massagli MP, Heywood J. Accelerated clinical discovery using self-reported patient data collected online and a patient-matching algorithm. Nat Biotechnol. 2011;29:411–4.
Wiggins GN, Stevenson RD, Crowston K. Mechanisms for data quality and validation in citizen science. IEEE Seventh International Conference on eScience Workshops; Stockholm; 2011. http://citsci.syr.edu/sites/citsci.syr.edu/files/sites/voss.syr.edu/files/Wiggins2011eScience.pdf. Accessed 17 Feb 2012.
Ziman J. 'Postacademic science': constructing knowledge with networks and norms. Sci Stud. 1996;9:67–80.

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Clusters, Networks, and Entrepreneurship

Marc-Hubert Depret[1] and Abdelillah Hamdouch[2]
[1]University of Poitiers, IRIAF, CRIEF, Niort, France
[2]Planning Department, Polytechnic School, University of Tours, Tours, Cedex 3, France

Synonyms

District; Hub; Milieu; National system of innovation; Park; Regional innovation system

Introduction

Innovation processes often depend upon the availability or constitution of a critical mass of knowledge, (multidisciplinary) competences, and (entrepreneurial, managerial, and human) resources that are complex, cumulative, and, for the most, still embryonic or difficult to access. Considerable efforts must be also devoted for the mobilization and training of the manpower, for the acquisition of new knowledge and know-how, and for informing employees about new technologies and services and their market potential. Equally important here is the need for a close coordination among a great number of heterogeneous and geographically dispersed actors. The potential for innovation and the competitive positioning of actors "depend increasingly on their differentiated abilities to collaborate with a wide range of partners – those with key complementary competences and significant specific resources, and/or those enjoying competitive advantages in terms of localization" (Depret and Hamdouch 2011, pp. 249–250). Hence there is a need for intense, more collective coordination between many heterogeneous and geographically dispersed actors. These collaborations are increasingly structured in the form of coalitions and networks of a very varied nature, which transcend geographical borders. This coordination often goes through the formation of interest coalitions, vertical and horizontal partnerships, inter-organizational networks (as well as entrepreneurial/social/political/cultural networks), clusters, etc. Only the geographical concentration of activities (spatial proximity) combined with the belonging to the same community (organizational proximity) and the adoption of a shared "cognitive space" (cognitive proximity, either scientific or technological) allow entrepreneurs to amortize the high R&D, production, and commercialization costs they often have to engage in. It is also at this condition that entrepreneurs could eventually overcome the various entry and mobility barriers that can block or slow the growth of their business. Finally, these combined forms of proximity are the conditional "gate" that allows entrepreneurs to preempt and control the knowledge, competences, and strategic resources that are needed in the achievement of increasingly complex, uncertain, and costly projects (Depret and Hamdouch 2009).

These innovation clusters and networks and the role that entrepreneurs play in their dynamics have given rise to a wide range of theoretical and empirical studies in a variety of disciplines (economics, sociology, geography, management). The core idea underlying these studies is that it is the combination of agglomeration and proximity logics that finds nowadays competitive, innovative, and entrepreneurial dynamics in most (if not all) industries. More precisely, the available literature converge around the idea that the geography of innovation and entrepreneurship is being fundamentally structured (or embedded) within the clusters (broadly speaking) and networks that encompass the collaborative, learning and knowledge spillover dynamics that are specific to certain territories and to the innovation actors (notably the entrepreneurs) they involve (Depret and Hamdouch 2009).

The literature (especially the empirical one) offers a highly diversified range of approaches in terms of research aims and methodologies and of countries or regions or industries studied. They are also highly varied as regarding the hypotheses tested and the results yielded. Hence, the aim here is not to provide a comprehensive survey of these studies. It is rather to draw a first (tentative) typology of the most visible pieces in the literature according to the approaches privileged and to their specific focus (for more detailed surveys, see Hamdouch 2008, 2010; Depret and Hamdouch 2009, 2011; Hamdouch and Depret 2009). In this perspective, the remainder of the entry is organized as follows: The first section defines the notions of clusters and innovation networks (grasped here, in a broad sense, under the generic term of *territorial innovation and entrepreneurial systems, or TIES*); the second section shows that there exists at least eight differentiated views of TIES depending on the hypotheses founding the approaches privileged by the researchers, and therefore that there exists also at least eight ways in defining the goals and the contents of policies (whatever their spatial scope) that are aimed at promoting or supporting or accompanying entrepreneurial and innovation dynamics in a given territory and/or sector.

Key Concepts and Definition of Terms

The common point of these different studies is to consider *entrepreneurship as a territorial innovation and entrepreneurial system (TIES)* that is characterized by Hamdouch and Moulaert (2006): (1) the fundamental role of territorial proximity and clustering dynamics; (2) the multiplicity and diversity of the actors (large companies, SME, entrepreneurs, business angels, venture capital, and private equity firms, layers, etc.); (3) the complex articulations between the multiple institutional, spatial, temporal, and cognitive frameworks; (4) the crucial importance of the historical, social, cultural, and geographical dynamics in structuring these frameworks; (5) the diversity of the forms taken by this system.

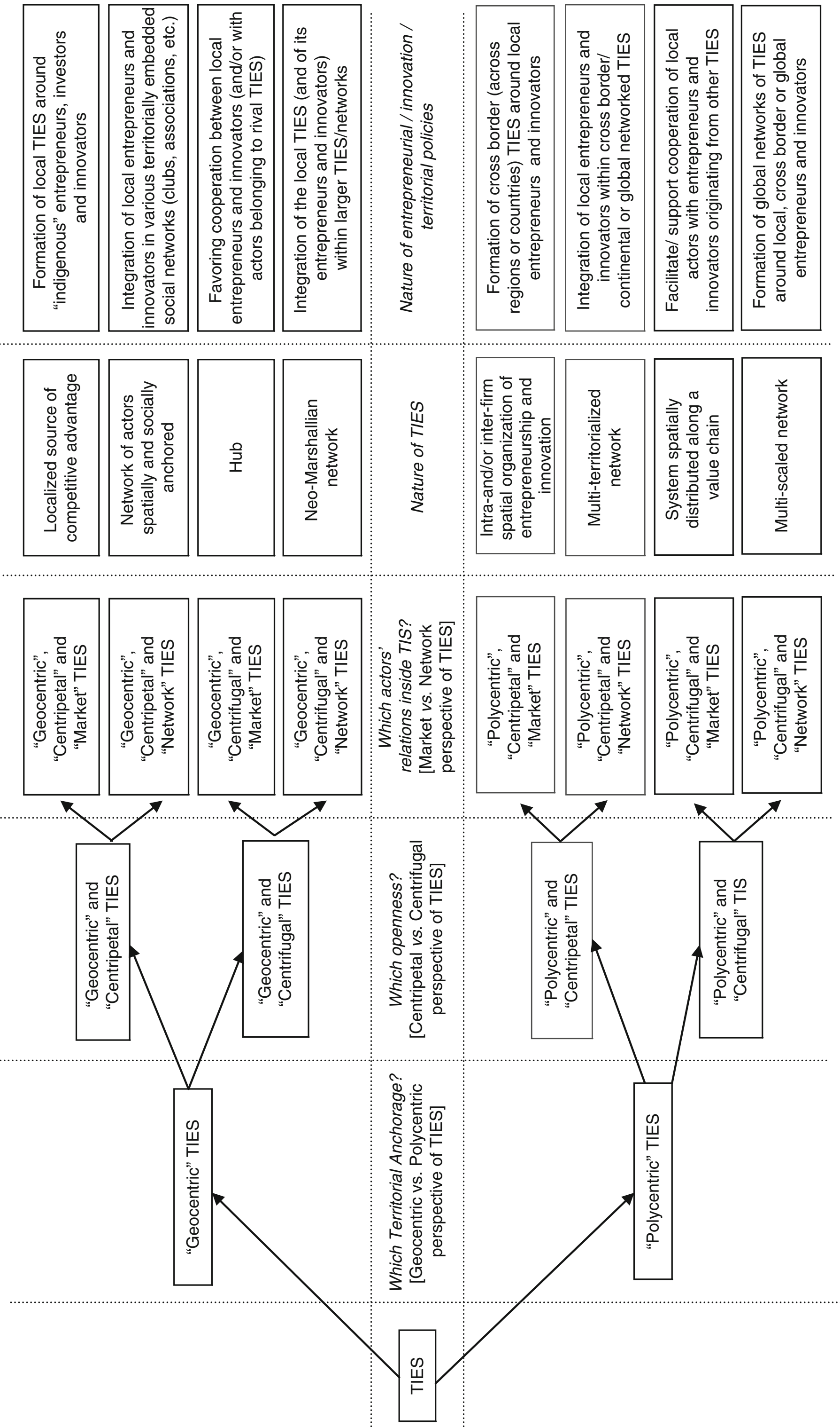
In this context, the TIES (as a cluster) is a spatial mode for the organization of entrepreneurship, innovation, and related activities (Depret and Hamdouch 2011). It "comprises an ensemble of various organizations and institutions (a) that are defined by respective geographic localizations occurring at varied spatial scales and within specific institutional environments, (b) that interact formally and/or informally through inter-organizational and/or interpersonal regular or more occasional relationships and networks, (c) and that contribute collectively to the achievement of all kind of innovations within a given industry or domain of activity, i.e., within a domain defined by specific fields of knowledge, competences and technologies. This definition is rather flexible, as it entails only that the three sets of conditions are being simultaneously verified. It could then correspond to a large variety of spatial, institutional and organizational concrete configurations of innovative dynamics. Moreover, it does not prejudge of the spatial topography of the interacting actors, nor does it impose any constraint on the way they may interact (i.e., cooperate or compete)" (Hamdouch 2010, p. 43).

At the same time, a network is a specific modality for the structuring or coordination of inter-organizational relationships among various legally independent actors (firms, entrepreneurs, institutions, etc.) "aiming at achieving a common project in a specific domain through the control, exchange or sharing of information, know-how, knowledge, as well as products and/or capital (. . .). The actors participating to a network may be co-located within the same cluster or belong to different clusters" (Depret and Hamdouch 2011, p. 232).

Unfortunately, the "understanding of the mechanisms at work within the dynamics of the emergence, structuring, coordination and development of the phenomena of the clustering and networking of [entrepreneurship and] innovation processes remains incomplete, dispersed and (let's admit it) fairly flimsy" (Depret and Hamdouch 2011, p. 231). Almost all the different approaches of TIES relate to realities (semantic, topographical, and contextual) which differ depending on the authors, for different reasons (Hamdouch and Depret 2009).

Clusters and Networks in the Entrepreneurship (and Innovation) Literature

In fact, it is believed here that the TIES literature is mainly organized around three major structuring dimensions, which partly overlap (Fig. 1). These dimensions refer respectively to the cultural and political territorial anchorage ("geocentric" or "polycentric") of TIES, to the degree to which they are open to "the outside," and to the nature of the inter-dependences ("competitive" or "reticular") between the actors. The combination of these three dimensions results in eight possible approaches of the notion of TIES that can be related to two bundles of works: The first group gathers the traditional approaches which build on the triple hypothesis of a strong territorial anchorage of the actors, of a strict impermeability of the territory vis-à-vis other territories, and of relationships among the actors mainly based on transactions or contracts; the second bundle relates to "evolutionary" approaches which postulate a spatially multiscalar, open, and networked view of the territory.



Clusters, Networks, and Entrepreneurship, Fig. 1 Drawing the "tree" of TIES approaches: a suggested 3-dimensional typology

The Traditional Approaches of Clusters and Networks

To analyze clusters and networks, it is then necessary to open "the 'black box' of the TIES approach" (Depret and Hamdouch 2009). In order to progress toward a better understanding of what "TIES" are or might actually be, it is necessary to change the analytical framework, and the manner in which TIES are traditionally studied (Hamdouch and Depret 2009). Indeed, within this framework the TIES appear to be at the same time (see Fig. 1):

"Geocentered" (i.e., Localized or Regionalized)

In this case, most TIES are generally defined as being very strongly (spatially) embedded in a territory (a district, a city, a region, a country) that is more or less extensive but which is still relatively well (spatially) defined (clusters, districts, parks, areas, *milieux*, cities, agglomerations, regional or national innovation system, etc.) (Hamdouch and Depret 2009).

In this perspective, the emphasis is placed, on the one hand, on the decisive role played by co-location, geographical proximity (preemptive access to knowledge, skills, resources, and strategic technologies, localized collective learning effects, access to new outlets, etc.) and spatial clustering effects (technological externalities of agglomeration), and on the other hand, on the formative importance of territorialized (technological, institutional, and economic) dynamics (Depret and Hamdouch 2011). This is why entrepreneurs, in this theoretical framework, should start and develop their businesses within the TIES where R&D centers of excellence, large companies, funding institutions, specialized business services, and other entrepreneurs are located.

"Centripetal" (i.e., Territorially Closed or Anchored or "Autarkic")

In this approach, the territorial bounding of the TIES is relatively strict, insofar as the other spatial scales have a relatively secondary or marginal role in this (Gordon and McCann 2000), although they are sometimes taken into account (Hamdouch and Depret 2009).

From this perspective, the authors focus on only one territorial scale and therefore mainly (even exclusively) on the only actors of innovation that are to be found there. The TIES therefore appear here to be "closed" systems (Bell and Albu 1999), relatively closed to the outside (even autarkic) (Hamdouch and Depret 2009). However, this doesn't seem to be detrimental to the territory's competitiveness, in view of the fact that, from this "centripetal" perspective, knowledge and resources are mainly distributed within the territory (and in all cases are distributed better than between the territories) (Jaffe et al. 1993).

The emphasis is therefore placed on the presence, within the TIES, of "pulling" or central actors socially embedded: star scientists, critical interfaces, intermediate actors or gatekeepers, entrepreneurial investors, business leaders (or anchors) or pioneer entrepreneurs, dense social networks, etc. (Hamdouch and Depret 2009; Depret and Hamdouch 2011).

From this perspective, extra-territorial relationships are an exception or a "second best" (Audretsch and Stephan 1996) because the extra-local level "comes as a supplement to relationships and properties pertaining to the local level" (Lagendijk 2002, p. 84).

And/or "Market-Dominated" (i.e., Exclusively Targeting Economic Competitiveness)

In this case, competition and the externalities of knowledge represent the two engines of competitiveness of the TIES (Hamdouch and Depret 2009). They therefore contribute toward "organizing" relations between actors within the TIES, by favoring the entrepreneurship and the distribution of knowledge and by encouraging actors to invest in R&D.

This approach thus presents the TIES as a specific spatial industrial organization based on two main dimensions: the links between actors in terms of geographical proximity, of complementarities, and of trustworthy relationship building, and the existence of both competitive and cooperative interactions among the co-localized entrepreneurs and firms (Hamdouch and Depret 2009; Hamdouch 2010). In other words, they "represent a kind of new organizational form in between arm's length markets on the one hand, and hierarchies, or vertical integration, on the other" (Porter 1998, p. 79). In this way, the inter-organizational and inter-individual relationships formed within TIES are generally seen from a contractual or transactional (market-oriented) perspective (Cooke 2005). Cooperation between the actors is only considered in logic of "coopetition" (Gordon and McCann 2000). In this perspective, the performance of the TIES will depend on the "right balance" between the intensity of competition and the heterogeneity (of actors) within the TIES (Bathelt and Taylor 2002). On the one hand, the probability of survival for the entrepreneurs will be weak if the competitive pressure is too strong. On the other hand, a too strong heterogeneity will translate into a greater number of surviving entrepreneurs but that are likely to be in average less creative/innovative and of smaller size.

In this approach, the relationships formed within TIES are generally seen from a purely transactional, contractual, or market-oriented perspective (Cooke 2005; Depret and Hamdouch 2011). Networks are often presented as fairly informal (Grabher 2006), sometimes decontextualized (Dicken and Malmberg 2001) – that is, without any real (social, informational, or cognitive) considerations – and sometimes even seen from a static (Garretsen and Martin 2010) or a-historical (Bathelt and Taylor 2002; Boschma and Frenken 2006) viewpoint (Depret and Hamdouch 2011). In this context, "nonmarket relationships" (entrepreneurial, institutional, cultural, jurisdictional, etc.) appear to be, in the TIES, as mere pecuniary positive externalities that can feed the economic growth and create jobs within the territory.

The emphasis is therefore placed on the (apparently necessary) "critical size" of TIES (Porter 1998; Orsenigo 2001; Folta et al. 2006; Trippl and Tödtling 2007). The performance of TIES is usually measured by the number of entrepreneurs, firms, and institutions of innovation that are present (or created) in the territory and by their R&D expenditure, the number of patents (or scientific articles), the number of employees, etc. (Audretsch and Stephan 1996; Suarez-Villa and Walrod 1997; Orsenigo 2001; Prevezer 2001; Trippl and Tödling 2007; Zucker and Darby 2007; Aharonson et al. 2008). The TIS therefore compete to attract (or to retain) the most competitive actors in their territory (Hamdouch and Depret 2009). Within this framework, the increasing integration of innovation actors fosters interaction and new connections; creates new investment, entrepreneurial, and recruitment opportunities; helps to develop supporting infrastructures; and, in fine, creates a "climate" that is a priori relatively favorable to entrepreneurship and innovation (Baptista and Swann 1998). Cumulatively, spatial integration also heightens the attractiveness (Bathelt 2005) of the territory and the performance of its members through "increasing agglomeration and proximity returns" (Depret and Hamdouch 2011) and the mimetic effects of a self-fulfilling and self-strengthening reputation (Appold 2005).

Other studies (Audretsch and Stephan 1996; Dicken and Malmberg 2001; Kaiser and Prange 2004; Wolfe and Gertler 2004; Casper and Murray 2005; Jong 2006; Trippl and Tödling 2007; Waxell and Malmberg 2007) focus on the central role played by the existence of a wide and diverse (local) labor market because it fosters the dissemination of knowledge and facilitates interaction (Hamdouch and Depret 2009; Depret and Hamdouch 2011). Most of the contributions also emphasize the major role of financial markets, investors, and business angels (Kaiser and Prange 2004; Zucker and Darby 2007).

Finally, they highlight the importance of a certain number of key actors, who, by their sufficient presence within a TIES, will play a critical role as coordinators, go-betweens, advisors, scrutinizers, and proselytes (Prevezer 2001; Wolfe and Gertler 2004; Hamdouch and Moulaert 2006; Trippl and Tödling 2007; Waxell and Malmberg 2007; Champenois 2008). This is why various "support stakeholders" (local institutions, business service organizations, technology transfer institutions, business incubators, think tanks, etc.), infrastructures (property, transport, etc.), venture capital, consulting and law firms have an important position in the TIES

(Hamdouch and Depret 2009; Depret and Hamdouch 2011).

The Evolutionary Approaches of Clusters and Networks

When these three hypotheses (i.e., local anchorage, weak openness, and market-dominated logics) are jointly (or, at least, by pairs) postulated, like it is often the case, TIES appear to be strongly anchored within the territory, with little room for openness toward the "outside" and based essentially on market-like relationships. This is the rationale explaining why various authors have attempted during the last few years to go beyond this restrictive vision of TIES by adopting an alternative approach (see Fig. 1) that is at the same time:

More "Polycentric" (or Multi-Territorialized or Scattered or Nested)

This approach places the emphasis more on the logics of organizational or cognitive proximity than on spatial proximity (Carrincazeaux et al. 2001; Boschma 2005). They consider that it is no longer so much the co-localization of actors which matters but more the nature and intensity of their "connectivity" (Amin and Cohendet 2005; Depret and Hamdouch 2011).

From this polycentric perspective, the TIES have an anchorage that is either transversal or multi-territorialized (Hamdouch and Depret 2009). In the first case, TIES is part of a (sectoral or technological) system, community, world or mode of production, or value chain. This "system" transcends geographical boundaries (Depret and Hamdouch 2011). In the second case, TIES are very clearly seen as being multi-anchored to several territories (more or less distant geographically) (Coenen et al. 2004). In some cases, TIES are multi-spatialized when a network-firm serves as a *node* (Amin and Thrift 1992; Gertler and Levitte 2005) between different spatial locations or scales (Hamdouch and Depret 2009).

More Centrifugal (or Openness-Based)

From this perspective, agglomeration dynamics are generally deployed under a constant tension between, on the one hand, the need to develop strong, cohesive relationships between the local innovative actors, and, on the other hand, the need to preserve a certain "permeability" (Bathelt and Taylor 2002) *vis-à-vis* outside actors (including sometimes geographically distant actors) in order to benefit from complementary cognitive or financial inputs (Lagendijk 2002; Wolfe and Gertler 2004; Depret and Hamdouch 2009). The different spatial scales therefore fit together (Depret and Hamdouch 2011), one inside the other, while impacting on each other (Dicken et al. 2001; Wolfe and Gertler 2004; Moodysson et al. 2008). In this way, exchanges outside the TIS are often more favorable to the transfer of knowledge than exchanges within these TIES. In fact, "local exchanges are often based on weak or routine links that only rarely (Bathelt et al. 2004) or insufficiently (Asheim 2002) foster learning, knowledge transfer, and synergetic effects and, therefore, major innovations" (Depret and Hamdouch 2011, p. 246). Actually, relatively distant actors at the geographical level can perfectly build and sustain over the long run "strong ties," interact (physically and/or virtually) on a recurrent basis, and exchange among them even tacit pieces of knowledge and competences (Breschi and Lissoni 2001; Gertler 2003; Bathelt et al. 2004; Bresnahan et al. 2004; Amin and Cohendet 2005; Niosi and Zhegu 2005; Torre 2006; Glückler 2007). Equally, several researches show that, beyond a certain degree (even intrinsically), spatial proximity does not impact (or insufficiently) on knowledge creation or dissemination and on innovativeness within the territory (Grotz and Braun 1997; Suarez-Villa and Walrod 1997; Wever and Stam 1999). Lastly, several researchers point out the fact that spatial proximity may well generate negative agglomeration externalities that can be higher than the expected positive externalities of agglomeration and closeness (Nooteboom 2000; Boschma 2005; Torre 2006).

As a matter of fact, most of the entrepreneurs and other actors of innovation processes within the TIES have often more (or stronger) ties with external than with internal actors of the TIES (Depret and Hamdouch 2009). This is particularly the case when local entrepreneurs must look "elsewhere" for the knowledge, competences, or resources they need but cannot find "locally" (Hussler and Rondé 2005). In this way, the probability of innovating is greater for firms benefiting from a favorable "local *milieu*" but also from close links with global networks of knowledge, capital, and people (Gertler and Levitte 2005; Depret and Hamdouch 2011). The dynamism of TIES also "depends on the capacity of their members to absorb knowledge outside the territory and to subsequently disseminate this within their own territory in order to 'hybridize' them with the knowledge or innovations" (Depret and Hamdouch 2011, p. 250) developed locally (Bathelt and Taylor 2002). Consequently, the entrepreneurship and innovation process can be seen as "a result of a 'combinaison' of close and distant interactions" (Oinas 1999, p. 365). Some authors (Lagendijk 2002; Powell et al. 2002; Nachum and Keeble 2003; Saxenian and Li 2003) even show that the openness of the TIS "does not necessarily translate into a reduction of the intensity and density of local links" (Depret and Hamdouch 2011, p. 247). In contrast, this openness may represent a factor in making (inter-organizational) relationships more viable and stronger (Powell et al. 2002; Owen-Smith and Powell 2004). This appears to be the case including for entrepreneurs and small-medium enterprises that can tap in "external" sources of knowledge, competences, or funding they cannot find (or not anymore) within their TIES. By a matter of fact, these enterprises are usually more developed (in terms of size), more mature (in terms of organizational and strategic experience), and positioned more downstream in R&D processes (i.e., more "close to the market") than the average of innovating enterprises (Powell et al. 2002).

Some authors stress the risk, for local stakeholders, of a progressive and often irreversible cognitive lock-in within TIES (Granovetter 1985; Uzzi 1997; Bathelt 2005), which is sometimes fatal (Camagni 1995). Worse, certain TIES "contain the seeds of their own destruction and may potentially disappear or die (. . .) if they [don't] develop ways to access external markets, adjust power relations in a fluid way and reproduce [their] structures through 'powerful' institutions" (Bathelt and Taylor 2002, p. 106, authors' square brackets).

And More Reticular

From this perspective, TIES and networks are inseparable from the logics of the spatial and strategic organization of innovation (Dicken et al. 2001; Cooke 2005; Grabher 2006). Relationships among actors within (and sometimes between) the TIES are usually based on formal *and* informal ties that refer to a "coopetitive" or non-strictly market-oriented logic (i.e., a mix of competition and cooperation) rather than on formal (i.e., through legal contracts or agreements) market-oriented rationales (Moulaert and Mehmood 2010).

Within this alternative framework, networks (and particularly inter-individual "social networks," in the original sense of local and physical or concrete interplay among co-located people or connections thanks to acquaintances or "go in between" people or whatever "bridge" role that some individuals, sometimes unforeseen, can occasionally play) are the core explanation of the co-location of innovation actors in some specific places, starting with "entrepreneurs," that is, researchers, potential innovators, and business-project's oriented actors. Hence, the articulation of networks within *and* across TIES appears to be a central component or conditional building block for a territorial (open) clustering dynamics.

This articulation of TIES and networks vary however, depending on the authors (for a detailed analysis, see, e.g., Hamdouch and Depret 2009; Depret and Hamdouch 2011). *A minima*, TIES can be considered as simple networks of actors, more or less co-localized in one territory (and sometimes in several territories). As a result, many approaches in the literature mostly come under the "market-oriented perspective" (see above). Indeed, in such approaches, networks are, roughly speaking, supposed to yield positive effects on entrepreneurs' performance (Baum et al. 2000). Entrepreneurs' relationships with large companies, research institutions, or universities are supposed to attenuate the inherent uncertainties related to their "youth in business." Accordingly, their initial performance increases along with their more or less size of "alliance networks" with "institutionalized partners" (Baum et al. 2000) but also with the "diversity" of such networks and partners (Owen-Smith and Powell 2004). The "age" of the network is also decisive. Indeed, Stuart (2003) shows how entrepreneurs have a greater probability to be funded further by a potential investor if they have already formed alliances (trustworthiness effect) with previous funders/investors and if the time run since their first alliance has been enough long to set a "good reputation." However, alliance networks are also "risky games": They can be a source of vulnerability for "candidate entrepreneurs," given the risks of opportunistic behavior from the "partners." This being said, some researchers rest on the conviction that "reputation effects" (both related to entrepreneurs and potential funders or "allies") play, in most situations, a greater role than short-sighted opportunistic behavior (Owen-Smith and Powell 2004; Hamdouch 2008).

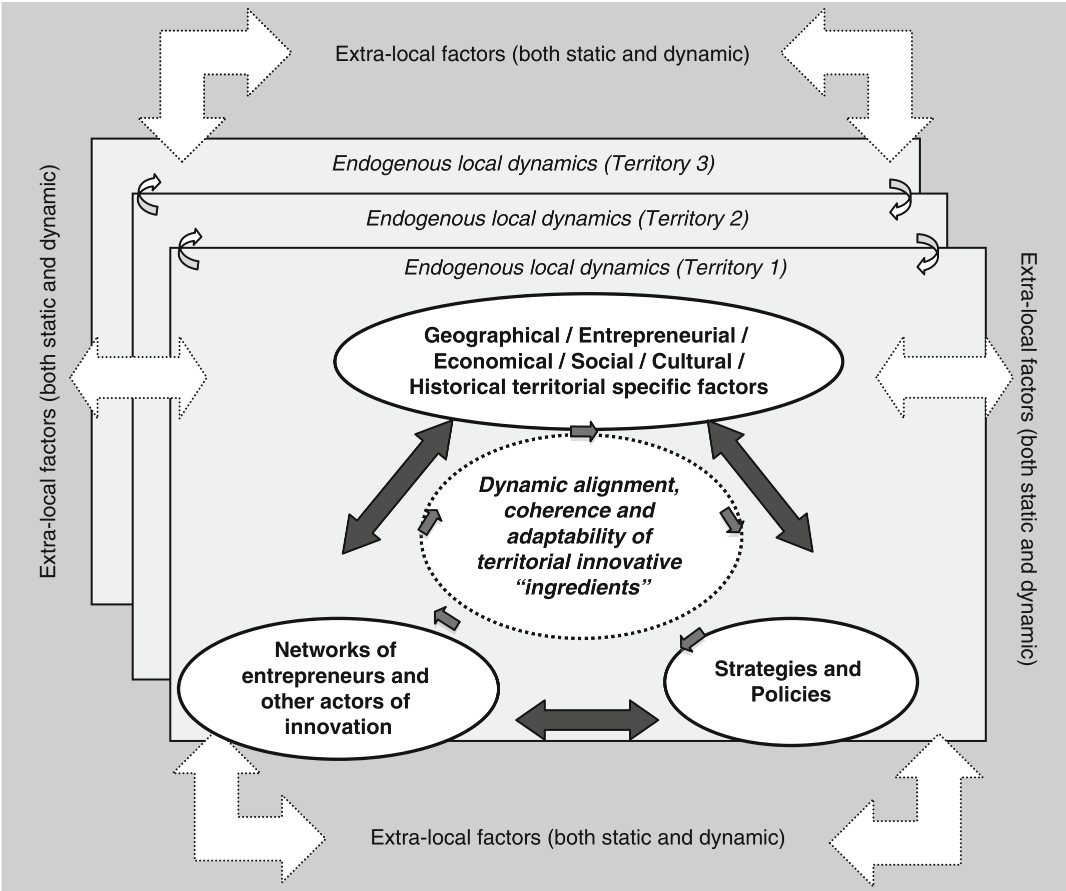
Moving further, other researches tends to show the importance of social networks and relationships, and of trust, reputation, altruism, friendship, leniency, forbearance, kindliness, integrity, social capital, *habitus*, culture, rules, conventions, routines, rites, symbols, taboos, beliefs, myths, or, more broadly, "extra-market" relationships (Castilla et al. 2000; Moulaert and Sekia 2003; Ter Wal and Boschma 2009).

For some, however, this approach seems to be locked into an overterritorialized view about the embeddedness of TIES (Coe et al. 2004). This is why some advocate a more integrated (even coevolutionary) vision of TIS and networks. In this network governance approach (Grabher 2006), TIES are no longer (only) considered as geographically "anchored" networks, within which actors are grouped together more or less on a co-localization basis (Depret and Hamdouch 2011). They appear more as combinations of "multi-scaled networks," in terms of both location and the variety of actors' modes of interaction (Hamdouch 2010). From this viewpoint, TIES and networks are intimately connected (Amin and Thrift 1992; Dicken et al. 2001; Nachum and Keeble 2003; Coe et al. 2004; Phlippen and van der Knaap 2007). TIES are seen as being juxtaposed and coevolving with each other (see Fig. 2). The different spatial scales fit into this, one into the other, each having an impact on the other (Wolfe and Gertler 2004). Following this line of thought, one can say that, "while networks are embedded within territories, territories are, at the same time, embedded into networks" (Dicken et al. 2001, p. 97), so that "the global economy is constituted by 'spaces of networks relations" (Dicken et al. 2001.) or, to put it differently, it builds on "multi-scaled networks of networks" (Hamdouch 2010).

The TIES, as a cluster, is also "a complex-networked entity that is systemic, structured (around stakeholders with highly varied organizational or institutional profiles), polymorphic, dynamic (that is, it evolves over time and in space) and relatively open to the outside world (that is, 'centrifugal') or even 'multiscalar' (or polycentric)" (Depret and Hamdouch 2011, p. 230). In this way, TIES is a web of social networks comprising a potentially large variety of entrepreneurial and innovation stakeholders who interact (or coevolve) within the framework of occasional or regular relationships, both inter- and intraorganizational, and who contribute to the performance of activities in a particular area (Depret and Hamdouch 2011, p. 232).

Finally, more often than advanced in the literature, the co-location of innovation actors within TIES is neither motivated by market-oriented purposes nor, intentionally, structured around networks.

As highlighted by Markusen (1996) and Torre (2006), it can sometimes be the result of diverse other factors (e.g., attractive property prices, tax breaks, the quality of the local employment market, the "critical size" of the outlets offered by the local market, the reputation of the TIES). It can even, in certain cases, be the result either of a "historical accident" or a "non-choice" (Champenois 2008) of purely subjective individual factors (Autant-Bernard et al. 2007), or even of a "copycat effect" (Appold 2005; Gertler and



Clusters, Networks, and Entrepreneurship, Fig. 2 A schematic representation of TIES time-space evolution dynamics (Source: Authors, inspired by Hamdouch and d'Ovidio 2009)

Levitte 2005) of "chain location" (Caplin and Leahy 1998). Certain works, some of which are quite "old," have equally shown that culture, well-being, diversity, "social glue," learning, social movements and "bottom-up" socially creative initiatives, governance modes, social conventions, ethical shared values or norms of behavior, "solidarity" among the actors, etc., can highly contribute (as much as economic and scientific, technological, business or financial networking processes) to the long-term territorial dynamics and therefore to TIES development trajectories and socioeconomic "achievements" (see Moulaert and Mehmood 2010).

Building on this three-dimensional analysis (see Fig. 1), it comes that at least eight "manners" for conceiving TIES can be envisaged. It comes also that there are as much varied ways to design policies aiming at promoting/supporting the development of entrepreneurship initiatives and successful outcomes.

Clusters, Networks, and Entrepreneurship Policies

During the last three decades, geographical borders have tended to become more permeable (through the influence of external factors) and, as a result, they subject national and regional spaces to developments (entrepreneurial, scientific, technological, institutional, economic, strategic, and organizational) that are in part influenced by dynamics that are external to the territories, e.g., strategies of multinational firms, monetary and economic developments at the global level, regional integration policies and their effects, free trade agreements, etc. (see Hamdouch and Moulaert 2006; Depret and Hamdouch 2011).

At the same time, the growing spatial interdependencies between actors of innovation – exacerbated on the one hand by interregional integration processes, globalization of economies, internationalization, and "networking" of firms, on the other by policies of devolution and regionalization at the infra-national level – tend to redefine the space and the modalities of expression of their respective rationalities and of their modes of interaction and, as a result, to link different spatial levels in the determination and evolution of institutional frameworks within which the processes of territorial entrepreneurship and innovation take place (cf. Hamdouch and Moulaert 2006; Depret and Hamdouch 2011).

It is in this context that the idea has been developed that it is within TIES (see above) that added entrepreneurial opportunities, value, growth, and, ultimately, jobs are created today. In the same time, the comparative advantage of TIES is not longer exclusively depends on the simple mobilization of the resources with which they have been provided by "nature," history, geography, institutions, or contingency. Competitiveness in markets, which have become global, requires the access to a wide range of (entrepreneurial, financial, and cognitive) resources and technological skills. "Hence the emphasis placed on greater proximity and closer coordination between the various 'holders' of resources and skills. In an environment characterized by a redistribution of spatial and sectoral 'cards' between" the different innovation "players" and entrepreneurs, the "comparative advantage lies in the ability of rival yet complementary actors(. . .) to manage increasingly close and structural" including extra-market interdependencies within an extremely wide range of clusters [TIES] and networks (Depret and Hamdouch 2011, p. 228, authors' square brackets).

Indeed, the governments (at all levels of territorial organization) are now multiplying the (TIES's) politics which aim to place entrepreneurship and innovation at the heart of their economic development strategies (Hamdouch and Depret 2009). These policies are differentiated across territories depending on the way public authorities conceive the TIES that exists or that they want to promote and develop (see Fig. 1).

Conclusion and Future Directions

Entrepreneurship and innovation dynamics, as related to specific territorial and institutional settings and evolution paths, appear to multifaceted phenomena. As illustrated by the literature reviewed and the analytical typology presented, it is rather clear that there are very contrasted approaches to TIES, though the reality offers concrete territorial dynamics that are probably lying along a continuum of configurations rather than matching "discrete" models of TIES. Equally important is the intertwining of clustering and networking phenomena in the shaping, deployment, and evolution of TIES. And it is this dynamic articulation between the two phenomena that constitutes a robust argument for conceiving TIES as multiscalar and rather "open" territorial settings that can best favor viable entrepreneurship and innovation processes over the long range. Finally, public policies appear to be capable of influencing the shape and evolution of the TIES they can influence, under the condition, however, that these policies are dynamically aligned with the strategies and networks deployed by local innovation and entrepreneurship actors, both inside and outside the TIES.

As regards future directions for research efforts, two axes should be privileged. The first one, mostly theoretical, is related to the effort that is still to be engaged for a better characterization of TIES and the configurations they may underlie. The second axis is essentially methodological and empirical. It relates both to the selection of efficient criteria and empirical methods (converging or complementary ones if possible) and to the realization of in-depth case studies on a comparative basis.

Cross-References

- ▶ Business Emergence
- ▶ Business Start-Up: From Emergence to Development
- ▶ Entrepreneur
- ▶ Entrepreneurial Opportunities
- ▶ Entrepreneurial Organizations
- ▶ Entrepreneurship and Financial Markets
- ▶ Entrepreneurship Policies
- ▶ Entrepreneurship Policy
- ▶ Innovation and Entrepreneurship
- ▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
- ▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
- ▶ Innovator
- ▶ Multilevel Innovation Systems
- ▶ Network and Entrepreneurship
- ▶ Networking Entrepreneurship
- ▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)
- ▶ Social Networks and Entrepreneurship
- ▶ Territory and Entrepreneurship

References

Aharonson BS, Baum JAC, Plunket A. Inventive and uninventive clusters: the case of Canadian biotechnology. Res Policy. 2008;37:1108–31.

Amin A, Cohendet P. Geographies of knowledge formation in firms. Ind Innov. 2005;12:465–86.

Amin A, Thrift N. Neo-Marshallian nodes in global networks. Int J Urban Reg Res. 1992;16:571–87.

Appold S. Location patterns of US industrial research: mimetic isomorphism and the emergence of geographic charisma. Reg Stud. 2005;39:17–39.

Asheim BT. Temporary organisations and spatial embeddedness of learning and knowledge creation. Geogr Ann. 2002;B84(2):111–24.

Audretsch DB, Stephan P. Company-scientist locational linkages: the case of biotechnology. Am Econ Rev. 1996;86:641–52.

Autant-Bernard C, Billand P, Frachisse D, Massard N. Social distance versus spatial distance in R&D cooperation: empirical evidence from European collaborations choices in micro and nanotechnologies. Pap Reg Sci. 2007;86:495–519.

Baptista R, Swann P. Do firms in clusters innovate more? Res Policy. 1998;27:525–40.

Bathelt H. Cluster Relations in the media industry: exploring the “distanced neighbour” paradox in Leipzig. Reg Stud. 2005;39:105–27.

Bathelt H, Taylor M. Clusters, power and place: inequality and local growth in time-space. Geogr Ann. 2002; B84:93–109.

Bathelt H, Malmberg A, Maskell P. Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. Prog Hum Geogr. 2004;28(1):31–56.

Baum JAC, Calabrese T, Silverman BS. Don’t go it alone: alliance networks composition and startups’ performance in Canadian biotechnology. Strat Manag J. 2000;21(3):267–94.

Bell M, Albu M. Knowledge systems and technological dynamism in industrial clusters in developing countries. World Dev. 1999;27(9):1715–34.

Boschma RA. Proximity and innovation: a critical assessment. Reg Stud. 2005;39:61–74.

Boschma RA, Frenken K. Why is economic geography not an evolutionary science? Towards an evolutionary economic geography. J Econ Geogr. 2006;6:273–302.

Breschi S, Lissoni F. Knowledge spillovers and innovation systems: a critical survey. Indust Corp Change. 2001;10(4):975–1005.

Bresnahan T, Gambardella A, Saxenian A. “Old economy” inputs for “new economy” outcomes: cluster formation in the new silicon valleys. Indust Corp Change. 2004;10(4):835–60.

Camagni R. Global network and local Milieu: towards a theory of economic space. In: Conti S, Malecki EJ, Oinas P, editors. The industrial enterprise and its environment. Aldershot: Avebury; 1995. p. 195–214.

Caplin A, Leahy J. Miracle on sixth avenue: information externalities and search. Econ J. 1998;108:60–74.

Carrincazeaux C, Lung Y, Rallet A. Proximity and localisation of corporate R&D activities. Res Policy. 2001;30:777–89.

Casper S, Murray F. Careers and clusters: analyzing the career network dynamic of biotechnology clusters. J Engin Technol Manag. 2005;22:51–74.

Castilla E, Hwang H, Granovetter E, Granovetter M. Social networks in silicon valley. In: Moon-Lee C, Miller WF, Cong Hancock M, Rowen HS, editors. The silicon valley edge. Stanford: Stanford University Press; 2000. p. 218–47.

Champenois C. La co-localisation d’entreprises innovantes comme non-choix: L’exemple de l’industrie allemande des biotechnologies. Géographie Economie Société. 2008;10:61–86.

Coe NM, Hess M, Yeung HWC, Dicken P, Henderson J. “Globalizing” regional development: a global production networks perspective. Trans Inst Br Geogr. 2004;29:468–84.

Coenen L, Moodyson J, Asheim BT. Nodes, networks and proximities: on the knowledge dynamics of the medicon valley biotech cluster. Euro Plann Stud. 2004;12:1003–18.

Cooke P. Regionally asymmetric knowledge capabilities and open innovation exploring "Globalization 2": A new model of industry organisation. Res Policy. 2005;34:1128–49.

Depret M-H, Hamdouch A. Clusters, réseaux d'innovation et dynamiques de proximité dans les secteurs high-tech: une revue critique de la littérature récente. Revue d'Economie Industrielle. 2009;128:21–52.

Depret M-H, Hamdouch A. Multiscalar clusters and networks as the foundations of innovation dynamics in the biopharmaceutical industry. Région et Développement. 2011;33–2011:227–68.

Dicken P, Malmberg A. Firms in territories: a relational perspective. Econ Geogr. 2001;77:345–63.

Dicken P, Kelly PF, Olds K, Yeung HW-C. Chains and networks, territories and scales: towards a relational framework for analyzing the global economy. Glob Netw. 2001;1:89–112.

Folta TB, Cooper AC, Baik Y-S. Geographic cluster size and firm performance. J Bus Venturing. 2006;21:217–42.

Garretsen H, Martin R. Rethinking (New) economic geography models: taking geography and history more seriously. Spat Econ Anal. 2010;5:127–60.

Gertler MS. Tacit knowledge and the economic geography of context, or the undefinable tacitness of being (there). J Econ Geogr. 2003;3(1):75–99.

Gertler MS, Levitte YM. Local nodes in global networks: the geography of knowledge flows in biotechnology innovation. Ind Innov. 2005;12:487–507.

Glückler J. Economic geography and the evolution of networks. J Econ Geogr. 2007;7(5):619–34.

Gordon IR, McCann P. Industrial clusters: complexes, agglomeration and/or social networks? Urban Stud. 2000;37:513–32.

Grabher G. Trading routes, bypasses and risky intersections: mapping the travels of "networks" between economic sociology and economic geography. Prog Hum Geogr. 2006;30:163–89.

Granovetter M. Economic action and social structure: the problem of embeddedness. Am J Sociol. 1985;91(3):481–510.

Grotz R, Braun B. Territorial or trans-national networking: spatial aspects of technology-oriented Co-operation within the German mechanical engineering industry. Reg Stud. 1997;31(6):545–57.

Hamdouch A. Start-up biotechnologiques et dynamique des clusters et réseaux d'innovation dans la biopharmacie: une revue de la littérature empirique. Journal des Entreprises Familiales. 2008;1(3):8–43.

Hamdouch A. Conceptualizing innovation clusters and networks. In: Laperche B, Sommers P, Uzunidis D, editors. Innovation clusters and networks. Brussels: Peter Lang; 2010.

Hamdouch A, Moulaert F. Knowledge infrastructure, innovation dynamics and knowledge creation/diffusion/accumulation processes: a comparative institutional perspective. Innov Euro J Soc Sci Res. 2006;19:25–50.

Hamdouch A, d'Ovidio M. Expected and unexpected creative cities. Is there an "Alchemy" of territorial creative dynamics? ESDP conference, Aveiro, 21–22 June; 2009.

Hamdouch A, Depret M-H. Surveying the literature on territorial innovation systems: a suggested interpretation framework. SSRN Working Papers Series, 22 p; 2009.

Hussler C, Rondé P. Les réseaux d'innovation des chercheurs universitaires sont-ils géographiquement circonscrits ? Revue d'Economie Industrielle. 2005;109:69–90.

Jaffe AB, Trajtenberg M, Henderson R. Geographic localisation of knowledge spillovers as evidenced by patent citations. Quart J Econ. 1993;108:577–98.

Jong S. How organizational structures in science shape spin-off firms: the biochemistry departments of Berkeley, Stanford, and UCSF and the Birth of the biotech industry. Indust Corp Change. 2006;15: 251–83.

Kaiser R, Prange H. The reconfiguration of national innovation systems: the example of German biotechnology. Res Policy. 2004;33:95–408.

Lagendijk A. Beyond the regional lifeworld against the global systemworld: towards a relational-scalar perspective on spatial-economic development. Geogr Ann. 2002;B84(2):77–92.

Markusen A. Sticky places in slippery space: a typology of industrial districts. Econ Geogr. 1996;72: 293–313.

Moodysson J, Coenen L, Asheim BT. Explaining spatial patterns of innovation: analytical and synthetic modes of knowledge creation in the medicon valley life science cluster. Environ Plann. 2008;A40: 1040–56.

Moulaert F, Mehmood A. Analysing regional development and policy: a structural-realist approach. Reg Stud. 2010;44:103–18.

Moulaert F, Sekia F. Territorial innovation models: a critical survey. Reg Stud. 2003;37:289–302.

Nachum L, Keeble D. Neo-marshallian clusters and global networks: the linkages of media firms in central London. Long Range Plann. 2003;36:459–80.

Niosi J, Zhegu M. Aerospace clusters: local or global knowledge spillovers? Ind Innov. 2005;12(1): 5–29.

Nooteboom B. Learning by interaction: absorptive capacity, cognitive distance and governance. J Manage Govern. 2000;4(1–2):69–92.

Oinas P. Activity-specificity in organizational learning: implications for analyzing the role of proximity. GeoJournal. 1999;49:363–72.

Orsenigo L. The (Failed) development of a biotechnology cluster: the case of Lombardy. Small Bus Econ. 2001;17:77–92.

Owen-Smith J, Powell WW. Knowledge networks as channels and conduits: the effects of spillovers in the Boston biotechnology community. Organ Sci. 2004;15:5–21.

Phlippen S, van der Knaap B. When clusters become networks. Tinbergen Institute Discussion Papers, TI 2007-100/3 (2007).
Porter ME. Clusters and the new economics of competition. Harv Bus Rev. 1998;76:77–90.
Powell WW, Koput KW, Bowie JI, Smith-Doerr L. The spatial clustering of science capital: accounting for biotech firm-venture capital relationships. Reg Stud. 2002;36:291–305.
Prevezer M. Ingredients in the early development of the U.S. biotechnology industry. Small Bus Econ. 2001;17:17–29.
Saxenian A, Li W. Bay-to-Bay strategic alliances: network linkages between Taiwan and U.S. venture capital industries. Int J Technol Manag. 2003;25:136–50.
Stuart TE. Governing strategic alliances. In: Buskens V, Raun W, Snidjers C, editors. Research in the sociology of organizations. 20th ed. Greenwich: JAI Press; 2003. p. 189–208.
Suarez-Villa S, Walrod W. Operational strategy, R&D and Intra-metropolitan clustering in a polycentric structure: the advanced electronics industries of Los Angeles. Urban Studies. 1997;34:1343–80.
Ter Wal ALJ, Boschma RA. Applying social network analysis in economic geography: framing some key analytic issues. Ann Reg Sci. 2009;43:739–56.
Torre A. Clusters et systèmes locaux d'innovation: retour critique sur les hypothèses naturalistes de transmission des connaissances à l'aide des catégories de l'économie de la proximité. Région et Développement. 2006;24:15–44.
Trippl M, Tödtling F. Developing biotechnology clusters in non-high technology regions: the case of Austria. Ind Innov. 2007;14:47–67.
Uzzi B. Social structure and competition in interfirm network: the paradox of embeddedness. Adm Sci Q. 1997;42:35–67.
Waxell A, Malmberg A. What is global and what is local in knowledge-generating interaction? The case of the biotech cluster in Uppsala, Sweden. Entrepreneurship Reg Dev. 2007;19:137–59.
Wever E, Stam E. Clusters of high technology SMEs: the Dutch case. Reg Stud. 1999;33(4):391–400.
Wolfe D, Gertler MS. Clusters from the inside and out: local dynamics and global linkages. Urban Stud. 2004;41:1071–93.
Zucker LG, Darby MR. Virtuous circles in science and commerce. Pap Reg Sci. 2007;86:445–70.

Co-citation

▶ Networks and Scientific Innovation

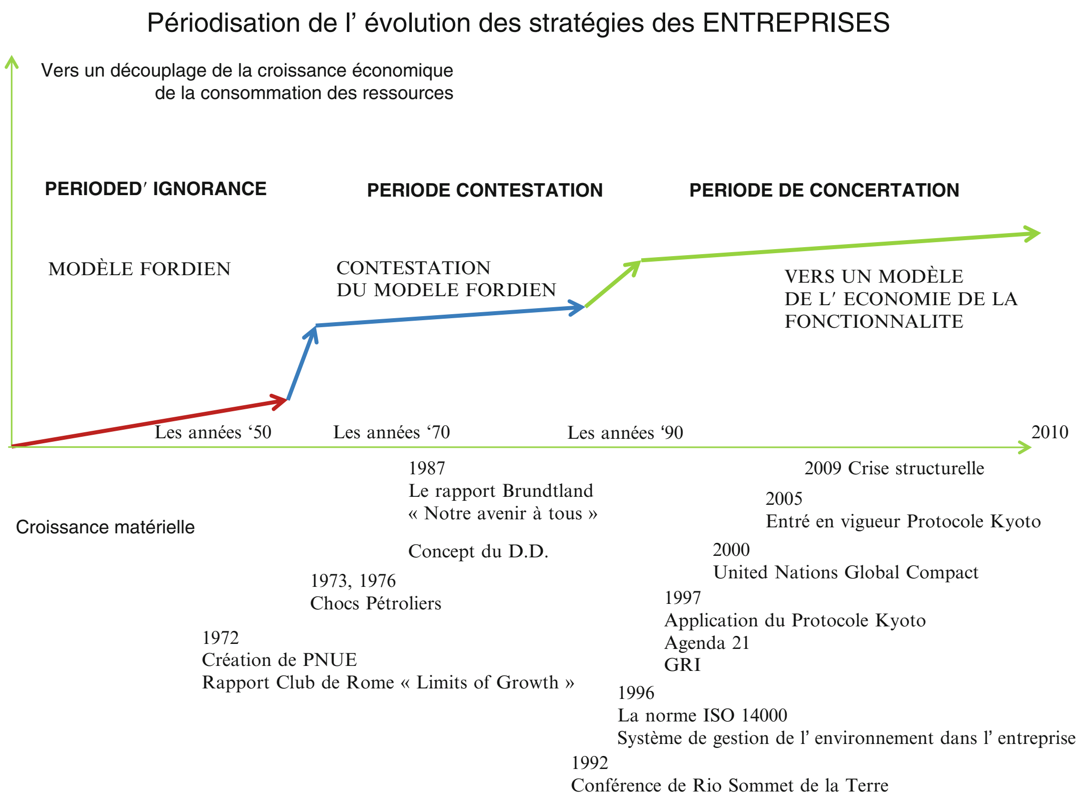
Co-Conception and Entrepreneurial Strategies

Ingrid Vaileanu Paun
Institut de l'Evaluation Participative de la Valeur Territoriale, Issy-les-Moulineaux, France

Synonyms

BtoBtoU; Collaborative work; Co-innovation; Marketing

Co-conception will be defined here in the context of the recent evolution in entrepreneurial strategies that value creation in compatibility with sustainable development and that have also lead to important changes in relations with clients (B to B) and with customers (B to C). The place of the client (and customer) in the economic process has changed in the last 60 years, depending on the economic model that has been adopted in different countries. For instance, the Fordism social-economic model from the period of the Thirty Glorious Years imposed a simple transactional relation (Moati and Corcos 2009), with the client meeting the offer of the product exclusively on the market. The "service economy" (Tertre 2006), which developed in the 1970s, relies on the co-conception of the solution with the client in the earlier stages of the economic process, during the conception and the production either of a product, a service, or a Product-Service System (PSS) (Stahel 1997) as solutions to specific needs. This collaboration relation with the client and the stakeholders, rather than a simple transaction relation, assumes organizational changes in terms of corporate management, contractual tools, and new forms of competition. Statistics from the OECD countries show the growth of the service economy (OCDE 2007) based on "service relation" (Gadrey 1996; du Tertre 2006), which brought clients and other stakeholders into the creation of the solution at the point of its conception, especially in the case of entrepreneurial strategies, and even made them a source of creation of new, innovative small and medium enterprises (SMEs).



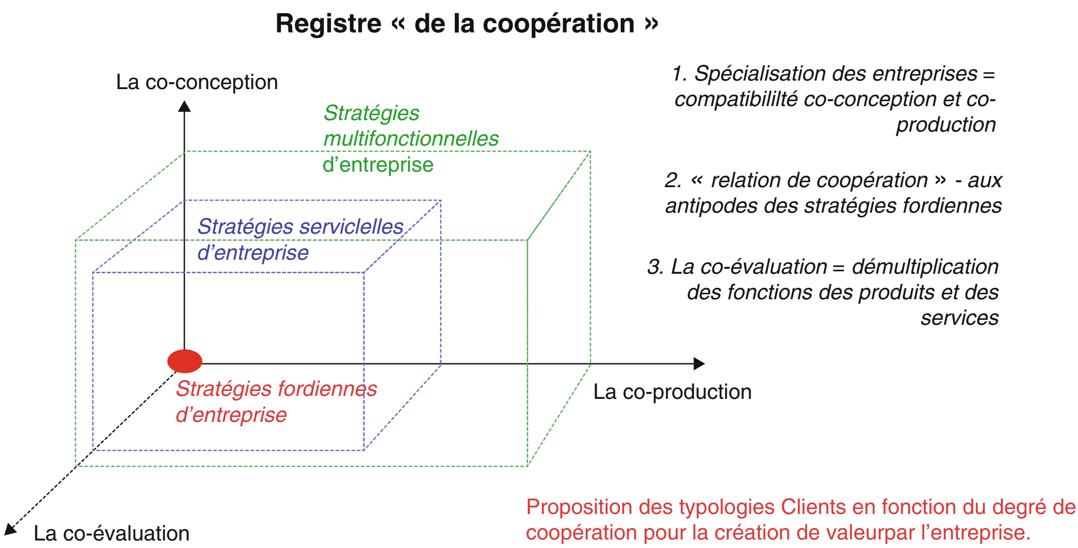
Co-Conception and Entrepreneurial Strategies, Fig. 1 Time line of the evolution of firms' strategies in the context of the increased demand for compatibility with sustainable development (Source: Vaileanu Paun 2010)

The perception of value by the client during the co-conception process resides in exclusive experiences while using the products or experiencing the service that was co-conceived together with the entrepreneur rather than in a transactional relationship. The role of the client will be discussed in the context of the evolution (Boutillier et al. 2010) of the role of the entrepreneur from the exclusive role of profit-maker to a role of shared-value co-creator with client and stakeholders.

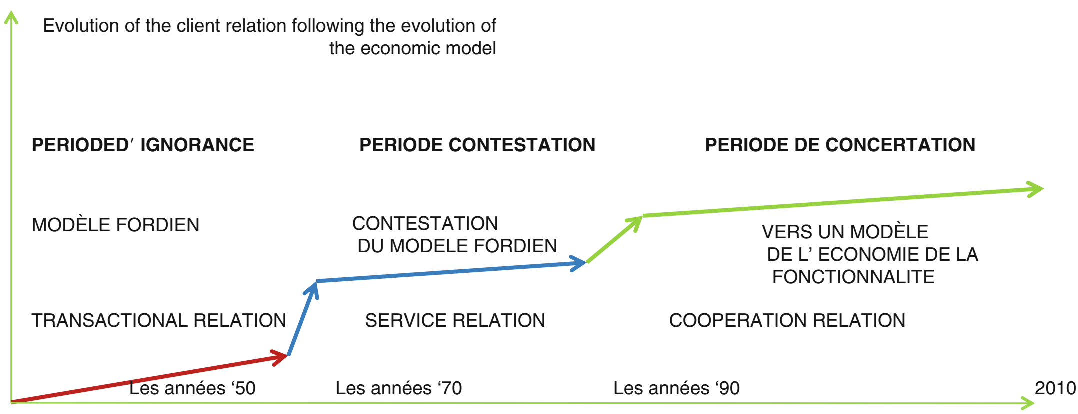
Definition and Process Description

The Co-Conception as a Consequence of the Evolution of the Economic Model: Context of the Concept Development

The context of the emergence and development of co-conception entrepreneurial strategies is important, as the place of the client in the economic process has changed in the last 60 years, following the evolution (Figs. 1–4) of business models in modern societies towards compatibility of economic growth with sustainable development solutions. For instance, the Fordism socio-economic model during the period of the Glorious Thirty Years corresponds to a period that saw social injustices and the destruction of resources, with multinational corporations pushed to achieve productivity gains via product standardization and low production costs, in spite of the social and environmental impacts. This model imposes a "simple transactional relation," with the client meeting the offer of the product exclusively on the market and ignoring the whole product life cycle (maintenance, repair, recycling). The "service economy," developed in the 1970s, relies, in exchange, on the co-conception of the solution with the client in



Co-Conception and Entrepreneurial Strategies, Fig. 2 Evolution of client relations toward collaborative work (Source: Vaileanu Paun 2009)

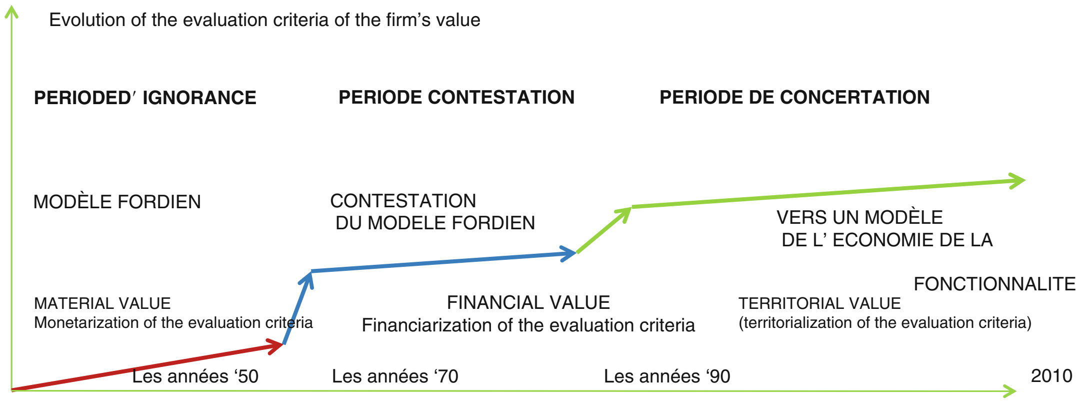


Co-Conception and Entrepreneurial Strategies, Fig. 3 Evolution of the client relation (Source: Vaileanu Paun 2009)

the earlier stages of the economic process, during the conception and the production of a product, a service, or a PSS (Mont 2002). Solutions of this type improve the performance of the result by adapting it to specific multiple needs of the client.

Actors of the Co-Conception

The actors in co-conception strategies are often SMEs, which are capable of investing more resources in adapting offers to their clients, as their economic model is not yet ready for mass production, which is the case with multinationals that are nevertheless experienced with the benefits of co-conception strategies, for instance, in the case of software innovations such as the "lead-user method" (Hippel 1988). The co-conception strategy offers opportunities for entrepreneurial developments, as the client's and stakeholders' contributions represent free resources and capabilities supporting



Co-Conception and Entrepreneurial Strategies, Fig. 4 Evolution of the evaluation criteria of a firm's value (Source: Vaileanu Paun 2009)

ex ante the business development of a SME lacking the financial resources to invest ex post in marketing and promotion but also in compliance with environmental and social constraints. The input of clients and stakeholders, the consumer work (Dujarier, 2008) at an earlier stage of the economic process (Fig. 2) of a SME could spare entrepreneurial investments and thus contribute to sustainable development by adapted use of resources and by integrating negative and positive externalities within a sustainable entrepreneurial business model (Vaileanu Paun 2010).

Impacts and Implications of Co-Conception

The service economy approach brought the client closer to the entrepreneur and encouraged the creation of new SMEs based on this new, virtuous circle of performance-related sales of solutions. Thanks to the co-conception dynamic, entrepreneurs embraced a new position in society, not just as a simple production point but as a "system" (Vaileanu Paun 2009) of related stakeholders with different interests influencing its strategy towards the co-conception of offers capable of providing a coherence between economic, social, and environmental performance. The co-conception collaborative work induces an évolution in the management strategies efficiency évaluation from the dichotomic approaches, either BtoB (Business to Business) or BtoC (Business to Consumer), towards an extended evaluation approach of whole system actors of BtoBtoC (Business to Business to Consumer) or even BtoBtoU (Business to Business to User) (Vaileanu Paun 2009), according to the functional economy concepts. Statistics in the OECD countries show the increase of the service economy (OCDE 2007) based on "service relation" (Gadrey 1996; du Tertre 2006), leading clients (Fig. 3) and other stakeholders to contribute to the creation of the solution in the phase of its conception, especially in the case of entrepreneurial strategies, and even to be the source of creation of new, innovative SMEs.

This collaboration relation with the client and the stakeholders rather than a simple transaction relation assumes organizational changes in terms of corporate management, contractual tools, and new competition forms. The co-conception strategy supposes the capacity and the decision to evolve in collaboration relations during the R&D process, which is more likely to be accepted in SME and entrepreneurial business environments (due to financial constraints and lack of capabilities) than in multinational corporations that are reluctant to share their knowledge with clients and stakeholders. Co-conception also implies a strategy of evaluating the contribution of each of the actors involved in the co-conception as well as the capacity to "reduce or compensate the different asymmetries" (Paun 2011) of the actors to favor co-innovation by entrepreneurs.

The impacts on the evaluation strategies are potentially important, considering the new organizational structure of the economic process and especially the new boundaries of action for the actors involved in this collaborative relation.

The evolution of evaluation criteria (Fig. 4) of a firm's value from an evaluation of the material value during Fordism was followed by the introduction of evaluation of the financial value during the period of contestation of the Fordism. Today, there is a need to integrate the extra-financial value (social and environmental impacts) of the firm. The evaluation methodology tends toward co-evaluation.

Co-evaluation has been perceived by different researchers as a collaborative process involving at least two evaluators in direct contact with the subject of the evaluation, representing more than just an evaluation by peers and possibly in the context of the changes of the post-modern revolution (top–bottom), legitimizing the multiple perspectives.

Co-evaluation, part of the territorialization tendency (Vaileanu Paun & Boutillier 2012) of the evolution criteria involving the stakeholders, is collaborative work and is a dimension of the collaboration relation that allows the actors in the value creation to find, through the co-conception process, a new, virtuous circle by constantly improving the solutions for better performance in terms of better response to needs that are in a dynamic evolution, heterogenic, and non-sectorized.

Structural institutional changes are necessary to encourage value creation based on co-conception. New, shared-value contracts and other contractualization forms of loyalty between the actors in the co-conception process should be specifically guaranteed in today's economic model while also retaining financial evaluation criteria. The issue of property rights to the results of the co-conception process are still to be addressed as the strategy proves its pertinence and gains recognition. An increasing number of SMEs are closer to the clients via adapted co-conceived solutions, whereas their value creation and sharing within society is still subordinate to capitalistic evaluation (Rifkin 2000; Stiglitz et al. 2008), which takes into consideration only the monetary value-driven evaluation system of economic growth today.

Conclusion and Challenges Related to Co-Conception

Entrepreneurial strategy, based on the service economy approach, could provide through the l co-conception strategy new evaluation criteria for value creation and sharing with clients and stakeholders. This new approach is considered pertinent in the context of the evolution of the economic model toward greater socio-economic performance of the firms as a complement to the multinational business model stemming from the Fordism model but potentially generating spin-offs and an entrepreneurial hybridization of market pull and technology push approaches (Paun 2011) for value creation through innovations.

Cross-References

- ▶ Externalities
- ▶ Innovation

References

Boutillier S, et Matagne P. Théories économiques, écologie et histoire, Forum IV Environment, Innovation and Sustainable development, Marseille, 7–8 octobre; 2010.

Du Tertre C. Economie de la fonctionnalité, performance et Développement Durable, colloque de Cerisy des 15–19 juin 2006.

Dujarier, MA. Le travail du consommateur. Comment nous coproduisons ce que nous achetons, Editions La Découverte, p 246; 2008.

Gadrey J. Economie des services, Repères, La découverte (2e édition), Paris; 1996.

Hippel E. (von), The sources of innovation, New York, Oxford University Press; 1988.

Moati P, Corcos A. Des marchés transactionnels aux marchés relationnels une approche théorique pour repenser l'impact des politiques de rétention de la clientèle, Cahiers du CREDOC, NC. Paris: CRÉDO; 2009.

Mont O. Clarifying the concept of product-service system. Journal of Cleaner Production. 2002;10(3):237–45. http://www.iiiee.lu.se/Publication.nsf/$webAll/0E4B621AEE907184C1256CD8003C2115/$FILE/PSS-JCP.pdf.
OCDE. Synthèse de l'étude sur la mondialisation et l'innovation dans le secteur des services aux entreprises, OCDE, Paris; 2007.
Paun F. From managing informational asymmetries towards a systemic asymmetries approach in technology transfer and innovation strategies: An economic analysis of the SME strategy at ONERA – The French Aerospace LabTM, in the IUP Journal of Knowledge Management, p. 27–52, Vol. IX, No. 4; October 2011.
Rifkin J. L'âge de l'accès. La nouvelle culture du capitalisme. Paris: La découverte; 2000.
Stahel W. The functional economy: Cultural and organizational change, in Richards D. J. (Ed.), The industrial green game: Implications for environmental design and management, Washington DC: National Academy Press, p. 91–100; 1997.
Stahel W. The performance economy. Basingstoke [England]/New York: Palgrave Macmillan; 2006.
Stiglitz J, Sen A, Fitoussi JP. Report by the commission on the measurement of economic performance and social progress. Paris: OECD; 2008.
Vaileanu Paun I. Entreprises et territoires dans l'économie de la fonctionnalité. Le cas de EDF, travaux de la première thèse en économie de la fonctionnalité en France, convention CIFRE chez EDF, Université Paris 7 Denis Diderot; 2009.
Vaileanu Paun I. Economie de la fonctionnalité et Smart Grids. DGALN/PUCA: Atelier Bepos et Smart Grids; 2010.
Vaileanu Paun I, Boutillier S. Économie de la fonctionnalité. Une nouvelle synergie entre le territoire, la firme et le consommateur ?, Innovations, 2012/1 n° 37, p. 95–125. doi:10.3917/inno.037.0095; 2012.

Coevolution

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
▶ Quality of Democracy and Innovation

Cognition

▶ Cognition of Creativity

Cognition of Creativity

Jay L. Brand
Ideation, Haworth, Inc., Holland, MI, USA

Synonyms

Cognition; Cognitive science; Divergent thinking; Information processing; Novelty; Originality

Key Concepts and Definition of Terms

Trying to understand creativity has produced a vast literature spanning psychology, anthropology, biology, archaeology, sociology, business, literature, the arts, architecture, design, and several other disciplines. Here is one definition from a recent compendium on creativity: *Creativity may . . . be . . . thought of as the entire system by which processes* [conceptual combination, conceptual expansion, metaphor, analogy, mental model construction, etc.] *operate on* [psychological, social, and cultural] *structures to produce outcomes that are novel but, nevertheless, rooted in existing knowledge* (Ward et al. 1997, p. 18). This brief review of the information available will concentrate on a psychological perspective, but all vantage points add important dimensions to the concept. Psychologists primarily study topics from an individual's point of view, but recent work has begun to appreciate the larger contexts in which creativity occurs and their role in its manifestation (Boden 1994). Nevertheless, irrespective of the definitional and evaluative context chosen to explore creativity, it ultimately depends on the mental experience of individual minds – both for its manifestation and appreciation (Gardner 1993).

From the current evidence, it appears that creativity rarely if ever involves completely new or original concepts or ideas. Instead, most creative work efficiently integrates the existing information into unusual syntheses or juxtapositions, together with only incremental novelty. The notion of an isolated genius with special powers who consistently stuns the world with great insights, inventions, or ideas – as if by magic – has likewise not enjoyed much empirical support. The bulk of the evidence points instead to the many influences that together produce the ability to build on past accomplishments; approach problems in novel ways; and entertain multiple, ambiguous, and even conflicting alternatives. In this regard, Sir Isaac Newton once remarked, “If I have seen farther than other men [sic], it is because I have stood on the shoulders of giants.”

Although creativity can be incremental in relation to its historical context or involve great leaps of imagination, it seems most often to be incremental. In fact, original ideas that jump too far beyond currently available conceptual frameworks are typically ignored or even vilified. There is some controversy over whether popularity alone can indicate evidence of creativity, or whether expert knowledge and information must also be considered. At least it appears safe to say that for something to be truly creative, it must have both a source and an audience. Analogous to the oft noted mystery regarding sound without anyone present to hear it, creativity must be appreciated by someone to be considered creative. Otherwise, it might be merely original or novel from its producer’s perspective.

However, novelty and originality figure prominently in many investigations of creativity. In fact, some studies have evaluated “degree” of creativeness specifically in terms of statistical or actuarial rarity. Something being new or original certainly fits with most people’s conception of creativity, but a little more thought reveals that it is an inadequate definition. For example, just because there are more yellow cars than purple ones does not mean that purple is thus a more creative color for cars. No doubt there are more “stick” or stone/brick houses than trailers in most countries, but few architects would argue that modular homes are more creative due to their scarcity. Nonetheless, novelty enjoys a time-honored distinction within most acts of creativity.

Theoretical Background and Open-Ended Issues

In general, two different perspectives broadly characterize the various methods used to investigate creativity. Researchers distinguish between “mundane” and “exceptional” creativity. The former is often studied under controlled laboratory conditions, while the latter necessarily involves studying individual examples of creativity within their historical or contemporary contexts (e.g., Gardner 1993). Studies of “mundane” creativity seek to understand the cognitive structures and processes involved when anyone behaves in creative ways (e.g., Zabelina and Robinson 2010), while studies of “exceptional” creativity try to determine if any unique features or attributes characterize outstanding, usually historical examples of creativity. Thankfully, the results from these two approaches yield many areas of conceptual agreement.

First, analogy and metaphor appear to play an important role in creative behavior. Analogies and metaphors relate things that on the surface do not appear to be similar, but understanding their use typically requires comparisons at higher levels of abstraction, thus allowing the similarities to be appreciated. For example, the observation, “When Carl stepped to the lectern, he confronted a sea of faces,” implies a comparison between crowds of people and large bodies of water. From the simple definitions of “crowd” and “sea” no immediate similarities exist. However, the analogy creates similarity at the level of “large, undifferentiated or unitary expanses” and can then be easily understood. Both the use and deciphering of analogy and metaphor may depend on searching through associative networks underlying long-term semantic memory (cf. Zabelina and Robinson 2010).

Studies have demonstrated that problem solving in general can be improved by the use of relevant analogies, similes, and metaphors. In addition, much of the research evaluating outstanding historical instances of creative genius (e.g., Kepler, Galileo, Newton, Picasso, Leonardo da Vinci, Einstein, Michelangelo) has found that the comparison processes underlying metaphors and analogies figure prominently in the accomplishments of these luminaries (cf. Gardner 1993).

Second, the cognitive processes underlying “mundane” and “exceptional” creativity appear to differ more in terms of quantity than quality. This is good news, because it means that everyone can learn to be more creative. These underlying processes include (1) Conceptual Combination; (2) Conceptual Expansion; (3) Metaphor; and (4) Analogy and Mental Modeling. There are obvious similarities among these creative behaviors as already noted, but exploring examples of each separately will aid discussion (Ward et al. 1997).

Conceptual Combination

This involves the combining of concepts (usually words) to form a completely new concept. For example, Darwin’s term “natural selection” built on the prevailing knowledge of artificial selection as used by breeders to influence subsequent generations of animals or plants. His creative new concept suggested that such an apparently intentional process might also occur without design interference, hence “natural selection.” Popular culture often employs this approach as well, as in “asphalt jungle,” “quiet riot,” “quantum leap,” etc. An important implication from findings in this area involves the salience of diversity in experiences and abilities within and across individuals in providing the fertile conditions necessary for the occurrence of useful combinations.

Conceptual Expansion

Children’s growing understanding of the world and language through development provides the most obvious example of conceptual expansion. However, anyone involved in learning something new also participates in conceptual expansion. Interestingly, research evidence suggests severe limitations on most people’s ability to jump very far beyond their current knowledge framework. For example, when children were asked to draw or describe imaginary animals, their attempts reflected many of the fundamental properties of species known to them. Essentially the same results have been reproduced in studies of adult subjects as well. An interesting implication from this research is that in order to be creative in an influential way, new ideas must relate to existing knowledge structures and familiar concepts, or they may not be recognized or accepted as useful (Zabelina and Robinson 2010).

Metaphor

The use of metaphor not only requires creativity on the part of the originator; it also can increase the creative experience of those comprehending the metaphor. Metaphors can, thus, at the same time be an example of creativity and also act as catalysts to spur further creative language. Metaphors, like analogies, usually demand that a comparison between the related entities be made at a higher conceptual level of abstraction for the implied similarity to be constructed. “You must accept the thorns with the roses” suggests a comparison between life’s experiences and a rose bush. While easily understood by most adults, young children can get distracted by the surface definitions of the terms involved.

Interestingly, the myth that children tend naturally to be more creative than adults and are subsequently stifled by the rigid structure of the educational system has not survived close scrutiny. Both children and adults tend to be influenced by their current conceptual knowledge structures and reach beyond these constraints only with difficulty. Again, the implication for business leaders is that diverse, extensive prior experience among one’s employees can foster creativity within the organization. Much like the acquisition of expertise, it would appear there is no substitute for accumulating vast amounts of knowledge in fostering creative breakthroughs (Winner 2000).

Analogy and Mental Modeling

Lord Ernest Rutherford’s comparison of a hydrogen atom to a planetary system (the nucleus as the “Sun” surrounded by orbiting electrons) made use of analogy; many other examples of the creative use of analogy could be given. Investigators of creativity have distinguished between "near" and "far" analogies. An example of a "near" analogy might be comparing Romeo and Juliet with West Side Story, while an example of a "far" analogy could be Kepler's comparisons between light from the Sun and the vis motrix (motive force; gravity was unknown at the time). Some investigators have argued that "far" analogies – those comparing categories that are highly conceptually distinct – are more important in creativity than "near" analogies, but recent evidence suggests this view may be too simplistic.

Mental models could enhance creativity by providing a rich context in which novel words, terms, ideas, and concepts can be explored. More elaborate cognitive frameworks in which novel ideas or objects could be embedded allow many more alternatives for their potential development or enhancement to be explored and compared. There is recent evidence that groups of people, who share a mental model of their task, outperform groups whose members do not. Again, a variety of experiences and responsibilities seem to promote more extensive, detailed mental models, resulting in richer conceptual structures stored in memory.

Implications for Theory, Policy, and Practice

Creativity usually comes from extensive, diverse knowledge rather than from eccentric or inherently gifted individuals with a bent toward bizarre imagery. Increasing the diversity of employees' cultural and ethnic backgrounds, their areas of expertise, and using interdisciplinary, cross-functional teams should enhance creativity wherever needed. To fully leverage their diversity and the opportunity for creative combinations and synergies, such teams need a shared vision, mission, and goals. Other important factors to promote group syntheses include training the group as a unit and explicitly sharing information about each group member's particular area(s) of expertise (cf. Ford and Gioia 1995).

Creativity depends both on its production and its appreciation. Context can be just as important as content. Thus, being very familiar with trends in the larger society can improve creativity by ensuring its relevance to an audience. Being creative can involve new insights about the recipients of ideas as well as the ideas themselves being original or novel. Pursue sensitivity to the sociocultural milieu, providing this broader organizational or institutional context for internal tasks, activities, and functions (cf. Ward et al. 1997).

Metaphors and analogies appear to be important in the creative process. Their usefulness depends not only on their novelty and originality, but also on how cleverly they integrate with existing knowledge structures and available information. Thus, creativity involves incremental progress as much as surprising leaps of logic. Exploring combinations of ideas as well as ideas in isolation can be a useful strategy (cf. Casakin and Shulamith 2011).

Creativity may be related to physical activity and bodily experience; thus, a variety of behavioral pursuits and opportunities contribute to being creative. This suggestion holds implications for education at all levels (e.g., the continuing importance and usefulness of recess – unstructured play time – during the school day), but may also improve the creative performance of individuals, groups, and teams within different institutions and organizations, public or private.

Creativity may depend on group interaction, particularly to prevent less useful ideas from being pursued. Individuals working alone quickly manifest a vested interest in their ideas and a bias toward confirming information. Collective contributions to creativity seem particularly important when tasks are well-known and participants have a high degree of expertise. Explanations of creativity tend more and more to rely on the importance of the broader social context in which it occurs. Diverse, autonomous, motivated, cohesive groups with a collective purpose can result in creative production in any organization (Sternberg 1999).

Conscious access to the process of creating appears to be lost soon after the realization of a creative outcome or problem resolution. It might, thus, be important to provide high-quality tools to support collective cognition and collaboration within schools, institutions, or corporate enterprises, thereby improving the quality of group/team interactions and capturing them while they are occurring.

Creativity may thrive on noticing how unlike things might be related. Only experienced individuals have an adequate understanding of multiple organizational or institutional levels and processes to leverage opportunities for creative synergy. Recruitment and retention of students, faculty members, executives or employees with an extensive, diverse knowledge base – both inside and outside of the relevant enterprise(s) – can increase the likelihood of creativity.

Although creativity may be modestly correlated with intelligence up to IQs around 120 or 125, extreme intelligence does not guarantee creative ability – nor vice versa. However, creativity does seem to be related to certain personality characteristics. Some of these include independence, nonconformity, being unconventional (even Bohemian), being open to new experiences, having wide interests, having both cognitive and behavioral flexibility (particularly, comfort with paradox), and a disposition toward risk-taking. These findings have important implications for the tendency among corporate executives to hire and promote individuals who reflect those executives' opinions, preferences, and lifestyles. Diversity – not conformity – is the watchword of creativity (Simonton 2000).

Creativity depends critically on the initiation and maintenance of effort – usually over extended periods of time. It is, thus, important for government and corporate leaders to analyze carefully both the implicit and explicit incentive systems currently operating within their institutions or organizations. Do the intrinsic and extrinsic reward structures encourage creative, innovative behaviors and taking risks? Or do they instead exert pressure toward the status quo, toward safe havens of normal, ordinary conduct? Do these functional incentives adequately reward useful creativity while at the same time effectively pruning bizarreness for its own sake? (Amabile and Kramer 2011; Hennessey and Amabile 2010).

Since creativity often involves unusual associations or novel integrations across conceptual boundaries, open sharing of knowledge and information across institutional or corporate entities may be very important. While competition for limited resources in some cases can be motivating, it also tends to promote the hoarding of ideas and lessons learned. Encouraging the wide sharing of best practices as well as mistakes within universities, government entities, or companies can help to eliminate redundancies of effort and prevent the repetition of unproductive pursuits, while providing an atmosphere for synergy, remote reference, and the fertile interaction of ideas. Recent evidence suggests that for speeding up the creative process, cycling between divergent (broad) and convergent (narrow) thinking may be very important; the exact timing and number of sequences for these activities depend on contextual factors, such as organizational/group culture, type of problem/topic (creative problem solving [CPS] represents an entire subspecialty in creativity research), team diversity (ethnic/nationality and disciplinary), team competencies, and motivational circumstances (Amabile and Kramer 2011; Ford and Gioia 1995; Sternberg 1999).

Initiating and maintaining creativity as an explicit corporate or institutional goal actually involves an inherent conundrum: The origin of "command and control" organizational structures hails from the industrial revolution when Frederick Taylor – among others – conceived of social organizations that could be arranged so that individual workers would mindlessly contribute to abstract goals defined by executive management and thus, collectively operate just like a grand, glorious machine. Some evidence indicates that true genius and creativity may depend as much on superior innate abilities as on characteristics acquired through diligent effort, and so to encourage creativity, corporations or institutions must intentionally identify, recruit, retain, and reward creative individuals and teams; creativity cannot be process-engineered (Sternberg 1999).

Some evidence suggests that daydreaming and fantasy may be related to creativity. Whether creative people daydream more or daydreaming can make ordinary people more creative has not yet been determined; however, it seems reasonable that to encourage creativity, some freedom from tight schedules and deadlines may be important. To increase the likelihood of creativity, the effectiveness and efficiency of repetition and "standard operating procedures" must be balanced with the time and flexibility to explore and innovate for its own sake (Amabile and Kramer 2011; Hennessey and Amabile 2010).

Conclusions and Future Directions

An important remaining controversy pertains to the degree of independence from concrete, physical experience that human conceptual behavior actually enjoys. B. F. Skinner and other behaviorists have argued that language and thought are simply behaviors grounded in the evolutionary and personal past of individual people. In this view, concepts and the words that came to symbolize them should reflect actual, bodily interactions with the environment. However, early work in cognitive psychology treated language in general and the formation of concepts in particular as convenient abstractions in the mind, only arbitrarily related to perceptual and behavioral interaction with the world. Language concepts that seem to lump arbitrary, dissimilar items together provide evidence for this perspective. For example, in one Australian aboriginal language, one category word includes women, fire, and dangerous things. In-laws aside, most people would not immediately apprehend the perceptual similarities defining this classification. Such illustrations seem to argue that conceptual language can have derivative meaning in the abstract – independent of any actual similarities among the objects symbolized (cf. Ward et al. 1997).

However, many other researchers insist that such extreme examples constitute the exception rather than the rule, and that the majority of concepts do simply reflect distinctions inherently present in the world of experience. Indeed, more contemporary work has begun to resurrect and enlarge on the behaviorists' views. According to some current accounts of the usefulness of analogies, metaphors, and similar comparison processes in creative thought, the meanings of words and concepts depend in important ways on a historical foundation of actual bodily experience.

For example, the term "comprehend," a virtual synonym for "understand," comes from the Latin *comprehendere*, which literally means "to seize" or "to grasp." Recent theoretical and empirical work suggests that many analogies and metaphors create meaning by ultimately being grounded in actual bodily experience in this way. Consider the statement, "I stand for affirmative action." Although most people readily accept an abstract meaning for the term "stand" in this instance, such meaning may ultimately derive from situations where people indicate their preferences by literally standing. The meanings of metaphors and other creative expressions may in important respects be similarly embodied. If bodily experience relates to producing or understanding creative expressions, then it might be useful to encourage workers entrusted with acting creatively to behave in a variety of ways while at work other than sitting down all day.

An additional attribute of creative endeavors involves their multifaceted and sometimes serendipitous nature. Lucky juxtapositions sometimes contribute to creative invention, but this usually occurs in an environment that systematically fosters rigorous exploration, thorough investigation, and broad knowledge acquisition. In addition to the role of accident in creation, research has not yet delineated each of the relevant structuring forces on the creative process, nor exactly how these may interact. Other remaining questions include, Can the process of creativity be usefully studied separately from its consequences? How can the effort, persistence, and motivation necessary for maintaining creativity best be initiated and sustained? Exactly how are completely new ideas produced and comprehended? How can society optimally understand and overcome individual and collective conceptual inertias? (cf. Casakin and Shulamith 2011).

For the future, what roles do emergence (chaos theory) and change play in creativity? These areas may indeed prove to be the most fruitful for future inquiry since the explosive variety of creativity in the natural world appears to reflect fundamentally emergent phenomena – the unpredictable outcomes from complex, adaptive systems. If complexity theory proves to be applicable to organizational behavior and other human creative endeavors, some of the influences on creativity may involve higher levels of abstraction and determination above the level of individuals and perhaps even groups of workers. How to characterize – much less predict – these possible coalescing eddies of conceptual convergence and divergence in the psychosocial fabric of an organization remains a mystery at present (cf. Ford and Gioia 1995; Ward et al. 1997).

Finally, some intriguing "detective" work has revealed that some of the most celebrated historical instances of creativity, such as Kekulé's analogy to a snake swallowing its tail for the structure of the benzene molecule – may have involved unintentional reconstructions after the fact. In other words, creators may fabricate analogies after arriving at their productive conclusions, and then unwittingly remember the analogy as formative of their ideas, when in fact it served primarily as a useful illustration a posteriori to help others understand their discovery. Likewise for groups involved in the creative process: The conceptual scaffolding so necessary and important during group interaction only serves as a temporary support structure for producing useful analogies. Most of the details of this process are subsequently lost after the creative outcome is obtained.

Cross-References

▶ Creative Mind: Myths and Facts
▶ Divergent Thinking
▶ Divergent Versus Convergent Thinking
▶ In Search of Cognitive Foundations of Creativity
▶ Mental Models and Creative Invention
▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education
▶ Psychology of Creativity

References

Amabile T, Kramer S. The progress principle: using small wins to ignite joy, engagement, and creativity at work. Boston: Harvard Business Review Press; 2011.
Boden M, editor. Dimensions of creativity. Cambridge, MA: MIT Press; 1994.
Casakin H, Shulamith K. The cognitive profile of creativity in design. Think Skills Creat. 2011;6(3):159–68.
Ford CM, Gioia DA, editors. Creative action in organizations: ivory tower visions & real world voices. Thousand Oaks: Sage; 1995.
Gardner H. Creating minds: an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stavinsky, Eliot, Graham, and Gandhi. New York: BasicBooks; 1993.
Hennessey BA, Amabile TM. Creativity. Annu Rev Psychol. 2010;61:569–98.
Simonton DK. Creativity: cognitive, personal, developmental, and social aspects. Am Psychol. 2000;55:151–8.
Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999.
Ward TB, Smith SM, Vaid J, editors. Creative thought: an investigation of conceptual structures and processes. Washington, DC: American Psychological Association; 1997.
Winner E. The origins and ends of giftedness. Am Psychol. 2000;55:159–69.
Zabelina D, Robinson M. Creativity as flexible cognitive control. Psychol Aesthet Creat Arts. 2010;4(3):136–43.

Cognitive Competencies

▶ Knowledge Society, Knowledge-Based Economy, and Innovation

Cognitive Computing

▶ In Search of Cognitive Foundations of Creativity

Cognitive Conflict

▶ Model of Dialectical Learning

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Collaborative Economy

► Entrepreneurship in Creative Economy

Collaborative Innovation and Open Innovation

Delphine Gallaud
INRA CESAER (UMR 1041), Unité Mixte de Recherche INRA-Agrosup, Dijon Cedex, France

Synonyms

Cooperations to innovate; Coopetition; Distributed innovation process; External relationships; Networks

Introduction

Consumers' demand for products has moved, since the eighties, toward products customized to personal needs. This change has incited firms to work closely with other organizations and especially customers, in order to anticipate better the future needs, inducing a growth in external relationships of firms. This trend is still at work in most of industries in which lead users impulse evolution in products. In consequence, the collaborative process continues to increase. At the same time, the efficiency of the production by in-house R&D of firms' decreases to such an extent that following Chesbrough (2003), many scholars advise firms to access knowledge externally and to develop innovation with an open process of development: the open innovation model. They incite firms to use all the external sources which are available to be the first to introduce a new product or process in the market.

Collaborative and open innovation seems quite similar at a first glance, but open innovation is a broader conception than collaborative innovation and includes this notion.

Various Process of Development of Innovation in a Collective Way

Collaborative Innovation

Collaborative innovation is the fact that an organization cooperates with other firms (suppliers, customers, competitors, and consultants) or other organizations (such as universities or public research organism) to develop or commercialize a new innovation. The organizations agree to pool their resources or to share information and knowledge to develop one project, at the end of the project, they keep independent from the legal point of view. The main goal of such collaborative innovation is to gain access to the partner's knowledge and competences especially to tacit knowledge. Indeed, tacit knowledge is by definition nonarticulable and generally inscribed into the routine and know-how of a firm. It can be transferred to external third parties only by the demonstration of its owner by face to face interactions. So, this kind of knowledge needs physical proximity between the owner and the receptor, even if any means allow reducing this need of proximity by using only temporary geographic proximity for interactions. For instance, firms can send their staff to the plant of the organization participating to the project.

The collaboration can be formal: the participants sign a contract of cooperation, or informal (that is the most common situation). The agreement can imply the creation of a common structure, known as a research joint venture, but in most of the cases, there are no such creation and organizations only pool their resources to solve technical problems or reduce risks of the project or share the costs of the development. This kind of collaboration is known as joint R&D. So, in practice a collaborative project can take many aspects from the more informal to the more formal. Collaboration can take place in all the stages of the development of the innovation from the R&D to commercialization of the artifact. Start-ups tend to cooperate for production and commercialization because they lack internal competences on these two fields whereas incumbent firms tend to cooperate in R&D because they need new ideas from start-ups to develop novelty (Colombo et al. 2006).

The size of the firm, industry, and belonging to a group are the most common factors that influence the propensity to cooperate. The size of the firm influences the propensity to cooperate to innovate. Larger firms tend to cooperate more than smaller firms. Industries differ for the use of cooperation, in sectors as biotechnology, informatics, or new materials most of the firms cooperate whereas in mature industry (such as textile or food sector), firms tend to cooperate less. Firms that belong to a group cooperate more than independent structure and especially with another unit of the group.

Collaborative innovation has grown since the eighties, but since the beginning of the year 2000, a new kind of collaborative project became of great importance for firms. In fact, the need for customization continued to grow, and in many industries, firms developed collaboration with their customers to be more in line with the future trends of the market. Recognizing that the customers play an important part in the innovation process is the real novelty of the years 2000 in the literature (Greer and Lei 2012). Firms realized the importance of customers with the development of numeric economy. As customers could become their own producers of contents and transmit these contents to other users, firms had to rethink their business models. In many industries, such as footwear, video games, or surgical equipment, users became an important source of new products (Greer and Lei 2012).

Collective Invention

Collective invention knew a renewal in the literature also in the years 2000, but it differs from collaborative innovation.

Collective invention is an old process in the industry, as Allen (1983) identified its existence in the blast furnace industry in the nineteenth century. In that industry, competitors shared information about all the improvement than one of them implemented in his plant. Doing so, competitors overcame technical problems of the industry. So, collective innovation is a process of exchange of information mainly between competitors. Then, Powell and Gianella (2010) defined collective invention as "a technical advance driven by knowledge sharing among a community of inventors who are often employed by organizations with competing intellectual property interests." Collective invention knew a new development with the development of open source software developments. In such process, developers belonging to various firms and even individuals share source code and make improvements that they diffuse to the "community of practices." All the participants of the community get access to the improvements, and the technical problems are solved with the collective intelligence. In such industry, participants regularly increase the stock of knowledge available for all and contribute to generate incremental improvements.

In the collective invention process, inventors freely reveal their invention to the participants of a community, so firms could not appropriate privately the invention coproduced by the community. To be able to capture private value of invention, firms must use the collective invention and integrate it to its own innovation process or must develop innovation on the rest of the value chain.

Collective invention is an invention, is as to say only an idea that inventors have not yet converted into a technical artifact introduced into the market. That point differentiates collective invention from collaborative innovation.

Open Innovation

The open innovation model (Chesbrough 2003, 2011) incites firms to open up their innovation process, giving up the model of the internal process. In the internal process of innovation, firms lean upon their own R&D laboratory and develop the entire projects alone, from initial research to industrialization, because firms used to consider R&D as a strategic asset and thought innovation requires control so they generated the new idea, industrialize, and commercialize by themselves. Companies such as Bell, IBM, or DuPont have succeeded in such strategy for almost all the twentieth century. If, more recently, companies failed to pursue such strategy, it is because knowledge became much more difficult to control. Knowledge became an essential asset in the innovation process, but as this asset grew it became more difficult to fix in a single company or country. Both internal as open innovation process help firms to scan the environment and to detect potential innovation. But open innovation is superior because it let the possibility to detect what Chesbrough qualifies as "false negative." These projects lack promises at one moment of the process, but if they turn out to be profitable, open innovation will be a way to access this technology. Companies which are focused too internally risk lack these opportunities.

Firms that have noticed the loss of efficiency of their process of development of innovation tend to open it by specializing in one part of the process and then using external partners to develop the innovation or acquiring license for the use of the technology. Procter & Gamble, for instance, is a company that turned its strategy from internal exploitation of idea to open innovation. This company now incites his staff to exploit better ideas by using an organizational rule: If an idea has not been exploited from 3 years, the company will sell it outside, even to competitors.

The end of the internal process gave birth to four kinds of firms specialized in the innovation process: innovation explorers, innovation merchants, innovation architects, and missionary organizations, and two kinds specialized in the commercialization stage: innovation marketers and one-stop centers (Chesbrough 2011).

Innovation explorers specialize in generating innovation, performing the R&D discovery function. Many of these firms are spin-off of the previous internal R&D lab of large firms. Any of these explorers are departments of public university that developed commercial function in the eighties.

Innovation merchants focus on property rights, they innovate by purchasing innovation developed by other firms or by combining this innovation with their internal resources to sell the technology outside. These companies use their IP portfolio and sell IP to get fund to finance R&D on their core competency.

Innovation architects act as brokers between various companies selling a specialized set of services to connect actors in the same field.

Innovation missionaries innovate to attain a goal and no to reap profits, for instance the community of practices in open software development as Linux model.

Two types of organizations specialize in bringing innovation to the market: innovation marketers and one-stop centers. Innovation marketers specialize in detecting the needs of customers and bring in-house the idea that will allow them to answer these needs. One-stop centers identify the needs and furnish a new extensive service to customers.

Collaborative Innovation and Open Innovation

Dahlander and Gann (2010) built a typology of open innovation defined by two criteria (Table 1). They oppose "inbound" innovation to "outbound" innovation for the first criterion. The second criterion is the fact of providing pecuniary compensation or, not, for the innovation. The typology produces four kinds of process of open innovation. Firms should use them jointly to improve their ability to introduce innovation onto the market more regularly.

Case 1: "inbound innovation" with a pecuniary compensation, firms can buy or acquire a patent license to be allowed to use an innovation developed by another firm. IP's strategy, here, leads to the question of how to exchange technology on the market. To be allowed to participate in the market of technology, firms should own property rights, such as patents or trademarks. As a consequence, Chesbrough incites firms to file patents to be able to exchange technology.

Case 2: "outbound" innovation, the firm develops an innovation, but it cannot exploit it by itself, so it sells a patent license to another firm. Case 2 is symmetric to 1 from the IP point of view. IP is only used to increase firm's revenue.

Case 3: "outbound" innovation without pecuniary compensation. This case has been studied a lot because it is the newest behavior of open innovation. Scholars named it the "free-revealing" process. It characterizes, above all, software development in open source models (Dahlander and Gann 2010). This type of openness can include many degrees from a closed process to collective invention (such as the one described by Allen) to newer behavior of crowd sourcing (von Hippel and von Krogh 2006). This case does not include pecuniary compensation because inventors voluntarily give up their rights on innovation, and they cannot appropriate privately the innovation. Besides, it is the entire

Collaborative Innovation and Open Innovation, Table 1 Process of open innovation and the links with collective invention and collaborative innovation

	"Inbound innovation"	"Outbound innovation"
Pecuniary compensation	Case1: acquire technology. Buy IP (patent license)	Case2: sell technology. Sell IP (patent license)
	Use marker for technology	Use marker for technology
Non pecuniary compensation	Case4: cooperation. Use external source of knowledge and projects in cooperation with external partners	Case3: free revealing into community of practices
		Business model of the open source software
	Collaborative innovation	Collective invention

Source: Dahlander and Gann (2010) and author

revealing of innovation that forms the basis of the firms "performance." Scholars suppose that free revealing brought competitors, in an industry, to a positive circle of information and technical knowledge exchange allowing firms to develop regularly incremental innovation. Free revealing leads firms to capture the innovative's rent by developing complementary goods.

Case 4: "inbound" innovation without pecuniary compensation. This process is well known, because it characterizes the development of innovation in cooperation with other firms or organizations such as public research organizations. Chesbrough (2003) underlines that cooperation is the basis of openness because firms have externalized some parts of their process of production. He even builds a typology of different kinds of organization. However, thereafter he does not describe this process of cooperation.

Case 4 corresponds to collaborative innovation. Case 1 and case 2 are symmetric and correspond to the acquisition of technology by using the market for technology. In Case 3 and 4, firms produce technology whereas in case 1 and 2 they only acquire an existing technology developed by other organizations. So, open innovation is broader than collaborative innovation because it does not focus on the same problem. Open innovation concerns all the means that can be used by a firm to gain access to technology whereas collaborative innovation focuses on a way for firms to create a new technology and artifact.

The development of open innovation by collaborative innovation leads to any open-ended issues: (1) the risks that collaborators become further competitors (Greer and Lei 2012), (2) the risk that the growth of opening of the process of innovation undermines the internal creativity of the firm, and (3) the issue of property rights.

1. Suppliers and customers can potentially become further competitors in defining standards, setting products expectation, and even capturing the rents generated by more open process of innovation.
2. Greer and Lei (2012) underline that collaborative process, especially with customers, could undermine the in-house R&D of the firms because technology-driven ideas would be neglected to the use of customers' ideas. Indeed, it is clear that the opening of the innovation process will cause a modification of the function of the internal R&D team. The R&D staff should evolve toward function of gatekeepers and serve of links between the external sources of innovation and the internal capabilities of the firm.
3. The property rights issue is the most important brake, at the moment, toward an evolution to more open process of innovation. Chesbrough focuses on the possibility for firms to participate on the market of technology (case 1 and 2) and on the case of free revealing. One of the open-ended issues of the model is the problem of intellectual property of the innovation produced by open innovation. Indeed, Chesbrough underestimates that problem (Gallaud and Nayaradou 2012). In the case 1 and 2, there is only one producer of the innovation: the firm and property rights are clearly defined. Then, the firm can acquire or sell its own rights to third parties. In case 3, of free revealing, innovators voluntarily give up their property rights to diffuse the invention to their community. As Chesbrough recognizes the importance of cooperation but focuses less on this kind of process of open innovation, he deals very little with the fact that many producers can own the property rights on an innovation. However, such cases have grown quickly since the eighties, with the development of co-patenting or patents pools. Co-patenting is the fact that many inventors can file a patent jointly. Patent pool is a consortium of at least 2 companies agreeing to cross-license patents relating to a particular technology. The creation of a patent pool can save patentees and licensees time and money; in case of blocking patents, it may also be the only method for making the invention available to the public. At last, the problem of property rights is a major cause of failure or negative judgment of the participants in collaborative projects of innovation.

Conclusion and Future Direction

The main message of open innovation model is to incite firm to increase their search of innovation opportunities. Even if such message is not new, this behavior of search is still a characteristic of the largest firms. Indeed, Chesbrough's model leans on case studies of large firms (the case study of Procter & Gamble for instance). Many SMEs have not yet developed such a search behavior and are still constrained by their lack of innovative capabilities. The main obstacles they declare for not innovating are the lack of information about market or the fact that they do not need to innovate. It seems that the incitation to increase the innovation capabilities is still a good recommendation. However, at the same time, public policy should take into account the difficulties to innovate for SMEs and incite them to develop more incremental innovation than radical projects to encourage them to overcome the difficulties of the innovation project.

Cross-References

▶ Business Creativity
▶ Decrease in Creativity
▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies

References

Allen RC. Collective invention. Journal of economic behaviour and orgnaization. 1983;4(12):1–24.
Chesbrough H. Open innovation. Cambridge, MA: Harvard University Press; 2003.
Chesbrough H. Top ten lessons on the new business of innovation. *MIT Sloan Manag Rev*. 2011;35–42.
Colombo M, Grilli L, Pili E. In search of complementary assets: the determinants of alliance formation of high-tech start-ups. Res Policy. 2006;35(8):1166–99.
Dahlander L, Gann D. How open is innovation? Res Policy. 2010;39:699–709.
Gallaud D, Nayaradou M. Open Innovation and co-operation: which choice of means of protection for innovation. J Innov Econ. 2012;10(2):167–90.
Greer CR, Lei D. Collaborative innovation with customers: a review of the literature and suggestion for further research. Int J Manag Rev. 2012;14:63–84.
Powell WB, Giannella E. Collective invention and inventors networks. In Hall BH, Rosenberg N, editors. Handbook of economics of invention, vol 1, California: Stanford University; 2010, pp 575–605.
Von Hippel E, von Krogh G. Free revealing and the private collective model for innovation incentives. R&D Manag. 2006;36(3,2):95–306.

Collaborative Process

▶ Technology Push and Market Pull Entrepreneurship

Collaborative Work

▶ Co-Conception and Entrepreneurial Strategies

Collective Creativity

▶ Creative Collaboration

Commercial Firm

▶ Academic Firm

Communication

▶ Speaking Pictures: Innovation in Fine Arts

Comparative Word Analysis

▶ Two Hs from Harvard to Habsburg or Creative Semantics About Creativity: A Prelude to Creativity

Competitive Dynamics

▶ Technology Life Cycles

Competitive Intelligence

▶ Information Monitoring and Business Creation

Competitiveness

▶ Technology Push and Market Pull Entrepreneurship

Complex Dynamics

▶ N-Tuple of Helices

Complex Thinking

▶ Dialogical Critical Thinking in Children, Developmental Process

Composition

▶ Creativity in Music Teaching and Learning

Computational Intelligence

▶ In Search of Cognitive Foundations of Creativity

Concept Development, Trends

► Creativity Definitions, Approaches

Conceptualization of Democracy

► Quality of Democracy and Innovation

Conflict and Creativity

Mark A. Runco and Sureyya Yoruk
University of Georgia, Athens, GA, USA

Synonyms

Adaptation; Asynchrony; Brainstorming teams; Cost of expertise; Marginality; Mindfulness; Originality; Preference for complexity

There are quite a few parallels between the evolution of *Homo Sapiens* and the development of individuals. The theory that ontogeny recapitulates phylogeny was not used to describe the entire lifespan, but only prenatal development, and in any case it did not hold up. Yet there are parallels between evolution and development, especially if you take the lifespan perspective. The most obvious may be that, just as adaptation allows a species to evolve and survive, so too do learning and coping allow an individual to live an effective life.

It is also true that creative behavior helps to lead an effective life. In fact, creative talent may facilitate adaptability. This is especially likely given the implication of the first paragraph that life is fraught with challenges. There are various ways to describe the benefits of creativity – it adds to the quality of life, helps us to stay healthy, and contributes to progress – and the most important benefit may be that it does allow us to adapt and cope. Life can be challenging, but creative behavior makes it easy to keep up.

Much of this reasoning is theoretical, but there are data showing that creativity is the result of challenges, conflict, and tension. These data can be found in case studies and experimental research. This entry will briefly review each. It covers all perspectives on the relationship of tension and creativity. Some of the data about the tension-creativity relationship are found in developmental psychology, while others are in the social.

Asynchrony

What makes a good parent? Is a good parent someone who comforts his or her child and satisfies all needs? Actually, a good parent will allow the child to experience tension and conflict. Otherwise, the child will not develop the capacity to tolerate tension nor learn the skills that will allow life-long adaption. A good parent does not even provide an environment that is perfectly aligned with a child's abilities. Instead the parent creates a slight mismatch and then scaffolds. The parent may speak to a child with a sentence that has eight words, and seven of them are in the child's current receptive vocabulary. But the meaning of that eighth word must be inferred. The child must work, just a bit, to grasp the meaning of the sentence. And as the child grows, so too do the mismatches. A good parent will keep just ahead of a child's current abilities. That is scaffolding.

But challenges are varied. They are not just in the parent-child communication. Many do occur during childhood and seem to contribute to the development of mindfulness and adaptability, and case studies of creative individuals suggest that many of them had huge challenges or all sorts (Runco 1994) Although these are retrospective reports, the implication is that the challenges contributed to the capacity for creativity. This makes sense if creative ability is a kind of adaptability.

Tension may result when there is an asynchrony or mismatch between the needs and capacities of the individual and what is available and supported by the environment. Some asynchronies occur within the family. They may be the result of a loss of a parent when the child is still quite young, or the loss of a sibling, both of which are remarkably common among famous creators. Yet other tensions result from mismatches and asynchronies outside of the family.

One kind of asynchrony occurs when an individual moves from one culture to another. This may put the person in a position where they feel that they should process information mindfully rather than make assumptions. It is almost as if they are forced to use the "question assumptions" tactic that is so often recommended in programs designed to enhance creative thinking. Another kind of asynchrony occurs when an individual moves from one profession to another. Again, the individual is forced to think in a mindful fashion. He or she also has the benefit of using concepts or methods from the original profession in the new profession, which of course means that they may do or see something that experts in the second field do not see. That kind of thing happens fairly regularly and has been labeled "the cost of expertise." The benefits of moving from one field to another are implied by the insights of Darwin (geology to evolutionary biology), Jean Piaget (biology to cognitive developmental psychology), and Sigmund Freud (physiology to psychiatry). Admittedly, it is possible that the same benefit occurs when an individual is on the periphery of a field for some reason other than moving from one field to another. Indeed, there is research suggesting that marginality, like asynchrony, has similar benefits. Note that these can often be explained by the fact that being marginal or asynchronous challenges the individual to think in a mindful, and often original, fashion.

Conflict that may lead to creative thinking sometimes involves different modes of thought. Convergent processes may lead to a solution to a problem, while, at the same time, divergent thinking suggests alternatives. This situation may lead to what Arieti (1976) called the magic synthesis. For Arieti, creativity results from a blend, or synthesis, of different ideas and feelings. Interestingly, he felt that these might come together in the corpus callosum, which is the neural bridge between the two hemispheres. A variety of other theories also view creativity as the blend of opposites. These create a tension which the individual resolves using creative processes. The tension is not necessarily only between cognitive modes of thought; it may also be between thinking and emotion.

Interestingly, there is a personality trait found in many highly creative individuals that may both result from but also in turn lead to these tensions between modes of thought. Sometimes called the *preference for complexity* (Eisenman 1997), this trait not only allows the individual to tolerate situations fraught with tension, but in fact the individual may have learned that from tension comes the satisfaction of creative insight. The individual learns to prefer complexity, even if there is a tension felt because of it. They know that the tension is indicative of the creative process.

Tension in Organizations and Teams

Tension is probably unavoidable in large organizations. It is also no doubt common in teams and brainstorming groups. Some of the time, this works to the advantage of the group. In fact, tension is one of the factors included in descriptions of optimal teams and workgroups (Rubenson and Runco 1995). In one of the most detailed theories of optimal groups, a team should be composed of six to eight people. If there are more, there is too great a cost for any one individual to take a risk and share a wild, and potentially original, idea. In fact, the least risk is in so-called nominal groups – someone working alone! The problem there is that creativity is not synonymous with originality. Creativity requires effectiveness as well as originality. This is especially true in organizations, which very likely are interested in innovation. That means that an idea must not be simply original; it must also work. It must be practical. It should lead to implementation. It would be good if it could sell. So although smaller groups are good for the risk taking that allows originality, creativity requires more than that. Hence, a team should be involved, with not too many (risk increases, originality drops) nor too few (high originality but lacking the diverse perspectives and experience that will insure that some ideas are practical as well as original).

In addition to an optimal size, a team should be diverse. This is where the tension comes in. It is probably best to have two to three highly experienced individuals. They are the ones that will bring information and huge knowledge bases to the problem at hand. They will evaluate and criticize and insure that only practical ideas move forward, from the team to the larger organization. Since assumptions are to be avoided and diverse perspectives on problems are useful, the experts in the groups should represent different points of view. If they were scientists, one could be an engineer, one a humanistic psychologist. The key is diversity. This will insure that assumptions (within any one field) are avoided, but it will probably lead to some tension and conflict. The experts may very well argue and debate. That is a good thing for creativity. It will allow ideas to be tested and evaluated and all relevant information to be brought to bear.

It is quite possible that the experts will not have the most creative insight. They will bring information and question assumptions, but the creative insight is actually most likely to be found by an inexperienced member of the team! This is because, with experience comes rigidity, or in the vernacular of creativity theory, inflexibility. Experts have so much invested in their own fields and theories and points of view that they tend to defend them and become increasingly rigid. This again is the "cost of expertise." But if the team is optimally composed, there will be novices as well as experts, and just as the experts are inflexible, so are the novices flexible. They will hear the conflict, the debate, and the exchange of information, and they are the ones that are most likely to benefit from the conflict and team work and have a useful insight.

Very importantly, this optimal team may find a creative idea. Then again, there is no guarantee. What the theory of an optimal group defines is a way of finding the conditions which should allow the creative process to occur. You could say that the optimal work group has the *potential* to be creative (see "▶ Four Ps of Creativity", this volume). As a matter of fact, much the same must be said about all of the different kinds of tensions and conflicts and asynchronies that are summarized in this entry. None of them guarantees creativity. Conflict sometimes supports mindful thinking and interactions that can lead to original and useful ideation. But conflict can go different ways. It can be used productively, or it can become an issue in and of itself, a distraction, a block to creativity. It is much like putting a deadline on a person. Many people are challenged by the deadline and do good work. But others are frozen by deadlines. The condition – the deadline – is the same, but interpretations of it differ. The impact varies from person to person. This is the same with conflict and tension. It works for some people, some of the time, but not everyone all of the time.

Conclusions and Future Directions

These last comments on conflict within teams apply most obviously to industry and organizations. But then again, schools sometimes use brainstorming, and diversity could be captured in student groups. Additionally, a beneficial tension was suggested by Dean Keith Simonton when he described how the best mentor-student relationship is not one of complete compatibility and camaraderie. The ideal mentor-student relationship is instead one where there is some discrepancy. Certainly there must be enough compatibility for good communication; but some distance and dissimilarity is also good. Otherwise, the student may merely imitate the mentor, and original insights are unlikely.

It is possible that creative insights sometimes occur when there is no conflict, no tension. Indeed, this is the humanistic view, proposed by Carl Rogers. Creativity is inextricable from the epitome of psychological health, namely, self-actualization, and individuals self-actualize when they are in environments which provide unconditional positive regard. Yet at the same time, there are logic and numerous examples of tension leading to shifts of perspective and creative insight. These two perspectives are not really at odds with one another if you keep in mind that much depends on the interpretation of the individual.

At least as important is the caution that must be taken whenever an attempt is made to enhance creativity by structuring experience or context. Simply put, even if conflict was the most likely route to the development of creative thinking skills (and more accurately, it is simply one route that sometimes works for some people), it would be unethical to impose conflict on individuals! There is probably no need to impose conflict anyway. Life throws challenges at us; we do not have to go looking for them.

This brings us to our last point. Much of the thinking in this entry implies that creativity can be stimulated by tension and conflict. That in turn may imply that creativity is a form of adaptation. This view can be refuted, however, since some creative behaviors are maladaptive. Creativity is sometimes associated with psychopathology, for example, and sometimes leads to such radical thinking that the individual creator can be alienated. Perhaps more convincing is that creative thinking is sometimes proactive, while adaptations are by definition reactive. In the evolution of a species, for example, adaptations are not selected unless they correspond with environmental pressures. This is not to say that they are directed or teleological. But creative behavior is often self-expressive and independent of environmental demand. Further, many of the most creative insights are not solutions to a problem (solutions would be reactions) but are instead a reflection of problem identification or problem finding. The point is that sometimes creative insight is the result of self-expression, and there is no problem. Other times there is a problem and perhaps tension. There are different routes to creative insight. Given the importance of creativity, future research should be directed to determine exactly what kinds of conflict and tension are beneficial, for whom, in what settings.

Cross-References

▶ Freedom and Constraints in Creativity
▶ Ideas and Ideation
▶ Risk

References

Arieti S. The magic synthesis. New York: Norton; 1976.

Eisenman R. Creativity, preference for complexity, and physical and mental health. In: Runco MA, Richards R, editors. Eminent creativity, everyday creativity, and health. Norwood: Ablex; 1997. p. 99–106.

Rubenson DL, Runco MA. The psychoeconomic view of creative work in groups and organizations. Creative Innov Manag. 1995;4:232–41.

Runco MA. Creativity and its discontents. In: Runco MA, Shaw M, editors. Creativity and affect. Norwood: Ablex; 1994. p. 102–23.

Contextual Determinants

▶ Environmental Determinants of Entrepreneurship

Continuity

▶ Idea-Marathon System (IMS)

Convergent Versus Divergent Thinking

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Definitions

Convergent and divergent thinking are two poles on a spectrum of cognitive approaches to problems and questions (Duck 1981). On the divergent end, thinking seeks multiple perspectives and multiple possible answers to questions and problems. On the other end of the spectrum, convergent thinking assumes that a question has one right answer and that a problem has a single solution (Kneller 1971). Divergent thinking generally resists the accepted ways of doing things and seeks alternatives. Convergent thinking, the bias of which is to assume that there is a *correct* way to do things, is inherently conservative; it begins by assuming that the way things have been done is the right way. Divergent thinkers are better at finding additional ideas, whereas convergent thinkers have a more difficult time finding additional ideas. Convergent thinkers run out of ideas before divergent thinkers. However, convergent thinking strengthens the ability to bring closure and to conclude problems.

Creative Process

In the creative process, the relationship between thinking for divergence and thinking for convergence is not simplistic. Convergent thinking and divergent thinking are both necessary for creativity but in different relative amounts, depending on the creative domain. Because divergent thinking considers problems from multiple perspectives and often discovers and develops original solutions, it plays a crucial role in most creative processes. Divergent thinking is central to innovative type creativity, the creation or development of new products, processes, services, technologies, or ideas that society accepts. Convergent thinking also plays a role in innovative creativity, though the role is often more subtle than divergent thinking. Convergent thinking, at the higher-order level, brings facts and data together from various sources and applies logic and knowledge to find solutions. Higher-order convergent thinking involves evaluation and is often crucial to maintaining viability of a paradigm or product.

Situations do not always require innovatively creative solutions. Sometimes, the creative process involves *adaptive* creativity: retaining the core elements of an existing paradigm or product and improving, revising, or adapting it to suit new circumstances. In product marketing, for example, many creative changes are merely adaptations of existing products to extend their product life cycles. So, for adaptive type of creativity, convergent thinking is more often used than divergent thinking is.

Because any creative act ultimately involves a decision, both divergent and convergent thinking are necessary for creativity to operationalize. In the process of creativity, divergent thinking is prevalent in the initial stages of finding novel ideas, but convergent thinking is needed later for analysis and evaluation of the ideas to arrive at a useful product. Initially, complex problems or questions should be approached divergently, that is, by looking at the problem from multiple perspectives and imagining different solutions. Then, at some point, the problem solver must converge or decide on one answer or solution. Thus, creativity requires both of these thinking processes, and creativity occurs when these two processes complement each other: divergent thinking to generate many novel ideas and convergent thinking to evaluate these ideas and select one of them to solve a particular problem.

Relationship of Convergent and Divergent Thinking to Intelligence

Convergent thinking is included in both intelligence, which is measured by IQ, and creativity, which is substantially independent of intelligence and not measured by IQ. Intelligence can support creativity because of the role convergent thinking plays in creativity, but extremely intelligent people are not necessarily creative: their knowledge can act as a blinder, forcing a degree of convergent thinking that limits their creative insights. In his analysis of scientific revolutions, Kuhn (1962) concluded that most scientists, who are generally considered highly intelligent, are fundamentally conservative and work to strengthen existing scientific paradigms. Only rare creative scientists have the creative capacity to think outside existing paradigms, including Copernicus, Galileo, Newton, and Einstein.

Although intelligence can support creativity, very creative people do not need to be very intelligent. Creative people need only enough domain-specific intelligence to be able to generate multiple possibilities or solutions. Divergent thinking is part of the creative personality and attitude, which must exist for a creative product to result. Divergent thinking requires intellectual curiosity and open-mindedness. Divergent thinking connects seemingly irrelevant ideas together and tends to approach problems from different perspectives. Divergent thinking will exhibit various other traits common among creative personalities, and these traits may encourage or result in their innovative problem-solving style.

Education systems, because they typically encourage convergent thinking, have generally favored development and measurement of IQ rather than of creativity. Most traditional forms of education focus on the transmission of knowledge, skills, and values of existing society. Teachers and professors impart knowledge to their students, whose acquisition of that knowledge is measured. The philosophy of education supporting this approach is known as Essentialism, which rests on a number of assumptions, above all that students' brains are blank slates, that the teachers possess correct answers (knowledge), and that the purpose of education is preparation for the future (Duck 1971). Because preparation for the future is unquestionably a significant purpose of education for many, perhaps most, middle-class families, Essentialist philosophy dominates most systems of schooling and education. Because educational systems often function within society to sort students into vocations or to determine who can advance, systems of assessment capture the degree to which students have successfully acquired the knowledge and skills of the existing social order.

John Dewey reacted to this situation and developed his own approach to education, which today is referred to as Constructivism. Constructivism rests on different assumptions: that students have innate ideas, that teachers and professors function as experienced co-learners with their students, and that education serves to enhance students' lives now. Educators in the tradition of Dewey foster divergent thinking by posing questions to which there are many possible answers and to which the teachers themselves do not possess any one *correct* answer. Students must inquire and develop their own solutions, ideally evaluating which is the best answer. Thus, although most schools have not excelled at fostering creativity, an educational philosophy and instructional approaches exist that can.

Extreme Convergent and Extreme Divergent Thinking

Just as innovation and adaptation overlap, divergent and convergent thinking are not fully distinct categories. Divergent thinking, for example, could consider as many perspectives as there are people or cultures, or customers; it could also consider just several perspectives, for examples, perspectives of two or three or four market segments. Convergent thinking can in a doctrinaire fashion imagine that there is one possible answer and refuse to consider any others. Or, in a less extreme form, a convergent thinking process could anchor itself in a few nonnegotiable presumptions and then synthesize new information in the context of these basic accepted facts. The most productive thinking does not occur at the extreme ends of the spectrum of convergence or divergence, but rather where the two types of thinking complement each other to produce creatively meaningful outcomes.

Just as a combination of divergent and convergent thinking is the most productive, extreme convergent or divergent thinking may be harmful. Extreme forms of either convergent or divergent thinking are unlikely to produce useful products. At the extreme edge of convergent thinking are high-functioning autism and Asperger's syndrome (Andersen and Kim in press). Individuals with high-functioning autism and Asperger's syndrome have a cognitive style that focuses on under-inclusion instead of over-inclusion. Under-inclusive thinking can result in excellent attention to detail and extraordinary memory, and children with Asperger's syndrome are prone to spend countless hours and devote a great deal of effort to minutiae of interest to them. This cognitive style associated with under-inclusion is more suitable to reality-based creativity or scientific creativity. Gifted mathematicians and engineers tend to share these traits. Less extreme but more common is the type of convergent thinking that, despite reflecting intelligence, lacks intellectual flexibility. In a classroom, a student with overly convergent thinking is the type who struggles with ambiguity and uncertainty or who is uncomfortable learning in a fashion outside their preferred learning style.

Extreme varieties of divergent thinking also exist. Schizophrenia is beyond extreme divergent thinking because the condition results in thoughts and behaviors that do not lead to creative thought or creativity (Andersen and Kim in press). However, artists and writers, who often reflect traits common to divergent thinking, sometimes exhibit schizo-type behaviors. Any of the common traits of creative people could be exhibited too frequently, or too strongly, and in doing so prevent creative output and product. Divergent thinking ranges into greater over-inclusion. Eminent artists and writers, for example, focus on over-inclusion and show elevated levels of unusual experiences and impulsive nonconformity. Less extreme but more common forms of strongly divergent thinking include an inability to come to closure or to make a decision because too many possibilities are under review. Extreme divergence can lead to irrelevance through thinking processes not anchored in socially meaningful points of reference. Extremely divergent thinking manifests as an unproductive variety of nominalism, preventing meaningful categorization and other cognitive tasks that are intellectually useful and lead to constructive and useful outcomes.

Education systems can work to mitigate extreme varieties of either convergent or divergent thinking. An ideal educational system would strike a better balance between Essentialism and Constructivism than currently occurs in most schools. Students do need to be prepared for a future, which includes acquisition of knowledge and values of the existing social order, an outcome achieved through convergent thinking. On the other hand, because the world changes faster and faster, students need the capacity to think divergently to see multiple possibilities and to consider multiple perspectives. Finally, students need to know how to combine the two forms of thinking in complementary fashion to know when to bring closure to an inquiry process to produce a good solution.

Role of Mentorship

Creative ideas spring from creative personalities plus enough intelligence to acquire an expertise in a specific domain. Without the creative personality and attitude, creative ideas cannot take place. Every child is born with a creative personality and attitude, and society and circumstances usually act to dim that spark. For creativity to thrive, therefore, it is important to understand what creative personalities are and how to encourage them.

As noted above, most school systems today, despite their best intentions, dampen creativity. Teachers ask their students questions with only one right answer or, worse, the teacher judges students' responses on the basis of one right answer. An obvious place of mentorship in the creative process can begin with parents and teachers, with whom most young people spend the majority of their day. Parents can learn the basics of fostering creativity and try to raise their children with those objectives in mind. Teachers can do the same. Some contemporary trends in education, especially the standards movement, challenge teachers to find ways to be creative and to foster creativity, but the impact in schools is reduced when teachers are grounded in the assumptions of other educational philosophies. Under those conditions, teachers can be aware when their instruction fosters convergent thinking and when it fosters divergent thinking.

Divergent Thinking and Invention and Innovation

Combining adaptive creativity and innovative creativity is best for invention and innovation, and both can give rise to entrepreneurship. Eminent creative invention or innovation arises generally through leading with thinking for divergence and complemented near the end of the process with thinking for convergence. The result often is the production of creative products (Kim and Pierce 2012).

In examination of the etymologies, both the terms invention and innovation highlight the role of divergent thinking in innovation. The roots of invention are "in" plus a form of the Latin word for "to come" (*venire*). Ideas need to come in, to come together. A similar stress on divergence underpins innovation, which stems from "in" plus the Latin word for "new" (*novus*). Both words rest innately on the concept of new ideas and possibilities other than those currently known. Virtually all groundbreaking innovations or inventions rest on this basis. Johannes Gutenberg, for example, combined ideas from his work as blacksmith and a goldsmith, to create (a form of convergence) mechanical movable-type printing, one of the most revolutionary inventions of the last 1,000 years. Other great inventions rest on similar foundations. From an economic perspective, new ideas or products are only innovations if they have socially meaningful applications. In Gutenberg's case, his invention of movable-type printing had immediate and powerful implications. Growing cities were producing an increase in literate populations, and strengthening central monarchies were in greater need of more literate people to serve in bureaucratic functions. This was all in a context where the basic instrument for teaching reading and writing were expensive manuscripted texts. By using metallurgical skills, the relatively simple Western phonetic alphabet, and basic types of presses available for use in other commercial contexts, Gutenberg devised a mechanical device that could produce numerous copies of sought-after texts at a far lower cost than before. With the decline in costs of books, demand increased significantly. Printing allowed for the diffusion and amplification of knowledge, which then brought about social and economic revolutions.

Today, many economists view innovation as central to economic growth. Schumpeter (1942), whose expression "creative destruction" today is much quoted and misquoted, asserted that innovation is central to economic growth and has led to the field known as "innovation economics." In earlier periods of human history, much of the basis of economic growth rested on natural resources and environment. As obvious sources of natural resources are tapped or depleted, the ability to innovate is viewed as the principle resource central to competitiveness and to maintenance of vibrant economies. Society and its institutions, including businesses, governments, and schools, should foster and pursue innovation, which can be achieved by understanding and fostering complementary divergent and convergent thinking.

Conclusions and Future Direction

Divergent and convergent thinking are two poles on a spectrum. Both types of thinking play a role in the creative process, although in their extreme forms, neither is particularly helpful and may indicate certain problems. Convergent thinking is closely related to intelligence, whereas divergent thinking is not. Schools generally privilege and seek to foster convergent thinking, though some educators, such as Dewey, have tried to foster varieties of divergent thinking. Toward that end, he was on the right track. Mentors, including teachers, can play a crucial role in fostering creative thinking. In light of the ever more competitive world economically and the place of innovation in economic growth, educators need to place greater emphasis on divergent thinking in their curriculum, assessment, and instruction.

Cross-References

▶ Business Creativity
▶ Cognition of Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Destruction
▶ In Search of Cognitive Foundations of Creativity
▶ Innovation and Entrepreneurship

References

Andersen L, Kim KH Are creatively gifted students different from academically gifted students. in press.

Duck L. Teaching with charisma. Burke: Chatelaine Press; 1981.

Kim KH. The creativity crisis: the decrease in creative thinking scores on the torrance tests of creative thinking. Creat Res J. 2011;23(4):1–11.

Kim KH, Pierce RA. Torrance's innovator meter and the decline of creativity in America. In: Shavinina LV, editor. The international handbook of innovation education. New York: Taylor & Francis/Routledge; 2012.

Kneller GF. Introduction to the philosophy of education. 2 ed., rev. New York: Wiley; 1971.

Kuhn T. The structures of scientific revolutions. Chicago: University of Chicago Press; 1962.

Schumpeter JA. Capitalism, socialism, and democracy. New York/London: Harper & Brothers; 1942.

Cooperations to Innovate

▶ Collaborative Innovation and Open Innovation

Coopetition

▶ Collaborative Innovation and Open Innovation

Co-publication

▶ Networks and Scientific Innovation

Corporate Creativity

Sam Stern[1] and Alan G. Robinson[2]
[1]College of Education, Oregon State University, Corvallis, OR, USA
[2]Isenberg School of Management, University of Massachusetts, Amherst, MA, USA

Introduction

When describing creativity at Pixar Animation Studios, cofounder and CEO Ed Catmull (2008) wrote, "A movie contains literally tens of thousands of ideas. They're in the form of every sentence; in the performance of each line; in the design of characters, sets and backgrounds; in the locations of the camera; in the colors, the lighting, the pacing. The director and the other creative leaders of a production do not come up with all the ideas on their own; rather, every single member of the 200–250 person production group makes suggestions. Creativity must be present at every level of every artistic and technical part of the organization" (p. 66).

Creativity in a corporate setting, whether in the private or public sector, a large or small organization, and manufacturing or service industry, is much more like Pixar than not. Creative ideas can and actually do need to come from everyone in the organization. Nobody can predict *who* will be involved in them, *what* they will be, *when* they will occur, or *how* they will happen. But rather than mean that nothing can be done, the very unpredictability of creativity leads to a greater understanding of how organizations can increase their creative performance. The unpredictability of creativity is the reason why more individually targeted strategies, such as attempts to hire especially creative people or training current employees to be creative, have not been particularly successful. As Curtis Carlson (2006), president and CEO of SRI International, put it, “top-down innovation is orderly but dumb, while bottom-up innovation is chaotic but smart.”

Corporate creativity differs from more individual perspectives on creativity in that it recognizes the collective and distributed nature of work in a corporate setting and the organization as the basis for determining usefulness. As Cameron Ford (1995) observed in his review of research on creativity, most definitions of creativity involve newness and usefulness but differ on the focus or reference point for the definition. This reflects the early and substantial involvement of psychologists, many of whom have defined creativity in terms of a person and their characteristics, or have focused on processes associated with creativity.

In contrast with more individually based definitions of creativity, Robinson and Stern (1997) defined ***corporate creativity*** so as to emphasize the company’s role as the reference point for both newness and usefulness:

> A company is creative when its employees do something new and potentially useful without being directly shown or taught. (Robinson and Stern 1997, p. 10)

This definition builds on the work of Paul Torrance who, very early in his career, conducted a multiyear research study with the US Air Force to determine how it could prepare pilots and crews to survive the brutal experiences they would be likely to face as prisoners of war in North Korea. In the end, what he found surprised him: The thing that had proved most critical for survival was something that no training program taught – *creativity*. Torrance found that no matter how much training people had received, when faced with the real thing, they almost invariably had to cope with *unexpected* situations. Those who survived had combined elements of their training and life experiences to create a completely new survival technique, one they had not been taught (Torrance 1959). This discovery fascinated Torrance and led him on to a distinguished research career in creativity, one that spanned more than 40 years.

Today, in an increasingly mobile, socially interconnected, and competitive world, the very survival of companies depends on their creativity. To survive and prosper, they must succeed not only at what they plan to do but also in ways they never expected. This is where creativity, both incremental improvement and breakthrough innovation, happens. Since both the situation and the actions are unexpected, the greatest leverage for increasing the capacity for creativity is in creating an environment that is friendly to this type of bottom-up creativity.

Through research on creative acts in different types of organizations in different countries, Robinson and Stern (1997) have identified six characteristics of an environment that increase the probability of creativity in a corporate setting. Although no one can predict the specific creative acts that will follow, the likelihood of their happening will significantly increase when these six elements are in place. “Managing” creativity is about raising probabilities, and in this respect it is similar to operating a casino. Even though casinos do not know how individual gamblers will fare at any given table, they know very well that if enough customers come and play for long enough against the house odds, the casino will make a very predictable and stable profit. In much the same way, although companies cannot know where specific creative acts will come from or what they will be, they can take action to increase the frequency with which creative acts occur. The specific six environmental characteristics that advance corporate creativity are alignment, self-initiated activity, unofficial activity, serendipity, diverse stimuli, and within-company communication (Robinson and Stern 1997).

The first characteristic, ***alignment***, is about ensuring that the interests and actions of all employees are directed toward a company’s key goals, so that any employee is more likely to suggest and respond positively to an idea with potential value for the company. On a hit-or-miss basis, creative acts can happen in any company, but they cannot occur consistently over time unless a company is well aligned. Companies can function with relatively poor alignment, but they cannot be consistently creative unless they are strongly aligned. Alignment is often overlooked; it is intangible and elusive, and as far as corporate creativity is concerned, its effects are readily visible only when a company is either extraordinarily well aligned or misaligned. In *Built to Last*, James Collins and Jerry Porras (1994) identified alignment as the key difference between their study's "visionary" companies (those select few that had steadily grown, survived, and prospered over a 100-year period) and the "also-ran" companies which had not.

The second characteristic is ***self-initiated activity***, and no unplanned act of creativity can happen without it. While companies can plan for new and useful things, these take an organization in only directions it has already anticipated. People have a natural drive to explore and create, a drive that leads them to initiate new activity. One reason why self-initiated activity figures so prominently in corporate creativity is that it allows employees to pick a problem that they are interested in and feel able to solve, for *whatever* reason. This means that their intrinsic motivation is much higher than would be the case if the project had been planned or picked for them by someone else.

Unofficial activity, the third characteristic, occurs in the absence of direct official support but with the intent of doing something new and useful for the organization. So many instances of corporate creativity, including the bar code, post-it notes, and ink-jet printer, all began as unofficial work by one person or a small group of people. When an idea is new to an organization, it is often resisted and opposed. Unofficial activity gives ideas a safe haven where they have the chance to develop until they are strong enough to overcome that resistance. Unless an organization makes some space for such activity, it leaves itself little room to be consistently creative – to bring along a stream of new and useful things without being shown or taught.

The fourth characteristic, ***serendipity***, is a widely used word, but few people are familiar with its history and original meaning. When this meaning is restored, the relationship to corporate creativity and specific actions that companies can take become clear. A serendipitous discovery is one made by *fortunate accident* in the presence of *sagacity* (keenness of insight). Creativity often involves recombining or making connections between things that may seem unconnected. The more abstruse the connection, the greater the intellectual distance that must be traversed to make it, and the greater role for the unexpected.

The fifth characteristic of corporate creativity is ***diverse stimuli***. A stimulus may provide fresh insight into something a person has already set out to do, or it may bump that person into something different. One reason why no one can predict who will be involved in a creative act, what it will be, or when or how it will happen is that it is impossible to know in advance what sort of stimulus will lead a particular person to initiate one. It could be anything from a casual conversation to a formal presentation or a seemingly unrelated activity. And what serves as a powerful stimulus for one person may not even be noticed by someone else. This unpredictability means that efforts to expose people to prescribed stimuli will necessarily have a low success rate. The real leverage lies in helping employees to get the stimuli and in creating opportunities to bring these stimuli back into the organization where then can be put to use.

The sixth characteristic is ***within-company communication***. Every organization carries out planned activities and should establish the necessary lines of communication to support them. But these official channels are of limited usefulness for corporate creativity, which goes beyond what is already done and planned for. Unanticipated within-company communication seems to happen more naturally at smaller companies but not so naturally at larger ones. The larger the company, the more likely it is that the components of creative acts are already present somewhere in the company, but the less likely it is that they will be brought together without some help. A company's creative potential increases with its size, but without systems in place to promote unanticipated exchanges of information, this potential is unlikely to be realized.

Conclusion and Future Directions

Given the unpredictability of corporate creativity, the greatest leverage for assuring ongoing creativity is in nurturing an environment that increases the probability that creativity, both small and large, will occur with regularity. However, the "borders" of any organization's environment are becoming increasingly blurred by globalization, social networking, and greater mobility and flexibility in the workforce. Increasing capacity for corporate creativity will relate to the development of strategies that successfully engage ideas and actions of people inside the organization as well as all those stakeholders who interact with it.

Cross-References

- ▶ Business Creativity
- ▶ Corporate Entrepreneurship
- ▶ Creative Leadership
- ▶ Organizational Creativity

References

Amabile TM. The social psychology of creativity. New York: Springer; 1983.

Carlson CR, Wilmot WW. Innovation: the five disciplines for creating what customers want. New York: Crown Business; 2006.

Catmull E. How Pixar fosters collective creativity. Harv Bus Rev. 2008;86(9):64–72.

Collins JC, Porras JI. Built to last: successful habits of visionary companies. New York: Harper Business; 1994.

Ford CM. Creativity is a mystery. In: Ford CM, Gioia DA, editors. Creative actions in organizations. Thousand Oaks: Sage; 1995. p. 12–49.

Pirola-Merlo A, Mann L. The relationship between individual creativity and team creativity: aggregating across people and time. J Organ Behav. 2004; 25(2):235–57.

Robinson AG, Stern S. Corporate creativity: how innovation and improvement actually happen. San Francisco: Berrett-Koehler; 1997.

Torrance PE. Surviving emergencies and extreme conditions: a summary of six years of research (Unpublished manuscript prepared for the survival training unit of the Air Force Personnel and Training Research Center). Washington DC: U.S. Air Force; 1959.

Corporate Entrepreneurship

Céline Merlin-Brogniart
CLERSE, Lille, France
University of Lille–France, Villeneuve d'Ascq, France

Synonyms

Corporate entrepreneurship, internal; Corporate venturing, internal; Independent entrepreneurship; Internal innovation; Internal venturing; Intrapreneurship; Redefinition; Reorganization; Revival; Strategic change; Strategic departure; Strategic renewal; Transformation

Introduction

Many innovative companies have progressively lost their creativity over time due to increases in size, bureaucracy, and hierarchy associated with their growth. To regain the entrepreneurial dynamic they once had, some companies are choosing to invest in employee-generated innovative projects linked to their core or closely related competencies. These types of initiatives can arise spontaneously from within the company or, in cases when the organization does not possess the internal entrepreneurial talent, they can be implemented through a top-down approach as managers instill an innovative work culture to modify employee behaviors. These entrepreneurial initiatives are typically facilitated by the main organization and are managed from within the firm or through an external entity.

Definitions: A Concept with Imprecise Semantic Boundaries

This brief summary explores several phenomena that fall under the notion of corporate entrepreneurship. Literature often classifies the different variations of this concept into four categories: *corporate venturing, strategic renewal,* *intrapreneurship, and corporate entrepreneurship* (Sharma and Chrisman 1999). Of this terminology, *corporate entrepreneurship* encompasses the widest range of definitions and will be used as the keyword in this entry.

Corporate Venturing

The first set of definitions refers to the phenomenon of *(internal) corporate venturing*, the creation of new activities (or business) within an existing firm.

> Block and Mac Millan "*consider a project a venture when it: Involves an activity new to the organization; Is initiated or conducted internally; Involves significantly higher risk of failure or large losses than the organization's base business; Is characterized by greater uncertainty than the base business; Will be managed separately at some time during its life; Is undertaken for the purpose of increasing sales, profit, productivity, or quality*" (1993, p. 14).

A corporate venture is typically characterized by the launch of a new (often risky) project, the relative autonomy of the project, and the fact that the project is being developed internally.

This type of undertaking requires the company to develop new skills, knowledge, or processes, but such new skills are generally never far from the firm's original core competencies. The resulting new initiatives or products have a significant and lasting impact on the organization.

Internal corporate entrepreneurship, internal innovation, internal venturing, and sometimes *intrapreneurship* all refer to the same phenomenon.

Strategic Renewal

The second group of definitions refers to the transformation or "renewal" of organizations.

We call this category "*strategic renewal*," but the terms "*organizational renewal*," "*strategic change*," "*revival*," "*transformation*," "*strategic departure*," "*reorganization*," and "*redefinition*" are also used to explain the same phenomenon. It is important to note that strategic renewal should not be confused with financial restructuring.

According to Zahra (1995, p. 227) "*Renewal means revitalizing a company's business through innovation and changing its competitive profile*."

This definition highlights the fact that the companies themselves are subject to business reorganization or innovation. Many authors use Schumpeter's broad definition to illustrate the broad range of potential changes stemming from entrepreneurial behaviors. These changes do not necessarily have innovation as the end goal; strategic renewal can also result from cost cutting or a reallocation of resources, which may bring about new business opportunities or innovation.

This category encompasses what is sometimes called "*Frame-breaking changes*," whereby changes focus on the rules of competitive engagement (e.g., creating new business models) (Stopford and Baden-Fuller 1994).

Intrapreneurship

A third perspective of corporate entrepreneurship is represented by the term *intrapreneurship*. Firms have genuine entrepreneurs among their personnel. "Intrapreneurs" are creative and often autonomous employees who try to implement innovative projects to improve the firm's performance. Overseeing intrapreneurs' projects is a way to generate increased profits. Intrapreneurs detect opportunities, build ad hoc internal and external networks, and shorten the duration of the innovation process (Bouchard 2009).

Many companies try to encourage their staff to adopt an "intrapreneur-like" mind-set and behavior. This model, therefore, analyzes the institutionalization of routines and the adoption of entrepreneurial behaviors within existing organizations.

The term "intrapreneurship," a neologism created by combining "entrepreneurship" and "internal," was popularized by Pinchot (1985) in the 1980s. In this school of thought, authors often cite the entrepreneurship literature since it is there that the entrepreneurial behavior is seen as a driving force.

The authors differentiate "*intrapreneurs*" from "*entrepreneurs*" (Pinchot 1985) and "*independent entrepreneurship*" from "*corporate entrepreneurship*" (Collins and Moore 1970; Sharma and Chrisman 1999). According to Pinchot, an intrapreneur is "*Any of the 'dreamers who do.' Those* *who take hands-on responsibility for creating innovation of any kind within an organization. The intrapreneur may be the creator or inventor but is always the dreamer who figures out how to turn an idea into a profitable reality*" (Pinchot 1985, p. iX). On the other hand, an entrepreneur is "*someone who fills the role of an intrapreneur outside the organization*" (Pinchot 1985, p. iX). The key distinguishing characteristic between entrepreneurship and intrapreneurship, therefore, lies in whether the entrepreneurial activity has been developed internally or externally.

Corporate Entrepreneurship

Guth and Ginsberg's definition combines the first two categories through the meaning of *corporate entrepreneurship*, the final category of definitions for discussion. "*The topic of corporate entrepreneurship encompasses two types of phenomena and the processes surrounding them: (1) the birth of new businesses within existing organizations, i.e., internal innovation or venturing; and (2) the transformation of organizations through renewal of the key ideas on which they are built, i.e., strategic renewal*" (Guth and Ginsberg 1990, p. 5). This interpretation is widely accepted because it encompasses many other definitions (Sharma and Chrisman 1999).

While Guth and Ginsberg's definition (1990) emphasizes the fact that corporate entrepreneurship can involve new businesses or initiate major changes within the organization, other definitions for this category also highlight the qualities of intrapreneurship (and consequently, encompass the three previous categories of definitions). According to Sharma and Chrisman, "*Corporate entrepreneurship is the process whereby an individual or a group of individuals, in association with an existing organization, create a new organization or instigate renewal or innovation within that organization*" (1999, p. 18). In this case, the individual or collective dimensions of entrepreneurship, as well as the partnership with the organization, are the key to defining the concept of corporate entrepreneurship.

Still other definitions stress the process and resources required to foster corporate entrepreneurship. "*Corporate entrepreneurship* [...] *refers to the process whereby firms engage in diversification through internal development. Such diversification requires new resource combinations to extend the firm's activities in areas unrelated, or marginally related, to its current domain of competence and corresponding opportunity set*." (Burgelman 1983, p. 1349).

Theoritical Origins, Corporate Entrepreneurship Practices, Innovation, and Intrapreneurs

The Field of Corporate Entrepreneurship Has Two Theoritical Origins

First, management researchers have been interested in the concept of *corporate entrepreneurship* or *corporate venturing* since the end of the 1960s. According to Bouchard (2009), the first article dealing with this issue dates back to the year 1969 (Wesfall 1969). Venturing is similar to traditional entrepreneurship, but it occurs exclusively within the bounds of the corporate organization. The practice is undertaken to improve sales, profits, productivity, or quality. Corporate entrepreneurship also consists of fostering a venturesome environment to help the firm's continuous development of new business opportunities or activities.

Second, the concept of corporate entrepreneurship has also been covered in various studies on entrepreneurship. Corporate entrepreneurship was originally analyzed as a particular form of entrepreneurship. Over time and especially with the emergence of "intrapreneurship" (Pinchot 1985) as an established concept, it eventually evolved as an independent field of study.

Management researchers are especially interested in intrapreneur behaviors, but also in the entrepreneurial practices implemented by firms.

Corporate Entrepreneurship and Innovation

The flexibilization and debureaucratization of the workplace since the 1970s has led to the increased popularity of corporate entrepreneurial practices. Most innovation models have come to be based on planned and systematic innovations with well-established procedures. These models became too expensive and rigid because they were often integrated within everyday operational routines. Such models did not bring about increased efficiency and only led to incremental innovations. While traditional innovation processes, such as R&D, stem from organizational continuity, intrapreneurship focuses on the role of human continuity in the innovation process (Blanchot-Courtois and Ferrary 2009). According to this interpretation, intrapreneurship leads to increased employee motivation and development.

The place of corporate entrepreneurship within firm's innovation process changes over time depending on the firm's strategic policy and its cultural perception of innovation in the workplace. While some firms develop corporate entrepreneurship externally, others integrate it within the company's organizational processes.

In the current climate of uncertainty, the adoption of innovative projects entails increased risk, so companies tend to view entrepreneurship as a secondary activity or may simply choose to abandon these types of projects.

The Intrapreneur: Status, Motivations, and Characteristics

Intrapreneurial projects may be generated spontaneously by employees. The intrapreneur may develop an independent project linked to the firm's core competencies or to peripheral activities. Initially, the employee may need to conceal the project from the management team until the project has reached an acceptable level of development. Then, he or she will have to get approval from the leadership to obtain financial support, human capital, or logistical resources and be allowed time to continue working on the project. The management may dismiss the project if it does not fit within the strategic goals of the company. This type of corporate entrepreneurship is called "spontaneous intrapreneurship" as employees launch projects – often in spite of limited or nonexistent corporate support – that they consider important for the firm's development.

To complete the project successfully, the intrapreneur must possess numerous technical competencies and motivational skills and also has to build the project's legitimacy within the firm. The intrapreneur must possess the political know-how of identifying stakeholders and mobilizing corporate networks to protect the project's autonomy and convince the senior management to support the initiative (Bouchard 2009). In that sense, an intrapreneur must possess strong managerial and entrepreneurial skills.

According to Bouchard (2009), intrapreneurial motivations have two origins. On the one hand, the altruist intrapreneur is persuaded to bring a major project to the firm and is not directly concerned with the potential financial rewards and promotion that may come with the success of the idea.

On the other hand, the ambitious intrapreneur has a strong desire to reach his or her full potential. The ambitious intrapreneur ultimately seeks to improve his or her intellectual capabilities, develop transversal skills, and frequently tries to free his or herself from the limitations of the firm's routines. Intrapreneurship can almost be seen as a second career path for an employee to improve social and professional status without following the traditional stages of professional development (Pinchot 1985).

To provide an example of spontaneous intrapreneurship, we can look to the case of Ian Telford, an employee who worked at Dow Chemical Company, and developed a project of e-commerce named "e-epoxy.com" (Chakravarthy and Huber 2003). The goal of his project was to reach small businesses and occasional customers who are not typically reached through traditional commercial visits. This project was progressively accepted by the company, and Ian Telford managed it at each stage (from the project's original conception to implementation) and chose his partners (Bouchard 2009).

While employee drive plays a key role in the success of a project, corporate entrepreneurship also depends on a company's organizational context. Burgelsman (1983) explains that spontaneous entrepreneurship occurs when the employee's proposed project matches the firm's opportunities and when the firm possesses a wealth of financial and human resources.

Projects may fail due to a weak intrapreneurial culture within the firm, especially during periods of economic uncertainty.

Corporate Entrepreneurial Practices

Various forms of corporate entrepreneurial practices exist. In addition to spontaneous intrapreneurship, three types of "induced intrapreneurship" practices have been identified: intrapreneurial units, intrapreneurial platform, and intrapreneurial division (Bouchard 2009).

- Induced intrapreneurship has led to the development of "intrapreneurial units" (called "task forces," "project teams," or "entrepreneurship cells"). Many companies evaluate their managers on their implementation of projects and push them to take on intrapreneurial behaviors.

  To control spontaneous intrapreneurship or to develop induced intrapreneurship, many firms develop a special task force devoted to project innovation to isolate high-risk projects from the rest of the organization. This business model reduces costs and allows the company to have the flexibility of stopping the operations of these special units when a particular project is completed. In large companies, many innovative projects have been developed with this type of intrapreneurial process.

  An example of induced intrapreneurship can be found in the case of the French Postal Service and its development of a new technology called Vigik – a nationwide access control system for residential buildings. The manager who spearheaded Vigik had his own independent team and resources throughout the development of the project. Today, Vigik has become a registered trademark for products that match specifications initially developed by an entrepreneurial unit of the French Postal Service (Merlin-Brogniart 2011).
- Other companies choose to implement significant intrapreneurship procedures. Two types of intrapreneurship dynamics are identified: The intrapreneurial platform, which fits within the firm's operational routines, and the intrapreneurial division, which is separate from the organization. Both reflect the most extensive entrepreneurial culture. Google, Procter & Gamble, Apple, and Xerox Corporation are all companies that encourage this type of corporate entrepreneurship. For example, Google launched the idea of "*a license to pursue your dream*" as part of their human resources program. The company's engineers have the ability to use up to 20% of their time to develop their own projects without having to receive approval from upper levels of management. Many of Google's most significant innovations, such as Google News, have come from this entrepreneurial culture.
- The goal of the intrapreneurial platform is to help intrapreneurs during the early stages of their projects. The activities can be very diverse, but have to enhance the company's growth and profits by reducing costs, improving quality or developing new products, combining existing skills in new ways, or creating new activities. Within this formula, intrapreneurs can keep their job, which helps to reduce the risk they are taking. Employees who want to develop projects are supervised by a small team of experts who can provide the necessary competencies and networks. This method contributes to decompartmentalizing the organization. To illustrate the intrapreneurial platform, we can look to Ohio Bell and the program "Enter-Prize" (Kanter and Richardson 1991). Employees could submit project in order to improve the firm's growth. Managers are leading the platform and have developed a network of experts (ex: innovation consultancy). If the project is selected, a time budget is granted to elaborate the project (Bouchard 2009).
- The intrapreneurial division is generally separate in order to avoid disturbing the company's overall organization. It possesses its own financial and human resources which enables it to dynamize the innovation process. Autonomy, transversal skills, and risk-taking are promoted. This type of intrapreneurship is usually developed to solve a malfunction in the existing organization (inadequate innovation promotion, loss of innovation dynamic). It increases the number of challenging projects

(finding new venture, developing new generations of products or new technologies, and opening new markets).

Employees's projects are evaluated at each stage in order to keep the costs down, reduce risks, and bring the innovations to market more quickly. In that form of corporate entrepreneurship, intrapreneurs may be allowed to return to their previous position or may have to leave it altogether.

For example, Procter & Gamble implemented "Corporate New Ventures" (CNV) to stimulate radical innovations (Amabile and Whitney 1997). This entrepreneurial structure is small, independent, and flexible so that it can set up good practices and make better use of the company's technologies. A team representing the various functional departments of the company was established. The team meets once a week at the start of new projects. Project implementation is subsequently transferred to operational divisions.

The Role of Managers

In the three kinds of corporate entrepreneurship structures, managers play a key role in driving innovation or corporate ventures. The involvement of middle level managers is crucial from an early stage. They support independent strategic initiatives and bring together various capabilities dispersed throughout the firm's operating system (Burgelsman 1983). Intrapreneurial structures can be run by a manager, a small team of venture managers, or by a venture-group operating within the corporation.

Top managers ensure that new business ideas are generated and play an important role in strategic recognition. They try to match entrepreneurial activities with their strategic vision, often retroactively. They balance diversity and order over time.

Corporate Entrepreneurship: An Interesting but Risky Process

The implementation of corporate entrepreneurship practices involves many risks.

First, as corporate entrepreneurship units are often complementary to the organization, they may conflict with the routines and units of the existing structure. These conflicts are a major source of project failure, which is why "Corporate" and "entrepreneurship" are sometimes seen as an oxymoron: The introduction of entrepreneurship behaviors involving creativity, flexibility, and reactivity may be incompatible with the structure, routines, and planning that companies have built so carefully over the years.

Second, support for spontaneous intrapreneurship also raises problems within companies.

While they can be an asset for the growth of the firm, intrapreneurs may generate mixed feelings among the other employees and managers. On one hand, intrapreneurs help the company find competitive advantages, and on the other, employees and managers do not always appreciate intrapreneurs who are given autonomy and extra financial or human resources. Tensions build up all the more as the success of the project is never assured.

Third, the process entails risk for the intrapreneurs: They bear the full responsibility if the project fails, and they can be rejected by the other employees and isolated. Even in case of success, their previous position is not necessarily guaranteed and their chances for promotion might be jeopardized because an intrapreneur is no longer part of the traditional system.

The company has to carefully balance the benefits of corporate entrepreneurship and its drawbacks before implementing it.

Conclusion and Future Directions

"Corporate entrepreneurship" is still a fairly new concept, and the different definitions and terms used to explain this phenomenon can be confusing. Particularly since the lines between the various definitions of *corporate entrepreneurship* are frequently blurred, the theoretical and practical mastery of this concept is not yet established and demands further examination.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Entrepreneurial Opportunity
- ▶ Entrepreneur's "Resource Potential," Innovation and Networks
- ▶ Environmental Determinants of Entrepreneurship
- ▶ Innovation Opportunities and Business Start-up
- ▶ Innovation Systems and Entrepreneurship
- ▶ Innovations of and in Organizations
- ▶ Venture Capital and Small Business

References

Amabile T, Whitney D. Corporate new ventures at procter & gamble. Boston: Harvard Business School; 1997. case 9-897-088.

Blanchot-Courtois V, Ferrary M. Valoriser la R&D par des communautés de pratique d'intrapreneurs. Revue française de gestion. 2009;35(195):93–110.

Block Z, Mac Millan IC. Corporate venturing: creating new businesses within the firm. Boston: Harvard Business School Press; 1993.

Bouchard V. Intrapreneuriat, innovation et croissance. Entreprendre dans l'entreprise. Paris: Dunod; 2009.

Burgelsman RA. Corporate entrepreneurship and strategic management: insights from a process study. Manag Sci. 1983;29:1349–64.

Chakravarthy B, Huber H. Internal entrepreneurship at the Dow Chemical Company. 2003. International, ref. IMD-3-1117, 29.07.2003

Collins O, Moore DG. The organization makers. New York: Appleton; 1970.

Guth WD, Ginsberg A. Guest editor's introduction: Corporate entrepreneurship. Strateg Manag J. 1990;11(5–15):5–15.

http://google24x7.blogspot.com/2008/03/9-rules-of-innovation-from-google.html

Kanter M, Richardson L. Engines of progress: designing and running entrepreneurial vehicles in established companies; the enter-prize program at Ohio Bell, 1985–1990. J Bus Ventur. 1991;6(3):209–29.

Merlin-Brogniart C. Intrapreneuriat et services publics marchands en réseau: Le cas de La Poste. In: Hamdouch A, Reboud S, Tanguy C, editors. PME, dynamiques entrepreneuriales et innovation. Bruxelles: Peter Lang, coll. Business and Entrepreneurship; 2011.

Pinchot G. Intrapreneuring, why you don't have to leave the corporation or become an entrepreneur. New York: Harper & Row; 1985.

Sharma P, Chrisman JJ. Toward a reconciliation of the definitional issues in the field of corporate entrepreneurship. Entrep Theory Pract. 1999;23(3):11–27. Blackwell, Spring.

Stopford JM, Baden-Fuller CWF. Creating corporate entrepreneurship. Strateg Manag J. 1994;15:521–36.

Wesfall SL. Stimulating corporate entrepreneurship in US industry. Acad Manage J. 1969;12(2):235–57.

Zahra SA. Corporate entrepreneurship and financial performance: the case of management leveraged buyouts. J Bus Ventur. 1995;10:225–47.

Corporate Entrepreneurship, Internal

▶ Corporate Entrepreneurship

Corporate Finance

▶ Financing Innovation

Corporate Management

▶ Cyberentrepreneurship and Proximity Relationships

Corporate Spin-Off

▶ Extrapreneurship

Corporate Venture

▶ Extrapreneurship

Corporate Venture, Internal

▶ Business Project

Corporate Venturing, Internal

► Corporate Entrepreneurship

Cost of Expertise

► Conflict and Creativity

Craft Companies

► Craftsman

Craft Industry

► Craftsman

Craft Trade

► Microfirms

Craftsman

Claude Fournier
Réseau de Recherche sur I'Innovation (RRI), Laboratoire de recherche sur I'industrie et I'innovation (Lab.RII), Dunkerque, France

Synonyms

Craft companies; Craft industry; Manual worker

Key Concepts and Definition of Terms

The most widespread meaning of the word "craft" is the one that covers the economic sector of producing decorative objects, often manually, by a local labor force using traditional tools and materials.

As such, the definition adopted by UNESCO (United Nations Educational, Scientific and Cultural Organization) is as follows: "Artisanal products are those produced by artisans, either completely by hand, or with the help of hand tools or even mechanical means, as long as the direct manual contribution of the artisan remains the most substantial component of the finished product. These are produced without restriction in terms of quantity and using raw materials from sustainable resources. The special nature of artisanal products derives from their distinctive features, which can be utilitarian, aesthetic, artistic, creative, culturally attached, decorative, functional, traditional, religiously and socially symbolic and significant" (Symposium Manila, October 1997).

However, is this a true picture or a stereotype found in every country's touristic representation? Is it not the visible but economically and socially least important side of the craft industry? In some countries, builders and electricians are legally recognized as craftsmen.

In fact, there are as many variations, definitions (if they exist that is), and ways of treating this type of economical sector through companies and people who work for them as there are countries!

Within the scope of this entry, different approaches used by different countries in different continents will be seen in order to show this diversity. A look to the common roots will then explain what the craft industry is in a modern economy and what is expected from artisans. Finally, one will approach, as per Europe's example, why it is worth evolving toward a united status of the craft industry.

Multiple Approaches to the Craft Industry and Craft Businesses

In Africa, more than anywhere else, the most widely used definition of craft is referring to the production of traditional decorative arts despite the fact that manufacturing of miscellaneous goods and service offerings are developing alongside the legal documents required to structure this sector of the economy. For example, the "Organisation for the Harmonization of Business Law in Africa" (OHADA) is made up today of 16 African states: Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Comoros, Republic of the Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Guinea, Guinea-Bissau, Mali, Niger, Senegal, Togo, Democratic Republic of Congo. This organization is a system of business laws and implementing institutions adopted by these nations. The laws promulgated by OHADA are exclusively business related. The OHADA treaty, Uniform Act relating to General Commercial Law, amended on 15 December 2010 in Lomé, ensures uniformity and consistent legal interpretations across the member countries. Article 2 shows the difference between the trader, "whose regular occupation is to carry out commercial transactions" and entrepreneur: "physical person who carries out a professional activity which can be civil, commercial, artisanal or agricultural," in line with the current Uniform Act. This entrepreneur status aimed at developing individual initiatives is not linked with the number of employees (as it is in other countries such as Algeria) but with the turnover generated over two consecutive accounting periods. This entry allows the harmonization of all different approaches and gives recognition to this type of business.

Each country executes its own classification by activity. For example in Niger, member of OHADA, Article 5 of Ordinance No. 92–026 of 7 July 1992 sets out the main lines of the national policy for the crafts industry. It can be divided into two groups: craft production (mining industry, processing of goods, including utilitarian use of craft as well as building trade and civil engineering) and craft services (transport, services to households and businesses, small restaurants and catering businesses). With regard to the craft industry, one is talking of a micro or small business (Article 6) or even a few craftsmen grouped in a cooperative. There could be three different types of businesses (Article 7): craft companies with storefront, craft companies with inadequate premises and taking their trade to local markets, and the one with neither of these, which are therefore very difficult to identify.

In Algeria, who is not a member of OHADA, the definition of the craft industry is widely inspired of the French system. Since 10 January 1996, the crafts of the art and traditional handicraft are regulated by the 96/01 of 19 Chaâbane 1416 law, which sets the conditions and rules for exercising handicraft activities in Algeria. The term "handicraft" covers any production, creation, restoration, or maintenance activity as well as mainly manual service delivery carried on in the following areas: decorative art, handicraft, "functional" craft (i.e., maintenance, repair, or restoration work). An artisan is a manual worker who makes items that require some particular kind of skilled work and is applied toward people occupied in production of goods, including the running and management of the whole process. The artisan worker is an employee who holds a professional qualification. With regard to companies, the decree 96–01 makes a distinction between "handicraft businesses" and "businesses producing goods and services." The legal status of both is free within the scope of the commercial code. In the first case, there can be an unlimited number of employees, when in the second case, the number is limited to ten. In both cases, the person in charge of the business does not necessarily need to hold a qualification relevant to the business, as long as there is at least one qualified person in charge of the technical side of things. The economic sector is structured around chamber of trades who act as consultative bodies between public authorities and craftsmen. These also manage the craft and the outline of the craft trades register. An index managed by the national trade chamber includes all this data.

These examples show the wide legal status diversity between countries: some have detailed legislations, other have legislatives tools under way, like in Morocco where the craft industry is a strong element of social inclusion, particularly with regard to women where craftwork is not supported by any law but by economical development programs, and targeted block actions. Both of these examples show the importance of the political significance granted to this economical sector, which is either already identified or part of the "informal economy," that is people's daily activities and quite often their way of surviving and therefore directly about the political stability of the state.

In America, there is not any law specific to the craft industry, whereas in Canada they are using the term "handicraft business" or "handicraft goods" whose parameters are described in detail in official documents such as memorandum D10-15-13. These are generally work of art or objects typical to the region or country from which they originate (fabric, pottery, jewelry). In Mexico, the same thing applies (Boutillier et al. 2011. The USA does not have a particular definition of handicraft businesses but, as early as 1953, they have set up a specific law for small businesses through the "Small Business Act." The legislative initiatives in Asia are the same. In China, for example, the craft business relies on its know-how, manual labor, and traditional processes; however, there is not any specific law like in Africa or Europe to define the craft industry.

Europe's case is quite unique as the handicraft business is defined in ten countries (Germany, Austria, Belgium, Denmark, France, Spain, Luxembourg, Poland, Portugal, and Slovenia) but in a different way in each (APCM, Assemblée Permanente des Chambres de Métiers). In Germany, for example, there is the "Crafts Code," which defines 125 craft trades and establishes the list in seven categories for jobs in this sector (Kari Embarek 2003; Sénat 1995): construction and installation (i.e., builder, painter); electricity and metal (i.e., mechanic, electrician); wood (i.e., carpenter); textile, clothing, and leather (i.e., upholsterer, tailor); food trade (i.e., baker, butcher); health and dry-cleaning (i.e., hairdresser, optician, dry-cleaners); glass, paper, ceramic, and other occupations (i.e., printer, postman, instrument maker). Business activities in the regulated skilled trades and crafts professions principally require that the providing company is managed by a master craftsperson or equivalently qualified individual. There is no size criterion involved. The business concerned is entered in a register kept by the relevant Regional Chamber of Trade and Craft. Luxembourg and Austria also have this type of definition based on the activity rather than the size of the business (APCM 2007). In Luxembourg, for example, the Law of 28 December 1988 (regulating the access to the professions of craftsman, salesman, as well as to some liberal professions), impose a principle of prior authorization by providing relevant qualification documents for all activities covered by this law. In Spain, the handicraft businesses are defined in the royal decree 1520/82, which limits the number of employees to ten on top of potential apprentices and family members. The artisanal sector covers the manufacture, production, and repair of goods or service delivery achieved "through a process where personal intervention is a dominant factor. . .." There are also lists of the concerned guilds. The business also has to be registered with the "craftsman register."

In Italy, the Law n. 443 dated 8 August 1985, on artisanal business, regulates artisanal work in the same spirit as in Spain but in a more restrictive approach. The entrepreneur "must carry out prevalently his personal manual labour in the manufacturing process and retain the greater part of the capital and of the deliberative powers." One of the downsides of this definition is that some legal status is prohibited (such as Limited Liability Company (LLC) and Limited Company (SA)). The number of employees is limited depending on the trade – 18 as a rule, including apprentices whose number should never exceed 9.

In France, according to the law of 5 July 1996 relating to the development and promotion of trade and handicrafts, craft businesses are defined irrespective of the craftsman who is himself defined in the decree 98–247 dated 2 April 1998 (Boutillier et al. 2009). A craft business should not have more than ten employees (however, under certain conditions, companies that so desire may remain registered on the register of trades beyond the threshold of ten employees – this is called "droit de suite") and exercise an independent professional activity involving the "production, transformation, repair of handicrafts or handicraft service provisions appearing on a list established by decree in Council of State." Only those persons having the required qualification can claim to their customers to be a craftsman or a master craftsman. Since 1969, various governments have developed supporting policies in this economic sector (Fournier 2006). In contrast, in the UK, there is not any status, regulation, or specific register to define the craft business.

Theoretical Background and Open-Ended Issues

The Craft Businesses Role in Different Types of Economy

This brief entry shows the diversity existing between the underlying social and economic reality of the craft business. However, if the legal side of the craft industry (and its definition alone) is already problematic, these various schools of thoughts are no better.

In the "Treatise on the craft industry and SME" ("Traité de l'artisanat et de la petite entreprise," Boutillier et al. 2009), S. Boutiller studies in detail the role played by the craft industry in the development of economic thinking from the eighteenth century until present. Some of her most interesting examples will be used before investigating the craft business research and development, especially in France. According to all eighteenth century economists (such as Smith, Quesnay), labor is a way of adding value – but which "labor" where they referring to? Smith advocated industrialization and division of labor... for the Physiocrats such as Quesnay, agricultural labor is the only productive labor; all other services and other labors than those of agriculture, including the craft, were sterile. Turgot considers that the cultivator produces not only his own wages, but, in addition, "the revenue which serves to pay the whole class of artisans and other stipendiaries..." (Turgot 1997, page 166 as quoted by Boutillier). The rest is history: industrialization, quest for profit, speculation, etc., have all led us to consider, for numerous years, the craft industry as a relic of the past. In the nineteenth century, Marx also considered that economic progress was synonymous with large companies and that unlike the proletariat which was revolutionary by nature, the craft industry was reactionary, for it was trying to "make the wheels of history turn backwards." He specifies however that a craftsman does not exploit the labor of other people but sells his work for his own profit.

Labor being a source of value creation, its organization became a major issue, which explains why companies, and especially big ones, became the focus of economists. During the whole period there will be a dichotomy between the worker who owns only his labor and is paid in wages for the exercise of that labor; he does not own the products of his labor, and has no right to any of the money from the sale of these products. One will have to wait until the 70s with Schumacher (Small is beautiful) for the SMEs to regain their popularity in terms of economic consideration. In France between 1980 and 1990, work from Julien in Canada and Marchesnay in France describe the SMEs like a "man-made invention enabling them to adapt to the complexity of changing environment." In 1982, Jaeger dealt directly with the craft industry in her publication "Artisanat et Capitalisme, l'envers de la roue de l'histoire" (craft. business and capitalism: turning back the wheels of history). In parallel to the main considerations regarding businesses, theories regarding entrepreneurs carry on evolving.

Implications for Theory, Policy, and Practice

During the 2000/2010 decade, theories and studies were developed with regard to the craft business and the craftsman as company leaders. A network of specialist researchers was also created (Fournier 2007) and produced perspective and insights about the economic and social specificity of craftsmen and craft businesses. The theoretical approach can be categorized through the "resource potential" concept developed by Boutillier and Uzunidis (Boutillier 2006; Boutillier and Uzinidis 2006) whose building blocks are as follows: knowledge, financial resources, and social relationships. From the beginning of the twenty-first century, craftsman and craft businesses have become very popular among scientific and social areas of research. The role played by the craftsman in the innovation process and in the strengthening of social cohesion is beginning to gain exposure and recognition (see section in the "Treatise on the craft industry and SME" – "Traité de l'artisanat et de la petite entreprise").

A definition rather different from the "official ones" touched upon in the first part of this entry is starting to emerge from all these different publications. Modern vision of a human society is now as far from backward-looking as the one described by economical speculators and specialists for who, to exaggerate a bit, companies are first and foremost a number which one can fiddle with in order to increase business profit. The modern craftsman is more and more a well-educated man or a woman who is perfectly integrated in the local community, well aware of innovation and able to picture his business' growth not solely through the number of employees. He is aiming to control his business and to live in an environment where he feels, rightly or not, free and independent. Practically, the craftsman manages, consciously or not, his areas of development depending on his resources, his trade, and his profession and puts forward its characteristics and institutional and normative setup. These three factors of development explain the limits of the craftsman's "freedom" and the wide range of diversities encountered in the field.

Conclusion and Future Directions

Toward a Unified Characterization of the Craft Industry

As seen previously, there is no definition of the craft industry: there are as many definitions, as there are countries, including within Europe. However, looking at various studies about the craft industry, it transpires that all these industries, men, and women share common characteristics and vision. For example, in Europe, the craft industry has now set up a European structure of representation, the "Union Européenne de l'Artisanat et des Petites et Moyennes Entreprises" – UEAPME (European Association of Craft, Small and Medium Sized Enterprises), which represents 12 million companies and 50 million people. This structure created a working group devoted to the culture of "craft enterprises" (Entreprise à caractère Artisanal, ECA) whose purpose is to define identification criterion for this type of business throughout Europe in order to establish a background for policy proposals and notably the EEC Commission. The consensus would be based on four ECA characteristics: production and processing of goods and services by outstanding craftsmanship at the head of the company, fundamental role of the head of the company who assumes responsibility and supervises the whole production process, acquisition, value building and knowledge capitalization, especially via a learning plan and integration of the company into its territory through its social responsibility.

The ECA's ambition is to show that a new business model is possible and would favor social stability. This new model must gain support of relevant public authorities by setting up appropriate flanking policies (like the Small Business Act in the USA).

Another factor, not frequently highlighted, characterizes the craft business: it is both the large number of businesses and their geographical dispersion. This largely contributes to the role of the craft industry in the community as well as its buffering role during an economic crisis: when a business employing hundreds or thousands of employees shuts down, it creates devastating economic and social effects in the area for numerous years to come. When a small craft business shuts down, unfortunately quite often nobody notices!

At the beginning of the twenty-first century, when the virtual economy has shown its limits, the craft industry by contrast could be assuring the well-being of future generations, by using a "real" economy as a way of moving the community forward through taking better account of the people and the environment. The craft industry is no longer then a "relic of the past" but one of the cornerstones underpinning our society and its evolution (Boutiller and Fournier 2006). That, combined with heads of companies' higher level of education (see above, as per OHADA use of the term "entreprenant"), should position the craft industry as a key player in any innovation process. That way, the professional representation' renewal could also move forward and politicians would be able to give a new meaning to craft industry policies which was well and universally expressed in Article 1 of the French law known as "Royer" (Fournier 2006 p.116): "They (trade and craft industries) must contribute to improvement of the quality of life, awakening of the urban life as well as increase competitiveness of national economy."

Vast programs which leave entreprenants a huge scope, should they be craftsmen, researchers, or elected representatives.

Cross-References

▶ Business Emergence
▶ Business Model
▶ Entrepreneur
▶ Entrepreneurial Opportunities
▶ Entrepreneurial Organizations
▶ Entrepreneurship and Business Growth

References

APCM. Quatrième conférence européenne sur l'artisanat et les petites entreprises. Stuttgart 16 et 17 avril 2007. www.artisanat.fr/portals/0/presse/dossiers_2007/2007_04_06_Conference_europeenne.pdf

Boutillier S, Castilla Ramos B. Les petites entreprises au Mexique, "Capitalisme aménagé" et réseaux sociaux, dans Boutillier S., 2011dir, *L'artisanat et la dynamique de réseaux*, Coll. L'esprit économique, L'Harmattan: Paris;2011. pp. 119–140.

Boutillier S, David M, Fournier C. (dir), Traité de l'artisanat et de la petite entreprise. Barcelona ES: Ed. Educaweb;2009.

Boutillier S. Du capital social au potentiel de ressources, Cahier du Lab. RII. 2006;115.

Boutillier S, Fournier C. Connaissance, finance, lien social: artisanat et innovation. Humanisme et Entreprise. 2006;280.

Boutillier S, Uzunidis D. Le potentiel de ressources de l'entrepreneur artisan dans le système territorial de production. Cahier du Lab. RII. 2006;127.

Fournier C. Artisanat et politique économique. In: Boutillier S, Fournier C (dir). Artisanat la modernité réinventée, coll. Marché et organisations. Paris: Ed. L'Harmattan;2006.

Fournier C. Une communauté de pratiques singulière: Le club des dirigeants du réseau Artisant-Université. In: Arnaud M (dir). Pédagogie en ligne, méthodes et outils. Barcelona ES: Ed. Educaweb;2007.

Kari Embarek. Le concept international de l'artisanat. Séminaire APCM/UIAPME Budapest 4 et 6 octobre 2003.

Sénat. Le statut de l'artisan;1995. www.senat.fr/lc/lc5/lc50.html

Symposium. Crafts and the international market: trade and customs codification;1997 October; Manila.

Turgot ARJ. Formation et distribution des richesses. Paris: GF-Flammarion (première édition 1766);1997.

Craftsmanship

▶ Microfirms

Create

▶ Invention Versus Discovery

Creation

▶ Business Start-Up: From Emergence to Development
▶ In Search of Cognitive Foundations of Creativity

Creation of Activities

▶ Entrepreneur and Economists

Creative Act

▶ Creative Behavior

Creative Behavior

John F. Cabra[1] and Diego Uribe-Larach[2]
[1]International Center for Studies in Creativity, Buffalo State, Buffalo, NY, USA
[2]Universidad Adolfo Ibañez, Las Condes, Santiago, Chile

Synonyms

Creative act; Creative being; Creative expression

What Is Creative Behavior?

Definitions and Perspectives

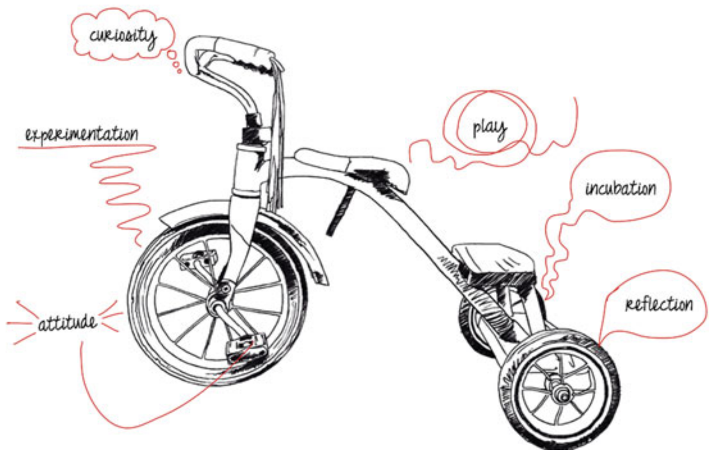
Creative behavior has been viewed as the creative act, or a set of acts, which is made explicit through behavior. Creative behavior is not submissive; it is action, which leads to a creative output or a solution to a challenge. Creative behavior is not confined solely to the domain of cognition and thought but rather it is action that yields output that is deemed original and useful (Puccio and Cabra 2011). It is a behavior that permits one to act unobstructed from self or externally imposed constraints in pursuit of self-expression, invention, discovery, design, and problem solving.

The actions most often associated with creative behavior can be drawn from Guilford's explanation and description of divergent thinking. Guilford (1977) constructed a three-dimensional model that he referred to as the Structure of Intellect (SOI) theory. In other words, intellectual abilities are described as a type of operation (e.g., divergent thinking, convergent thinking, memory, evaluation, cognition), which is set in motion by a kind of content stimuli (e.g., visual, auditory, semantic, symbolic, behavioral) for the purpose of organizing information into meaningful products (e.g., units, classes, relations, systems, transformations, implications).

Torrance (1966), who was influenced by Guilford's work, conceptualized measures of divergent thinking called the Torrance Tests of Creative Thinking (TTCT). These measures introduce individuals with a number of open-ended situations for which they are asked to provide either written or visual responses. The four primary cognitive skills assessed through respondents' answers are fluency (the total number of germane responses), flexibility (the number of categories associated with the germane responses), originality (the number of uncommon responses), and elaboration (the elaboration or extension of responses) (Millar 1995; Runco 1999; Torrance 1966). It is these four cognitive abilities that are most often associated with creative behavior. To the original four cognitive abilities, Torrance (2000) included 14 indicators of creative behavior, namely, abstractedness of titles, resistance to premature closure, emotional expressiveness, story articulateness, movement, expressiveness of titles, synthesis of ideas, unusual visualization, internal visualization, extending or breaking boundaries, fantasy, humor, colorfulness of imagery, and richness of imagery.

Creative behavior has also been described as incorporating spontaneity, which at its core is a reflection of freedom and incorporating sensitivity, which also involves a greater sensory perception to one's surroundings and to one's own feelings and thoughts (Klein 1972). Creative behavior also incorporates persistence and resilience.

What is most striking about these descriptions of creative behavior is its pattern. There is no single definition of creative behavior (Klein 1972). Instead, several words are used in concert to describe behavior. For example, Torrance's fluency, flexibility, and originality are pooled to identify a behavioral pattern. Resilience, persistence, and intra- and interpersonal awareness are used to describe a pattern that is demonstrated in everyday life. And, uniqueness, divergence, and spontaneity are used to identify characteristics of a normal behavioral pattern. These aforementioned qualifiers look at creative behavior as an essential life skill (Puccio et al. 2011). It is also worth noting that most of these descriptors speak to the cognitive abilities related to creative thought rather than to a more holistic concept of



Creative Behavior, Fig. 1 "TRYCycle" model of creative behavior (From (Uribe-Larach and Cabra 2012)

exercising creative behavior. As elusive as the constructs for creativity and creative thinking are to the layperson, the construct for creative behavior is even less developed, researched, and understood.

Creative Behavior Versus Creativity

Creative behavior in its most primitive form is a subset of play behavior (Brown 2009). From a biological perspective, play behavior is regarded as a form of exploration and adaptation. Conversely, creative behavior is also a form of exploration and adaption for the purpose of producing novel and useful outcomes. Creative behavior allows us to explore ways to rearrange features of an experience into something that is joyfully meaningful and novel (Uribe-Larach and Cabra 2011) – though creative behavior and creativity are intimately related, there is a distinction; while creativity is commonly understood as the production of novel and useful ideas (outcome centric), creative behavior relates to what we do to achieve such outcomes (attitude/behavior centric). First, an individual engaged in creative behavior scans a field for stimuli that is either external, internal, or both. Then out of curiosity, the individual explores the stimuli to gain understanding, insight, and a point of view. From this point of view, the individual experiments with new combinations or engages in sense making by generating analogies and metaphors. Responses can vary ranging from incubation, reflection, or more experiments that lead to discovery.

Using a "TRYCycle" Metaphor to Synthesize Attributes of Creative Behavior

The term "creative behavior" comprises a host of terms that are applied collectively to describe behavior. How then to organize and give physical form to a working definition of creative behavior? Toward a model to synthesize attributes most germane to creative behavior, a metaphor was identified, namely, the tricycle (see 1). The tricycle is an iconic toy and a symbol of childhood play and adventure. This metaphor has a strong emphasis on trying things and experimenting as a means to discover and learn; therefore, the word tricycle is adapted to include the word *TRY*. Additionally, this metaphor rests on three core behaviors (tri → try) that fuel creative behavior and they are experimenting (an iterative and hands-on approach to exploration), reflecting (a process to make meaning of past experiences), and incubating (a break from the energetic pursuit of a solution to a challenge or an experience) (Puccio et al. 2011). These three core behaviors occur in ongoing cycles until one's curiosity is fulfilled. The creative person then proceeds to the next thing that peaks his curiosity; curiosity's thirst is quenched and then off to the next adventure, which in turn reignites the ongoing *Cycle*. The TRYCycle's three wheels represent these three core behaviors.

Creative behavior is a form of play and, as such, makes up an early and natural way of discovering and making meaning of the world. Play is a state of mind that revolves around an absorbing, apparently purposeless activity, which provides enjoyment, and suspension of self-consciousness and time. Findings indicate that as in childhood, playfulness serves as a robust adaptive operation in adulthood (Magnuson 2011). Play also provides individuals with more cognitive resources from which they can manifest effective coping mechanisms while confronting stressful situations (Magnuson 2011). The tricycle seat therefore represents play since the seats serve as a mechanism for a child to fuss about and wiggle. In addition, sitting on a seat is the first behavior/action that is demonstrated, which parallels an early and natural way of discovering and making meaning of the world. Building on this metaphor, play sets the stage for creative behavior (experimenting, reflecting, and incubating).

The pedals represent the attitude of a child as shown through the child's vigorous peddling and metaphorically represent a sense of adventure, risk taking, passion, and openness to experience. The handlebars signal curiosity as the child scans for an attention-grabbing target and then manipulates the handlebars toward the target that captures the child's imagination. The child exhibits a focused attention, then questions what is observed, wanting to know more about what caught the eye's attention, then seeks to explore the object. Finally, the frame symbolizes a creative mindset essential to overcoming the constraints that get in the way of creative performance much like the frame keeps the tricycle together as it navigates bumps in the road. Specifically, the creative mindset operates three affective skills that permits exploration, such as openness to novelty (the ability to entertain ideas that at first seem outlandish and risky), tolerance for ambiguity (the ability to deal with uncertainty and avoid leaping to conclusions), and tolerance for complexity (the ability to stay open and persevere without being overwhelmed by large amounts of information, complex issues, and competing perspectives) (Puccio et al. 2011).

The TRYCycle metaphor serves as an organizing framework to visualize a simple, holistic, and coherent picture of what is involved in the complex phenomenon of creative behavior. This metaphor brings about an understanding of the interplay between the core behaviors of curiosity, play, experimentation, reflection, and incubation and the attitudes needed to sustain creative behavior.

Role of Creative Behavior in Creativity and Innovation

Typically, groups do not personalize creativity models to the fullest extent because they have too many steps and too much language for the models to be remembered. Despite the excitement creativity models can bring, the groups can appear enabled not necessarily empowered to want to internalize creative behavior. Many models are results oriented. Instead, if creativity and innovation models were behavior centric, then the model would serve as more effective prods to creative behavior. A behavior centric model offers easy access to organizational members because it prompts individuals to do more of what comes natural. Thus, the role that creative behavior can play is one of a sustained catalyst to creativity and innovation. If innovation is viewed as products, concepts, theories, and/or processes that are novel, useful, and successful (meaning that there is a high level of acceptance of the innovative qualities by a given domain), then creative behavior is essential to building innovation capabilities for any given social system (e.g., company/organization, community, country). That is, the more that creative behavior is seen within a social system, the greater the probability of producing novel and useful outcomes and, conversely, the greater the probability that one or more of these outcomes can result in successful innovations in their respective domains.

From a person-centered perspective, Ackoff and Vergara (1988) asserted that creativity is the ability to overcome self-imposed constraints. Therefore, creative behavior, when made explicit and is applied, can overcome perceptual, affective, and implementation blocks that get in the way of creativity and innovation (Klein 1972).

Perceptual blocks comprise inabilities to read people, circumstances, and even oneself. Without these reads, one is denied access to a host of data and knowledge useful for creative output. Instead, creative behavior sharpens one's ability to observe, hear, feel, smell, discriminate, touch, and access tacit knowledge. It is the perceptive person who can feel shades and degrees of meaning based on what is being observed. It is the perceptive person who broadens their scanning field. For example, one day, someone is seen placing a small amount of baking soda in a refrigerator and notices that it absorbed odors.

Affective blocks comprise inabilities to demonstrate empathy, formulate feelings based on observations, control emotions and one's relationship with others. The creative person, who is free of these blocks, can both anticipate and plan emotional reactions. They can see the point of view of others. They can build relationship with others and are not necessarily affected by societal judgments that hinder freedom of action (e.g., Who would have thought that a cup of coffee could be sold for $4.00? Yet, Starbucks did not permit the fallacy of a mature market, and the reaction it may have against the $4.00 coffee, to stop it from revolutionizing the take-out coffee business).

Implementation blocks comprise the inability to act upon emotions and the data that is garnered via perceptions. In other words, implementation blocks preclude the generation of new ideas and connections based on the insights that stem from increased perceptions, knowledge, and sensitivity. Instead the creative person can see new ways to use an object beyond its traditional use (e.g., Seeing other uses for baking soda such as baking-soda deodorant, baking-soda toothpaste, and, recently, baking-soda diapers). It is important to note here that implementation also requires overcoming further self-imposed constraints that might inhibit people from moving their organizations toward an innovative output.

Some people may have a fear of vulnerability that is attributed to change, which is an inevitable collateral of pursuing creative results and innovation. As a result, they may be inclined to go back to past ways of doing things. In other circumstances, other people are unable to flex. People may associate pain with new experiences, and as a consequence, they simply avoid them. Others may subscribe to a belief that their span of control is limited. This relates to people who do not go after new ideas because they believe they do not have the influence, the resources, or the political power to make things happen. Here they play it safe because they are overly concerned with the negative consequences that might come about if they try something new and fail.

In summary, creative behavior shifts or removes behavioral boundaries and, as such, aids in over coming self-imposed blocks, thus enhancing the probability of producing creative outcomes and innovation. A person who behaves creatively takes full advantage of options. They know they have a broad range of options and by itself can overcome cognitive paralysis or emotional hijackings. They realize that all things are possible, and all are worth knowing, worth exploring, and experiencing. Creative behavior searches for freedom. People who exhibit creative behavior feel comfortable and are free to define themselves not through the eyes of others but rather through their individual preferences. Creative behavior involves deferment of judgment, taking responsibility for creativity, taking risks, and being open to new experiences.

Future Directions and Conclusions

Given the importance of creative behavior as an essential life skill for thriving in a complex world, future research and practice should focus on the following lines of inquiry:

(a) *Behavioral components and skills*: The metaphor described above offers a holistic understanding of core behaviors that contribute to creative behavior. However, the metaphor is short of offering a developmental framework that nurtures the core behaviors and skills as described in the model. How can individuals be trained for curiosity, exploration, and play in a manner that adopts a more experimental hands-on approach to inquiry? In the same way in which thinking skills have been made explicit for optimizing creative thinking processes (Puccio et al. 2011), a deeper understanding of core behaviors and their embedded skills are needed to develop methods to assist individuals, teams, and organizations.

(b) *Environmental conditions for creative behavior*: While there has been an abundance of research to identify psychological climate dimensions supportive of organizational creativity (Ekvall 1996; Amabile et al. 1996), only loose connections can be drawn between these dimensions and the creative behaviors represented in the tricycle, namely, curiosity, play, experimentation, reflection, and incubation. For example, Ekvall's (1996) dimension of play and humor can be directly connected to the behavior of play, yet there is no climate dimension that can be connected in such way to experimentation, incubation, and curiosity. It can be asserted that the stronger the climate dimension of *risk taking*, as measured by the SOQ assessment instrument (Isaksen et al. 2001), the greater the volume and degree of experimentation expected from individuals and teams in an organization. Although the above correlation is rational and logical, such a relationship has not been established empirically. In other words, the dimensions identified in the literature for nurturing a creative climate connect to the outcome of creativity and not specifically to the behaviors involved in producing such outcomes. Moreover, it has been hardly established that these dimensions have predictive validity in nurturing conditions that foster creative behavior. Therefore, more and new research is needed to refine and unveil climate dimensions that correlate directly to creative behavior. Such a climate model that is linked to creative behavior would permit academics and practitioners to design effective intervention plans for building environments that trigger creative behavior in teams and organizations.

T. S. Eliot once asserted that we must not cease from exploration and at the end of all of our exploring will be to arrive where we begin and to know the place for the first time. Understandably, behavioral psychologists paid little attention to Eliot's prose as creativity was deemed an elusive construct and as such they avoided studying it. There are good reasons of course to explain their reticence. Myths and other misunderstandings have served as cognitive and cultural blocks to its study. Creativity suggested that only a few had it. And of those who had it, their creativity could not be studied, as it would unveil its magic. If only a few possessed this gift, then it would suggest that creativity was an endowment bestowed by the gods to those special few (Puccio et al. 2011). Although these myths have been largely marginalized by today's contemporary research efforts to explore these multifaceted phenomena, the layperson continues to believe that creativity cannot be trained. It is precisely these kinds of constraints that lead scholars to assert that a crucial ingredient to creative behavior is acting freely from the many restraints society puts around people and the self-imposed constraints people place on themselves.

Creative behavior is an essential function of the human experience. It is not something you turn on and off like a water faucet. Instead, it is an ongoing process of behaving in society, of engaging in the vicissitudes of life. Creative behavior is a way of viewing the world in the moment. Read how Hallmark poignantly described the experience outside its tricycle keepsake box.

> What could be more thrilling than your first set of wheels? From its finger-grip handlebars to the ride-along platform, the little red tricycle inspires almost universal nostalgia. It's easy to imagine the expression of surprise and joy on the face of its new owner. Not long afterward, with a rush of independence, the rider pedals off down the sidewalk and the adventure of a lifetime begins.

It is through creative behavior that adventure is experienced in the same manner in which a tricycle ride translates into self-expression, discovery, invention, design, and problem solving.

Creative behavior is about manifesting full potential in a mad world of complexity, volatility, uncertainty, and ambiguity. At its core, creative behavior prompts us to take a dynamic hands-on role in shaping a life as free and determined as possible – if only we would invest half as much childlike effort attempting to capitalize on our choices for behavior as we invest adult-like effort in restricting them (Klein 1972).

Cross-References

- ▶ Creative Mind: Myths and Facts
- ▶ Creative Personality
- ▶ Creative Styles
- ▶ Creativity and Emotion
- ▶ Decrease in Creativity
- ▶ Divergent Thinking
- ▶ Freedom and Constraints in Creativity

References

Ackoff RL, Vergara E. Creativity in problem solving and planning. In: Kuhn RL, editor. Handbook for creative and innovative managers. New York: McGraw-Hill Book; 1988. p. 77–89.

Amabile TM, Conti R, Coon H, Herron M, Lazenby J. Assessing the work environment for creativity. Acad Manage J. 1996;39(5):1154–84.

Brown S. Play: how it shapes the brain, opens the imagination, and invigorates the soul. New York: Avery; 2009.

Ekvall G. Organizational climate for creativity and innovation. Eur J Work Organ Psychol. 1996;5(1):105–23.

Guilford JP. Way beyond the IQ: guide to improving intelligence. Buffalo: Creative Education Foundation; 1977.

Isaksen SG, Lauer KJ, Ekvall G, Britz A. Perceptions of the best and worst climates for creativity: preliminary validation evidence for the Situational Outlook Questionnaire. Creat Res J. 2001;13:171–84.

Klein RD. Evolving creative behavior. An unpublished doctoral thesis. Amherst, MA: The University of Massachusetts; 1972.

Magnuson CD. The playful advantage: How playfulness enhances coping with stress. An unpublished master's thesis. Urbana-Champaign: Graduate College of the University of Illinois; 2011.

Millar GW. E. Paul Torrance: the creativity man. Norwood: Ablex; 1995.

Puccio GJ, Cabra JF. Idea generation and idea evaluation: cognitive skills and deliberate practice. In: Mumford's MD, editor. Handbook for organizational creativity. New York: Elsevier; 2011. p. 187–213.

Puccio GJ, Mance M, Murdock MC. Creative leadership: skills that drive change. 2nd ed. Thousand Oaks: Sage; 2011.

Runco M. Divergent thinking. In: Runco MA, Pritzker S, editors. Encyclopedia of creativity, vol. I. San Diego: Academic; 1999. p. 577–82.

Torrance EP. Torrance tests of creative thinking. Bensenville: Scholastic Testing; 1966.

Torrance EP. Research review for the Torrance tests of creative thinking: verbal and figural forms A and B. Bensenville: Scholastic Testing Service; 2000.

Uribe-Larach D, Cabra JF. The opportunities and challenges of technology driven collaborations. In: Mesquita A, editor. Technology for creativity and innovation: tools, techniques and applications. Hershey: IGI; 2011. p. 325–42.

Uribe-Larach D, Cabra JF. TRYCycle: Comportamiento creativo [Creative behavior]. Santiago, Chile: Idemax; 2012.

Creative Behaviors

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Creative Being

▶ Creative Behavior

Creative Brain

Ph Nina Slanevskaya
St. Petersburg Centre for Interdisciplinary Neuroscience Ltd., St. Petersburg, Russia

Synonyms

Creative insight; Creativity in neuroscience, studies; Creative process in brain

Key Concepts and Definition of Terms

The concept of "creativity" includes different aspects, such as a human ability of a creative insight, the product created by such a creative insight, and the appreciation of this product as something new and valuable by people. The term "creative insight" implies a process occurring in a flash but which brings something very substantial and completely new, it differs from conscious production, it can happen during sleep or in a dreamlike state, and this process seems to be inspired (Andreasen 2006). If a creative insight is a topic of interest, the human brain and human psychology are studied. However, the psychological reaction and brain work are inseparable from sociocultural context. To enhance creativity, there must be knowledgeable experts to assess the product of creation, universities to teach top-level science, and the field which wants a created product. Thus, creativity can be considered as a kind of interaction between a person's thoughts and sociocultural context (Csikszentmihalyi 1997).

Theoretical Background and Open-Ended Issues

Contesting Views on Creativity and Challenges

There has been a long-lasting discussion in science concerning creativity and the interaction of "nature" (genes) and "nurture" (good education, the accessibility of the domain for a researcher, and societal encouragement).

As a rule, neuroscience does not include the wider social aspect of creativity and limits itself to the study of neurophysiological processes in the brain. But this narrower field has its own challenges: what is consciousness and what is the exact mechanism of transformation of neural firing into an abstract thought? Only after answering these questions, we can reliably define what a creative insight is and how to enhance human creativity.

The creative insight is difficult to study with the help of scanning in the laboratory conditions, because the owner of such an insight never knows when it will come to him/her. So neuroscientists have to restrict themselves to the studies of neurophysiological characteristics of creative people and to scanning the brain during various tests on creativity.

The tests on creativity are usually on divergent thinking and consist mostly of verbal tasks. However, the creative people, who are tested, work in different spheres (literature, music, science) and can see an image or hear sounds as a creative solution without any words or conscious thinking. It means that, perhaps, their neuronal activation patterns in the creative process will differ and they are not what the test-designers suppose. And, perhaps, a highly creative person might be unwilling to answer such irrelevant to his work a question as: "How many uses can you think of for a brick?"

In other words, how do we know that the existing tests on creativity identify the creativity, indeed? And what kind of level of a creative person is studied by a neuroscientist: a clever original conversationalist, a creative person whose creativity is directed at himself, or a person who has changed the public culture and science (Csikszentmihalyi 1997)? Everyone is mainly interested in the third phenomenon, but neuroscientists never discriminate between these three categories of creative people, though it is clear that their brains will work differently.

There are also some technical and data assessing challenges in neuroscience. The creative activity of the brain is scanned and usually compared with a baseline, when the brain is considered to be in a passive state. But the brain is never passive at all, and it is, perhaps, when the person is not thinking consciously about the solution of the problem that a creative insight takes place due to the formation of uncontrollable unconscious associations in the mind (Andreasen 2006).

The attention of neuroscientists has been focused on the following questions in the study of creativity:

– What are the properties of a creative brain?
– What goes on in the brain during a creative process?
– How does a creative process influence the brain itself?
– How can we help the brain to be more creative?
– How can we use the process of creativity (e.g., in art therapy) for curing disease?

Various research methods have been used for answering these questions, and various hypotheses have been put forward:

- Anatomical importance of some brain structures with unusual characteristics (the phenomenon of synesthesia) and, perhaps, the thickness/thinness of the brain cortex at certain places
- Inborn or acquired specific neurochemistry of the brain
- Genetic predisposition (rather close to the characteristics of schizophrenia)
- Specific functioning of neural circuits in the brain under certain circumstances (tiredness, dream, beautiful landscape, a pleasant shock, etc.), i.e., the controlling neural circuits stop controlling or control less, new neural circuits start working, and creative associations are formed
- Neurophysiological importance of specific brain waves at specific brain areas for a creative state

Many neuroscientists also emphasize special traits of character of a highly creative person and a specific behavior: the courage of insisting on the nonconventional way of solving a problem, obstinacy and "doggish pursuit" of the task, and the elimination of all irrelevant aspects of life which distract the attention from a creative process.

Implications for Theory, Policy, and Practice

Creativity: Studies and Hypotheses in Neuroscience

What Goes on in the Brain During a Creative Process?

There are four basic types of creative thinking with distinctive neural circuits depending on the knowledge domain (emotional or cognitive) and the processing mode (deliberate or spontaneous) (Dietrich 2004). The first type operates in an emotional field and has the deliberate processing (e.g., writing and rewriting a novel). The second type is based on the spontaneous processing in an emotional field (e.g., writing a poem). A cognitive field with the deliberate processing (e.g., working, planning, and experimenting in science) is the third type. A cognitive field with the spontaneous processing is the fourth type (e.g., the solution of the problem comes quite on a sudden when the person is doing something else and stops thinking about the work). For this classification, it is important to distinguish the function of the frontal lobe from three posterior cortices – the temporal, the occipital, and the parietal (TOP) (Dietrich 2004). The frontal lobe does not get direct sensory information and does not have long-term memory unlike the TOP, but the frontal lobe is important for working memory and responsible for the deliberate focusing of attention, critical assessment, and flexibility of thinking that allows new combinations. In the TOP, there are mainly neurons engaged in perception, because there are primary sensory areas and associative areas. The representation of the information received by the TOP goes to the frontal lobe and is present in the working memory. The deliberate mode in the cognitive domain is supported by the prefrontal cortex, which gets the necessary information from the TOP and other cognitive structures of the brain. The deliberate mode in the emotional domain is supported by the frontal attentional neural network and the structures of the brain responsible for emotions. The spontaneous mode in the emotional domain recruits the structures which process emotional information spontaneously, and this information gets into the working memory. The spontaneous mode in the cognitive domain starts in the TOP areas during the unconscious thinking full of free associations. The more brain structures are involved in the integrative brain process, the more new combinations are formed. Such a classification is an attempt to combine knowledge, emotions, and deliberate and spontaneous modes involved in creative thinking. A creative person uses mostly one type of creating thinking out of four, but it does not mean that he cannot use another type.

Bekhtereva considers that creativity is a natural process and any brain needs creativity for normal functioning because customary actions gradually become partly automatic reducing the activity of neural networks engaged in novelty and the brain stops working in the optimal regime (Bekhtereva 2007). Creative thinking, according to Bekhtereva, is connected with the reorganization of neural activity in the brain. There are fixed links and flexible links between some neural areas. The fixed links work constantly, but flexible links have a tendency of disappearing, with other ones appearing. The brain fights monotonous work done by a researcher with the help of the formation of new flexible links which, nevertheless, are engaged in the general task performed by a researcher. Both fixed and flexible links continue working for the solution of the task. The appearance of new flexible links depends on both the monotonous work (inner cause) and the signals from the surrounding (outer cause). The more flexible links are involved, the more original and creative the solutions are.

Damasio emphasizes some requirements for creativity, for example, the strong generation of representative diversity (i.e., the ability to generate a lot of novel combinations of entities or parts of entities as images and bring these images to the conscious mind) (Damasio 2001). The images demand the work of sensory cortices, but they are conducted and ordered from the prefrontal cortex. Creativity demands also a large capacity of working memory which permits to retrieve and generate representations internally, to hold these representations ready, and operate on them. The term "working memory" means not only the retention of some information but also the manipulation on it. Creativity needs the prefrontal cortex to recognize novel representations and to choose the best. The signals from the perceived surrounding first go to the primary cortices responsible for auditory and visual perception. At this stage, the map of activated neurons is created. The areas of brain responsible for sensory perception are surrounded with associative areas where neurons are polyfunctional. Here, the new representations are created out of the mapped information from sensory cortices. Damasio calls such representations in the associative areas of the brain as dispositional representations (Damasio 2001). Such dispositional representations preserve all mapped recordings of neural activities. From here, the representations can go back to the sensory areas, and the person can see in his mind, for example, the features of his friend's face without seeing him. It is in this backward process that the modification usually takes place and novelty appears. If such memory, for example, of a friend's face brings about some emotions, it means that the prefrontal area participates in the process and the representations are important for the whole organism/body of the person. These above-mentioned dispositional representations correlate with the first state of the body when the event or object was first mapped and produced an effect on the human body. Neurochemical responses in the brain change the functioning of neural circuits and influence the emotional state and creative abilities. For example, the level of creativity due to the changed neurochemicals in the brain caused by depression is much lower; the hippocampus of the brain, which is important for remembering, shrinks; and working memory becomes worse.

What Are the Properties of a Creative Brain?

The relation between knowledge and creativity has always been of great interest for scientists. It has been found that the ability for creative thinking does not depend so much on the level of intelligence. If the IQ is higher than 120, it does not correlate with creative abilities anymore (Andreasen 2006). The person can have a higher level than 120, but he/she can be less creative than the other one who has a lower IQ. Neuroscientists conducted scans of people to measure levels of N-acetylaspartic acid (NAA) to define the correlation between creativity and intelligence and made measurement of the thickness of the cortex at certain places in the brain where they thought a creative process took place (Jung et al. 2009a, b). The decrease of the level of NAA indicates the dysfunction or the death of neurons. Jung and colleagues arrived at the conclusion that their NAA tests confirmed the psychological studies that for creativity it is not necessary to have a high IQ and that after 120, the level of intelligence is not important for creativity (Jung et al. 2009a). As for the thickness of the cortex, the thickness at some places had a positive correlation with the level of creativity, but at other places, there was a negative correlation (Jung et al. 2009b). For example, the thicker the cingulate cortex is, the better it is for creativity (a cingulate gyrus is responsible for detecting a mistake), and the thinner the cortex is in the area of a cuneus (Brodmann area 18, left hemisphere) or in the fusiform gyrus (Brodmann area 19, left hemisphere), the more creative a person is. If to speak about the cortex of the brain, on the whole, the thinner the cortex is, the more creativity its owner shows. Jung explains it by an easier and quicker possibility of forming associative connections by neurons, which is necessary for creative thinking.

There is also a hypothesis that creativity is connected with synesthesia because synesthesia promotes metaphoric thinking, helpful for creativity (Ramachandran and Hubbard 2001). Synesthesia is a neurological phenomenon. The stimulation of one neural network (sensory perception or cognitive thinking) is accompanied automatically by the activation of another network at the same time and which under the normal conditions is not activated. For example, when a man is looking at figures, he sees them in color, or when he listens to music, he sees it in color. Sometimes color, sound, and smell are combined.

The concept of creativity has always been connected with the term "genius." The behavior of a genius, as it is generally noticed, is different from an ordinary person. The hypothesis of the connection between high creativity and mental disorder (especially mild forms of schizophrenia) was put forward long ago. According to this hypothesis, creativity has a genetic basis.

Andreasen agrees with the hypothesis on the whole but remarks that mental illness is not a necessary requirement for creativity, besides she insists that one should discern extraordinary abilities for creativity from normal abilities for creativity because different neural circuits are engaged (Andreasen 2006). If we deal with extraordinary abilities, a subconscious mental process prevails. The brain of a genius works differently. Andreasen finds similarity of the state of the brain in meditation (or the altered states described by the great mystics) with the state of the brain of a creating person (intense focus, dissociative state as though being in some transcendent and remote place) (Andreasen 2006).

How Can We Help the Brain to Be More Creative?

To answer this question, the hypothesis of the enhanced creativity due to a hypnagogical effect on the brain was proposed. Hypnagogia is the transient state which happens when waking becomes sleeping. In such a state, a person often has fragmentary thoughts and visual imagery. The hypnagogical state starts when the theta band (6–7 Hz) amplitude becomes more pronounced than that of alpha (8–11 Hz) (Gruzelier and Egner 2004). With the help of electroencephalogram (EEG) and neurofeedback training, it is possible to enhance creativity in live performance. After alpha-theta training, for example, conservatoire musicians demonstrated a higher level of performance and musicality by 12% on average and some of them even by 50% (Gruzelier and Egner 2004).

Conclusion and Future Directions

Conclusion

However elusive a creative process may be for studying with the help of brain scanning, what makes things much worse is an unsolved mind-brain problem. The ontological position on the nature of consciousness and hence on creativity makes a neuroscientist choose a matching epistemological approach for his research. For example, having chosen a materialist ontological position on brain and mind, Rex Jung studies the thickness of the cortex as a physical property of creative thinking. The thinner (or thicker) the cortex is at certain places, the more creative ideas one will produce. Meanwhile a non-materialist neuroscientist would draw our attention to the neuroscientific fact that the brain changes physically under the pressure of non-material thoughts (Beauregard and O'Leary 2007). So the thickness of the cortex can develop after practicing creative activities for a certain period of time (if thickness/thinness is important for creativity at all). A non-materialist neuroscientist would also say that such an epistemological approach is wrong and it cannot show the true nature of creativity, however well and thoroughly Rex Jung might study the thickness of the cortex. The thickness/thinness does not cause creativity, it follows it. A materialist neuroscientist, on the contrary, would claim that any thought arises after and on the basis of neural firing, and so does creativity. However, none of them has yet discovered the exact working mechanism of interaction between a non-material abstract thought and a material biological neuron.

Science comes into our life and its conclusions influence social policy. Is it the brain whose neurophysiology should be changed for better creativity? Must there be the change of sociocultural climate for the better interaction between a person's thought and sociocultural context? Is creativity similar to a mystic state when a human mind freely travels to get the information from the Universal Mind? Should meditation be introduced into schools and universities to train a student to bring about a creative trance at will?

Though the source of creative insight has always been one of the most interesting for people, neuroscience is not ready yet for giving a definite answer to all these questions.

Cross-References

- ▶ Creative Behavior
- ▶ Creative Personality
- ▶ Creativity, Experiential Theories
- ▶ Four Ps of Creativity
- ▶ Genius
- ▶ Measurement of Creativity
- ▶ Nature of Creativity
- ▶ Research on Creativity
- ▶ Role of Intuition in Creativity
- ▶ Science of Creativity

References

Andreasen NC. The creative brain, the science of genius. New York: A Plume Book; 2006.

Beauregard M, O'Leary D. The spiritual brain. A neuroscientist's case for the existence of the soul. New York: HarperOne; 2007.

Bekhtereva NP. The magic of the brain and labyrinths of life. Moscow/St. Petersburg: Sova; 2007.

Csikszentmihalyi M. Creativity. Flow and the psychology of discovery and invention. New York: Harper Perennial; 1997.

Damasio A. Some notes on brain, imagination, and creativity. In: Pfenninger K, Shubik V, editors. The origin of creativity. New York: Oxford University Press; 2001. p. 59–68.

Dietrich A. The cognitive neuroscience of creativity. Psychonomic Bull Rev Psychonomic Soc. 2004; 11(6):1011–26.

Gruzelier J, Egner T. Physiological self-regulation: biofeedback and neurofeedback. In: Williamon A, editor. Musical excellence: strategies and techniques to enhance performance. New York: Oxford University Press; 2004. p. 197–219.

Jung RE, Gasparovic C, Chavez RS, Flores RA, Smith SM, Caprihan A, Yeo RA. Biochemical support for the "threshold" theory of creativity: a magnetic resonance spectroscopy study. J Neurosci. 2009a;29:5319–25.

Jung RE, Segall JM, Bockholt HJ, Flores RA, Smith SM, Chavez RS, Haier RJ. Neuroanatomy of creativity. Hum Brain Mapp. 2009b;31:398–409.

Ramachandran VS, Hubbard EM. Psychophysical investigations into the neural basis of synesthesia. Proc R Soc Lond B. 2001;268:979–83.

Creative Business

▶ Creative Management

Creative Climate

▶ Measuring Organizational Climate for Creativity and Innovation

Creative Collaboration

Titus Yong
Singapore Management University, Singapore, Singapore

Synonyms

Collective creativity; Great groups; Group creativity; Interdisciplinary groups; Open creativity

Introduction

Creative collaboration refers to two or more individuals, teams, entities, or organizations coming together to work on a project or challenge of common concern typically that is too challenging to be undertaken alone; the creative process of the collaboration would produce novel and useful work. Members can collaborate either physically or remotely through electronic or other means at all or different phases of the project.

This entry explores the various conditions for creative collaboration to thrive. In social science research, instead of relying on generalizations, the more useful approach is to study the conditions upon which a desired outcome (in this case, creative collaboration) would likely happen.

There have been debates surrounding the question on whether creative individuals or groups are more optimal for generating creativity. Judging from historical outputs or successful outcomes, the creative tasks that lend well to being undertaken by individuals include tasks that require organizing and expressing ideas that are partially formed in one's mind or those that involve the ideas from deep in the unconscious such as writing novels, poetry, art, or symphonic score.

For more significant projects, including those that arise from issues in our increasingly complex world and hypercompetitive business environments, the creative ideas and execution would demand a pool of talented people. The notion of the lone genius, such as Steve Jobs or Thomas Edison, is partly a myth because creative geniuses depend on many other people in the team or external organizations to bring their visions into fruition. Many significant discoveries that won Nobel Prizes increasingly have been the result of collaboration or sharing of information among two or more individuals. A case in point is the discovery of the DNA – this is the result of a creative collaboration between a physicist Francis Crick and a biochemist James Watson; they relied on data from Rosalind Franklin and the considered the ideas of Maurice Wilkins and Linus Pauling.

A Northwestern University team of researchers, after having analyzed millions of academic papers and patents from the past five decades, found that the average team size has increased by 20 % each decade, and levels of teamwork have increased in over 95 % of scientific subfields (Wuchty et al. 2007). "Home-run papers" – publications with over one hundred citations – are six times more likely to be the result of creative collaboration of teams of scientists than the solo author. As research questions become increasingly more complex, and researchers and experts become more specialized due to the limit a mind can handle, this leads to a natural need for collaboration – and more cross-disciplinary explorations.

The Process of Creative Collaboration

The process of group creativity can be categorized into four stages:

1. *Identifying and clarifying the project/problem.* This involves scanning the external and internal environment for problems and opportunities. The leadership needs to set the desired results clear for the group.
2. *Creating the ideas (ideation)*, which involves generating and assessing the different ways to circumvent the problems and exploit the opportunities. This is typically perceived to be the diverging phase of the entire process where the members search for or contribute many ideas. Two-time Nobel Prize winner Linus Pauling was quoted: "The best way to have a good idea is to have lots of ideas."
3. *Developing the selected ideas*. This stage is the converging phase where the best possible options are selected and further elaborated upon.
4. *Implementing the solution(s)*. This is the stage where the detailed ideas are put into fruition.

In terms of the assessment of creative outputs, a commonly used criterion is the Torrance framework, which forms the basis for the Torrance Creative Thinking tests. The four criteria include fluency (number of ideas), flexibility (ideas from different categories), originality, and elaboration.

Fluency and flexibility during the ideation phase is desirable; hence, the psychological conditions of the team (team diversity) described below is helpful toward this aim.

The second stage (ideation) is often associated with group brainstorming, and quantity and variety of ideas are useful. The term "brainstorming" was created in the late 1940s by Alex Osborne, a partner in the advertisement firm BBDO. Among the rules were the members of the team are not allowed to criticize other people's ideas. There has been research findings on brainstorming that suggest that this aspect of non-critical group ideation may not be very effective. Charles Nemeth, at the University of California (Berkeley), found that groups given brainstorming guidelines created more ideas than groups that were not given any brainstorming guidelines; however, the most creative groups are the ones who debated and criticized each other's ideas. Nemeth postulates that dissent forces team members to understand other team members' ideas more fully and makes each team member reassess his/her viewpoints, thereby stimulating more ideas (fluency).

The exposure to unfamiliar perspectives and discussions around initially disjointed ideas can lead to idea flexibility. This phenomenon is termed "breaking set" – instead of going down familiar cognitive pathways to generate the most obvious connections, the team members instead go off tangentially to explore novel idea connections. A related idea is Janusian thinking or the concept of paradox. Janus, in Greek mythology, is a god with two faces looking in opposite directions, one eastward, the other westward. In Janusian thinking, the thinker holds opposing views or images concurrently; this is the process of holding antithetical ideas and then trying to resolve them. In a group setting, this can be achieved when different team members come up with the opposing ideas (debate) and then collectively iron out the plausible solution(s).

The team members involved would typically have preferences in one or more of the stages. A good way to parcel out the tasks is to identify the stage or stages that each member has clear preferences in. The creative collaboration would then have a clear path from problem identification to successful implementation.

Besides consideration on the stages, there are social, psychological, and physical conditions that affect the outcome of the creative collaboration.

Social and Organizational Conditions

There are many group norms and organizational conditions that favor very successful creative collaborations (Bennis and Biederman 1998; Edmundson 1999):

(a) People: Strong leader(s) and superb team members who have a symbiotic relationship. The leaders love talented people and know where to find them. The right person is assigned the right job.
(b) Mission: They think they have a divine mission and are able to remove distractions. The leaders provide them what they need and free them from other commitments. They are like an island but still bridged to the mainland. The intrinsic motivation of delivering the great work or product in itself is the reward (Amabile 1996).
(c) Optimism and risk taking: They are not realistic, they are optimistic. They identify for themselves an enemy target and also see themselves as winning underdogs. The culture of risk taking should be one where there is psychological safety. This is defined as the "characterized by a shared belief that well-intentioned action will not lead to punishment and rejection." The risk-taking culture that leads to improved performance is the responsibility of good team leadership.

Certain forms of collaborations lend themselves better for scalability and are therefore more powerful (Hagel et al. 2009):

- Relational versus transactional collaboration: Relational collaboration, the seekers and solvers build relational capital for longer period of time, supports the creation and exchange of tacit knowledge – hence, is more likely to be scalable. Transactional collaboration relies on companies putting

forward specific problems and asking groups of people to propose potential solutions such as the case of InnoCentive – this is an example of crowd sourcing.
- Dynamic versus static collaboration: In static collaboration, participants contribute existing knowledge. For dynamic collaboration, new knowledge and capabilities are formed continually.
- Loosely coupled versus tightly coupled collaboration: Tightly coupled collaboration is a more hardwired approach in which the activities or connections between the collaborating parties need to be renegotiated each time there is a change in the activity or connection. More loosely coupled collaborations tend to be more flexible; hence, this form of collaboration scales better.

Brian Uzzi and Jarrett Spiro (2005), who studied Broadway musicals from 1945 to 1989 in their quest to find the ideal model of group creativity, proposed a five-point scaled called the Small World Quotient (or Q, in short), which is a measure that quantifies the density of social connections from low to high connectivity or familiarity from past collaborations. He found that musicals that were commercial successes were three times more likely to be produced by teams with a Q score within the range of 2.4–2.6 than teams with scores above 3.2 or below 1.4. The best creative outcomes come from networks of people with an intermediate level of social intimacy (between a), i.e., a mixture of old friends and newbies or strangers – which can be an injection of unknown talent in an otherwise overly comfortable team that reverts to its former ideas.

For research-type roles, a moderate flowthrough of new members joining the collaboration is helpful as they bring along with them fresh ideas and perspectives which the original group would not have otherwise been exposed (Allen et al. 1988).

Psychological Conditions

For collaboration to yield creative outcomes, the selection of team members can comprise people with substantial knowledge of the field, different cultures, and thinking styles. Thinking or cognitive styles refer to the left-brain, right-brain dichotomy. Although this is a simplified view of the brain structure and function, it is a quick classification that can be easily implemented through questionnaires. The left-brain thinking is characterized by an analytical, sequential, and logical approach to problem solving, while the right-brain thinking approach is more intuitive and nonlinear (Leonard and Strauss 1997). Interactions among people with different thinking styles and preferences for the process stages described above may result in creative abrasion - this term, coined by Jerry Hirshberg at Nissan Design International, is defined by Xerox Parc leader John Seely Brown as “ideas that really rub against each other productively as opposed to destructively.” The team members with differing thinking styles are deliberately chosen to maximize the diversity of the team. This diversity can be helpful particularly during the ideating stage of the collaboration.

Successful collaborations tend to exhibit substantive conflict (i.e., conflict arising from differences in views regarding the ideas or substance of the project) instead of interpersonal conflict that are more personal in nature (Eisenhardt et. al 1997). Diverse groups that can get over the initial challenging periods where team members learn to adjust with each other would end up with ideas or products that are more creative than those generated by homogeneous teams that have smoother interactions from the start (McLeod et al. 1996).

Physical Conditions

The collaboration space should allow for interaction and movement as teams move around to group and regroup. Smaller tables that accommodate several people are preferable to large conference style tables. Psychologist Ivan Steiner found that actual productivity increases for a while as the size increases, then reaches a plateau, and then decreases as the group gets too large; the optimal number is between four to five people.

A study of geographically dispersed teams (Leonard et al. 1998) found that, for complex tasks, the teams prefer face-to-face interactions for optimal creative process. Face-to-face meetings afford the richest multichannel medium of communication, including body language. Researchers from Harvard Medical School found from their study of 35,000 peer-reviewed papers, concurred the above findings. The best research papers, i.e., those with high number of citations, were coauthored by people working within 10 m of each other. Papers written by coauthors working more than 1 km apart were the least cited (Brownstein et al. 2010). This suggests the need for the optimal design of architectural spaces that support spontaneous, regular, and face-to-face interactions.

Future Directions

The process of globalization has resulted in an increasing trend of global collaborative creativity resulting in cross-border patents. Although the number of inventors collaborating on cross-border projects has increased exponentially, the number of cross-border patents has only grown linearly. Although the nature of collaborative creativity has become more globalized, this form of collaboration has so far mainly concentrated in countries such as the USA, the UK, France, Germany, and Canada (Huang et al. 2012).

Another trend is the Creative Commons licensing framework or Public Domain Mark, started by a nonprofit company by the same name (web: creativecommons.org). Content owners can choose to grant limited permission (licenses) for their work to be used for noncommercial purposes or to be further built upon by others to create derivative works, including by people unrelated to the original content. Through this sharing framework, this new concept of creative collaboration can result in a derivative work taking on a new life of its own, unrestricted by the boundaries of an intact team.

Cross-References

▶ Brainstorming and Invention
▶ Convergent Versus Divergent Thinking
▶ Corporate Creativity
▶ Creative Behavior
▶ Creative Personality
▶ Ideas and Ideation
▶ Interaction, Simulation, and Invention

References

Allen T, Katz R, Grady JJ, Slavin N. Project team aging and performance: the roles of project and functional managers. R&D Manag. 1988;18(4):295–308.
Amabile T. Creativity in context: the social psychology of creativity. Boulder: Westview Press; 1996.
Bennis WG, Biederman PW. Organizing genius: the secrets of creative collaboration. Reading: Nicholas Brealey Publishing; 1998.
Edmondson A. Psychological safety and learning behavior in work teams. Adm Sci Q. 1999;44:350–83.
Eisenhardt K et al. How management teams can have a good fight. Harvard Bus Rev. 1997.
Hagel III, J, Brown JS, Davison L. Introducing the collaboration curve. HBR Blog Netw. 2009.
Huang M-H, Dong H-R, Chen D-Z. Globalization of collaborative creativity through cross-border patent activities. J Informetr. 2012;6(2):226–36.
Lee K, Brownstein JS, Mills RG, Kohane IS. Does collocation inform the impact of collaboration? PLoS One. 2010;5(12):e14279.
Leonard D, Strauss S. Putting your whole company's whole brain to work. Harvard Bus Rev. 1997.
Leonard DA, Brand PA, Edmonson A, Fenwick J. Virtual teams: using communications technology to manage geographically dispersed development groups. In: Bradley SP, Nolan RL, editors. Sense and respond: capturing value in the network era. Boston: Harvard Business School Press; 1998. p. 285–98.
McLeod P, Lobel S, Cox T. Ethnic diversity and creativity in small groups. Small Group Res. 1996;2(27):248–64.
Uzzi B, Spiro J. Collaboration and creativity – the small world problem. Am J Sociol. 2005;111(2):447–504.
Wuchty S, Jones BF, Uzzi B. The Increased Dominance of Teams in Production of Knowledge. Science. 2007;316:1036.

Creative Conditions

▶ Creative Knowledge Environments

Creative Contexts

► Creative Knowledge Environments

Creative Destruction

Faruk Ulgen
UFR ESE-University of Grenoble II, Grenoble Cedex 9, France

Synonyms

Economic dynamics; Entrepreneurial economy; Entrepreneurship financing; Innovation

Intellectual Roots of the Concept

Creative destruction refers to the phenomenon of economic change through the creation of new ways of doing things that endogenously destroy and replace the old ways. It is assumed that new products and new processes are the main source of the capitalist economy's development. The term "creative destruction" is usually used to emphasize the dynamic nature of the modern economic system and is more readily thought as a positive evolutionary process.

Creative destruction is originally derived from Marxist economic theory (*The Communist Manifesto* of Marx and Engels, 1848, *Grundrisse* of Marx, 1857 and *Das Capital*, 1863), which put to the fore the capitalist processes of destroying and reconfiguring previous economic structures. This approach argued that the capitalist evolution must ceaselessly devalue existing wealth (through war economic crises) in order to prepare the environment for the creation of new wealth. In its most common sense, this process points out the way in which capitalist economic development goes through the destruction of the prior economic order to create some new structures. But the intellectual roots of the term "creative destruction" can also be found in Nietzsche's *Zarathustra* (1883–1892) and in the *Krieg und Kapitalismus* (War and Capitalism, 1913) of German Marxist sociologist Werner Sombart (see Reinert and Reinert 2010).

Creative Destruction as an Evolutionary Process of Economic Change

Economic Change

After World War II, creative destruction has become identified with Joseph Schumpeter (1883–1950) who used and popularized it as a theory of economic change due to innovations framed and implemented by a specific class of economic agents in a capitalist society, called entrepreneurs. This approach gained analytical and political ground within neoliberal models of free-market economics as a description of market dynamics resulting in the increase of the efficiency of the economy through decentralized and self-interested private agents' behavior.

In Chap. 7 (*The Process of Creative Destruction*) of his book *Capitalism, Socialism and Democracy* (2000 [1942]), Schumpeter states that "The essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process." Then he adds that: "Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary." This evolutionary character of the capitalist process is due to the fundamental impulse "that sets and keeps the capitalist engine in motion which comes from the new consumers' goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates" (p. 83). The opening up of new markets or the creation of new production processes and organization incessantly revolutionizes the economic structure *from within*, "incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in" (p. 83). Therefore, Schumpeter argues that the relevant problem is how capitalism creates and destroys existing structures.

This incessant change process is led by entrepreneurs who are at the heart of the economic system. The entrepreneurs also called by Schumpeter the "wild spirits" (*Unternehmergeist*, German for *entrepreneur-spirit*, English for *entrepreneurship*, and French for *enterprise*) drive capitalist dynamics and obtain market power to create temporary monopolies. In his early work, Schumpeter argued that the innovation and technological change are due to individual entrepreneurs who make things work in the economy through. From World-War II, at Harvard, he changed his interpretation of the roots of economic dynamics and he asserted that the major changes in the economy stem from big companies which have the resources and capital to invest in research and development. Then, in a capitalist economy, the entrepreneur or the enterprise, whatever its size, is *the actor* of the endogenous change, the process of industrial mutation, which should replace the invisible hand-competitive price theory of classical and new classical economics.

Entrepreneurs' Innovations as the Source of Creative Destruction

In his *Theory of Economic Development* (1961 [1934]), Schumpeter maintains that the creative destruction process is mainly due to entrepreneurs' innovations that create an endogenous motion which revolutionizes the economic structure. New combinations "appear discontinuously in groups or swarms." As this process does not only sweep old structures but also calls for new horizons to be widened, it is called creative. Such a creative motion comes from novelty about goods and services, new methods of production and all related activities, new process of implementing projects, new ways of organization, new combinations of factors of production, and so on. The field is large, limitless, depending on the imagination of Schumpeterian entrepreneurs. The Schumpeterian entrepreneur is not a single physical person and not a well-defined group of people. The entrepreneur may be the capitalist, a corporate manager, or a visionary who tries to change the established economic structure in order to create novelty. He or she is a novelty lover who is like an adventurer, a pioneer who is incessantly searching for changes in his existence. In this picture, the competition is a source of change through innovations that are destroying and remaking the existing structures so positions of agents cannot rest on a pillow of previous situation. Therefore, such an incessant change must be studied as a vehicle for uncertainty which allows economic actors to adopt leapfrogging strategies in order to reshape market structures following their expectations and own interests.

This approach offers a specific way of apprehending economic development through the introduction of innovations onto the market that would disturb the existing economic environment and trigger overall structural change.

Schumpeter identified entrepreneurial innovations as the major source of economic change. He argued that economies revolve around entrepreneurial innovations that often create temporary monopolies, allowing high profits that would soon be competed away by rivals and imitators. Then he remarks that the creative destruction dynamics stand out most clearly in the case of sectors which at any time happen to embody the impact of new things and methods on the existing industrial structure. In this vein, he argues that "The best way of getting a vivid and realistic idea of industrial strategy is indeed to visualize the behavior of new concerns or industries that introduce new commodities or processes or else reorganize a part or the whole of an industry" (2000 [1942], p. 89). Such concerns are assumed to be aggressors by nature and wield the effective weapon of competition. The meaning of the competition is therefore related to that kind of competition which comes from new commodity, new technology, new source of supply, and new type of organization that command a decisive cost or quality advantage and "strike not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives" (2000 [1942], p. 84).

In the same vein, but considering a global and continuously changing world of the twenty-first century, David Audretsch (2007) argues that in modern economies, there is a shift from the (old) managed economy to the emergence of an entrepreneurial society where individuals and firms as well as groups and communities try to proactively use the opportunities of the time. The connections between entrepreneurship and growth, founded on the creative destruction schema, can be narrowed also to entrepreneurship's stimulation of developing economies as entrepreneurs can serve, according to Audretsch, as a conduit for knowledge spillovers, improving competition for new ideas and methods and increasing diversity.

Innovation and Invention

There is no commonly accepted definition of innovation within a business context. However, in the literature, invention and innovation are distinguished.

In the *Theory of Economic Development*, Schumpeter distinguished between the invention and innovation. The invention is the discovery of a new technical knowledge and the innovation is its application to industry. The innovation, in its broader sense, is the introduction of new technical methods, new products, and new sources of supply and new forms of organization.

Invention is used in order to define a fundamental technological change, the apparition of which is usually depending on scientific changes which would affect our way of life.

Innovation expresses the way that aims to derive anticipated benefits from change and concerns new commercial uses that the decision-making unit perceives to be profitable in economic terms. The innovation can be a new idea, new practice, method, or process, product, or market opportunity.

So the term "innovation" is a generic term of all strategic economic and financial changes which may mean the developing of new services (allowing to the product differentiation), new products (diversification and penetration of new markets with new products and creating new needs and demand), new manufacturing processes (reducing production costs or supplying better products), and new business processes.

Research and Development as the Source of Modern Entrepreneurial Innovation

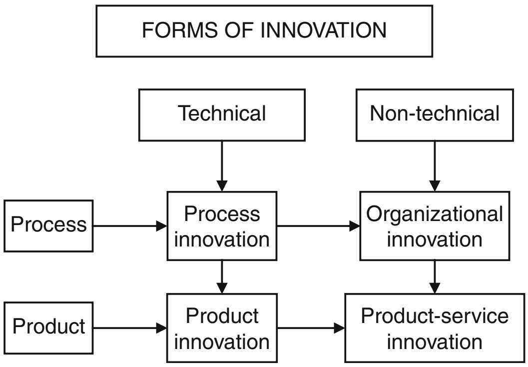
Therefore, it is obvious that the innovative process is related to the research and development (R&D). The fundamental research produces new knowledge (scientific-invention level of the process of change) while the applied research aims to lead to the acquisition of new knowledge for specific purposes as the launch of new products and processes including design, prototyping, testing, construction of pilot plants, etc. It is usually assumed that, given the financial and scientific requisites of the R&D activities, the process must be found on public and private structures cooperation.

Forms of Innovation

Innovations can take an incremental or radical form as regards their effects on existing economic structures:

Incremental innovation	Minor change at the industry level
Radical innovation	Major change at the industry level
Change in technological system	New industry and/or change at the intersectoral level
Change in techno-economic paradigm	New industry and/or change at the intersectoral level with heavy socioeconomic consequences

There is also a distinction between technical and nontechnical innovations. While product or process innovations represent technical innovations, product-service and organizational innovations are assumed to be nontechnical innovations. From this point of view, the second type of innovation can be classed as commercial innovations because they concern the methods of commercialization, advertising and market searching, etc. Then the main types of innovation, following Schumpeter, can be classified into three main categories: product innovation, process innovation, and commercial innovation. However, the following schema can be used to present different forms of innovation summarizing various conceptual and observational factors intervening in the design and implementation process of innovative activities:



In the technical category, product innovation is defined as the development of new products or technologies supported by research and development activities of firms. Process innovation aims at finding new process technologies in order to reduce costs of production and time costs and/or to increase quality.

In the commercial category, service-product innovation consists in offering the customers new services such as maintenance or operating services. Organizational innovation comprises the development and implementation of new organizational structures and processes in order to offer customers more flexibility and efficiency.

One can find in this category just-in-time concepts as applied by the Japanese firms in the 1970s. Organizational innovations are differentiated into two types of innovation:

– Procedural organizational innovations which affect the routines and operations of a firm. They are aimed at increasing the speed and flexibility of production.
– Structural organizational innovations change responsibilities, accountability, and information flows and affect therefore the divisional structure of functions within the firm's hierarchical framework.

Organizational innovations can occur within a firm. Then, they are called intraorganizational innovations and affect the overall strategy of the company as a whole. When they include new organizational procedures beyond a firm's border, they affect the firm's environment throughout R&D cooperation with customers or other firms, and they are called interorganizational innovations.

Relevant Examples and Issues

Innovation at the Roots of Modern Economies' Change

To date, innovation is at the top of the strategic agenda of corporations (Tzeng 2009). One can argue without exaggeration that in the wake of numerous technological and organizational changes that modern economies' dynamics provoke through new products, processes, and services on industrial as well as on financial markets, the late twentieth and the early twenty-first centuries' capitalism is certainly the age of Schumpeter.

In modern economics, creative destruction is a relevant way to study the stability concerns as it can explain most of the dynamics of industrial change and the evolution of market structures from competition to oligopolistic/monopolistic markets. It constitutes also the main reference for endogenous growth theories (Speight 2001) and evolutionary economics.

New Industrial Economics

In the new industrial economics (or the theory of organizations), the Schumpeterian model of creative destruction is used as one of the main references. This approach consists in considering the behavior of new organizational forms which introduce new process or products. This model allows economists and market analysts to consider new organizational forms which introduce new process or products in a dynamic setting. The issue of innovation in firms' market strategies for which the first initiative comes from firms themselves and not only due to given market structure constitutes a relevant analytical purpose in order to apprehend different market structures (imperfectly competitive markets, monopolistic or oligopolistic markets with dominant firms which determine the market's conditions in the aim of dominating evolution of markets and preventing the entry of new rival firms).

Innovations, Merger, and Acquisition

In *Capitalism, Socialism, and Democracy*, putting the emphasis on the *routinization* of technical innovation and the obsolescence of entrepreneurs' creative activities, Schumpeter presents a pessimistic view of the future of capitalistic economies. If R&D becomes centered in large corporations (financial needs of R&D activities may prevent little firms from undertaking innovative strategies), by exercising their market power, the large oligopolies would be able to use their market power to blockade Schumpeter's entrepreneurs' dynamics. Therefore, large corporations will come to dominate innovation; new entry and creative destruction would decline. In this perspective, Edgar Norton (1992) studies evidence of creative destruction in the US economy to deal with this issue thorough the examination of the role of merger and acquisition in the process of creative destruction, firm growth, and firm decline. He shows that mergers and acquisitions were also major forces behind the exit of firms from the top 500 during the 1970s–1980s. He states that the net impact of merger and acquisition activity on creative destruction and wealth concentration is an empirical and a public policy question needing further study.

Innovations and Factors Affecting R&D Activities

Various factors affect the R&D activities of firms then the creative destruction process in an economy:

– The "technology push" factor: According to the available level and state of technology in a market, firms may try to use different opportunities to develop new technologies. For example, there seems to be more technological opportunity today in the biotechnology than in the cloth manufacturing industries.
– The "demand pull" factor: It is the evolution of the demand in a given market that gives firms the effective orientation of their market strategies. For example, when the thinness is fashionable, some firms develop new technologies and slimming products.
– Profitability factor: Can firms appropriate the monetary returns to R&D? If the patent rights are strong, firms should be able to capture the profits that could come from inventions and innovations created during the R&D. If not, either (1) other firms copy the invention or innovation, (2) other firms develop minor variations of the new technology and capture parts of the market demand, or (3) large firms with strong investments in the technology can maintain dominance by having large numbers of patents and copyrights, and by defending them legally, so that new firms are kept out of the market.
– Ability of firms to use the new technologies developed in other firms or by academic researches. That is the extent to which a firm has the relevant R&D personnel and other resources needed to use efficiently the new technologies.
– Scale and scope factor: This is related to the possibility for the firm to realize scale or scope economies. When the firm is small, the scale of production is usually low and then profitability of the innovative activity (costs of development, of market analysis, of advertisement, etc.) may take more time than the case of larger firms, which may spread the costs of R&D over the numbers of units produced and distributed.
– Financing factor: Availability of the internal finance and conditions of the external finance (borrowing conditions in the financial markets) for the R&D activities usually give more advantages larger firms and can prevent the little firms' innovative activities.

Innovations and the Size of Firms

Some critical questions then arise: How does the structure of an industry (the numerous characteristics of firms in a given market) affect R&D in the sector? Why might the bigger or the smaller tend to do more R&D?

Acs and Audretsch (1988) show that the possibility of innovations from small firms, especially from new start-ups, is related to sector-specific conditions. If the industry is capital-intensive and highly unionized, small firms have no access to innovative activities.

Larger firms tend to have more capabilities than smaller firms to improve and streamline existing technologies. Hence, large firms often pursue large numbers of minor improvements to products and manufacturing processes. It is also observed that in capital intensive sectors, large firms can innovate more than small firms which have no sufficient access to capital markets while in new sectors, with low barriers to entry and less capital-intensive, small firms can follow aggressive and innovative strategies and can change the path of sector's evolution. However, it is also obvious that if an innovation comes from smaller firms, commercialization still takes a lot of effort for young firms which do not have expanded distribution networks or enough advertisement structures.

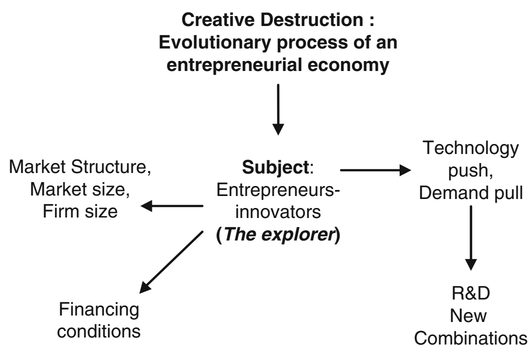
Financing of Innovations

In the Schumpeterian economic development model, dynamics enter the picture with the innovation decisions of entrepreneurs. Innovation is the driving force of accumulation. Innovation means to change deeply the economic status quo. The subject of the innovation is the entrepreneur who tries to execute new combinations. But the sole presence of entrepreneurs is not sufficient to guarantee the system's evolution. In order to innovate, to found a new firm, and to construct a new plant and order new equipment from existing firms, entrepreneurs need means of financing. As the creation of novelty requires new ways of doing things, the entrepreneur-explorer needs new ways of financing. If one presents the entrepreneur as the source of the creative destruction process and the innovations-new combinations as his objective, the way to reach the objective is related to the access of entrepreneurs to monetary means required to fund new plans and strategies. The result of such an adventure will also determine the final performance of entrepreneurs.

Consequently, the financing conditions of innovations are a real concern in the creative destruction process of an economy but also regarding its stability (Ülgen 2001).

Schumpeter argues in *The Theory of Economic Development* that the access to money (credit) is the power to command and to determine the level of economic change. Credit money becomes the critical variable which authorizes an economic separation between entrepreneurs-innovators and other agents. The financing of enterprise has been assigned logical priority in the process of economic development since innovations have to be supported by new funds beyond the existing ones. Therefore, the financing conditions of innovative activities and the evolution of banks and financial markets play a crucial role in the creative destruction process.

Therefore, the creative destruction process becomes a global issue in the analysis of economic evolution:



Conclusion and Future Directions

The creative destruction is used to describe the evolution of a capitalist economy through its endogenous dynamics assumed to be mainly founded on entrepreneurs' decisions and strategies. These strategies aim at strengthening dominant positions on markets in order to give firms more profit and higher control on market's development.

Such a (anti)competitive aim does improve, according to some economists, the functioning of market economies while other economists believe that the creation can finally result in some destructive processes.

Whatever the theoretical position that one can adopt in the analysis of economic change, it is obvious that the creative destruction process depends on innovative behavior of market actors. Therefore, the relevant question is related to the issue of creating, improving, and, maybe, framing entrepreneurial dynamics to let them reinforce positive changes which would be able to raise the welfare of the society. Then the size of firms, measures, and mechanisms to give entrepreneurs incentives to innovate more and the adequate market structures and financing rules and tools to accompany firms' evolution gain importance in economic change. The design and implementation of relevant and consistent industrial policies become then a crucial issue in the development of an entrepreneurial economy.

Cross-References

▶ Angel Investors
▶ Epidemiology of Innovation: Concepts and Constructs
▶ Financing Entrepreneurship
▶ Informal Venture Capital
▶ Innovation
▶ Joseph A. Schumpeter and Innovation
▶ Love Money
▶ R&D

References

Acs ZJ, Audretsch DB. Innovation in large and small firms: an empirical analysis. Am Econ Rev. 1988;78:678–90.
Audretsch DB. The entrepreneurial society. Oxford: Oxford University Press; 2007.
Norton E. Evidence of creative destruction in the U.S. economy. Small Bus Econ. 1992;4:113–23.
Reinert H, Reinert ES. Creative destruction in economics. In: Backhaus JG, Drechsler W, editors. Friedrich Nietzsche (1844–1900). Economy and society. New York: Springer; 2010. p. 55–86.
Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard University Press; 1961 [1934].
Schumpeter JA. Capitalism, socialism, and democracy. London: Routledge; 2000 [1942]. With a new introduction by Richard Swedberg.
Speight AEH. Innovation, creative destruction, and endogenous growth: contemporary economic theory and the Schumpeterian legacy. In: Orati V, Dahiya SB, editors. Economic theory in the light of Schumpeter's scientific heritage, vol. I. Rohtak: Spellbound Publications; 2001. p. 171–86.
Tzeng C-H. A review of contemporary innovation literature: a Schumpeterian perspective. Innovat Manage Pol Pract. 2009;11:373–94.
Ülgen F. The monetary dynamics of growth: credit economy and stability. In: Orati V, Dahiya SB, editors. Economic theory in the light of Schumpeter's scientific heritage, vol. I. Rohtak: Spellbound Publications; 2001. p. 119–34.

Creative Ecology

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Creative Entrepreneurship

▶ Entrepreneurship in Creative Economy

Creative Environments

▶ Creative Knowledge Environments

Creative Expression

▶ Creative Behavior

Creative Insight

▶ Creative Brain

Creative Knowledge Environments

Carl Martin Allwood[1], Sven Hemlin[2] and Ben R. Martin[3]
[1]Department of Psychology, University of Gothenburg, Göteborg, Sweden
[2]Gothenburg Research Institute (GRI), School of Business, Economics and Law & Department of Psychology, University of Gothenburg, Göteborg, Sweden
[3]SPRU – Science and Technology Policy Research, The Freeman Centre, University of Sussex, Brighton, UK

Synonyms

Creative conditions; Creative contexts; Creative environments; Systems of innovation

Definition

> Creative Knowledge Environments (CKEs) are those environments, contexts and surroundings, the characteristics of which are such that they exert a positive influence on human beings engaged in creative work aiming to produce new knowledge or innovations, whether they work individually or in teams, within a single organization or in collaboration with others (Hemlin et al. 2004, p. 1).

CKEs promote the production of new creative knowledge and can best be understood by taking a holistic multi-perspective, interdisciplinary approach. One important aspect following from the definition of CKEs is that they need to be understood at different micro-, meso-, and macro-levels, from the environment surrounding the individual knowledge worker to the more global level surrounding organizations. Indeed, CKEs can be viewed as nested layers of environmental factors influencing the unit undertaking the knowledge and innovation-producing activities. Examples of important dimensions and aspects of creative knowledge environments (with brief explanations and more specific examples in parentheses) include *task characteristics* (simple/complex, routine/novel), *discipline* (type of disciplinary field), *individuals* (e.g., knowledge profile, skill profile, abilities, cognitive style, motivation, career plans), *group characteristics* (size, degree of integration, inward/outward looking, degree of heterogeneity, degree of group tension, knowledge mix, skill mix, ability mix, common/contested beliefs), *general work situation for individuals* (work tasks, time available for research, degree of freedom in goal setting, quality of IT available), *physical environment* (facilities, architecture, location, equipment), *organization* (economic situation, organizational structure, reward profile, managerial style, degree of organizational harmony), and *extra-organizational environment* (size of economy and whether expanding/declining, degree of market openness and outreach, reward profile, information access, job opportunities and mobility, cultural features).

The unit undertaking the knowledge and innovation-producing activities can be conceptualized at different levels from individuals to groups, to a research laboratory or institution, and to whole nations or associations of nations. In order to understand the factors that help produce CKEs, one needs to have a clear conception of what is meant by creativity; otherwise, the degree of creativity of the resulting knowledge product cannot be evaluated. Traditionally, a creative product is defined as a product that is new, useful, and of good quality. A well-known problem in this context is to find robust criteria for judging the quality of a product, be it knowledge or an innovation. Quality criteria are likely to change over time and to have a relational character, and an important issue is when in the product's life cycle, the quality evaluation should be made – i.e., early, middle, or late in the cycle.

Examples of features that hinder the efficient functioning of CKEs are low individual competence levels, unclear objectives and badly coordinated team workers, lack of a genuine research-promoting culture, poor group/organizational climate, hierarchical and formal organizational structure, inability of group members to influence the direction of group work, poor internal and external communication, lack of encouragement and basic resources for staff, homogeneous groups with respect to disciplinary/subdisciplinary background and skills, externally and weakly motivated members, poorly managed staff selection, poor leadership lacking vision and useful external contacts, and excessive or intrusive quality control.

Cross-References

- ▶ Creative Leadership
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Creativity in Invention, Theories
- ▶ Organizational Creativity
- ▶ Psychology of Creativity

References

Hemlin S, Allwood CM, Martin BR. What is a creative knowledge environment? In: Hemlin S, Allwood CM, Martin BR, editors. Creative knowledge environments. Cheltenham: Edward Elgar; 2004. p. 1–28.

Creative Leadership

Andrei G. Aleinikov and David A. Smarsh
International Academy of Genius, Monterey, CA, USA

Synonyms

Absolute leadership; Idea leadership; Ideal leadership

Definition

Creative leadership is the process of accelerated advancing organization.

Introduction: New Type of Leadership

Creative leadership, as a type of leadership, is rarely understood properly, but it is so fundamental that its ultimate form can be called ideal leadership or absolute leadership.

In traditional terms, “good” leadership (and good leadership is always creative leadership) means having the “right ideas” and “doing the right thing” which includes having the “right behavior,” knowing when and how to ask the “right questions,” then taking the “right action,” and producing the “right results.” A good leader communicates, that is, creates and sends positive messages (nonverbal and verbal) that clearly depict the vision (new organization of the future world) and inspire people to do their best to achieve the vision. A good leader can use these processes in multiple situations to lead people or organizations successfully, effectively, and with efficiency. A good leader can solve complex problems – and the more creative the solutions are, the more successful the organization, civilian, or military will be. Moreover, any good leader (a creative leader) projects creativity to subordinates, and their collective (united, combined) creativity becomes unbeatable.

Creative leadership (ideal leadership, absolute leadership), as a fundamental form of leadership, reveals itself in other types of leadership. Thus, it is useful to review the well-known styles of leadership.

Traditional Types of Leadership

Most people would agree that a good general definition of leadership is “the process of influencing others toward a common goal” (see other definitions in Bennis 1985; Burns 1978; Yukl 1981; etc.).

For the majority of researchers, leadership is personified by great people and is carried out in historically great events. Thus, the leadership typically analyzed and discussed in literature is based on either traits or behaviors. The well-known classifications include:

- Autocratic versus charismatic (Avollo and Bass 1988; Kuhnert and Lewis 1987)

- Formal (leadership of position) versus informal (a leader controls the group without being in a leadership position)
- Transactional versus transformational (the leader changes the circumstances of events) (Bass 1998)
- Exclusive versus inclusive (the leader embraces the opinions of the group and includes the group in the process of decision making)
- Authoritarian versus servant (the leader accepts the goal of serving the group and its interests) (Greenleaf 2002)

Characteristics (Traits) of a Leader

Since the main emphasis in leadership research is placed on the behavioral characteristics, the majority of researchers go straight to the basic characteristics of a leader. In numerous resources, you will find from 3 to 50 basic traits that successful leaders must have (see, e.g., Maxwell 2007; Smith 1986; Taylor and Rosenbach 1984). These key qualities of a leader include strong character, charisma, commitment, communication, competence, courage, focus, vision, etc. However, even the authors who identify the 21 qualities of a leader do not mention creativity. They mention problem-solving ability, but not creativity.

The Leadership of Idea (Empirical Proof)

As a counterexample of all "trait theories," there are instances when a person *does not* have all of these traits, *does not* say anything to the group, but functions as a leader nonetheless:

Case 1. During a raging flood, a group of people became trapped on the roof of a house. The water was rising rapidly, and there was no way to escape. As the waters rose, inflated tires from a nearby garage began to wash up onto the roof. One woman saw the tires, grabbed one, sat in the middle of it, and jumped into the river, using it as an inner tube. The floodwaters carried her to a nearby hill where she jumped off to safety. The other people trapped on the roof watched her do this and followed her example. As a result, all of the people were saved.

In this case, without saying a word, simply by acting correctly and achieving the desired result, the woman was able to lead the people to safety. That is leadership by example, some researchers would state, but notice that the woman's leadership began with an idea ("right idea"), went through to the action stage ("right action"), and finished also with an idea ("right idea") in the minds of the other people. There was no coordination, no communication, and no charisma. The woman created an idea – a connection between earlier non-connected entities (situation: danger of drowning; goal: safety; means: inflated, floating tires) that led to saving her life and the lives of other people. This was certainly an act of creative leadership: (a) a creative act – she generated a creative idea and (b) a leadership act – by her example, she led people out of danger. It was also "ideal leadership": (a) idea-based and (b) the best in the situation (ideal) – it required no radio, no helicopters, no rescue workers, no explanations, and no instructions. It was simply **ideal**. The concept of ideal is used here as it is understood and explained in the works of Altshuller, the author (see TRIZ, ▶ Inventive Problem Solving (TRIZ), Theory) who introduced the so-called ideal final result (IFR) as achieving a goal with minimal effort and minimal material expenses (Altshuller 1986).

Another life example that required no other traits of leadership except creativity is given below:

Case 2. During WWII, airplanes were built and repaired in hangars. Imagine winter time in Russia. Working on airplanes in the open air was impossible. There was frost, snow, winds, and blizzards. So the obvious question was how to put more aircraft into one hangar so as to do the repairing faster. People were not a problem: there were lots of mechanics. Space was a problem. All the specialists from the Constructor General to the entry-level engineers were thinking of the problem. The Constructor General visited the hangars and talked to workers. A stunningly simple idea came from an older mechanic. He suggested lowering the pressure in all the left (or all the right) tires of the chassis. The airplanes would lean to one side, and their wings would not interfere with those of other airplanes. The same hangar could accommodate nearly twice as many airplanes. Here was a creative idea–creative solution to the problem. The Constructor General was happy with the idea; he called Stalin; Stalin gave an order to the aviation industry, and all airplane production plants and maintenance facilities followed the suggested idea. As a result, literally overnight, the air force repair industry nearly doubled its production (adapted from Altshuller 1986).

In this specific case, an older mechanic was the creative idea generator or idea leader. It was his idea that the Constructor General, then Stalin, then ministers, then plant directors, and finally engineers, followed. This is a clear case where no other traits of traditional leadership come into play, only creativity. Moreover, this case is an example of "ideal leadership": no construction of new hangars, no cutting of wings, no special platforms, and no lifting mechanisms were needed. Minimal energy was exerted to reach the goal. Thus, this case is very close to an ideal leadership solution.

These cases illustrate one aspect that has been missed by most leadership theories: it is not the person who is leading. It is the idea(s) that this person generates or perceives and then makes available to people. The existing theories of leadership either did not see this kind of leadership, or they were unable to explain it. A new theory was needed.

New Concept and New Vision of Creative (Ideal, Absolute) Leadership

The concept of creative leadership can have both a narrow and a broad meaning. If creative leadership is understood as leadership in a creative area, then its meaning is narrow. If creative leadership is understood as training leaders to solve problems creatively, then its meaning is also narrow. However, if creative leadership is understood as leadership by creative ideas, then this is a broad meaning.

When creative leadership is understood as leadership by idea (no matter who the author of this idea is), the scope of the leadership concept is widened and the volume of the concept is increased.

For example, from the religious point of view, God leads people by ideas (absolute leadership), so God's leadership is included in the concept of creative leadership. In secular life, a genius who develops a breakthrough idea and is then led by this idea is encompassed by the new concept as well. A great explorer led by the dream to conquer the North Pole is included. Any person following an idea is led. As Lord Byron stated, "And when we think we lead, we are most led."

Ideas, however, are immaterial. They cannot be touched, seen, or heard until they are manifested. They may be articulated in speech (utterances, monologues, dialogs, presentations, etc.) or in writing (notes, letters, reports, articles, books, or even covenants carved in stone). In any case, the process of manifestation of ideas is present.

Emotions and feelings may exist without language. Ideas (thoughts, concepts, conclusions) need language in order to exist. People think in words. Leadership, therefore, is communication, verbal or nonverbal.

Theoretical Analysis: Paradigm Shift

Language is the main tool whereby ideas are manifested. Language communication is the domain where people exchange ideas coded in words, sentences, or statements. That is why linguistics – the science of speech and language – has to be taken into account in order to deal with the manifestation (expression) of ideas. As a response to the need, creative linguistics, introduced in 1988, developed the tools for analyzing the creative aspects of speech and proved that any speech act is a creative act (see ► Creative Linguistics, Aleinikov 1988, 1992). This development led to the explanation of creative leadership and eventually to a new science of leadership – agogics.

As shown in cases 1 and 2, an idea (a correct, useful, and problem-solving new idea) can lead the positional and even the autocratic leader. A creative idea can advance the group (society) to a better (more efficient) organization of its activities and resources.

In any communicative act, whether at work or at home, people listen to each other in search of new ideas. In contrast, imagine that some individual mumbles one and the same thing all the time. This person will be of no interest to anyone. But a person with lots of new ideas is listened to. People listen to those individuals who have ideas. In any problem situation, people listen to a person for at least a short period of time and then decide whether or not to use this person's idea as a part of the common solution. If they decide yes, they continue to follow the idea (so the idea is still "leading"). If not, they listen to someone else with a more creative idea or offer their own idea. Obviously, the person who offers the best (most creative) idea becomes an idea leader without any additional or special effort. This is creative leadership (ideal leadership) at its best.

From the theoretical point of view, this creative leadership can be viewed as the best possible version of leadership or as "ideal." To combine these two meanings (*ideal*$_1$ because it stems from an *idea* and *ideal*$_2$ because it is the best), a special spelling of the term IdeaLeadership© was introduced (Aleinikov 1999b).

In contrast to the traditional view that a leader is required to have certain characteristics of a leader (often described in a lengthy list), the broad vision of creative leadership includes the possibility that *any* person who produces an idea – a useful idea – becomes a leader in a given situation. Such an individual can be in the lowest possible position in an organizational or social hierarchy. Such an individual may have no traditional leadership traits at all. This does not matter. The idea producer becomes an instant leader because the idea leads other people. The life episodes described in the cases above are examples of a useful idea leading. Such situations happen in the family life when a useful idea comes from a child, at work, school, etc.

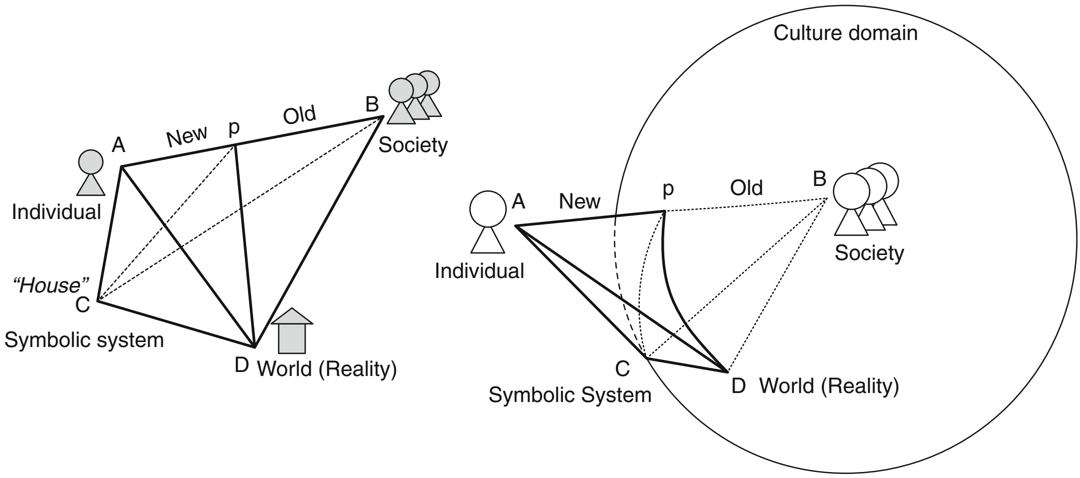
Now, it is easy to see how creative leadership shapes the basis for all other types of leadership.

- Even the most autocratic leaders (despots, dictators) rule mostly with words, and words merely manifest their ideas.
- The charismatic leaders also lead or rule by communicating ideas. Even those with the sweetest of personalities have to have ideas to wrap them up into charismatically delivered verbal or nonverbal message.
- Transformational, inclusive, and servant leaders have to have ideas in order to lead. They themselves may be very intelligent and creative generating ideas on their own or they may solicit and use the ideas of the others (as inclusive leaders do), but *having* ideas is a must. Good leaders both generate ideas and are open to the ideas from the followers.

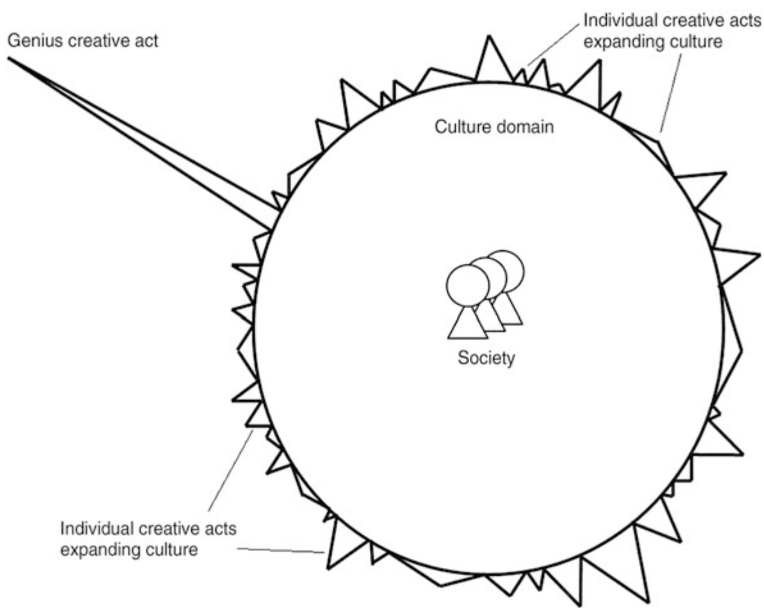
A person in charge – in a leadership or management position at any level – has to generate (create) an idea before that idea can be communicated to followers, subordinates, employees, etc. The idea must come first; communication and the manner of communication come second.

A new theoretical approach states that if creativity, in traditional terms, is a new combination of known elements, then people who speak engage in creativity all the time. In every statement, people take the known elements of language and combine them in a unique manner – suitable in this particular moment for solving this particular communication problem. The degree (rate) of creativity in a statement may vary: one statement with a low degree of creativity will be forgotten in a second, while another – with high degree of creativity – will be remembered for centuries, like Shakespeare's "to be or not to be" speech. In leadership terms, one statement "leads" people's minds (and behavior) for a very short period of time, and another "leads" people's minds (and behavior) for hundreds of years. Nevertheless, any statement is a result of **creative** thinking, and any **created** utterance in turn **creates** a new communicative situation and causes other people to **create** their responses too.

To illustrate this understanding, creative linguistics offers the theoretical model of sign, language, language consciousness, and speech act that also reflects a heuristic act (the act of discovery, invention, or art creation – all *leading* by ideas). That is why the model is called universal. This three-dimensional model allowed



Creative Leadership, Fig. 1 Universal model of sign, language, speech act, and heuristic act (*left*) and how it expands the culture domain (*right*)



Creative Leadership, Fig. 2 Genius creative leadership (*leading* into the future)

researchers to represent the creative act graphically in relation to the society (Aleinikov 1999a).

This vision (Fig. 1) of speech act and creative (heuristic) act shows an individual (A) as creating ideas about the world (D), coding them into language tools (C) and communicating them to the society (B), thus expanding the available domain of culture that includes knowledge, traditions, etc.

Such a graphic representation allows researchers to make the next step (Fig. 2) and to visualize the creativity of a genius whose creative acts (breakthrough discoveries or art masterpieces) expand the domain of culture in the most accelerated manner and *lead* the society for a long time (see ► Genius).

Geniuses are the most powerful leaders. Their ideas lead all of the humanity (not simply one country) for centuries. Moreover, their leadership does not need armed forces, police, or any other enforcement. Their leadership needs no other means except learning about their ideas. People read their books, learn their ideas, and follow their explanations. Geniuses are the most prominent representatives of IdeaLeadership: they are IdeaLeaders that people follow.

For example, since early in our human history, people have been using the game-changing invention, the wheel. People have been using calculation since somebody created it. People have been using logic since Aristotle described it. People have been using x-ray technology in various forms after Röntgen discovered this type of short-wave rays. People use thousands of things and processes, including language that is renewed and recreated in every statement. Somewhere back in our history, there was a discoverer, an inventor, a creator, an author of an idea. For more examples of creative leadership, see Modern Applications below.

With this new concept of creative leadership that spans from a single speech act to the books that attract thousands of researchers and millions of comments, such as the Bible, and movies that attract millions of viewers in a matter of months, the general concept of leadership expands as well. In addition to traditionally construed political, military, business, and education leadership, leadership now includes scientific, technological, artistic, cultural, athletic, and media leadership, as well as leadership in all other spheres of social life. This is leadership by creativity, leadership by creative act.

A society that leads other societies into the future (e.g., a democracy) safeguards intellectual property in scientific research (certificates of discoveries), technological development (patents), literature (copyright), and other forms of protection, which allows people to create freely and to implement their creative solutions rapidly. This is acceleration in development, and this **accelerated advancing organization** is the creation of the new world organization by creative leadership.

With this rapid advancement, such fields as creative education (Creative Education Foundation, Buffalo, NY), the search for creativity-enhancing techniques and the most powerful idea-generation methodologies as well as teaching innovations - all become a priority. The reason is obvious: the more efficient the process of generating new ideas, the more successful the society (group) that employs it will be. Even this encyclopedia is an example of attention to the sphere of creativity and innovation. The first *Encyclopedia of Creativity* was published in 1999, and this *Encyclopedia of Creativity, Innovation, Invention, and Entrepreneurship* is another powerful step to popularizing the field of creativity and innovation, which is now being examined on the scientific level.

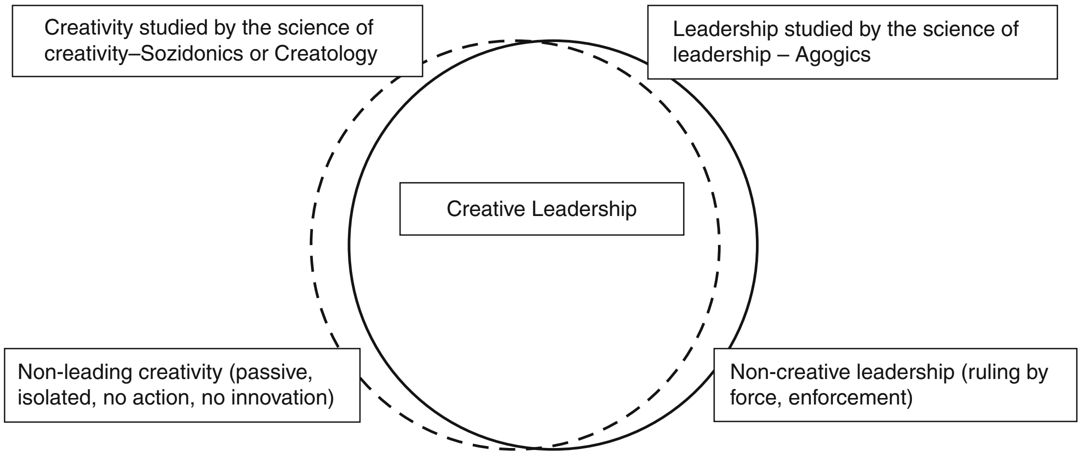
Limits of the Concept

Where are the limits of the creative leadership concept? Below is a graphic representation of two fields – creativity and leadership – as well as the two sciences that reflect them and overlap (Fig. 3).

As the model shows, the bulk of leadership is creative leadership, but there are two domains that border the limits of the concept: non-leading creativity and noncreative leadership.

- Non-leading creativity occurs when someone creates alone and never shows the works to public. In such a case, the works do not "lead" (attract, entertain, fascinate, enthuse, inspire) anybody, so there is no leadership at all. The person might be a founder of a new style of art or a discoverer of new scientific laws, but since no one even knows about these works, no one is led by them.
- Noncreative leadership happens when destructive methods are used to rule, govern, or control somebody's behavior (as in slavery). Such a leadership style does not create anything and actually destroys the subordinates. The final result is that a leader who practices such leadership style (a despot, a dictator) is usually destroyed as well.

Creative leadership, as opposed to both "trait" and "event" leadership, does not have time and space limitations and is much more enduring. For instance, past military or political leaders are still remembered, honored, studied, and followed. It means creative leadership as a concept is broader than an individual leader's life, features, and behaviors. If events, such as wars, battles,



Creative Leadership, Fig. 3 Creative leadership domain

revolutions, as well as the victors of these encounters, are still studied by students, then creative leadership as a concept is broader than the event leadership.

People are led by ideas – ideas from the past (people study history), ideas from the present (people watch TV, listen to the radio, read newspapers), and ideas from the future (people dream and have goals). Education and training as a whole is nothing more than learning about the ideas developed in history for solving problems.

For example, Socrates became a great intellectual leader not because of his ability to motivate groups of people to do something but because of his ideas. Socrates continues to lead centuries after his death because his ideas remained valuable. He is still remembered and considered a genius. The Socratic method of teaching (an educational idea) is a viable methodology.

Genius ideas is exactly what John F. Kennedy meant when he said, "A person may die, nations may rise and fall, but an idea lives on. Ideas have endurance without death."

New Science of Leadership

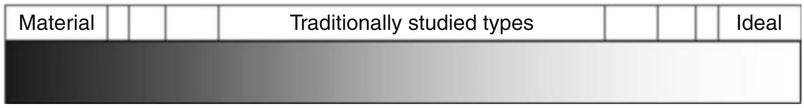
Despite numerous attempts to develop some scientific theories of leadership, "…leadership theories are, at this point, sets of empirical generalizations and have not developed into scientifically testable theories" (Johnson 1990). Such situations are typical in the history of science – it takes time to move from recognizing and describing the phenomena to distilling the essence.

The research into creative leadership and finding the ultimate forms of leadership (ideal leadership, absolute leadership) helps shape a new science of leadership that is growing out of descriptions and stand-alone theories. The research is moving from phenomena to the essence, from separate theories to science.

This science of leadership is called agogics. This name is coined from the Greek *agogos*, which means "leader." This root is seen in the second part of modern terms like ped*agogy* and andr*agogy* which are translated as *leading child* and *leading adults*. The traditional suffix -*ics* is added to follow the model of the names of other sciences: physics, mathematics, linguistics, etc. This new science, agogics, explains both the material and ideal worlds of leadership while dealing exactly with its essence – advancing organization.

New Definition of Leadership

The concept of leadership in general should include all types and styles of leadership. As we have seen in the earlier example, the woman in the flood managed to find the right **organization** of materials, means, and movements that



Creative Leadership, Fig. 4 Leadership types spectrum

advanced her and the other people to the "right" solution – survival and safety. Political, scientific, and social leaders do it all the time. They shape the future – they lead the society to a new **organization** of the world. This new organization of the world created by the leader, expressed in language and called vision, attracts followers, and they begin to help leaders to achieve this new organization.

The new definition of leadership that takes into account all types of leadership is as follows: "**Leadership is the process of advancing organization.**"

New Classification of Leadership

Clearly, there are two polar types of leadership:

- Material leadership (coercion/physically pushing/pulling – the most primitive)
- Ideal leadership (communicating/transferring an idea/inspiring/motivating by idea/convincing that the idea is "right")

The scale below graphically depicts the types of leadership, with the darkest shading representing material leadership and the lightest representing ideal leadership.

Ideal leadership, on one side of the spectrum, is the most powerful. It is the first to start and the longest to live, instant and eternal (at least as long as there is one follower). Creative leadership would be the closest to the ideal depicted on the chart (Fig. 4).

Note that all types of leadership can be classified according to the degree of ideality. The less effort and enforcement a type of leadership needs, the higher the level of leadership. The more effort and enforcement a type of leadership needs, the lower the level. This is a scientific, energy-based criterion of leadership. It is objective and measurable.

From this point of view, the dictator type of leadership (dark on Fig. 4), which requires police, military, terror, prisons, and other enforcement activities, turns out to be at a much lower level than a democratic type of leadership where "majority rules" and ideas are freely discussed or, for instance, a charismatic type of leadership that works by inspiration.

What Is an Idea?

An idea, whether it takes the form of thought, notion, concept, conception, image, decision, or association, is the product of mental activity, the creation of the human mind. It can be a reflection of the material world (an image), but it can also be the reflection of reflection (an idea about the image, a concept of the concept). Ideas are capable of multiplying without regard to the material world.

Such is the power of ideation. Ideation can bring the images of the future world, and the current material world can be reorganized to fit this image. Architects and inventors engage in this kind of imaginative activity all the time.

It is certainly better for humanity if our scientific ideas reflect the world realistically with minimal fantasy, but when it comes to technology, literature, arts, theater, and movies, there are no limits to ideation.

In any case, since an idea is the **creation** of the mind, it is already **created** and it is **creative**. The question is *how* creative an idea is?

What Is a Creative Idea?

An idea is often understood as a very new idea, but sometimes, an idea is a known pattern applied to a new situation. In this case, the amount of newness is different. A world chess champion, for example, recognizes moves and strategies that have been used by others and has a store of winning tricks and combinations. The champion may apply an existing idea or a combination of ideas to a particular chess game. However, true champions may also create new ideas even under the pressure of a world championship match.

There are thousands of attempts to define creativity (see details in Aleinikov et al. 2000). For example, Stanley Gryskiewicz, Center for

Creative Leadership, defines creativity as novelty that is useful (Gryskiewicz 1999). More often, creativity is understood as the ability and the process of generating new ideas, an ability to find not previously seen combinations of existing concepts.

The scientific definition of creativity states that creativity is the process of accelerating organization (see ► Creativity Definitions, Approaches). Since creativity is the process of accelerating organization and leadership is the process of advancing organization, then **creative leadership is the process of accelerated advancing organization.**

Born or Made?

There are debates on whether leaders are born or made. In the same manner, people debate whether creativity is innate or can be taught and whether genius is born or nurtured. The right answer to this debate is to delete "or" and use "and" instead. Creativity characteristics, genius features, as well as leader traits are both genetic **and** nurtured. If in the natural world survival of the fittest occurs, then in the human world, the strongest and the most creative will have advantages as well. The strongest individuals may become champions and leaders in sports. The most creative individuals find solutions, survive, and endure. Strength, creativity, and leadership are trainable and teachable. Thus, a trained person can be stronger, more creative, and a better leader.

No wonder that organizations like Center for Creative Leadership (Greensboro, NC) are in demand and so successful – they adequately reflect the essence of the issue: **leadership must be creative, and creativity (by generating winning ideas) leads to success**! Creative leadership (idea leadership, IdeaLeadership) is more powerful and definitely much more spread than non-creative leadership.

Applications to the History and Modern World of Leadership

The world's religions – Judaism, Christianity, Islam, Buddhism, and Hinduism – all are the ideas that have led masses of people throughout history. In the best cases, no enforcement was needed. On the other hand, under political doctrines like Marxism, Leninism, or fascism, the enforcement was horrific and led to enormous loss of human lives. The wars of ideas often led to actual wars between the countries and coalitions (WWI and WWII) as well as between the groups of people within single countries (civil wars). Wars of ideas are the fight for the dominance of a particular idea in the world of the future. Ideas (through people they lead) are fighting for the future organization of the world (Hamel and Prahalad 1996). Creative ideas are accelerating this advancement.

Some examples of this advancement are as follows:

- Creators of religions are next to geniuses in creative leadership power. Their ideas lead masses of the world's population and have succeeded in doing so over the centuries and across the borders of numerous countries.
- Creators of new technologies, such as Apple, Microsoft, and World Wide Web, are vivid examples of creative leadership. They create the ubiquitous technologies, thus leading to free communication among human populations.
- Movie makers and movie industries are among the leaders in the creative leadership domain. Their products move masses to the desired organization of the world by creating images and phrases that indelibly influence the minds of viewers.

Implementation of Creative Leadership Ideas

Many countries promote creative leadership principles through organizations and educational institutions.

For example, the Creative Education Foundation (Amherst, Massachusetts, USA), one of the first in the world, since its inception in 1954 in Buffalo, NY, has offered creativity education to all sectors of the population, including military and business leaders. Their unique programs, such as Creative Problem Solving Institute (CPSI), offer week-long conferences where creativity specialists from around the world get together to share their ideas and teaching methodologies. They also teach children – future leaders – to think creatively.

The Center for Creative Leadership (Greensboro, NC) since 1970 has led the trend in creativity by teaching leaders in the United States and now globally in the Americas, Europe, the Middle East, Africa, the Asia-Pacific region, Russia, and other countries. Creativity-oriented and customized programs are geared to all levels of leadership, from the entry level to the top executives in business, education, healthcare, law, the nonprofit sector, pharmaceuticals, and government.

The American Creativity Association has for over 20 years supported global creativity and innovation initiatives through local chapters in the United States and with international affiliates in Australia, Canada, Chile, China, Singapore, and Taiwan.

Creative leadership organizations and individual companies for training leaders exist in Europe, Africa, Asia, and Australia. They train leaders via conferences, live programs, and consulting.

One of the strongest and most consistent organizations promoting creative leadership principles and innovation initiatives is located in South Africa. The South African Creativity Foundation, founded and headed by Dr. Kobus Neethling, has been advancing the country and region for about two decades. In addition to publishing research papers and literature on creativity and creative education, the foundation organizes unique conferences and teaches political, business, and educational leaders to lead creatively. The South African Creativity Foundation produces a TV show on creativity and sponsors TV contests for the most creative man in Africa. Its leader, Dr. Kobus Neethling, together with the author of this entry, holds the Guinness World Record in publishing for the fastest written, printed, and published book in 2001.

Some forward-looking universities and colleges have begun to introduce new programs on creativity. For example, Buffalo State College, State University of New York, pioneered a Master's Degree in Creativity Studies in the 1940s. The International Center for Studies in Creativity (1967), established in the college, also educates researchers and creative education practitioners from all over the world.

At present, there are some attempts to create Ph.D. Programs for Studies in Creativity (e.g., Saybrook University, San Francisco, California, and other universities). These institutions are the places where the new concepts of creative leadership will be researched and developed further.

Conclusions and Future Directions

Leadership is a phenomenon that is not and must not be limited by behaviors, traits, events, or material activity. Leadership by ideas, creative leadership, forms the foundation of any human leadership. Creative leadership, therefore, must be included in the concept of leadership, thus expanding the traditional view. Now that the volume of the concept of leadership is defined precisely, this concept has become a subject of study for the new science of leadership, agogics. The new science offers a new definition of leadership, a new classification of leadership, and puts forward new models for studying leadership.

The ultimate versions of creative leadership are ideal leadership (IdeaLeadership©) and absolute leadership, where leading occurs without enforcement, without extra effort or without resources and where the idea is so good that the manifestation (communication or demonstration) of the idea is sufficient to motivate people to follow it.

The struggle of ideas (creative or destructive) is as old as ideation itself. The winners in this struggle are people with the better ideas or a better ability to produce (generate, create) winning ideas. The power of ideas created by individuals determines the power of the social entity because they shape the future. If leadership in general is defined as **advancing organization**, then creative leadership is defined as **accelerated advancing organization**.

If there is value in ideas, then any forward-looking society should be in search of the best (fastest) methods and techniques to generate innovative ideas. Moreover, the more efficiently these methods work, the faster they lead to creative ideas and so the higher is the probability that the subject (person, group, organization) will become a leader. This is where the efficiency of idea generation comes into play and methodologies leading to top-level creative efficiency, like MegaCreativity (see ▶ Science of Creativity), become necessary for succeeding in the future. These are the directions of future research and development as well as broad implementation to industrial, educational (see ▶ Creative Pedagogy), social, and political life.

Cross-References

▶ Creative Linguistics
▶ Creative Pedagogy
▶ Creativity Definitions, Approaches
▶ Genius
▶ Innovation in Business: Six Honest Questions
▶ Inventive Problem Solving (TRIZ), Theory
▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index
▶ Political Leadership and Innovation
▶ Science of Creativity

References

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Language awareness: stereotypes and creativity. Institute of Linguistics, USSR Academy of Sciences, Moscow (russ. Креативная лингвистика (обоснование, проблемы, перспективы). Языковое сознание: стереотипы и творчество. Институт языкознания, Академии Наук СССР, Москва, 1988).

Aleinikov AG. Theoretical foundations of creative linguistics. (russ. Теоретические основания креативной лингвистики). Unpublished Doctor of Sciences dissertation. Military University, Moscow, 1992.

Aleinikov A. Humane creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999a. p. 837–44.

Aleinikov AG. Mega-creator: from creativity to mega-, giga-, and infi-creativity. Montgomery: MIMII; 1999b.

Aleinikov A. MegaCreativity: five steps to thinking like a genius. Cincinnati: Walking Stick Press; 2002.

Aleinikov A, Kackmeister S, Koenig R, editors. Creating creativity: 101 definitions (what Webster never told you). Midland: Alden B. Dow Creativity Center Press; 2000.

Altshuller GS. To find an idea. Novosibirsk: Nauka; 1986.

Avollo BJ, Bass BM. Transformational leadership: charisma and beyond. In: Hunt J, Baliga B, Dachler H, Shriesheim C, editors. Emerging leadership vistas. Toronto: Lexington Books; 1988.

Bass BM. Transformational leadership: industrial, military and educational impact. Mahwah: L. Erlbaum Associates; 1998.

Bennis SW. Leaders. New York: Harper and Row; 1985.

Burns JM. Leadership. New York: Harper and Row; 1978.

Greenleaf RK. Servant leadership: a journey into the nature of legitimate power and greatness. 25th Anniversary ed, New York: Paulist Press; 2002.

Gryskiewicz SS. Positive turbulence. San Francisco: Jossey-Bass; 1999.

Hamel G, Prahalad CK. Competing for the future. Boston: Harvard Business School Press; 1996.

Johnson DE. Leadership: some thoughts after twenty years. In: Concepts for air force leadership. Maxwell AFB: Air University; 1990. p. 352–7.

Kuhnert KW, Lewis P. Transactional and transformational leadership: a constructive/developmental analysis. Acad Manage J. 1987;12:648–57.

Maxwell JC. The 21 indispensable qualities of a leader: becoming the person others will want to follow. 2nd ed. Nashville: Thomas Nelson Publishing; 2007.

Smith PM. Taking charge. A practical guide for leaders. Washington, DC: National Defense University Press; 1986.

Taylor RL, Rosenbach WE, editors. Contemporary issues in leadership. Boulder: Westview Press; 1984.

Yukl GA. Leadership in organizations. Englewood Cliffs: Prentice Hall; 1981.

Creative Linguistics

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Synonyms

Sozidolinguistics

Definition

Creative linguistics is a subscience of linguistics that studies creative aspects of language/speech and language aspects of creativity.

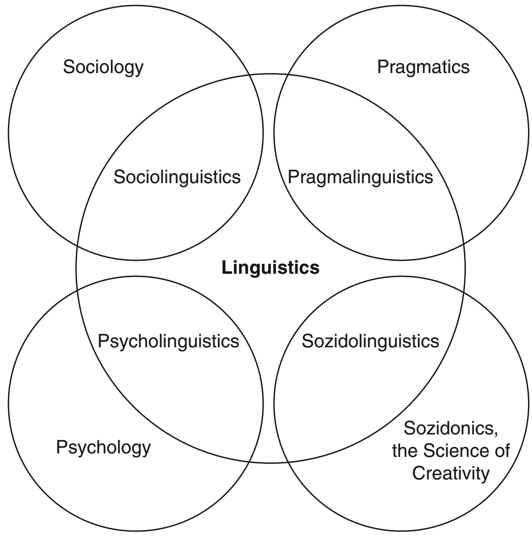
Introduction

Creative linguistics (sozidolinguistics) is a study of the domain common for language/speech and creativity (Aleinikov 1988a; 1992b; 1994). Sozidolinguistics selects in any communication event only those factors that deal with the generation of newness, that is, with the creative aspect of language and speech. On the other hand, both creative thinking and creative behavior, as it is well known, are based on and/or are wrapped into the language (including music and visual arts), and thus sozidonics, as the science of creativity (see ► Science of Creativity), just cannot ignore the language as a colossal machine generating more and more of the new products. Neither linguistics nor sozidonics separately can understand and explain how language and creativity coexist and interact. That is why there grew a need for creative linguistics as a combined field of research. That is why it appeared, just as one day in the past there appeared mathematical linguistics, pragmalinguistics, psycholinguistics, sociolinguistics, etc.

Definition and Differentiation from Psycholinguistics, Sociolinguistics, and Pragmalinguistics

Creative linguistics, as a field of linguistics that studies creativity in language and language in creativity, emerged at the cross section of two sciences.

Graphically speaking, if two circles, representing two domains, partially overlay each other and make a cross section, then this section belongs to both domains. Here is how the cross sections of fields mentioned above look on the graph.



Creative Linguistics, Fig. 1 Subsciences at the cross sections of sciences

As Fig. 1 illustrates, there are subsciences or emerging fields of research on the cross sections of sciences, and creative linguistics (sozidolinguistics) is one of them. Just as objectively there is creativity in language and there is language in creativity, the science of creativity and linguistics create a cross section to reflect this interaction. Certainly, in life, for example, sociolinguistics phenomena are interrelated with pragmalinguistics phenomena (Labov 2001), as well as psycholinguistics phenomena are interrelated with sozidolinguistics phenomena, so the corresponding circles could be overlapping, but this simplified graph is used just to visualize the basic relationship with other sciences when they emerge as subsciences.

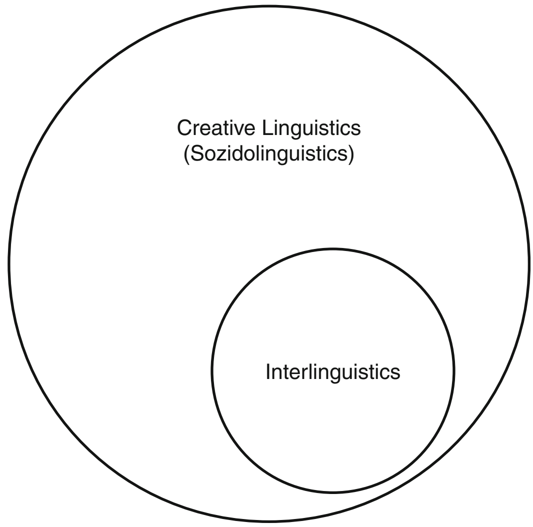
There are some other fields like the ones depicted in Fig. 1, for example, mathematical linguistics, computational linguistics, neurolinguistics, a cross-section of neuroscience and brain research with language research (Luria 1975), etc.

The main difference in the process of developing creative linguistics was the fact that there was *no* established science of creativity at that time. It was a growing field of research, but not a science yet. So the founder of creative linguistics (sozidolinguistics) had to either foresee (predict) the formation of the new science or to create it. That is why sozidonics, the science of creativity (see ► Science of Creativity), was being developed at the same time, and both sciences benefited from this symbiosis.

On its way to recognition, creative linguistics had some differentiation problems. Some authors, probably far from the field of linguistics, made an attempt to apply this term to the field of constructing artificial languages. In addition to the website on creative linguistics that dealt with artificial languages, there were some articles that associated creative linguistics with constructed languages (Spencer 2012). Moreover, there was even an unsuccessful attempt to create a Wikipedia page named "Creative Linguistics" for describing constructed languages. The latter was absolutely correctly redirected by Wiki editors to the article "Constructed Languages" because creative linguistics is different. It should be differentiated (disambiguated) from the field of constructed languages. As a field of research that deals with creativity and creative acts in the language domain, sozidolinguistics certainly includes the acts of creating new languages, such as Esperanto and over 1,000 other projects, but it is not limited to such acts and cannot be attached to them exclusively. There is a special field that deals with constructed languages. It is called interlinguistics (Kuznetsov 1987; Schubert 1989). It studies the international auxiliary languages, also called "constructed" and "planned" languages as opposed to the natural languages developing spontaneously. The term interlinguistics itself goes back to 1911 and was greatly popularized by the famous Danish linguist Otto Jespersen (Jespersen 1931).

Creative linguistics, as opposed to interlinguistics, is 77 years younger (1988 vs. 1911) but much broader in its subject of study (see New Subject of Research: All Language Innovations below). If depicted graphically, interlinguistics may be seen as a part of creative linguistics.

As Fig. 2 illustrates, the field of interlinguistics is only a part of creative linguistics, and, therefore, it should not be confused with it, as any part cannot be confused with the whole.



Creative Linguistics, Fig. 2 Creative linguistics (sozidolinguistics) and interlinguistics

The second difference between creative linguistics and the other fields is the fact that creative linguistics was designed consciously and published first in a series of articles and then described in a doctor of sciences dissertation. That is why creative linguistics has its own name, sozidolinguistics, its own well-defined subject of study, as well as its own methods, models, and research results (achievements). For comparison, shaping psycholinguistics took about 60 years and the efforts of many outstanding researchers such as Wilhelm Wundt, Noam Chomsky, Dan Slobin, Judith Greene in the West, and Aleksey A. Leontyev, the "father of the Soviet school of psycholinguistics," with his followers in the East.

Theoretical Foundations: Cross Section of Creativity Research and Language Research (Linguistics)

As a new field of research, designed scientifically, creative linguistics had formidable tasks to accomplish. The outline of research included:

1. The ontological and gnosiological foundations of Creative Linguistics

- 1.1. Ontological (empirical) level of research. Facts of interaction between creativity and language. Domain of study.
  - 1.1.1. Creativity in general and communicative component in it
  - 1.1.2. Creativity in communication (language and speech)
  - 1.1.3. Field of study
- 1.2. Gnosiological level of research
  - 1.2.1. Mentioning of the language in the creativity research
  - 1.2.2. Mentioning of creativity in the linguistic research
  - 1.2.3. Subject of study
- 1.3. Hypothesis, stages and projected results of research

2. Designing the basic models of research
   - 2.1. Modeling. Creative Modeling
   - 2.2. Main concepts, theories, and models of creativity. Approaches to research in creativity. The suggested concept and model.
     - 2.2.1. Main concepts and theories of creativity. Available definitions and approaches to its study
       - 2.2.1.1. Creativity phenomenon limits (volume of the concept)
       - 2.2.1.2. Essence of creativity (contents of the concept). Paradoxes of being undefinable
     - 2.2.2. Solving the paradoxes. Offered concept of creativity. New approach to the study of creativity phenomenon
     - 2.2.3. Models of creativity and the suggested new model
   - 2.3. Main concepts, theories, and models of linguistics (semiotic) objects. The suggested concept and model
     - 2.3.1. Sign. Four-side essence. Universal creativity model
     - 2.3.2. Language awareness and its modeling. Models of consciousness as functional organ and the place of language consciousness in it
3. The basic concepts and methods of Creative Linguistics (Sozidolinguistics)
   - 3.1. Modern speech innovations and the need for special tool for their research
   - 3.2. Gnosiology of newness–the sub-language of creativity
   - 3.3. Sozidonics and Novology
     - 3.3.1. Newness. Explication of the concept
     - 3.3.2. Units and methods of Novology
     - 3.3.3. Units and methods of Sozidonics
   - 3.4. The model of Sozidonics' act as the act of speech and languages creation. Heuristic capabilities of the model in the research of language structures generation
     - 3.4.1. Generation of language consciousness
     - 3.4.2. Forming of Sozidolinguistics units
   - 3.5. Analytical power of the model. Classification experience
   - 3.6. The main techniques and methods of generating newness by linguistic means. Lingua-heuristics and Lingua-design.
4. Applications of research
   - 4.1. Application of Creative Linguistics to education (Creative Pedagogy)
     - 4.1.1. Designing theoretical discipline programs with creative orientation
     - 4.1.2. Designing foreign language acquisition programs with creative orientation
     - 4.1.3. Designing faculty development programs (Creative MetaPedagogy)
   - 4.2. Application of Creative Linguistics to translation and interpretation
     - 4.2.1. Creative translation: Fundamentals of creative theory of translation
     - 4.2.2. Methodologies of teaching interpreters with the Creative Linguistics model
   - 4.3. Application of Creative Linguistics ideas to management, positioning, and media
     - 4.3.1. Creative Linguistics in creative management
     - 4.3.2. Creative Linguistics in positioning
     - 4.3.3. Creative Linguistics in media

5. The perspectives of further theoretic development and practical testing of the theory (List includes 18 types of practical applications).

The dissertation (Aleinikov 1992b), completed and approved for defense, due to dramatic changes in the life of the author, has never been published. Some compressed data from this research appeared in various publications and can be viewed below.

Sociocultural Background (Need)

By the eighteenth/nineteenth century, it became obvious that languages change faster and faster. Wilhelm von Humboldt mentioned that language is *energeia* (Greek *ενεργεια*), which means the language is creating and recreating itself in everyday speech act (Humboldt 1987). Historical and comparative linguistics described thousands of lexical, grammatical, and phonetic changes in the history of any language. When F. de Saussure differentiated chronological (historical) and synchronic research, the latter was understood as a contemporary cut, but even a contemporary cut has some duration. In abstract, it can be a momentous cut, but any real research takes time; therefore, it is *not* really a moment. So the question is what happens if during that interval, called "cut," something new appears in the language. How to research this newness? Also, within the historical trend, the question is not only which sounds, words, and constructions change but also why there appeared new forms and new words and how they appear. Thus, both chronological and synchronic linguistics have to deal with the issue of newness – the issue of constantly flowing language innovations.

Globalization brought so much international and intercultural interaction that borrowing words, concepts, and even grammar patterns became the norm. English vocabulary grew to over 1,000,000 words. Neologisms... after neologisms... after neologisms. Some examples can illustrate the issue:

- Coined words, like *nylon, Coca-Cola, Pepsi-Cola*, *iPhone, iPad*, appeared in the language, thanks to new products on the market: new products had to have new names.
- Words with slightly changed spelling, like *Kwik Printshop* (for *quick*) or *Kollege* (for *college*), became a traditional marketing trick.
- Contracted words or word combinations, like *StoRoom, BlanKids*, *SteriCycle* or even *Toys Я Us* (with the reversed letter *R* that stands for *are* in *Toys "R" Us*), created by the marketers to attract customers' minds and multiplied by the advertising, movies, and media, added to this avalanche of verbal newness.
- Slang stepped out of the "thieves' cant," out of the suburbs, onto the movie screens and then to ordinary life.
- Jargon in any professional field, like *megabyte, gigabyte,* and *thumb-drive,* filled the world of communication, business, and everyday speech.
- Dialectal pronunciation and grammar, like *y'all* or *I ain't got n'ting* – ridiculed but still multiplied by media – spread far beyond the geographical location of the dialects.
- Finally, the Internet and global connectivity completed the breakthrough to totally unlimited language creativity. New domain names, new programs, new acronyms, and abbreviations are being added constantly. Now, anything goes. If a phrase or abbreviation, accidentally or intentionally misspelled word brings a giggle, if it shortens the message, if it shocks somebody, it is cool. Lol. Authors of successful phrases even copyright them.

Language purists, who have been fighting for the clear, grammatically and phonetically correct language, had to give up. Language changes are so massive that they may seem overwhelming to some people. Newness, verbal newness, is ubiquitous. General research in classical linguistics could not explain this process.

On the other hand, researchers of creativity saw the language as a powerful mechanism generating more and more of the new products in literature, science, patents, and even in music and visual arts, but they did not have the tools to analyze and describe these language innovations. For example, synectics (Gordon 1961) offers a set of methods united by the name "symbolic analogy." One of the methods is called "book title" where participants of the group have to imagine they are writing a book about some subject and then make up new titles for the book that have to consist of two contradictory words. Obviously, participants work with the language, and creative ideas are coming from the language source. The results of these and other language-based creativity boosting methodologies had to be evaluated…and perhaps, even better, they had to be scientifically evaluated. There was no such a thing.

A special field of research that could explain how and why it is done was needed.

That is why creative linguistics came into being.

Origin and History of Development (Historical Sketch)

Creative linguistics researched the history of creativity (see ▶ Science of Creativity) to find out that the concept of creativity changed dramatically in volume and contents. First, at the dawn of civilization, it was applied only to God the Creator and the only true creation was "creation from nothing." Then, much later, poetry and poets were considered creative (they seemingly create their poems from nothing). Then slowly, creativity concept grew to its contemporary understanding which states that every human is creative.

Note that the second step after God was poetry, that is, a language activity. As opposed to poets, fine artists were considered just imitators of the nature, and the concept of creativity did not apply to them. Thus, poetry, the creativity in the language forms and the creativity of the language, was the first human activity recognized as creative. Poets were the most prolific newness producers. Shakespeare, for example, introduced 1,700 new words. It makes about 10% of the 17,000 words that he used in all his works. It means he "made up" every tenth word he used.

When creativity studies appeared (see the list of outstanding researchers in ▶ Science of Creativity), the knowledge of creativity processes could be applied to language studies and language training, thus leading to the birth of a new field of research – creative linguistics (sozidolinguistics) and then creatively oriented education (see ▶ Creative Pedagogy).

New Subject of Research: All Language Innovations

Just as traditional linguistics, creative linguistics studies all levels and aspects of the language starting from nonverbal communication and paralanguage factors and ending with phonetics, lexicology, grammar (traditional, structural grammar, functional grammar), stylistics, and even translation, however, only from one point of view – the point of view of generating (and generated) newness.

The volume of study, therefore, includes every act from the smallest (the creation of the meaningful speech sound by a baby) to the largest (like the creation of greatest literature masterpieces or the creation of an artificial language, human, or machine). Creative linguistics certainly studies the creation of new sounds, new words (neologisms) and word combinations (logos, symbols), new grammar patterns, new figures of speech, new styles, etc. Thus, creative linguistics studies all the traditional language/speech units from a new perspective. It also gives linguists new tools to see the creative aspect of each unit functioning in the flow of language communication.

Simply put, all language innovations make for a subject of study for sozidolinguistics: any newness in the form, meaning, or use of the language units, any newness the language brings to the society, as well as any newness caused by societal or individual changes make subjects of study for sozidolinguistics. The field of research is vast, and, therefore, it opens new horizons for the new researchers to explore.

Creation of the artificial international languages is only a little part of it, no matter how visible and romantic it is.

Here is the array of units that the subject of study includes.

Entity	Example
New artificial (constructed) languages for human communication	Like Esperanto, Ido, Volapuk. . .
New fictional languages	Like Tolken. . .
New programming languages (machine communication)	Like Java, HTML. . .
New special languages	Like Braille for the blind or sign language for the deaf
New Creole languages (mix of developed language like English and local languages)	Like Chinese Pidgin English, Swenglish. . .
New dialects	Like Ebonics. . .
New sociolects	Like gender or age group dialect. . .
New professionalisms (jargon)	Like *RAM, bit, byte, CPU, thumb-drive, flash-drive*
New colloquialisms	Like *y'all, gonna, wanna, raining cats and dogs*
New slang	Like *Cool! G to G (Good to go)*. . .
New alphabets, new letters	Like transition from Cyrillic to Latin for some languages. Also, letter ё was introduced to the Russian Cyrillic alphabet in 1797 to reflect the sound [yo] as opposed to letter *e* [ye] on the one hand and letter *o* [o] on the other hand.
New texts	New poetic forms, new prose forms. . .
New syntax structures (sentences configurations, phrases)	As *Toys are us, Toys "R" Us* (*Toys Я Us*) instead of *We are toys, We sell toys.*
New words (neologisms)	Like *nylon, quark, cyberspace, blog, webinar*. . .
New meanings	Like the meaning of *green* in *green movement*. . .
New morphemes	
New phonemes	
New abbreviations and acronyms (abbreviations pronounced as words)	Like *LOL* (Laughing out loud) or *ROFL* (Rolling on the floor laughing) in chatting. . .
New intonations	As in robot-like speech. . .
New sounds (new pronunciation)	Like in personal speech, in second language communication. . .
New signs	Like road signs, logos. . .
New symbols	Like in *Toys Я us* (with the reversed letter *R* that stands for *are*), as well as Wingdings and Webdings on the computer. . .
New. . .	

Universal Model of Sign, Speech Act, Language Consciousness, and Heuristic Act

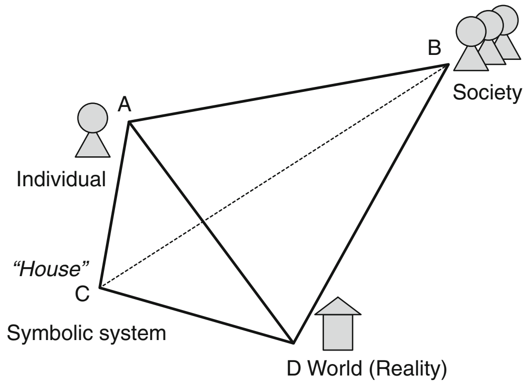
The new model of sign was developed in 1977 in Baku, Azerbaijan. It was first presented at the conference and mentioned in publishing in 1979. In 1988, it was published by the Institute of Linguistics, Soviet Academy of Sciences, Moscow, Russia (Aleinikov 1988c), and then by the *Journal of Creative Behavior* and *Encyclopedia of Creativity* in the USA (Aleinikov 1994, 1999).

The most well-known models of that time included:

- One-side sign model: the sign is the sound or letter (Solntsev 1977)
- Two-side sign model (an oval divided in two): the signifier and the signified (Saussure 1916, 1977)
- Three-side sign model (a triangle of reference): symbol, referent (object), and thought or reference (Ogden and Richards 1923; Frege 1892)
- Four-side sign model (a square): world or referent, writer's thought, symbol or word, and reader's thought (Searle 1975)

Despite the fact that the introduction of each of these models was a big step forward and the discussion of their pros and cons lasted for decades, all these models had some common deficiencies because *none of them*:

- Portrayed the communication situation (the only environment a true sign really lives in) in full
- Took into consideration the speech versus language asymmetry
- Reflected the syntagm/paradigm dichotomy of speech/language



Creative Linguistics, Fig. 3 Universal model of sign, language, speech, and heuristic act

- Allowed the application of the systems approach
- Depicted the layers of coding/decoding
- Permitted the analysis of newness
- Could be used for real analysis of speech samples (they were more philosophical than linguistic)
- Had heuristic power (proved to discover something)

In other words, a new type of model was needed. Linguistics had been developing for so many years after F. de Saussure and all gathered knowledge had to be implemented into the sign and language model. In addition to the requirement to be more specific, the model should be also more general (or even universal) because both the act of communication and the act of modeling have heuristic power (Aleinikov 1988b).

The offered model was a four-side model, but it became a 3D model. Here is how the universal model of sign, language, speech act, and heuristic act looks (Fig. 3).

In general, as Fig. 3 shows, an individual (A) is the person who creates a vision of the world (D), expresses it in symbols of the system (C), and sends it to the society (B). Society (or its representative) is any person speaking the same language or using the same semiotic system, system of signs. The message (AB) is received by the society (B), decoded, evaluated, and appreciated or not appreciated. If answered, the speaker gets into position A, and the listener becomes the society B.

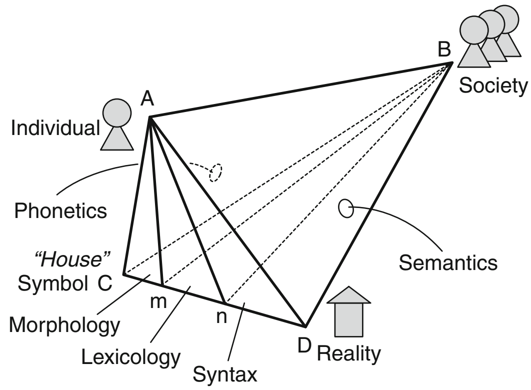
The size and the depth of the message can be easily reflected by the size and the depth of the model. That is why some messages would be ordinary (low on the creative scale) and quickly forgotten, while the others – deep and original (highly creative) – would be remembered (= valued) for centuries.

The newness of the model lies in the following:

- The essence of every sign is represented by four absolutely necessary and interrelated elements that form a tetrahedron of language functioning: individual (A) creating the message, society (B) or its representative receiving the message, symbolic system (C), and reflected reality (D). These are the invariant elements of every communication situation and, therefore, of the sign and of the language.
- Speech (AB) flows from individual (A) to society (B). Speech is now shown not as a one point object (word) as in the previous models, but linear, as it is in actual life. It is either a spoken message with one sound after another in line or a written message with letters one after another – also in line. Language (ABCD) on the contrary is shown as a volume. Linguists often noted the asymmetric relationship between speech and language. The model provides simple visual corroboration: line (speech) is one-dimensional, while volume (language) is three-dimensional. The model unites and separates them. Language is the organization (ABCD) that allows speech (AB) to fulfill its function.
- The model shows that it is not the mere symbol (word, statement) that has the meaning – it is somebody's speech directed to the society that includes the symbol (word, statement) which can be interpreted by the society. Symbols, pronounced or written, do not have meanings by themselves. Their meanings exist in the minds of the users (A and B), and, by the way, the depth of the model demonstrates the depth of understanding by the individual and the society.

- The depth of the language model allows researchers to visualize and reflect the paradigmatic relations (AC, AD, BC, BD, and any perpendicular to AB lines) as contrasted to syntagmatic relations (AB) existing in speech. Paradigmatic ("either or") relations, as opposed to syntagmatic ("and") ones, form the foundation of any language – if there are no paradigms, there is no language.
- The volume (ABCD) presentation of the language also allows researchers to visualize four constituting surfaces (planes): reflecting symbolic system (ABC), reflecting the reality system or the system of meanings (ABD), reflecting the society (BCD), and reflecting the individual (ACD). The internal organization of all these reflections makes the skeleton of the language.
- The tetrahedron configuration of the language model explains its strength and flexibility at the same time. It also exemplifies one of the Catastrophe Theory statements that the organized matter can go into unorganized (chaos) only by the sharp end. Language model has four tops – all sharp – and the tetrahedron, one of the basic archetype world structures, is truly one of the most stable forms. That is why languages, despite the everyday change, are stable enough to survive and grow.
- If the line (AB) represents speaking by A and listening by B, then the opposite to the speech line (CD) represents coding/decoding process. This is the process connecting the meanings (reality reflections, D) with symbols (symbolic reflections, C). The coding/decoding layers and fields of research studying them can be presented like this:

As it is seen in Fig. 4, the mind of the individual (A) has to do the coding from images of the reality (D), reflected by the plane ABD (semantics) in syntactic configurations (AnDB); then fill them with lexical units, words (AmnB); then shape the morphological units, like prefixes, roots, and suffixes (AmCB), and then express this all in sounds of the symbolic system (C) reflected by the plane ABC (phonetics). Note that the coding layers illustrate how language as a paradigmatic volume (ABCD) gives individual (A) some options to create the message (AB), and these paradigmatic options exist in all layers of coding/decoding shown in Fig. 4. When society or its representative (B) receives the message, it has to do the decoding process in the back order: from the sounds reflected by the phonetics (ABC) to the meaning reflected by semantics (ABD) or, in case of written speech, from the letters reflected by graphemics (ABC) to the meaning reflected by semantics (ABD).

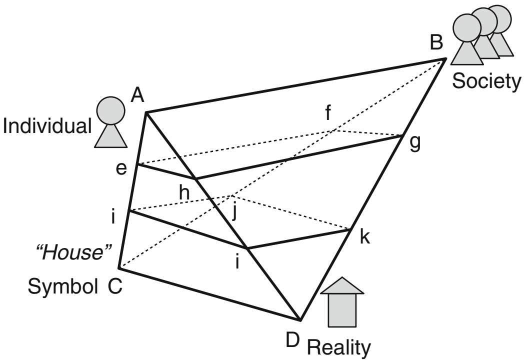


Creative Linguistics, Fig. 4 Layers of coding/decoding in the model

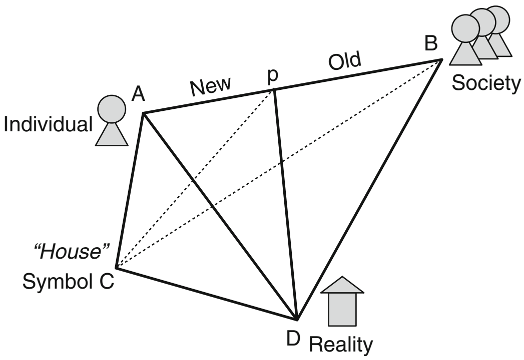
Further Interpretation:

- Now, when the model has a volume as seen in Fig. 3, researchers can apply the systems approach (Bertalanffy 1968) to the sign and language analysis. The systems approach offers to see any object (process) as a system with its function, elements, and structure. Mariam Karaeva suggested that these aspects should be viewed as three interconnected and interdependent levels: the levels of function, substance, and structure (Karaeva 1972). These levels, when applied to the model, can be visualized as follows: functional level (ABefgh), substance level (efghijkl), and structural level (CDijkl).

As it is illustrated by Fig. 5, the functional level (ABefgh), as most superficial and most changeable, lies close to the speech message AB (on top), while the structural level (CDijkl), as the deepest and least changeable, lies far from the speech.



Creative Linguistics, Fig. 5 System levels in the model



Creative Linguistics, Fig. 6 The new/old plane in the model

The next step in building the model:

- Finally, the new model gave an opportunity to introduce and to show one more cutting plane: the plane of new/old, CDp. This plane shows that there is old (part) and new (part) in every message, text, statement, and phrase, in every communicative act.

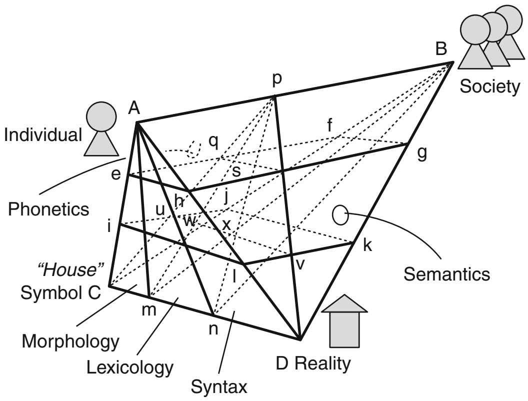
As Fig. 6 shows, every message of speech (AB) carries a part that is known to the society (B) that should recognize it in decoding (BCDp) and then the new part (ACDp) that the individual speaker (A) delivers as one's input. The amount of this new may vary in volume – the plane is flexible and movable.

The presence of new/old in every speech act was researched by the Prague Linguistic Circle and Functional Grammar as theme (topic) and rheme (comment, focus) dichotomy. They showed how the word order and intonation influence the presentation of theme (old) and rheme (new) in every speech act. For example, in the simplest case, the phrase stress (as opposed to word stress) emphasizes the new (rhematic information). One sentence "students arrived later" can be stressed differently: (1) *Students* (not teachers) arrived later. (2) Students *arrived* (not departed) later. (3) Students arrived *later* (not earlier).

What creative linguistics has proven is that every message exists to add newness and to deliver newness to the communicator (society B). Therefore, there is newness in every message. It may be significant or insignificant, but it is available. Otherwise, communication has no sense and it stops. In real life, if the person delivers too little newness in communication (for instance, repeats oneself all the time), people stop communicating with that person or limit the time of communication because it is boring. However, even the most boring communicative act is still an act: it delivers the fact that the individual A is still alive and communicating. This moment is frequently emphasized in the movies where a hero is shouting to the dying friend, "Stay with me! Talk to me!" Here, the newness of the message is nearly equal to the fact that message is available.

If every message delivers newness, then it is a creative act (big or small – this is another issue). If traditional creativity approach states that creativity is the process of combining existing ideas into new combinations, then a communicator does it in every speech act. A communicator (individual A) takes known elements of the language (nouns, verbs, adjectives, etc.) and combines them into a new message to solve the communicational problem. Every situation is unique (time is irreversible), and every message is unique because none of these can be repeated or reversed.

If a discovery or invention is tested on the model, then every discovery or invention has a unique (new) vision of the world (D), developed by individual (A) and expressed in the symbolic system (C) to be delivered to society (B) for evaluation and implementation. It may be in the form of an article or patent application, but it is still a message containing some old information



Creative Linguistics, Fig. 7 Complete model of sign (language)

(what was before) and some new information (what it is now in the opinion of individual A). So the model reflects a speech act and a heuristic act equally well. That is why it is called a universal model.

The final model that unites all the previous divisions looks as follows:

As Fig. 7 shows, the newness plane (CDp) cuts all the coding/decoding layers shown in Fig. 4, as well as all the systems levels shown in Fig. 5.

- The final model allows researchers to see the inner volumes or the outer surfaces of the fields to study. Having this instrument, a linguist or any other researcher will never "miss" a field. Many of the planes and volumes have already been discovered by linguists – the model only placed them visually and corroborated their existence. However, not all of them. In a case, when the model points at some unknown field of research, the model becomes a heuristic instrument. In some cases, the change is nominal: for example, the plane (ACD) "looking" at the individual (A) could be named competentics because it reflects the individual's competence, the command of language, or the proficiency, as educators call it. This plane is also reflected by such a well-known science as psycholinguistics.
- The side opposed to competentics (ACD) and represented by the field BCD that "looks" at the society (B) reflects the overall language knowledge of the speaking community (or its representatives). In commonly accepted linguistics, this plane is reflected by pragmatics (pragmalinguistics) and sociolinguistics. Creative linguistics gives it a general name gnosionics, from Latin *gnosis* – knowledge. The units of gnosionics may be called gnosemes (like the units of phonetics are called phonemes and the units of morphology are called morphemes). When somebody says, "You can't say so!" or "People do not speak like that!" or "Usually, we say it differently!" they state a discrepancy between what they know from their language experience (gnosionics) and what they hear. This generalized language experience forms gnosemes – patterns of the language knowledge. That is why foreign language learning takes so much effort: it is not only words but also the WAY it is said.
- Graphically, the superficial knowledge of the language may be depicted by a shallow model. On the contrary, profound knowledge of the language with its structural richness, substance fullness, and functional fluidity may be depicted by a deep model. The model, therefore, can serve as a visual diagnostic tool.
- The main achievement of the model is the visualization of the necessity for the creative linguistics represented by the volume ACDp. The science of new words called neology takes only the volume Amnp, thus totally skipping the grammatical coding changes (AnDB – syntax and AmCB – morphology). So, the model "pointed" in the direction of new research and, therefore, proved its heuristic value.

The development of the model and its extrapolation to the other fields continues till today. This model turned out a universal model of language and language consciousness (1988), sign, speech situation, and speech act. The model shows and explained things that have never been explained by any other sign models in linguistics. It is simple and heuristically powerful at the same time. Most importantly, though, it also gave the basis for introducing a structural plane between the old and the new. By doing this, in addition to all previous extrapolations, the model became a model of innovative act as well as a model of directions for future innovations. It is this model that determines what one needs in order to make an innovation. It is the model that shows the directions to the future research, including the research of genius (see ► Genius), education (see ► Creative Pedagogy), and leadership (see ► Creative Leadership).

New Methods and Results of Research

The model described above, in addition to its general philosophical and linguistic value as a universal model of sign, language, speech act, and creative act, becomes a practical everyday tool for creative linguistics research. The model helps:

1. To describe the newness in unified terms.
2. To figure out the location of the newness: whether it belongs to semantics (D), phonetics, graphemics, or, in general, symbolics (C), pragmatics (B), or competentics (A).
3. To find out the depth of newness: whether it belongs to the functional level (superficial), substance level (intermediate), or structural level (deep).
4. To place the newness to the coding layer (syntax, lexicology, morphology).
5. To visualize and describe the exact unique profile of particular newness as a combination of all points. Measuring the profile in quantity units makes the comparison of the created variants more objective (not as *I like it* or *I do not like it*, which is subjective). It means, for instance, that the marketing efforts (creating new ads) can be more precise and less expensive.

In short, the main advantage of this model is that it allows researchers to formalize and visualize the amount of newness – usually so vague or refined that for centuries it seemed impossible to measure.

New type of analysis, the sozidolinguistical analysis, analysis of the newness presented, is introduced as a new method of analyzing the speech products. Some speech products are trivial (low volume of newness), the others are original and interesting (high volume of newness). Geniuses create the top volume of newness in their works. That is why the creative act of a genius, illustrated by the model, looks different from the creative act of an ordinary person (see ► Genius).

The new measurement methods were introduced thanks to paradigmatic analysis used by creative linguistics (see ► Novology).

Applying Creative Linguistics to Education and Training

The first applications of creative linguistics were in the field of education. There were three directions: teaching theoretical disciplines, teaching practical disciplines (both belong to creative pedagogy), and then teaching teachers of both theoretical and practical disciplines how to teach creatively (creative metapedagogy).

The first article on creative pedagogy was published in 1989 (Aleinikov 1989b) and on creative metapedagogy in 1990–1992 (Aleinikov 1990c, 1992a).

Creative Orientation of Theoretical Programs

Creative linguistics was first introduced and tested on the theoretical studies of English grammar and history of English. The results of the application were unusually positive: students who were involved in the creation of their own props, posters, plays, and finally wrote a book, called it the best course in their lives. Students began (voluntarily) to apply new methods of learning to practical courses, like speech practice. The leadership of the Military Institute saw it as a new potential, a new direction in education. The author was awarded the first in the Soviet Union 3-year “doctorantura” fellowship (usually it was for 2 years) with the task to describe the new teaching system. A new book titled Созидание грамматики и грамматика созидания/ *Grammar Creation and Creation Grammar* became the first in the Soviet Union “creatively oriented” program (Aleinikov 1990a). A methodology manual for creative orientation in teaching and learning theoretical disciplines was published the same year (Aleinikov 1990b).

Creative pedagogy principles were applied to the theoretical courses of military translation, theory of translation, lexicology, and other disciplines at the Military Institute, Moscow.

In the United States, creative orientation was applied to:

- Word Origins and Usage (ENG2210), 1994–2006
- History of Russia (HIS335, 535, 336, 536), 1995–1996
- Psychology of Creativity (PSY3390), 2001–2006 (see ► Psychology of Creativity)

The latter became the third program in the USA offered at the university level and the first in the South East.

Creative Orientation of Practical Disciplines: Hyper Efficient Language Program (HELP +2000)

Creative linguistics was also applied to the practical foreign language studies – to the acquisition of English and Russian as foreign languages (Aleinikov 1989a, c).

Since the new definition of creativity states that creativity is **a human activity of accelerating organization and/or deceleration disorganization** (see ► Creativity Definitions, Approaches and ► Science of Creativity), the main task was to create a system of the fastest (most accelerated) course of foreign language acquisition from level 0 (zero).

Such a program was designed and tested in Perm, Russia. The experimental program was named Hyper Efficient Language Program (First HELP +2000) because the students acquired over 2,000 words and phrases in 40 h of learning (Aleinikov 1995b). A new methodology allowed participants to learn the basic dialogs and understand simple conversations needed for traveling to England. An episode that happened on the seventh day of studying can offer some illustration. Children of the adult students (CEO and managers) visited the class after 7 days of learning. When they saw their parents (without any previous knowledge of the language) communicating in English and doing it with fun, they declared that they were not going back to traditional school where they had been studying English for 3–5 years but could not speak at all. They wanted to join the experimental group.

After success in Perm, where the new methodological approach was first exposed to public, the author of the program was invited to teach and license this program with certification and recertification of the teachers for the Center "Professional" (Moscow) offering classes in 40 languages.

Later, the elements of the Hyper Efficient Language Program (First HELP +2000) were used in India for the Indian Navy officers and Russian specialists (1990–1991). At present, the elements of this program are used for the Immersion program of the Defense Language Institute Foreign Language Center, Monterey, California (2008–2012).

In the United States, Creative Orientation of Practical Disciplines was applied to:

- Russian (all levels) at Auburn University, Montgomery, Alabama
- Effective Communication (COM1110) at Troy University, Montgomery, Alabama

Creative Metapedagogy: Teaching Managers and Teachers

The next natural step after the creation of creative pedagogy was to check whether methodologies of creative teaching are teachable. **Creative metapedagogy – the science and art of teaching teachers how to teach creatively –** appeared and was reported in 1990–1992 (Aleinikov 1990c, 1992a).

Within 2 years, three professional development centers tested the new creative pedagogy methodologies – all with success:

- Russian Academy of Sciences Center for Creativity Research (Moscow)
- Russian Academy of Sciences Center ILAN (Moscow)
- Center for Pedagogical Innovations (Krasnodar)

The Russian Academy of Sciences Center for Creativity Research (Moscow) and Russian

Academy of Sciences Center ILAN (Moscow) used it for creative management programs to teach managers. Thus, after the collapse of the Soviet Union, creative linguistics and creative pedagogy were immediately applied as new tools for changing the methods of leadership and management in Russia (Aleinikov 1991). The Center for Creative Research (Moscow) offered training to military and civilian leaders and then published a five-volume book titled *Creative Management* – a totally revolutionary concept for the country under totalitarian regime for over 70 years. The book included the translation of the most famous Western authors on creativity as well as an article on how to use creative linguistics for the new realities (for details on the innovative vision of leadership developed thanks to creative linguistics, see ► Creative Leadership).

The Center for Pedagogical Innovations (Krasnodar) took it to educators. The center sponsored the development of the creativity test (Aleinikov 1990d) that could be used for individual and group creativity and then organized creative metapedagogy training for professors of five colleges.

The concept of creative pedagogy immediately became popular and got into the encyclopedia editions (Popov 1995).

In the United States, creative management training in the form of creative problem solving was offered to a number of Fortune 500 companies, such as 3M, Alabama Power, Georgia Power, Mississippi Power, Procter and Gamble, Schlumberger, etc.

Creative metapedagogy for the first time in the world was offered for the graduates as the course titled Foundations of Creative Education (EDU6625) at Troy University.

By 2010, creative pedagogy and creative metapedagogy in the form of numerous programs for teachers, managers, and educational and business leaders spread from the USA to Pakistan, Singapore, South Africa, and Thailand. It has been successfully applied to:

- School education (New Challenge School, Montgomery, Alabama; Franklin Junior High School, Franklin, Ohio; Jiemin Primary School, Singapore, etc.)
- Postsecondary education (five colleges in Russia, higher education institutions, like Military Institute, Moscow; Air War College, USAF University, Maxwell AFB, Alabama; Troy and Auburn Universities, Montgomery Alabama; Defense Language Institute, Monterey, California)
- Teacher and professor professional development (the University of Cincinnati, Ohio; United States Air Force Junior Reserve Officer Training Corps (USAF JROTC) Instructors, Garmisch, Germany, and Maxwell AFB, Montgomery, Alabama; Davis and Elkins College, Elkins, West Virginia; Ohio State University; Teachers Centers in Bangkok, Thailand; Karachi and Islamabad, Pakistan; principal education in Pretoria and Johannesburg, South Africa, as well as universities, colleges, schools, and officials of the Ministry for Education, Singapore)

The results of applying creative pedagogy to real education problems are more than positive. In Singapore, for example, the Jiemin Primary School officials selected 13 sixth-graders (out of 1,200 students) who were labeled “incorrigible and doomed to fail.” After 2½ days of pedagogical intervention, all students proved to be “ideal learners” and...7 months later (without any follow-up), they passed all four state exams (math, science, English, mother tongue) and proceeded to the next level of academic education, thus leading to 100% success of the program. Teachers and parents called it a “miracle” (Aleinikov 2003).

At present, the term creative pedagogy is well spread. It is used for monograph titles and programs names. The concept is studied and taught at the university level. Some of the methods have already been considered “classic” (see ► Creative Pedagogy). Finally, a new Encyclopedic Reference Dictionary titled Creative Pedagogy (Popov V.V. - editor) is being published in Russia.

This is how creative linguistics contributed to solving world educational problems.

Applying Creative Linguistics Research to Science

The application of creative linguistics (sozidolinguistics) research to education led to the development of new field of research like creative pedagogy, creative andragogy, and creagogy as a combination of both. Creative pedagogy led to creation of Genius Education Methodology, the fastest method of human mind orientation to genius development (see ▶ Creative Pedagogy).

Studying the thinking methodologies of genius led to the discovery of the methodology of discovery. As a result, a group of California scientists discovered 11 new laws of conservation (Aleinikov and Smarsh 2010).

The application of creative linguistics research to the field of creativity, as a give-back, contributed to the development of the science of creativity, whether called sozidonics or creatology (see ▶ Science of Creativity and Magyari-Beck 1999).

Introduction of the new measuring units and ways to measure creative output by creative linguistics led to the development of the fastest methods and techniques boosting creativity to the level of megacreativity (see ▶ Genius and Aleinikov 2002).

The application of experience on how to create a new science like creative linguistics (sozidolinguistics) led to founding new sciences:

- Geniusology, the science of genius (see ▶ Genius)
- Novology, the science of newness (see ▶ Novology)
- Organizology, the science of organization (see ▶ Science of Creativity)
- Agogics, the science of leadership (see ▶ Creative Leadership)
- Generagogy, the general science of teaching that unites pedagogy and andragogy (see ▶ Creative Pedagogy)

In addition to new sciences, the application of creative linguistics (sozidolinguistics) research to the leadership and management field led to the development of concepts of creative leadership, ideal leadership, and IdeaLeadership© that broadened the classification of types of leadership and helped to define the field of agogics (see ▶ Creative Leadership).

In the same manner, new concepts like ideal learner, ideal teacher, and ideal education model have been introduced to pedagogy, thus expanding the field of education.

This is how new concepts, models, theories, and definitions that have been developed by creative linguistics, influenced the scientific vision of the world.

Disseminating Creative Linguistics: Dissertations and Conferences

The process of dissemination of creative linguistics concepts and achievements was going in a traditional pattern: from one country and one language to the other countries and other languages (Armenian, Azeri, and Georgian in thesis), and then via English (published first in India) to international recognition. The process was slowed down by the dramatic events in the life of the founder (transition from the Soviet Union to the USA), but still was going on. Despite the fact that the main work on creative linguistics (Doctor of Sciences Dissertation titled *Theoretic Foundations of Creative Linguistics*) has never been published, the applications of creative linguistics to education, creativity research, leadership and management field, advertising and publishing, as well as science in general, as corroborated by the author's national and international awards, including a Guinness World Record in publishing, are impressive.

The pioneering role of the author in the creation of the new trend of research was directly stated about 20 years later after the publication of the first article on creative linguistics by V.I. Karasik, who wrote:

> "In the contents aspect, this category [routine vs. creative aspects of communication], as far as I know, has never been the subject of linguistic research, except the publications of A.G. Aleinikov, who stated the need to develop Creative Linguistics.... (Aleinikov 1988a)" (Karasik 2008).

Creative linguistics continues to benefit both the linguistics field and the creativity field. As a relatively new trend in linguistics, it continues to attract new researchers. For example, the creative potential of linguistic units is studied in the dissertation of Remchukova (2005). On the other hand, the term creative linguistics is also used as a generic term for creative thinking techniques that employ the language heuristic power for finding new ideas (Vagin 2010).

Moreover, after over 20 years in existence, which had been predicted by the founding article (Aleinikov 1988a), creative linguistics became the theme of scientific conferences (Gridina 2008).

Finally, with the spread of the Internet, the term *creative linguistics* becomes a kind of commonly used word combination, and people apply it, for example, to create new logos and trademarks (Retrieved from http://www.multitran.ru/c/m.exe?a=4&MessNum=5522&l1=23&l2=2) or just to have fun in creating new combinations of words and statements. Some authors even call creative linguistics "a consultant's marketing tool in the new world order" (Binneman 2011). So the popularization stage of the term creative linguistics is going on.

Conclusion and Future Directions

Creative linguistics (sozidolinguistics) that appeared on the cross section of creativity domain and linguistics domain studies the creativity aspects in language and the language aspects in creativity. As a branch of linguistics, sozidolinguistics selects in any event having a sign nature the factors dealing with the generation of newness, that is, with the creative aspect of language and speech.

Creative linguistics was the first to prove that every speech act is a creative act because, by using the known elements of the language, a person *creates* a message (speech act) that is unique (will never be repeated) and, by doing so, solves the problem of communication just as an inventor or engineer solves a technical problem. This simple proof is so significant because it eliminates the dichotomy creative or not creative. If the person can speak, the person is creative. The question now is *how creative* or how much newness the person is delivering in his/her messages. This can be taught, and people who get through training in creativity begin to deliver much more creative results. This is how creative linguistics paved the way to creative pedagogy (that got into encyclopedia nearly immediately) and creative metapedagogy, both of which received wide international recognition for their innovative teaching methodologies, new vision of innovative education (Aleinikov 1995a), and impressive educational results.

Creative linguistics also contributed significantly to the science in general by founding seven new sciences and three subsciences, new models, new theories, and new concepts (see, e.g., Aleinikov 2002b).

In the creativity field, creative linguistics led to a new (scientific) vision of creativity (see ► Creativity Definitions, Approaches) and served a catalyst for shaping a new science of creativity (see ► Science of Creativity). Creative linguistics, with its well-structured approach, developed the way to measure creative output, thus leading to the development of the most powerful methods boosting creativity to megacreativity and more (Aleinikov 2002a).

Combining creative pedagogy methodologies and megacreativity concept led to the design of the unique educational system "Genius" and brought the author worldwide recognition in the form of best seller, invitations for keynote speeches at the international creativity and education conferences, numerous international awards, and even, as some creativity experts think, the title of "the most creative man in the world" (Ramos 2006).

When applied to business, creative linguistics worked its way to training managers of the Fortune 500 companies and showed the fastest results in publishing confirmed by the unbeatable Guinness World Record in publishing.

Since the main research on creative linguistics has not been published, the author's main task is to publish the work that brought so much to humanity but still remains hidden. Therefore, the task of translating creative linguistics from Russian to English and publishing it is one of the main directions of work.

Applying creative linguistics methods and models to business, advertising, marketing, media for practical improvements, and savings is another direction. Some of the directions that creative linguistics is working on may seem like science fiction, but what was predicted by creative linguistics and seemed science fiction 20 years ago has already been achieved.

If creative linguistics methods of research and achievements have proven to be so successful and powerful, then the future scientific directions it can lead to are limited only by the imagination of those who take them to work.

Cross-References

- ▶ Creative Leadership
- ▶ Creative Pedagogy
- ▶ Creativity
- ▶ Genius
- ▶ Novology
- ▶ Psychology of Creativity
- ▶ Science of Creativity

References

Aleinikov AG. On creative pedagogy. Higher Educ Bull. 1989b;12:29–34. russ. Алейников А.Г. О креативной педагогике//Вестник высшей школы.

Aleinikov AG. Grammar creation and creation grammar: creatively-oriented course of grammar and history of English. Moscow: Military Institute; 1990a. Созидание грамматики и грамматика созидания.

Aleinikov AG. Creative orientation in teaching and learning theoretical disciplines. Moscow: Military Institute; 1990b. russ. Алейников А.Г. Творческая ориентация в преподавании и изучении теоретических дисциплин.

Aleinikov AG. Creative pedagogy and creative metapedagogy. Progress in Educ. 1990c;66(12):274–80.

Aleinikov AG. Test battery "ALEANDR". Moscow: Russian Academy of Sciences Center for Creative Research and Krasnodar Center for pedagogic innovations; 1990d. Алейников А.Г. АЛЕАНДР.

Aleinikov AG. Creative linguistics in creative management. In: Shmakova LE, Malovichko VS, editors. Creative management, vol. 1. Moscow: Creator, Russian Academy of Sciences; 1991. p. 227–68. russ. Алейников А.Г. Креативная лингвистика в креативном управлении. Креативный менеджмент.

Aleinikov AG. Creative metapedagogy: D-day. Alma-Mater. Higher Educ Bull. 1992a;1:34–9. russ. Алейников А.Г. Креативная мета-педагогика. Время "Ч". Alma Mater/Вестник высшей школы.

Aleinikov AG. Sozidolinguistics for creative behavior. J Create Behav. 1994;28(2):104–23.

Aleinikov AG. An approach to innovative education (Editorial). Int J Innov Higher Educ. 1995a;11:5–7.

Aleinikov AG. Humane creativity. In: Runco M, Pritzker S, editors. Encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999. p. 837–44.

Aleinikov AG. Mega creativity: five steps to thinking like a genius. Cincinnati: Walking Stick Press, F&W Publications; 2002a.

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, Academy of Sciences; 1988a. p. 77–89. russ. Алейников А.Г. Креативная лингвистика (обоснование, проблемы и перспективы). Языковое сознание: стереотипы и творчество.

Aleinikov AG. Creativity and language acquisition. In: Shiryaev A.F. Editor. Collected articles. Vol. 25. Moscow: Military Institute; 1989a. p. 5–10. russ. Алейников А.Г. Творчество и освоение языка. Сборник статей.

Aleinikov AG. Genius Education Methodology helps creating a nation of geniuses: new horizons, awards and rewards in creative and innovative education. (Retrieved from http://www.humiliationstudies.org/news-old/archives/000039.html June 13, 2012; 2003).

Aleinikov AG. Hyper efficient language program – "First HELP + 2,000." Sharing the dream. NAFSA: Association of International Educators, Region VII Conference. Memphis, Tennessee; 1995b.

Aleinikov AG, Editor. Novology, the science of newness, for creativity and innovation research. The future of creativity: Dr. E. Paul Torrance lecture series at the University of Georgia. Bensenville, IL: Scholastic Testing Services; 2002b. p. 114–41.

Aleinikov AG. On the heuristics of communicative and modeling acts. In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, Academy of Sciences; 1988b. p. 55–76. russ. Алейников А.Г. Об эвристичности актов коммуникации и моделирования. Языковое сознание: стереотипы и творчество.

Aleinikov AG. Sign. A four-side essence. Universal creative model. In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, Academy of Sciences; 1988c. p. 89–115. russ. Алейников А.Г. Знак. Четырехсторонняя сущность. Универсальная креативная модель. Языковое сознание: стереотипы и творчество.

Aleinikov AG. Speech activity model and translation. In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Studies of translation and culture: goals, methods, results. Moscow: Institute of Linguistics, Academy of Sciences; 1989c. p. 27–40. russ. Алейников А.Г. Модель речевой деятельности и перевод. Переводоведение и культурология: цели, методы, результаты.

Aleinikov AG. Theoretical foundations of creative linguistics. Unpublished Doctor of Sciences in Philology Dissertation. Moscow: Military Institute; 1992b. russ. Алейников А.Г. Теоретические основания креативной лингвистики. Диссертация доктора филологических наук.

Aleinikov A, Smarsh D. Eleven new laws of conservation: the discovery of the century. Allied Academies. Spring International Conference, New Orleans, Louisiana, April, p. 37; 2010.

Bertalanffy L. General system theory: foundations, development, applications. New York: George Braziller; 1968.

Binneman D. Creative linguistics – A consultant's marketing tool in the new world order. (Retrieved from http://deonbinneman.wordpress.com/2011/06/23/creative-linguistics-a-consultants-marketing-tool-in-the-new-world-order/ on March 30, 2012; 2011.

Frege G. On sense and reference (Über Sinn und Bedeutung). Zeitschrift für Philosophie und philosophische Kritik C. 1892;1892:25–50.

Gordon W. Synectics. New York: Harper & Row; 1961.

Gridina TA. All-Russia conference with international participation on the problems of Russian language "Creative linguistics." Ural State Pedagogical University, 2008. russ. Гридина Т.А. Всероссийская конференция с международным участием по проблемам русского языка "Креативная лингвистика"), (Retrieved from http://www.rfh.ru/index.php?option=com_content&task=view&id=239&Itemid= 231&limit=1&limitstart=1 March 30, 2012).

Humboldt W. On language. Cambridge/New York: Cambridge University Press; 1987.

Jespersen O. Interlinguistics, International Communication; 1931.

Karaeva MS. To concretizing of the notion "language system." In: Scientific works of Azerbaijan pedagogical institute of languages, Series XII, Baku, 2, p. 38–42; 1972. russ. Караева М.С. К конкретизации понятия "система языка". "Ученые записки" Азербайджанского педагогического института языков.

Karasik VI. Routine and creative communication: functions, types, methods. In: Kaplunenko AM, editor. Vestnik of Irkutsk State Linguistic University, p. 112–8. russ. Карасик В.И. Рутинное и креативное общение: функции, типы, способы. Лингвистика дискурса, Вестник ИГЛУ. Retrieved from www.islu.ru/rar/vestnik_2008_3.pdf 20-Sep-2010; 2008.

Kuznetsov SN. Theoretical foundations of interlinguistics. Moscow: University of peoples friendship; 1987. russ Кузнецов С.Н. Теоретические основы интерлингвистики.

Labov W. Principles of linguistic changes: social factors. Malden: Blackwell; 2001.

Luria AR. Main problems of neurolinguistics. Moscow: Moscow State University; 1975. russ. Лурия А.Р. Основные проблемы нейролингвистики.

Magyari-Beck I. Creatology. In: Runco M, Pritzker S, editors. Encyclopedia of creativity, vol. 1. San Diego: Academic; 1999. p. 433–41.

Ogden CK, Richards IA. The meaning of meaning. 8th ed. New York: Harcourt, Brace & World; 1923.

Popov VV. Creative pedagogy. In: Polovinkin AI, Popov VV, editors. Encyclopedic dictionary "Technical creativity: theory, methodology, practice". Moscow: Logos; 1995. p. 165–7. russ. Попов В.В. Креативная педагогика. В энциклопедическом словаре "Техническое творчество: теория, методология, практика.

Ramos S. "The most creative man in the world" Press release of the International Academy of Genius, 2006 (Retrieved from http://www.eworldwire.com/pressreleases/13690 on Dec 20, 2011; 2006)

Remchukova EN. Creative potential of russian grammar: morphological resources of the Language. Doctor of Sciences in Philology Dissertation. Moscow; 2005. russ. Ремчукова Е.Н. Креативный потенциал русской грамматики: Морфологические ресурсы языка. Диссертация доктора филологических наук.

Saussure, F. de. Cours de linguistique générale. (Bally C, Sechehaye A (eds). with the collaboration of Riedlinger A) Lausanne and Paris: Payot, 1916 (trans: Baskin W) Course in general linguistics, Glasgow: Fontana/Collins, 1977; 1916.

Schubert K, editor. Interlinguistics. Aspects of the science of planned languages. Berlin/New York: Mouton de Gruyter; 1989.

Searle J. A taxonomy of illocutionary acts. In: Gunderson K, editor. Language, mind, and knowledge. Minneapolis: University of Minnesota Press; 1975. p. 344–69.

Solntsev VM. Language as a system-structural entity. Moscow: Science; 1977. russ. Солнцев В.М. Язык как системно-структурное образование.

Spencer G. Creative Linguistics. (Retrieved from http://www.vcn.bc.ca/~gartho/CreativeLinguistics.pdf June 2012)

Vagin IO. The best psycho-techniques for success. russ. Вагин И.О. Лучшие психотехники успеха. Retrieved from http://lib.ololo.cc/b/214699 (2010). 07-Nov-2010.

Creative Management

Fangqi Xu
The Institute for Creative Management and Innovation, Kinki University, Higashi-Osaka, Osaka, Japan

Synonyms

Creative business; Creativity in business; Innovative management

Definition

Creative management is the study and practice of management, drawing on the theories of creative processes and their individual, group, and organizational application.

Origin of the Concept

Creative management has its origin in two academic research spheres: one is management studies and the other is creativity research. The former has a history that is longer than a century, and the latter is more 80 years old. Management studies paid more attention to a person than a thing, and creativity research has been developing applicable ranges since the 1980s; creative management was born as an inevitable result (Xu and Rickards 2007).

Research Activities in the Main Countries

Research on creative management began in the United States in the early 1980s, although one can find terms like "corporate creativity," "organizational creativity," and "creative business" in some books and academic journals prior to that time.

In 1982, the First Conference on Creative and Innovative Management was held October 5–6 at the RGK Foundation in Austin, Texas (Charnes and Cooper 1984). The second conference was held at the University of Miami November 7–9, 1984 (Kuhn 1985), and the third conference was held June 2–3, 1987, in Pittsburgh at the Graduate School of Industrial Administration, Carnegie-Mellon University (Ijiri and Kuhn 1988). All three conferences were sponsored by the IC^2 Institute at the University of Texas at Austin. The conference proceedings were published by Ballinger Publishing Company in 1984, 1985, and 1988. Such conferences have an influence on academic circles and the industrial world in the United States.

In the United Kingdom, the Open University Business School offered a course called "Creative Management" for MBA candidates in 1991 (Henry 1991). The course is now called "Sustainable Creative Management" and is still held at the school.

In China, Changzhou University established the Institute for Creative Management in 2005. It is the first institute on this research area in China.

In 2010, the Institute for Creative Management and Innovation was launched at Kinki University in Japan. It is the first institute on this research area in Japan.

Research on creative management has been developing from North America to Europe and Asia, and the level of research has become higher with the development from conferences to MBA courses and research institutes. Thus, creative management has become a promising research area for the future.

Research Subjects

There are two primary research subjects in creative management: the creative company and the creative manager (Xu 2005).

Creative Company

In assessment of a creative company, two aspects are observed: creative behavior and creative environment.

Creative Behavior

A creative company is an enterprise that has won intense competition with creative behavior. For a company, creative behavior has three layers: individual creativity, team creativity, and organizational creativity. Individual creativity is the foundation of team and organizational creativity. Because corporative competition in the market is not an individual play, it is an all-out play; a company must pull together individuals' creativity to become team creativity and organizational creativity.

Creative Environment

A created environment includes both physical environment and social environment. The former means facilities, materials, literature, and so on. The latter includes human relations, organizational atmosphere, and corporate culture. In short, hard (physical) environment and soft (social) environment come together at the same time. In this environment, employees can do their best creative work.

Canon is a high-technology maker of cameras and printers, and had about 194,000 employees and ¥3707 billion (US$46.5 billion) of revenue in the 2010 fiscal year. It is a creative company not just because of its share of the market but because it owns 80,000 patents and its achievement in new product development (Tanaka 2004). Other creative companies from the Fortune 500 include Apple, Samsung, Sony, Lenovo, and Haier.

However, creative companies are not only large corporations. Some smaller companies have distinctive competitive power in the world. For example, Okano Industrial Co., Ltd is a small company in Japan with only six employees, including the president. However, its revenue is ¥600 million (about US$7.8 million) (Okano 2003). On the average, one person's revenue is ¥100 million (about US$1.3 million)! In general, average revenue for a small company is only ¥10 ~ 15 million, and even for a big company the average revenue is ¥20 ~ 25 million in Japan. Why is this company so successful? Because they have some original techniques and developed several unique products. They invented a needle so that patients never feel pain at injection. Sony asked the company to make the case for the lithium ion battery for its mobile phones, because of Sony was unable to find a maker to do it without Okano.

Creative Manager

The creative manager is a creative person who possesses a creative personality and has the abilities of creative thinking, creative decision making, and creative leadership. A creative personality is a psychological characteristic. It refers to an individual's overall constitution and capacity to be creative.

Creative Personality

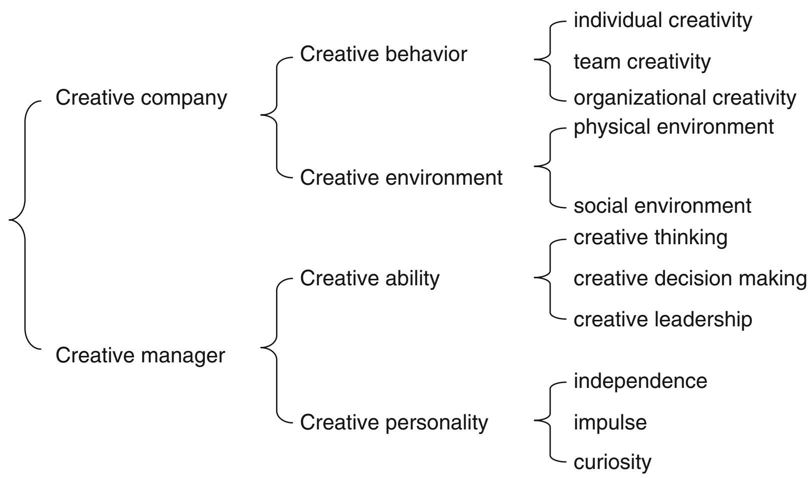
Personality is a psychological concept. It consists of a person's make-up and interactions with the environment. A person's behavior is prescribed by his/her personality. Independence, impulse, and curiosity are characteristics of creative personalities.

Creative Thinking

Creative thinking is an original function of the brain that is related to problem solving. Creative thinking is not a gift but can be formed through training. The premise of creative thinking is to do away with common sense. If one sticks only to common sense, he/she never thinks creatively. It requires bravery to do away with common sense because of the potential risks – failure, loss of position or job. Therefore, it is necessary rational thinking – hypothesis, reasoning, verification, and so on – is also included.

Creative Decision Making

Decision making is the ability to decide something by one's self. It is a necessary ability for a CEO to judge the conditions and future when he/she wants to take action. But it is impossible to know whether all decisions will be correct. A CEO has to do such decision making every day. If a CEO's decision has brought about huge profit, one can consider that he/she has a capacity for creative decision making. Tadashi Yanai, the chairman, president, and CEO of Fast Retailing, has said, "1 win and 9 defeats (Yanai 2003)." This means that, although he had failed many



Creative Management, Fig. 1 The elements of creative management

times in his business life, if only one time was successful, the business will be sustainable.

Creative Leadership

Leadership is an ability to manage a company. A CEO should lead the company with a broad view of things and does not need to be involved in daily operations. A creative manager can make the best of the subordinates' creativity and lead them to solve the short-term problems and deal with longer-term research. Because leadership has an abstract character, it is difficult to assess from the outside. Therefore, creative managers often use their own words to explain it. For example, Liu Chuanzhi, the founder of Lenovo, subdivided leadership into three concrete abilities: the ability to make a managerial team, the ability to enact strategy, and the ability to pull together subordinates (Xu 2007).

The late Steve Jobs, founder of Apple, was one of the most creative managers in the world. Sometimes he was seen as an uncommon man by the people around him because of his strong creative personality. His abilities of creative thinking, creative decision making, and creative leadership were better than any manager in the industrial world. Apple became the one of the most creative companies in the world because of his leadership (Isaacson 2011).

Tadashi Yanai is a creative manager in Japan. He transformed a small clothes shop that was started by his father into the number one retailer of clothes in Japan and created the worldwide UNIQLO brand due to his creativity and management innovation.

Zhong Qinghou is the founder of the Wahaha Group, the larges maker of soft drinks in China. Under Zhong's creative leadership, the company competes with foreign giants such as Coca Cola, Pepsi, and Danone and has been developing rapidly. Zhong was named as the number one billionaire in Mainland China by *Forbes* in 2010 (March 29, 2010).

Figure 1 provides a summary of the elements of creative management that are explained above.

Creativity in Business

The history of creativity research in business goes back to the 1930s in America. It began in product development and advertising and explored aspects of people and organization within the development of management. "Brainstorming," the famous creative thinking method, was born at an advertising company, BBDO, in 1938 (Osborn 1953).

Later, other fields related to management identified the significance of creativity. For example, idea creation, product development, design innovation, acquisition of knowledge capital, enforcement of spin-off, marketing development, cost control, human resource development, and competition have acknowledged potential for creativity and its stimulation. Courses related to creativity and business are offered at many colleges and universities (Xu, McDonnell and Nash 2005). For example, Harvard Business School has a course called "Managing for Creativity"; Columbia Business School offered an MBA course called "Entrepreneurial Creativity"; DePaul University's MBA program includes the required course "Creativity in Business"; Indiana University offered an MBA course entitled "Creativity and Innovation: Generating New Venture Ideas"; Northwood University has a course "Creativity and Business"; Stanford Business School has two courses entitled "Creativity in Business" and "Personal Creativity in Business"; Hass School of Business at University of California, Berkeley, offered an MBA elective course entitled "Creativity in Business"; Michigan Business School's course is called "Managing Creativity" as is HBS's; and University of Southern Maine's business school offered an MBA course called "Change and Creativity". These courses started in 1980s and 1990s.

Principles of Creative Management

The Universality Principle

Creativity is an inherent potential of all human beings. This appears to be contested by theories concentrating exclusively on extraordinary creative talents in arts, science, and even in business. However, the universality principal is more widely accepted in the educational domain, where intelligence is regarded as universal, although some people display evidence of having superior levels of intelligence than others.

This principle is related to corporate behavior. If a CEO believes everyone has creativity, he/she will do something for the all employees, not only for a few experts. For example, Canon, a Japanese maker of cameras and printers, gives a promotion opportunity to everyone every year. If someone passes the promotion test, he/she will be promoted (Mitarai 2001). Haier, a Chinese maker of home electric appliances, invites public applications in the company when an administrative post becomes vacant (Xu 2006). Canon and Haier consider everyone as a creative person.

The Developmental Principle

Potential creativity will become actual creativity under suitable developmental conditions. Conversely, actual creativity will decline if the person is restricted in opportunities to display his/her creativity. Creativity is not fixed attribute; it must be changing and developing. In most cases, development is the main characteristic. Development has two sides: outside and inside. Suggestion systems, group action, and project teams are outside. On-the-job training (OJT), self-education, and self-development are inside. Because employees' potential creativity will gradually become actual creativity through development, a CEO should offer opportunities to apply actual creativity. For example, offering work that provides someone with a sense of purpose or higher responsibility.

It is possible that someone's creative talent changes from one domain to another. For example, a sports champion may become a manufacturer's CEO, a carpenter may become a famous painter, and so on.

The Environmental Principle

Environmental features influence the development and manifestation of creativity (the developmental principle). Research will increasingly shed light on the mechanisms through which contextual features limit or enhance creativity. There is gathering consensus that creativity is supported through features encouraging "ownership," participation, and the enhanced sense of well-being through self-actualization. Generally speaking, a good environment stimulates creativity. For a researcher, "good" means both hard environment and soft environment. The hard environment includes having research funding, research assistants, laboratory, materials, and so on. And the soft environment includes human relationships, flextime, evaluation and encouragement, and so on. A bad environment represses creativity. For example, dirtiness, noise, small space, lack of funds and equipment, tense atmosphere in office, arbitrary boss, unfaithful colleagues, and so on, will represses creativity. However, some people are successful in a bad environment. In these cases, it is necessary to have the strong spiritual power.

Creating a good environment in order to make the best of employees' creativity is important work for a CEO.

Conclusion and Future Directions

Creative management has a history of 30 years. It began in the United States and has influence in Europe and Asia. Creative management, because of a lack of theoretical research and interpretation, has not yet gained a significant academic position. Research on creative companies is scarce, and more theoretical research, interpretation and case studies are needed in the future.

Cross-References

- ► Business Creativity
- ► Corporate Creativity
- ► Creative Behavior
- ► Creative Leadership
- ► Creative Personality
- ► Creativity Management Optimization
- ► Organizational Creativity

References

Charnes A, Cooper WW, editors. Creative and innovative management. Cambridge, MA: Ballinger Publishing Company; 1984.

Henry J, editor. Creative management. London: Sage Publications; 1991.

Ijiri Y, Kuhn RL, editors. New directions in creative and innovative management. Cambridge, MA: Ballinger Publishing Company; 1988.

Isaacson W. Stave jobs: the biography (in Japanese) (translated by Inokuchi K.). Tokyo: Kodansha; 2011.

Kuhn RL, editor. Frontiers in creative and innovative management. Cambridge, MA: Ballinger Publishing Company; 1985.

Mitarai F. Lifetime employment is competitiveness (in Japanese). Nikkei Sangyo Shinbun, March 6, 2001.

Okano M. I make it (in Japanese). Tokyo: Chukei Publishing Company; 2003.

Osborn AF. Applied imagination. Buffalo: Creative Education Foundation; 1953.

Tanaka Y. Invention of corporation and its value assessment (in Japanese). J Nikkeibp Chizai Aware, May 13, 2004.

Xu F. A proposal for establishment of creative management (in Japanese). J Jpn Creativity Soc. 2005;9:111–23.

Xu F. Comparative study between Japanese and Chinese enterprises (in Japanese). Kyoto: Nakanishiya Shuppan; 2006.

Xu F. Liu Chuanzhi: the founder of Lenovo (in Japanese). Kyoto: Nakanishiya Shuppan; 2007.

Xu F, McDonnell G, Nash WR. A survey of creativity courses at universities in principal countries. J Creative Behav. 2005;39(2):75–88. Second Quarter 2005.

Xu F, Rickards T. Creativity management: a predicted development from research into creativity and management. J Creat Innov Manage. 2007;16(3):216-228.

Yanai T. 1 win and 9 defeats (in Japanese). Tokyo: Shinchosha Publishing Company; 2003.

Creative Mind: Myths and Facts

Norbert M. Seel
Department of Education, University of Freiburg, Freiburg, Germany

Synonyms

Creative thinking; Inventive creativity; Productive thinking

Key Concepts and Definition of Terms

Creativity is a dazzling concept and a resource which refers to a human capacity to produce or create something new through imaginative skills. The product may refer to a new solution to a problem, a new method or device, or a new artistic object or form. In general, the term creativity refers to a richness of ideas and originality of thinking. Often it is associated with the development of ideas or particular fields of application.

Up to now, the concept of creativity has not been precisely defined. Nevertheless, it has attracted many researchers and practitioners for centuries. In consequence, creativity has many facets and aspects. For a long time, creativity was mainly considered as a disposition of artists. In the course of the twentieth century – and especially as a result of the "Sputnik shock" – psychologists began to focus on creativity and its nature, components, and variants. Nowadays, creativity has an ambiguous connotation, which ranges from the hype of the zeitgeist and a wholehearted emphasis of creative domains to a dismissive attitude toward other domains (e.g., creativity in business).

Creativity can be understood as a construct composed in accordance with many references to different fields of interest, such as fine arts, advertising, design, innovation, and *invention*.

Theoretical Background

Creativity is a natural human capability for the creation of and dedication to options. The idea of creativity is probably as old as humankind, and for centuries and in all cultures, it has been understood as imagination and ingenuity. This holds true with regard to the production of tools, the fine arts (e.g., during the Renaissance), or eccentric inventions. Usually, creativity ranges from necessary auxiliary means of survival to a form of expression of inventive geniuses. Some prominent examples from history are the lithic tools of primitive times, cave paintings, the invention of the wheel, metal tools of the Bronze and Iron Age, the telephone, battery, train, automobile, light bulb, and many other inventions of modern times (Brockman 2000).

Processes and Products of Creativity

For centuries, creativity was usually considered as a divine gift. Creative people were believed to be inspired by God. In medieval times, the idea of genius resulted from this original conception of divine creativity. The concept of *illumination* as the creative moment of enlightenment and insight (the so-called eureka moment) became the leading conception. It took some time for creativity to be transferred to fields other than the arts, and the idea of genius lost its attraction once people began to attribute creativity to common people. Contrary to earlier argumentations that focused on the preternaturalness of exceptional people in artistic and scientific domains, psychologists of the twentieth century emphasized the versatility of creativity. Evidently, there are as many forms of creativity as there are human activities, and there are as many aspects of creativity as human nature is capable of producing. Creativity can be found at all ages and in all cultures. An absolute creativity does not exist. Rather, its various forms and aspects differ in degree and level. For the industrial manager, the art historian, and the scientist, creativity appears in the creative *product*; for the psychotherapist and many artists, creativity means a *process*; whereas educators and psychoanalysts focus on the *creative personality* and its characteristics because they are interested in the predictability (and training) of creativity. Accordingly, a distinction should be made between the creative personality, the creative product, and the creative process. Innovation and invention refer to the creative personality, but invention also refers to the creative product and process.

Although creativity is no longer considered a capability of extraordinary and ingenious individuals, it is still associated with a hint of mysticism and some enduring myths (Boden 2004; Weisberg 1986).

Myths About Creativity

There are many age-old myths and legends about creativity. In most cases, these myths may be put down to a lack of knowledge or hindsight. However, they intentionally cultivate the idea that creativity should be considered as an inexplicable phenomenon that only a few chosen people possess (Anderson 1992).

Some myths are very old and go back to ancient times, while other myths are new. Most recently, for example, one can find the insistent myth that creativity can be traced back to hemispheric specializations of the human brain. It is consistently maintained that the right hemisphere of the brain is the creative one. The truth is that current research on brain functions does not support such a functional specialization but rather the observation that the human brain is a very complex organ that has the capability of adaptation and compensation (Stephan et al. 2007). However, in the past two decades research on neurophysiological correlates of creativity has produced contradicting results. Although some studies support the assumption of a right hemisphere dominance in creative thinking, there are also studies that report a left hemisphere dominance. Furthermore, research indicates that people who have access to only one hemisphere due to an accident or surgery develop cognitive capacities similar to those of "normal" people. Most recently, Mihov et al. (2010) performed a meta-analysis of studies in order to test the assumption of a relative hemispheric dominance. Their moderator analyses did not show any predominant right-hemispheric activation in any of a variety of cognitive tasks.

Other myths about creativity are as follows:

- *Creativity is innate*. The fact is that research has long shown that creativity is not innate but rather learned, i.e., it can be advanced and developed by the environment. Earlier theories have stated that creative people have often emerged from conflicted families. However, Csikszentmihalyi (1996) shows that these individuals usually experienced normal childhoods and grew up in families that provided them with a stable social background and a solid set of values. One difference between them and most other people, however, was that a number of them had suffered parental loss, particularly the loss of a father. In such cases, most were influenced and inspired by other supportive adults. Csikszentmihalyi's work culminates in the identification of a really distinctive characteristic of creative people: the capacity to experience "flow." This is defined as the timeless and complete involvement of individuals in an activity. Persons experiencing a flow have a sense that their abilities are only equal to the challenges at hand, and they become caught up in the creative process in order to achieve their goal. In addition, a number of personality characteristics have been shown to be associated with creative productivity. One of these is autonomy: creative individuals tend to be independent and nonconformist in their thoughts and actions. Equally important is mastery of a particular domain – that is, a sphere of activity or knowledge that requires a high level of ability.
- *Creative individuals are social outliers*. Indeed, some creative individuals behave in a nonconformist manner, and sometimes they have emotional or mental problems. However, this holds true with regard to less creative persons, too (Amabile 1983). Creative individuals may occasionally exhibit a high degree of self-assurance. Some possess an exceptionally deep, broad, and flexible awareness of themselves. Others are shown to be intellectual leaders with a great sensitivity to problems (Fleming et al. 2007).
- *Creativity emerges from chaos* (Abraham et al. 2001). The fact is that the desired openness and playful handling of issues do not imply that creative people are chaotic. Certainly, some creative individuals may be challenged by asymmetry and chaos, but there are also many creative persons who are disciplined, well-organized, and concentrative. The unconventionality of thought that is sometimes attributed to creativity is not an expression of chaos but rather a resistance to acculturation. A nonconformist lifestyle is not essential to creativity; indeed, many creative individuals live quite ordinary lives but express their autonomy and independence in unconventional ideas.
- *Experts are barely creative*. Actually, experts are made. However, this does not exclude the possibility that experts are creative because success breeds success. Gabora (2011) has pointed out that the standard view that creativity entails both originality and appropriateness often leads to the paradox conclusion that experts who *converge* on an optimal solution to a problem are considered less creative than nonexperts who are involved in divergent thinking which leads to manifold original solutions. Accordingly, it is maintained that

experts are too prejudiced with regard to new ideas. It is not easy to understand this argumentation because it is a fact that novices are often highly prejudiced and do not understand a given problem. This can be demonstrated through the example of politics, when people casually discuss proposals for better policy making over drinks. Most proposals made in such situations are neither realizable nor creative. True mastery in most domains requires a considerable investment in education, training, apprenticeship, and practice (Ericsson 1999). However, the time and resources required to master a particular domain preclude most people from excelling in other domains of interest. Additionally, creative people may not have equally strong gifts across the spectrum of all possible domains or the capabilities to master them effectively. A notable exception was Leonardo da Vinci, whose achievements in the visual arts, mechanics, and engineering disclosed the talents of a creative polymath. Another true polymath was Herbert A. Simon (Seel 2012).

- *Creativity is independent of intelligence*. In the literature, a sharp distinction is often made between creativity and intelligence. This distinction has historical reasons because research on creativity emerged from criticism of traditional research on intelligence (Getzels and Jackson 1962). The fact is that creativity is not the opposite of intelligence but rather its complement. If we suppose a hierarchy of intellectual abilities, creativity can be considered the highest level of this hierarchy. Numerous studies have shown that an extreme general intelligence does not necessarily imply high levels of creativity. The results of these studies as well as of meta-analyses (e.g., Kim 2005) support a "threshold" model of intelligence and creativity, which claims that, above a certain level, intelligence shows little correlation with creativity. That is, a very intelligent person may not be as highly creative. It seems that intelligence sets the limits on information processing, while creativity provides the flexibility necessary for producing of innovative ideas (Preckel et al. 2006). Both convergent and divergent thinking seem necessary for creative performance.
- *Creativity is idiosyncratic and, therefore, does not emerge in social groups*. Indeed, a characteristic of creative people is their individualism and introversion (Gancalo and Staw 2005). However, this does not imply a lack of social skills but rather a strong tendency to be reflective and thoughtful. Although creative people rely strongly on their intuition, they also respond to interactions with others and their attitudes and behaviors. Actually, interactions with other people may improve the creativity of the group as well as its members. Collecting ideas within a group may facilitate creative solutions. The extent to which social groups are creative has wide implications for their overall performance, including the quality of their problem solutions, judgments, and decisions. Bechtholdt et al. (2010), for example, report that groups produce more ideas when their members are characterized by high epistemic motivation as well as prosocial motivation. In accordance with the social norms of a group, the ideas produced are more original, appropriate, or feasible.
- *Children and adolescents are more creative than old people*. Traditionally, creativity was considered a specific characteristic of children and adolescents. This assumption is a correlate of the aforementioned myth that experts are not creative. Accordingly, older people are not considered to be creative. Actually, Smolucha and Smolucha (1985) reported that the development of creativity follows a nonlinear path; they describe this developmental path as a J-shaped pattern with a small peak at age 6 and a higher peak in the twenties. It is certainly true that children and adolescents are more open and adventurous than old people, but this does not rule out creativity in old age. Nevertheless, most studies reveal age differences in creativity to the disadvantage of the old (Ruth and Birren 1985; Wu et al. 2007). An age-related reduced speed in information processing, a lower level of complexity, and a decreased willingness to risk original solutions are offered as explanations. Most

recently, Jones and Weinberg (2011) analyzed data on Nobel Laureates which shows that the age–creativity relationship varies substantially more over time than across fields. Evidently, there are fundamental shifts in the life cycle of research productivity.

- *Creativity is connected with spontaneity,* which combines curiosity and problem seeking. Creative individuals seem to have a need to seek novelty and an ability to pose unique questions. A study on the relationship among spontaneity, impulsivity, and creativity by Kipper et al. (2010) shows a positive relationship between spontaneity and creativity, consistent with Moreno's (1953) "canon of spontaneity-creativity," but a negative relationship between spontaneity and impulsivity. Creativity is very often, if not regularly, the result of an extended cognitive confrontation with a complex problem. A number of other personality characteristics have been shown to be associated with creative productivity. One of these is autonomy: creative individuals tend to be independent and nonconformist in their thoughts and actions. Equally important is cognitive mastery of a particular domain – that is, a sphere of activity or knowledge that requires a high level of ability. An individual may therefore possess creative thinking abilities and exhibit a creative personality but fail to produce works that are valued and influential because he or she has not developed any specializations.
- *Creativity needs no techniques.* Creativity techniques are not a panacea. Their ultimate goal is only to provide a person with the best conditions for divergent thinking and breaking a blockade of thinking. The leading thought and the creative idea cannot be forced, but rather, thoroughgoing reflection always is necessary. However, creativity techniques may produce an open atmosphere which supports the emergence of creative ideas (Fasko 2000/01; Ferrari et al. 2009).
- *The novelty of a product is the criterion and measure of creativity.* Creativity is considered to be the first and unique operation involved in forming something; it is an expression of how a person may comprehend the world. Creativity is usually differentiated in accordance with the degree of how a creative product may change the world. A product is all the more creative depending on its breadth of applicability. Here, two levels can be distinguished. The first level causes new insights that fundamentally change a given world and culture; the second level only extends to existing insights. Ideas and products deemed worthy by the field are incorporated into the domain, and only then is the originator considered creative. In some cases, the field can be defined as the world at large as it adopts the product of the creative process – be it an idea, a product, or a solution to a problem.

Conclusion and Future Directions

Explaining creativity requires abandoning the various creativity myths. For a long time, they told us that creative inventions are a burst of spontaneous inspiration from a lone genius, that a person working alone is always more creative than a group, and that social conventions and expectations always interfere with creative invention and innovation.

As Sawyer (2006) states, "the myths quickly fall apart when we examine the lived reality of creativity" (p. 259). Psychological studies show that explaining creativity presupposes an action theory that explains how the process of creative invention results in a creative product. Usually, there is not a moment of spontaneous insight into a solution to a problem, but rather creative invention is "hard work peppered with mini-insight, and . . . these mini-insights don't seem that mysterious in the context of the preceding hard work" (Sawyer 2006, p. 259). Creativity is mostly the result of collaborative work.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Age and Creative Productivity
▶ Creative Personality

▶ Freedom and Constraints in Creativity
▶ How does Material Culture Extend the Mind?
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Multiple Models of Creativity
▶ Nature of Creativity
▶ Psychology of Creativity
▶ Research on Creativity
▶ Strategic Thinking and Creative Invention
▶ Thinking Skills, Development

References

Abraham R, McKenna T, Sheldrake R. Chaos, creativity, and cosmic consciousness. 2nd ed. Rochester: Park Street Press; 2001.
Amabile TM. The social psychology of creativity. New York: Springer; 1983.
Anderson JV. Weirder than fiction: the reality and myths of creativity. The Executive. 1992;6(4):40–7.
Bechtholdt MN, De Creu CK, Nijstad BA. Motivated information processing, social tuning, and group creativity. J Pers Soc Psychol. 2010;99(4):622–37.
Boden MA. The creative mind: myths and mechanisms. 2nd ed. London: Routledge; 2004.
Brockman J, editor. The greatest inventions of the past 2,000 years. London: Weidenfeld & Nicolson; 2000.
Csikszentmihalyi M. Creativity: flow and the psychology of discovery and invention. New York: Harper Collins; 1996.
Ericsson KA. Creative expertise as superior reproducible performance: innovative and flexible aspects of expert performance. Psychol Inq. 1999;10:329–33.
Ferrari A, Cachia R, Punie Y. Innovation and creativity in education and training in the EU member states: fostering creative learning and supporting innovative teaching. Luxembourg: European Communities; 2009.
Fleming L, Mingo S, Chen D. Collaborative brokerage, generative creativity, and creative success. Adm Sci Q. 2007;52:443–75.
Gabora L. If experts converge on the same answer are they less creative than beginners? Redefining creativity in terms of adaptive landscapes. Kelowna: University of British Columbia; 2011. Retrieved from the Internet: http://arxiv.org/ftp/arxiv/papers/1106/1106.2265.pdf
Getzels JW, Jackson PJ. Creativity and intelligence: explorations with gifted students. New York: Wiley; 1962.
Goncalo JA, Staw BM. Individualism-collectivism and group creativity. Faculty publications – organizational behavior. Paper 1; 2005. http://digitalcommons.ilr.cornell.edu/obpubs/1
Jones BF, Weinberg BA. Age dynamics in science creativity. Proceedings of the National Academy of the United States of America (PNAS); 2011. http://www.pnas.org/content/early/2011/11/03/1102895108
jr Fasko D. Education and creativity. Creat Res J. 2000/2001;13(3&4):317–27.
Kim KH. Can only intelligent people be creative? A meta-analysis. J Second Gifted Educ. 2005;16(2–3):57–66.
Kipper DA, Green DJ, Prorak A. The relationship among spontaneity, impulsivity, and creativity. J Creat Mental Health. 2010;5(1):39–53.
Mihov KM, Denzler M, Förster J. Hemispheric specialization and creative thinking: a meta-analytic review of lateralization of creativity. Brain Cogn. 2010;73(3):442–8.
Preckel F, Holling H, Wiese M. Relationship of intelligence and creativity in gifted and non-gifted students: an investigation of threshold theory. Person Individ Diff. 2006;40(1):159–70.
Ruth JE, Birren JE. Creativity in adulthood and old age: relations to intelligence, sex and mode of testing. Int J Behav Dev. 1985;8(1):99–109.
Sawyer RK. Explaining creativity. The science of human innovation. Oxford: Oxford University Press; 2006.
Seel NM. Simon, Herbert A. In Seel NM, editor. The Encyclopedia of the Sciences of Learning. New York: Springer; 2012. pp. 3069–71.
Smolucha LW, Smolucha FC. A fifth Piagetian stage: the collaboration between analogical and logical thinking in artistic creativity. Vis Arts Res. 1985;11:90–9.
Stephan KE, Fink GE, Marshall JC. Mechanisms of hemispheric specializations. Insights from analyses of connectivity. Neuropsychologia. 2007;45(2–4):209–28.
Weisberg RW. Creativity: genius and other myths. New York: W. H. Freeman; 1986.
Wu CH, Cheng Y, Ip HM, McBride-Chang C. Age differences in creativity: task structure and knowledge base. Creat Res J. 2007;17(4):321–6.

Creative Music Education

▶ Using Movement, Music, and Humor - Creative Approaches to Enhance Student Engagement

Creative Pedagogy

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Synonyms

Creative teaching methodologies; System of creative teaching

Definition

Creative pedagogy is the science and art of creative teaching.

Introduction

If pedagogy in general is defined as the study of the process of teaching, then creative pedagogy is defined as the science and art of creative teaching (Aleinikov 1989). Creative pedagogy is a branch of pedagogy that emphasizes the leading role of creativity for successful learning. In its essence, creative pedagogy teaches learners how to learn creatively and become creators of themselves and creators of their future.

The functional definition of creative pedagogy is longer and more complex. The founding work on creative pedagogy gives a definition in the form of a formula of invention – a strict word pattern used to describe inventions for patenting:

> Creative pedagogy that includes educational influence on the learner for acquisition of certain study material (subject) [as pedagogy in general] and differing from the above by the fact that in order to achieve higher efficiency of learning, the pedagogical influence is provided on the background of centrifugal above-the-criticism mutual activity in which the learner is raised from the object of [pedagogical] influence to the rank of a creative person, while the traditional (basic) study material is transformed from the subject to learn into the means of achieving some creative goal, and the extra study material includes the description and demonstration of the heuristic methods and techniques. (Aleinikov 1989)

The first work on creative pedagogy was published in the *Bulletin of Higher Education* (Moscow, Russia), got noticed, and cited by numerous educators and innovative editions. The authors of *Encyclopedic Dictionary* not only included an article on creative pedagogy but also made some comments on its unusual form – the formula of invention (Popov 1995).

In its distilled methodological essence, as opposed to other pedagogies, creative pedagogy creates a creative learner who begins to create individual knowledge (learning techniques and methodologies), creative abilities (creativity techniques and methodologies, see ► Creativity Techniques), and finally innovative abilities (innovation techniques and methodologies), thus laying the foundations for life success.

The description of creative pedagogy includes its comparison with and contrast to the neighboring concepts, then discussion of the background, origins and development of the concept, and lastly the statement of some theoretical and practical achievements.

Differentiating Creative Pedagogy from Creative Education and Creative Teaching

The concept of creative pedagogy, on one hand, differs from the concept of creative education that is usually associated with teaching creativity as a subject. A very good example for this is the efforts of the Creative Education Foundation, Buffalo, NY, that serves to helping individuals, organizations, and communities transform themselves as they confront real-world challenges. Through well-organized efforts of this organization, creative education (education in creativity) is being spread around the world. As opposed to creative education in this particular sense, creative pedagogy (and creative andragogy) is specifically designed for teachers, professors, and education administrators. It aims at modifying the teaching process of any subject, whether it is arts, language, math, science, technology, and even the process of teaching creativity itself.

On the other hand, creative pedagogy as a concept is different from the concept of creative teaching that is usually emphasized in every good school. Creative teaching is actually the practice of teaching/learning that is more creative than traditional. As opposed to creative teaching, creative pedagogy is a philosophy, theory, and methodology with a theoretically predetermined sequence of activities that leads to the accelerated child's (or adult's) creative development – not just the teacher's own creative practice in the classroom. When this methodology is applied to any subject, it dramatically changes the process of teaching/learning and the results.

The concept of creative pedagogy has both historical (sociocultural) and etymological roots.

Historical and Etymological Roots

Etymological Analysis

The term creative pedagogy consists of two concepts. The word pedagogy derived from the Greek παιδαγωγέω (*paidagōgeō*) is combined of two roots:

1. παῖς (*país*, genitive παιδός, *paidos*) that means "child" – actually "boy"
2. ἄγω (*ágō, agogos*) that means "to lead." So literally it means "to lead a boy (a child)."

Historically, in Ancient Greece, παιδαγωγός was a slave (that could be a philosopher captured as a prisoner of war) who supervised the instruction of his master's son. This instruction could include taking the boy (girls received no public education) to school or gym, looking after him, carrying his musical instruments, and directing his behavior.

In English and other languages, the term "pedagogue" means a teacher who follows certain pedagogy, and pedagogy is used to refer to instructive theory. Pedagogy is studied at the universities by student teachers. Institutions that educate and train future teachers are called *pedagogical institutes*.

When Malcolm Knowles introduced the term andragogy (*andr*-, man; courageous + *agogos*, leader) and defined it as the art and science of teaching adults, the term pedagogy stepped down from the generic term to the complementary term, and there appeared a need in a new term – a generic term for "the art and science of teaching" (see below).

Note: For the etymological analysis of the word *creativity*, see ▶ Creativity.

Historical (Sociocultural) Roots

Different societies treat creativity differently (Ramos 2005), but whether named so or not, tolerated or not, it was still present in every new invention in technology, discovery in science, and methodology in education.

Creative pedagogy origins and ideas can be traced far back throughout history. Socrates, for example, instead of giving youth a one-time "wise advice" (as most wise men of the past and many teachers of all times do), asked engaging questions that led his interlocutors to profound answers. Actually, he was developing his contemporaries to the point they could *create* their own answer. Now it is called the Socratic Method.

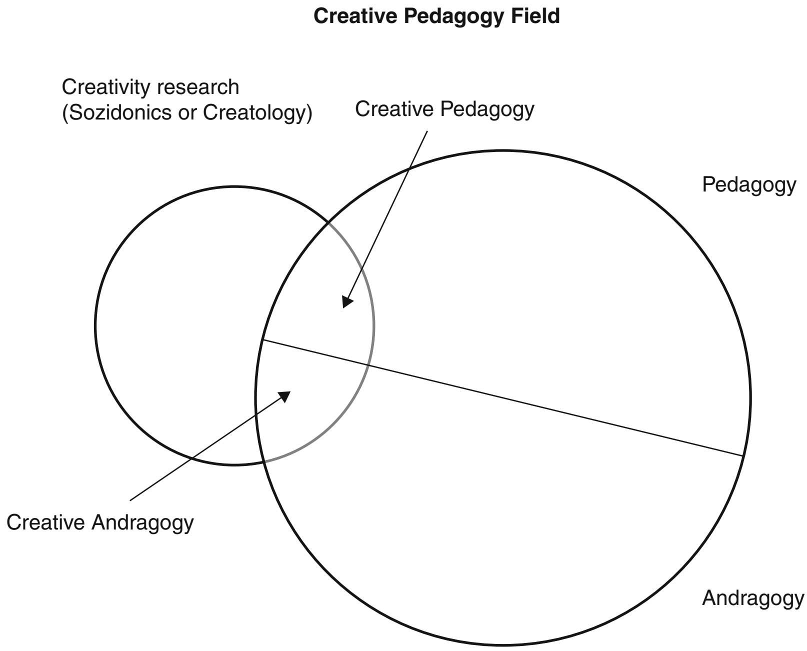
Just as this early prototype, creative pedagogy teaches students to *create* their own learning processes for continuous success in their lives.

Certain periods of history required certain pedagogies. History of education shows that the type of pedagogy usually depends on the needs of the society.

- Society of the ancient times needed followers. So the training expressed in the phrases, "Do after me! Do as I do!" worked best. This pre-pedagogy produced hunters, fishermen, gatherers, warriors, etc. Nowadays, it is known as "on the job training."
- In Ancient Greece, speakers were needed. Speakers were trained in rhetoric classes, in public discussions. Speech training pedagogies were used.
- Early capitalist society needed craftsmen and then workers. Technical schools were organized, and they employed training methodologies for technical teaching.
- Developed capitalism needed more knowledgeable professionals, like engineers, doctors, and teachers. As a response to this need, pedagogy of knowledge acquisition and testing spread to schools, colleges, and universities.
- The twentieth century put forward the need in problem solvers. Naturally, there appeared problem-oriented education as well as schools for creative problem solving. Creative pedagogy grew out of them to reflect and explain the trend.

All these types of pedagogy can be dominant at a certain time, but they do exist and coexist in contemporary education as well. This century, however, has been many times called the century of creativity and innovation, so as society matures, there are more and more creative

Creative Pedagogy, Fig. 1 Creativity research and education domains



people, and the need in educating such people is becoming more vivid. The emergence and growth of the creative class (Florida 2003) is a reality. That is why there appeared creative pedagogy as pedagogy aiming at the upbringing of a creator (a creative person) capable of meeting the constantly growing complexity and accelerating development of the society (Aleinikov 1999b).

In the field of education, creative pedagogy is opposed to critical pedagogy, just as creative thinking is opposed to critical thinking. While critical pedagogy calls for criticism (Giroux 2010) and actually aims at growing the number of political radicals (Searle 1990), creative pedagogy offers the philosophy, theory and methodology of constructive (creative) development for individual and society.

The twentieth century brought the creativity research to prominence, and it began to extrapolate to the other domains. Creative pedagogy is the result of extrapolating creativity research to the domain of education that includes pedagogy (teaching children) and andragogy (teaching adults, Knowles 1950, 1968). These concepts can be illustrated by the following picture.

Figure 1 illustrates how the field of creativity research and the field of education, divided into pedagogy and andragogy, make a cross section named creative pedagogy and creative andragogy.

Historically, creative pedagogy appeared in 1989 (Aleinikov 1989) – a year after creative linguistics (Aleinikov 1988a). Creative pedagogy was so successful that later its principles and practices were applied to adult education thus giving birth to creative andragogy. Creative pedagogy and creative andragogy together were generalized into creagogy (Aleinikov 1998) which is also depicted on Fig. 1.

Theoretical Foundations

If creative pedagogy could be seen as a structure, then as any structure it stands on some cornerstones.

- E. Paul Torrance and Torrance Tests of Creative Thinking Tests (TTCT)

  The first cornerstone for the building of creative pedagogy was the theoretical separation of creative thinking as opposed to critical thinking and then practical designing of Torrance Tests of Creative Thinking (Torrance 1974, see also ▶ Creativity Tests). The concept of critical thinking earlier gave birth to critical pedagogy (Giroux 2010; Searle 1990), while the concept of creative thinking paved the way for creative pedagogy.

- S. Parnes and Creative Problem Solving (CPS)

  The second cornerstone for the structure of creative pedagogy is creative problem solving (Parnes 1992) that developed and advanced the methods and techniques for a deliberate creativity in technology and social life. Creative pedagogy applied it for teaching.
- G. S. Altshuller and TRIZ

  The third cornerstone for the building of creative pedagogy was the development of Algorithm and Theory of Inventive Problem Solving (ARIZ/TRIZ) by G. Altshuller and many of his followers, including Azerbaijan Institute of Inventive Creativity (see ▶ Inventive Problem Solving (TRIZ), Theory). Their concepts (discussed below) and vision of the genius life strategies were fundamental for the growth of the creative pedagogy (Altshuller and Vertkin 1994).
- V. A. Moliako and Creativity Activation Methods

  The fourth cornerstone in the foundation of creative pedagogy was laid by Dr. V. A. Moliako who offered the description of the methods aiming at the activation of the person's creative thinking (Moliako 1985).

Summarizing the stated above, creative pedagogy is the result of generalizing the new achievements in the creativity research field (G. Wallas, A. Osborn, J. P. Guilford, S. Parnes, E. P. Torrance, etc.) and applying them to the processes of teaching – the field already developed by the best educators of the past like Jan Amos Komensky, Johann Heinrich Pestalozzi, Rudolf Steiner, Lev Vygotsky, Maria Montessori, Anton Makarenko, etc.

Creative pedagogy then matured with further discovery of the universal formula of creativity development (Aleinikova and Aleinikov 1991), ideal education, ideal learner, and ideal teacher models, thus contributing to the solutions of numerous educational problems.

The Main Components of Creative Pedagogy

The main components of creative pedagogy include philosophy, theory, and methodology of creative teaching.

Philosophy of Creative Pedagogy

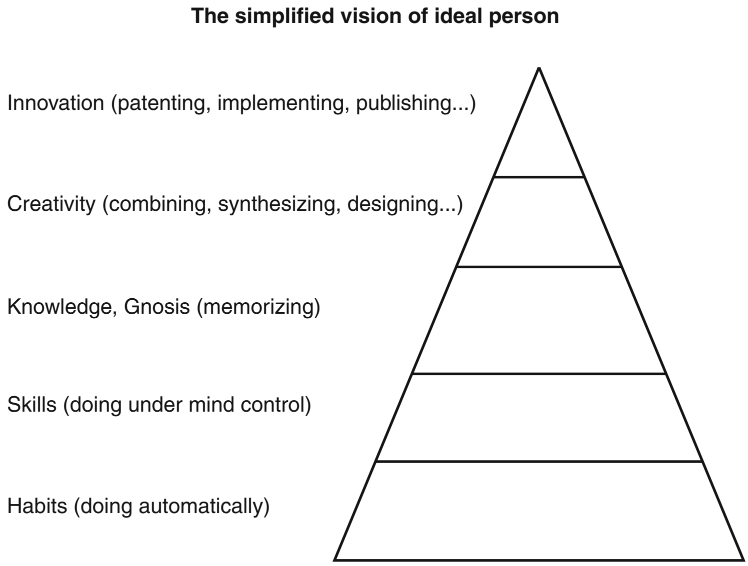
For the Humanistic Trend: Every human being is creative, but the rate (see ▶ Measurement of Creativity), the domain, and style of creativity (see ▶ Creative Styles) may differ. Nature generates newness on all levels, so the phenomenon of creativity existing at the psychological level of newness generation is natural. Creativity accelerates the natural newness generation process results which become greatly appreciated and valued by the social level (society). Therefore, research of this phenomenon by science (Sozidonics or Creatology, see ▶ Science of Creativity) and utilizing this research for the accelerated development of society is the trend in social life while accelerated development of creative ability in humans (creative education and creative pedagogy) is the next trend in education for the century of creativity and innovation, or the next step to ideal education (Aleinikov 1999b).

For the Religious Trend: God is the creator, and he created humans in his image. Therefore, people are designed and destined to be creative. People are the creators of the new world around them; thus, they can create new objects, new processes, and certainly they can create new educational systems, including new methodologies for developing creativity to the higher levels. God is the ideal, so striving for this ideal is the human being's mission. The more creative, the closer to the ideal!

Theory of Creative Pedagogy

The first and foremost achievement of creative pedagogy is the determination of the core feature, or the main link in the success of any education – interest – and development of the steps to maintain this interest till it becomes the internal (self) motivation of the person. For this purpose, creative pedagogy employs the

Creative Pedagogy, Fig. 2 Ideal person model



universal formula of creativity development (Aleinikov and Aleinikova 1990, 1991) and introduces the models of ideal learner and ideal teacher that participate in the process of ideal education (Aleinikov 1999a). The formula and models are based on the universal **model of sign**, language, speech act, and heuristic act (Aleinikov 1988b, see ► Creative Linguistics) that led to the creation of ideal person and ideal education model (Aleinikov 1999a).

Ideal Person Model

To avoid complex graphs, this article offers a simplified vision of an ideal person.

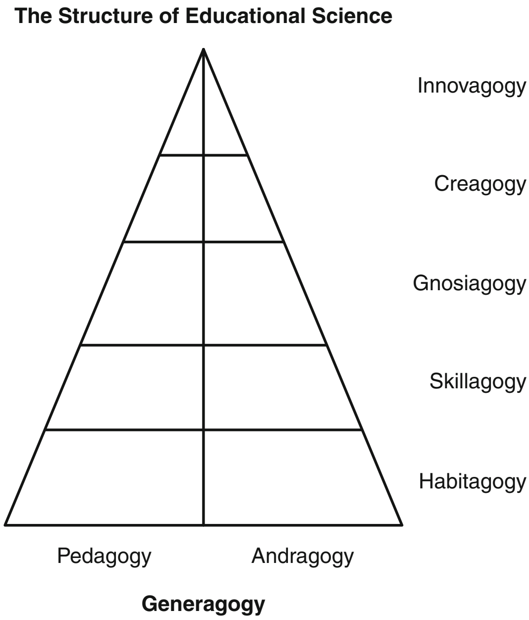
The model on Fig. 2 illustrates that a child (baby, toddler, teen, adult) learns:

- Habits (looking, crawling, walking, etc.), then based on them
- Skills (playing toys, reading, writing, counting), then based on them
- Facts and theories (studying, testing, etc.), then based on them
- Combining and synthesizing patterns and models (problem solving, designing, modeling) then based on them
- Presentation methods and techniques for delivering newness to the society

The teaching methodologies for these five levels are different. The first in the pyramid level (habit) requires 100–1,000 repetitions. When applied to adults, it is called a drill, even more negatively, a rot. The second level (skills) requires 10–100 repetitions. It is usually referred to as training. The third level (knowledge) requires 1–10 repetitions. Some students can remember things after one-time presentation; some others need more. The next level up (creativity or creative act) occurs only once – there is no such a thing as creating the same thing by the same person for the second time. Teaching creativity is teaching how to make these one-time creative acts more often or at will. The teaching methodologies for this level are discussed below. Finally, innovation is an act of transferring the result of creativity to the society in a real-life situation.

Ideal Education Model

So the activity of leading (*agogos*) human beings through these stages is an education process. For the childhood period, there is pedagogy to explain this process. For adult education, all ages after childhood, there is andragogy to explain the process. When andragogy split from



Creative Pedagogy, Fig. 3 Educational science model

pedagogy and proved its right for existence, it became obvious that from the logical point of view a generic term is needed to include these two branches. That is why the term generagogy (*generalis*, common + *agogos*, leading) was offered to embrace both (Aleinikov 1998).

Now, based on the above model of ideal person (Fig. 2), the simplified vision of education domain looks like the following:

As you see from the model on Fig. 3, pedagogy and andragogy (split since 1950s) are united back by the generic science of education – Generagogy (below). In the same manner, creative pedagogy and creative andragogy are united into the generic science of creative teaching – creagogy (fourth from below).

IdeaLearner = Ideal Final Result in Education

The concept of ideal person, shown above on Fig. 2 (above), requires progressing through the steps of development via education. This progression naturally leads to the concept of an ideal learner (or IdeaLearner©).

All terms that include the term "ideal" are derived from the concept of ideal final result (IFR), which is widely mentioned in the works of G. S. Altshuller who offered the Algorithm of Inventive Problem Solving (ARIZ) and then the Theory of Inventive Problem Solving (TRIZ) – for details, see ▶ Inventive Problem Solving (TRIZ), Theory. The IFR method proved to be a powerful approach in solving technical problems (Altshuller 1986).

In technology, the idea of perpetual motion machine is one of the most famous IFRs. Though such a machine has never been built, so many outstanding technical discoveries were made and physical processes described in the attempts to make it, that this example alone can corroborate the value of the quest for the "impossible" (ideal).

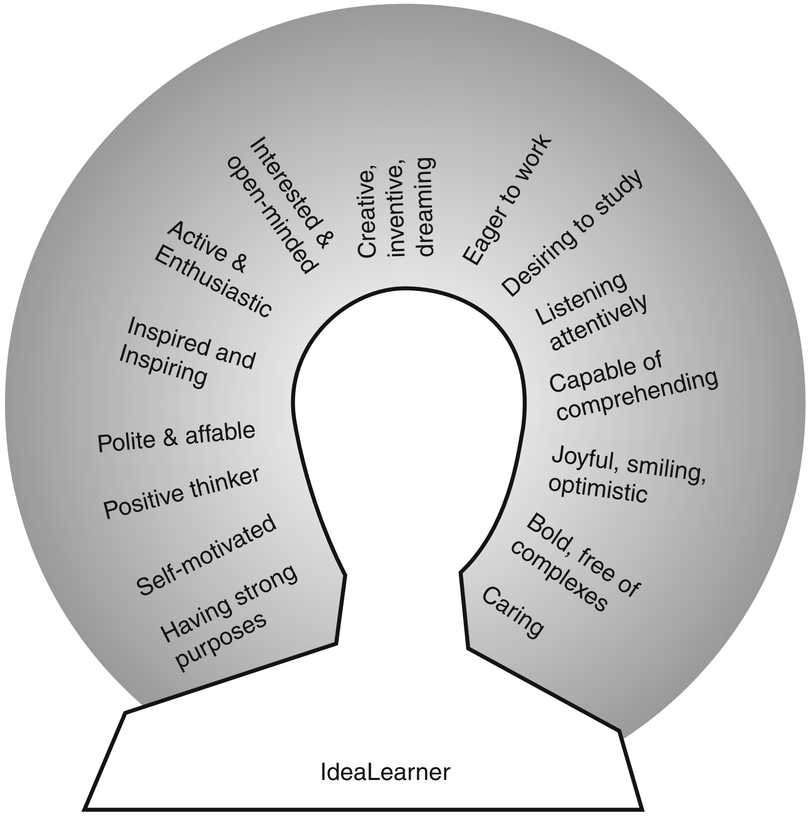
Similarly, in ethics and ideology, religion is still one of the most powerful IFRs. With some vision of the "ideal" (or divine) in their minds, people strive for it, and though not a single one of them can become equal to their ideal, the results achieved trying to obtain the ideal can be powerful.

If the results of employing IFR are so impressive in technology and ethics, why not use the same idea or concept in education? Creative pedagogy does employ this method by empirically (in classes with teachers and education administrators) collecting and selecting the characteristics of an IdeaLearner.

Prioritizing these characteristics helped educators to understand that the basic feature determining the others is creativity. If a person is creative, he/she is interested, listening, active, self-driven, joyful, open-minded, and eager to work. Creativity is not only the basic feature but also the moving force of gaining knowledge. True creators are enormously laborious learners. Thomas Edison, Marie Curie, Johann Goethe, Ludwig van Beethoven, Albert Einstein, Wolfgang Amadeus Mozart, etc., have been learners for their entire lives because they needed more and more knowledge for their creations. The variant picture of an IdeaLearner is shown on Fig. 4.

The ideal learner model depicted on Fig. 4 shows the empirically gathered characteristics that teachers under training ascribed to the best learner possible. The prioritizing and putting the

Creative Pedagogy, Fig. 4 Ideal learner (IdeaLearner) model



features like "creative/inventive" to the top of the list has been done after elaborated discussion and voting because if the learners are creative, they are interested and open-minded, active, enthusiastic, inspired, eager to work, etc. On the other hand, if they are "bold and free of complexes" but destructive (instead of being creative), they might be a trouble for the class and the school.

Ideal Teacher

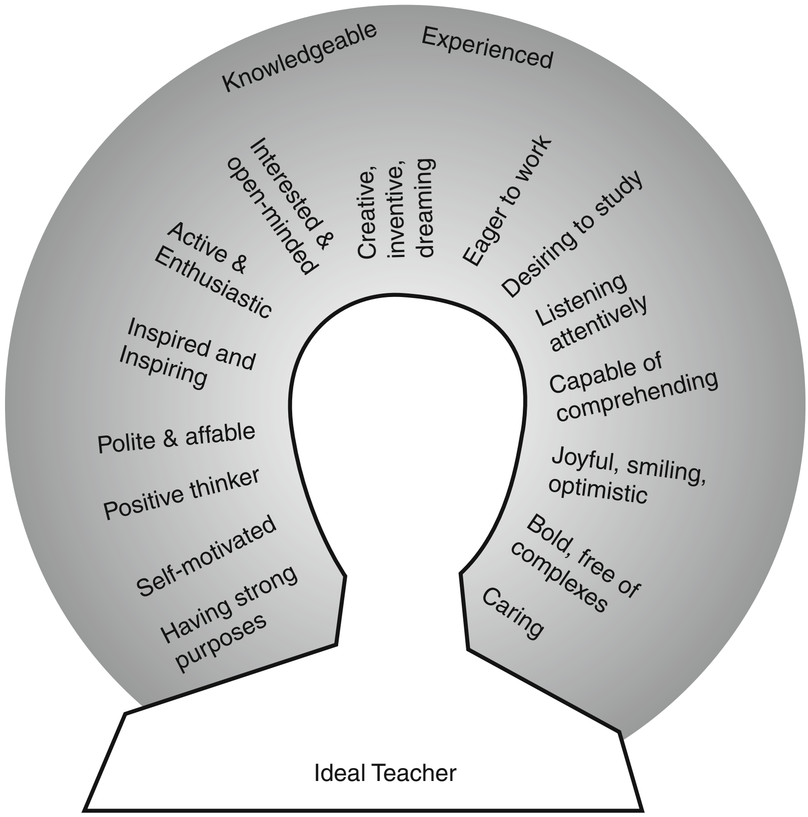
The question, where the ideal learner comes from, leads to the answer – from an ideal teacher. Collection and selection of characteristics of ideal teacher, to the surprise of many teachers, gave the same features as ideal learner plus only two features: experience and knowledge. A model of the ideal teacher can be seen on Fig. 5.

The ideal teacher model depicted on Fig. 5 shows characteristics empirically gathered by a different group of teachers and ascribed to the best teacher possible. The prioritizing and putting the features like "knowledgeable" and "experienced" to the top of the list as features differentiating a teacher from learner has been done unanimously.

When compared, these two lists of characteristics coincide with all groups trained. When presented in the form of the table, they look like that (Table 1).

Very naturally, the teachers under training come to the conclusion that in order to have ideal students in the classroom, they themselves have to be ideal teachers! If they are, then the ideal teaching/learning process becomes the process of creation. The ideal final result of ideal teaching/learning is to make another individual a creator of one's knowledge, of one's surrounding, a creator of one's own life, and a creator of new reality of the future. This is an exciting, joyful process of active, interested participation in transferring knowledge, skills, and habits with the purpose of making a self-learner, a doer (maker),

Creative Pedagogy, Fig. 5 Ideal teacher model



Creative Pedagogy, Table 1 The comparison of ideal learner and ideal teacher characteristics

Ideal learner	Ideal teacher
Interested and open-minded	Interested and open-minded
Active, ready to take knowledge and initiative	Active, ready to take knowledge and initiative
Desiring to study	Desiring to study (and teach)
Listening attentively	Listening attentively
Capable of comprehending material	Capable of comprehending material
Joyful, smiling, optimistic	Joyful, smiling, optimistic
Eager to work	Eager to work
Inspired and inspiring the others (charismatic)	Inspired and inspiring the others (charismatic)
Polite, socially positive, affable, communicable	Polite, socially positive, affable, communicable
Self-driven or self-motivated	Self-driven or self-motivated
Having strong purposes	Having strong purposes
Creative, inventive, and capable of dreaming	Creative, inventive, and capable of dreaming
Bold and free from psychological complexes	Bold and free from psychological complexes
Caring about the others (loving)	Caring about the others (loving)
Positive thinker (deep thinker, true believer)	Positive thinker (deep thinker, true believer)
Capable of kindling the light	Capable of kindling the light
–	*Knowledgeable*
–	*Experienced*

Creative Pedagogy, Fig. 6 Creative pedagogy methodologies

CREATIVE PEDAGOGY
Three-level methodology

Object-oriented methods (OOM)

- Morphological analysis
- BAMMA (Brainstorming Advanced by Morphological Matrix Analysis)
- Focal object
- Fantastic analogy
- Personal analogy
- Symbolic analogy
- Title (+ Non-scientific cut)
- Check list
- Semiotic modeling
- Dynamization
- Vitalization

Subject-orients methods – open (SOM-o)

- Method of paradox pedagogic inversion
- Method of extra difficulties
- Method of time limitations
- Method of space limitations
- Method of substance limitations
- Method of stupid limitations
- Method of extra variants
- Method of dramatization
- Method of absurd
- Method of unexpected prohibitions
- Method of insufficient information
- Method of excessive information

Subject-oriented methods – closed (SOM-c)

- Omitation – universal method of creativity formation
- Method of highest (genius) orientation
- Method of applied nonverbal dominance

and a creator. The process creates an ideal learner and the bright future for this ideal learner – the path to the ideal person achievements.

After creating this theoretically "ideal" picture of education, creative pedagogy can be put into practice by using its methodologies.

Methodologies of Creative Pedagogy

Since encyclopedia article is limited in space and should avoid detailed descriptions, this article addresses three layers of methods as they are explained to teachers in metapedagogy (teacher training):

- Methods that teach a learner work with an object (process). They are called object-oriented methods. The majority of them was taken from creative problem-solving techniques (see ► Creativity Techniques) and then adjusted for *any* subject.
- Methods that teach a teacher to influence the learner, to open the mind, to activate the mind, and to make the person interested. They are called subject (individual)-oriented methods. The majority of them was borrowed from the work of Moliako and then developed further. These methods are open – it means in the process of learning, a teacher can explain what happened in the classroom and how the process influenced the learner. The learner actually learns these methods.
- Methods that are also subject (individual)-oriented, but they are taught only to teachers in Creative MetaPedagogy (Aleinikov 1992).

Figure 6 illustrates the methodology as it is presented to teachers. It illustrates the levels of influence and the arsenal of the teacher. All methods, except closed ones are revealed to students. Some of the methods in the methodology developed by predecessors of creative pedagogy; the other are designed within creative pedagogy.

The first layer of methods shown on Fig. 6 among object-oriented methods (OOM) includes not only well-known creativity boosting techniques such as brainstorming and focal object (see ► Creativity Techniques) but also developed by the author methods like BAMMA, leading to MegaCreativity (Aleinikov 2002). The group of methods in the second layer (SOM-o) includes not only techniques designed and described by Moliako but also new methods like paradox pedagogic inversion (teaching from difficult to easy, from complex to simple which contradicts all educational principles). Finally, all methods of the third layer (SOM-c) constitute the unique innovative contribution of creative pedagogy to the field of pedagogy. The power of these methods is so high that they form the foundation of Genius Education Methodology (see ► Genius). For more detailed description of these methods, please see Teaching for Success, an online magazine for professors, which published and republished (as "classics") the most powerful of these methods (Aleinikov 2007, 2008).

Practical Applications

As *The Encyclopedia of Creativity* article on Humane Creativity states, "Creative Pedagogy, as a trend in science, generalizes and explains everything from music and art classes to creatively oriented courses so thoroughly gathered and precisely described by Alex Osborn." Creative pedagogy generalizes:

- Art (creativity) classes
- Technical creativity
- Psychology of creativity (see ► Psychology of Creativity)
- Creative problem solving (CPS)
- Creatively oriented courses (so thoroughly collected by A. Osborn) (Aleinikov 1999b).

The Spread of the Term and Perspectives

Since 1990s, after the first publications in India (Aleinikov 1990), creative pedagogy and then creative metapedagogy (teaching teachers how to teach creatively) has spread around the world.

Some examples of the first creative pedagogy applications include:

- Creatively oriented Linguistics, Military Institute, Moscow, Russia, 1984–1992
- Creative Management, Center for Creative Research, Russian Academy of Sciences, Moscow, Russia, 1990–1992
- Word Origins and Usage (ENG2210), Effective Communication (COM1110), Psychology of Creativity (PSY3390), Foundations of Creative Education (EDU6625), Troy University, Montgomery, Alabama, 1994–2006

By 2010, creative pedagogy and creative metapedagogy in the form of numerous programs for teachers, managers, and educational and business leaders, spread from the USA to Pakistan, Singapore, South Africa, and Thailand. It has been successfully applied to:

- School education (e.g., New Challenge School, Montgomery, Alabama; Franklin Junior High School, Franklin, Ohio; Jiemin Primary School, Singapore, etc.)
- Postsecondary education (five colleges in Russia, higher education institutions, like Military Institute, Moscow; Troy and Auburn Universities, Montgomery, Alabama; Defense Language Institute, Monterey, California)
- Teacher and professor professional development (The University of Cincinnati, Ohio; United States Air Force Junior Reserve Officer Training Corps (USAF JROTC) Instructors, Garmisch, Germany, and Maxwell AFB, Montgomery, Alabama; Davis and Elkins College, Elkins, West Virginia, Teachers' Centers in Bangkok, Thailand; Karachi and Islamabad, Pakistan; Principal education in Pretoria and Johannesburg, South Africa, as well as universities, colleges, schools, and officials of the Ministry for Education, Singapore).

The results of applying creative pedagogy to real education problems are more than positive. In Singapore, for example, the Jiemin Primary School officials selected 13 sixth graders (out of 1,200 students) who were labeled "incorrigible and doomed to fail." After 2½ days of pedagogical intervention, all students proved to be what Creative Pedagogy calls "ideal learners," and. . .seven months later (without any follow-up), they passed all four state exams (Math, Science, English, Mother tongue) and proceeded to the next level of academic education, thus leading to 100% success of the program. Teachers and parents called it a "miracle" (Aleinikov 2003).

In Russia, where the description of creative pedagogy was developed, it turned most "boring" university programs into outstanding ones as well as moved some colleges from the bottom of the list to the top of the list.

The term creative pedagogy that was so new in late 1980s has become popular. Now it is used for educational conferences and monograph titles. Creative pedagogy received further development as "collective creative pedagogy" by I. P. Ivanov. The methodologies of creative pedagogy are taught and studied at the university level (Kruglov 2002; Morozov and Chernilevsky 2004).

B. Zlotin and A. Zusman, the TRIZ specialists, state, "Creative pedagogy is an attempt to replace the battle between the teacher and students with the child's struggle for self-perfection. The teacher is the child's assistant and ally in this struggle" (Zlotin and Zusman 2005).

At present, a new electronic Encyclopedic Reference Dictionary on Creative Pedagogy (russ. Энциклопедический словарь-справочник "Креативная педагогика") is being developed by a group of researchers headed by V.V. Popov in Russia (retrieved from http://www.thisisme.ru/ Aug 25, 2012).

Since creative pedagogy provides the philosophy, theory, and methodology of creative teaching, it is also becoming an educational movement for positive change in schools.

Conclusion and Future Directions

Creative pedagogy that appeared on the cross section of creativity domain and education domain is defined as the science and art of creative teaching. As a branch of pedagogy, it emphasizes the leading role of creativity for successful learning. It teaches learners how to learn creatively become creators of themselves and creators of their future. In over 20 years of existence, creative pedagogy with its specific philosophy and methodology of creative teaching, its own models of ideal learner, ideal teacher, and ideal learning/teaching process led to solving numerous educational problems and experienced a widespread to a number of educational institutions from kindergartens to universities in many countries. The most remarkable impact is not only changing pupils (students) but also igniting the creative spark in teachers and principals (creative metapedagogy) which quickly leads to the change of atmosphere and institutional improvement. Since creative pedagogy provides a sound theoretical and practical foundation for change at school, it is also becoming an educational movement for positive change in schools.

The future directions of development include the continuous spread of the ideas and values that creative pedagogy already contributed to the field of education to new communities and new countries (see ► Creativity Across Cultures). The future directions of research include collection of empirical data from international sources, evaluation of general impact on the global scale, comparison of the generalized data to the established theoretical model, review and modification of the theoretical model, and finally the publication of the overall results for education researchers as well as popularized version for general population.

Cross-References

- ► Creative Linguistics
- ► Creative Styles
- ► Creativity Across Cultures
- ► Creativity Definitions, Approaches
- ► Creativity Techniques

▶ Creativity Tests
▶ Genius
▶ Inventive Problem Solving (TRIZ), Theory
▶ Measurement of Creativity
▶ Psychology of Creativity
▶ Science of Creativity

References

Aleinikov AG. On creative pedagogy. Higher Educ Bull. 1989;12:29–34. russ. Алейников А.Г. О креативной педагогике. Вестник высшей школы.

Aleinikov AG. Creative pedagogy and creative metapedagogy. Progress in Educ. 1990;65(12):274–80.

Aleinikov AG. Creative metapedagogy: D-day. Alma-Mater. Higher Educ Bull. 1992;1:34–9. russ. Алейников А.Г. Креативная мета-педагогика. Время "Ч". *Alma Mater*. Вестник высшей школы.

Aleinikov AG. Creative Pedagogy+Creative Andragogy =Creagogy (How to create a creator). Paper presented at the IX International Conference on Creativity in Universities and Colleges. Midland, Michigan: The Alden B. Dow Creativity Center; 1998, July.

Aleinikov AG. Mega-creator: From creativity to mega-, giga-, and infi-creativity. Montgomery, Alabama: MIMII; 1999a.

Aleinikov A. Humane creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999b. p. 837–44.

Aleinikov A. Megacreativity: five steps to thinking like a genius. Cincinnati: Walking Stick Press; 2002.

Aleinikov AG. New horizons in creative & innovative education: Genius Education Methodology helps creating a Nation of Geniuses. Human dignity and humiliation studies; 2003 (retrieved from http://www.humiliationstudies.org/news-old/archives/000039.html June 2012).

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, USSR Academy of Sciences; 1988a. p. 77–89. russ. Креативная лингвистика (обоснование, проблемы и перспективы). Языковое сознание: стереотипы и творчество.

Aleinikov AG. Sign. Four-side essence. Universal creative model. In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, USSR Academy of Sciences; 1988b. p. 89-115. russ. Знак. Четырехсторонняя сущность. Универсальная креативная модель. Языковое сознание: стереотипы и творчество.

Aleinikova EN, Aleinikov AG. The stages in creativity development: options for universalizing the methods. In Shmakova LE, Malovichko VS, editors. Creative Management. Vol. 1. Moscow: Creator, Center for creative research, Russian Academy of Sciences, 1991; p. 269–96. russ. Алейникова ЕН, Алейников АГ. Этапы формирования творчества: возможность универсализации приемов. Креативный менеджмент.

Aleinikov AG, Aleinikova EN. Forming creativity: Psycho-pedagogic and Creative Linguistics aspects. In Y. Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Structures of language awareness. Moscow: USSR Academy of Sciences, Institute of Linguistics; 1990, p. 70-96. russ. Алейникова ЕН, Алейников АГ. Формирование творческой активности: психо-педагогические и креативно-лингвистические аспекты. Структуры языкового сознания

Aleinikov AG. Openness – It's that simple. Republished by Teaching for Success (TFS) as "The TFS Classic" 2007; 8 (5) and (6), p. 15. First published in 1997.

Aleinikov AG. How GEGA (Genius expectations - genius achievements) supercharges learning, Teaching for Success, 2008;19 (4), p. 1-2.

Altshuller GS. To find an idea. Novosibirsk: Nauka; 1986. russ. Альтшуллер Г.С., Найти идею.

Altshuller GS, Vertkin IM. How to become a genius. The life strategy of a creative person. Minsk: Belorussia; 1994. russ. Альтшуллер Г. С., Верткин И. М. Как стать гением: Жизненная стратегия творческой личности.

Florida R. The rise of the creative class. North Melbourne: Pluto Press; 2003.

Giroux HA. Lessons from Paulo Freire. The chronicle of higher education (Oct 17, 2010, Retrieved 11/14/11); 2010.

Knowles MS. Informal adult education: a guide for administrators, leaders, and teachers. New York: Association Press; 1950.

Knowles MS. Andragogy, not pedagogy. Adult Leadership. 1968;16(10):350–2. 386.

Kruglov JG, editor. Creative pedagogy: methodology, theory, practice. Moscow: Center "Alfa"; 2002. russ. Креативная педагогика: методология, теория, практика. Под ред. Ю.Г. Круглова.

Moliako VA. Technical creativity and labor upbringing. Newness in life, science and technology. Ser Pedagogy Psychol. 1985;6:20–1. russ. Моляко, В.А. Техническое творчество и трудовое воспитание. Новое в жизни, науке и технике. Серия "Педагогика и психология", 6, 1985, 20–21.

Morozov AV, Chernilevsky DV. Creative pedagogy and psychology. Academic Project; 2004. russ. Морозов А.В. Чернилевский Д.В. Креативная педагогика и психология, Академический проект.

Parnes SJ, editor. Source book for creative problem solving. Buffalo: Creative Education Foundation; 1992.

Popov VV. Creative pedagogy. In: Polovinkin AI, Popov VV, editors. Encyclopedic dictionary “Technical creativity: theory, methodology, practice.” Moscow: Logos; 1995. p. 165–7. russ. Попов В.В. Креативная педагогика. В энциклопедическом словаре “Техническое творчество: теория, методология, практика”. Под ред. А.И. Половинкина, В.В. Попова.
Ramos SJ. Cross-cultural studies of implicit theories of creativity: a comparative analysis between the United States and the main ethnic groups in Singapore. Unpublished master’s thesis. New York, Buffalo, N.Y: State University; 2005.
Searle J. The storm over the University, The New York Review of Books, Dec 6, 1990.
Torrance EP. Torrance tests of creative thinking. Bensenville: Scholastic Testing Service; 1974.
Zlotin B, Zusman A. TRIZ and pedagogy. Southfield: Ideation International; 2005.

Creative Performance

► Effects of Intuition, Positive Affect, and Training on Creative Problem Solving

Creative, or a Behavior Problem?

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Synonyms

Creativity and behavior problems

Introduction

A creative personality is closely related to certain personality types, various classifications developed over the past half-century. Personality classifications have neurological bases, though sociocultural factors also influence a person’s personality type. Different personality types are not positive or negative. Rather, individuals with particular personality types have particular dispositions. Those dispositions are better suited for some contexts than for others. Evaluation of a personality, such as a creative personality, depends upon context. In many settings, the traits of a creative personality are highly valued, but in others criticized. For example, as schools are currently constituted, many traits common to creative personalities are often perceived negatively. Awareness of what common characteristics of a creative personality are may reduce negative evaluations of creative dispositions and might lead to enhanced mentorship of creative children.

Personality Types: Type A, Type B, and Type T

An individual’s personality type influences their creative behavior. One of the more commonly referred to personality typologies is that of Meyer Friedman and Ray Rosenman, American cardiologists; in 1959, they developed the theory of Type A and Type B personalities. A Type A personality shows angry and impatient behavior, which raises their risk of heart attacks. “Type A” individuals are competitive, driven, and stressed, and are workaholics. The Type B personality is relaxed, patient, and friendly.

Another classification of personality is that of Frank Farley: Type T, the thrill-seeker. Farley (1983) spent decades interviewing mountain climbers, marine adventurers, balloonists, and skydivers and explained that these people shared some element of Type T personality. They thrive on challenge and are self-confident, believing that they can control their destiny. Often notorious rule breakers, they are hungry for constant variety; sheer repetition would drive them crazy. Farley explained that many of the world’s daredevils, doers, and delinquents, whether scientists, criminals, or mountain climbers, share a common Type T personality.

Low Arousable Individuals and Type T Personality

Arousal refers to cortical activation. Individuals fall on a spectrum of low- to high-cortical activation. Arousal has a negative relationship with stimulation seeking (for example, someone with low-cortical activation seeks high degrees of stimulation seeking). Farley (1983) explained that low arousable individuals have thought processes that have greater flexibility and greater transferability between modes of cognitive representation. Their thought processes also have greater interrelatedness of cognitive process, more emphasis on parallel (as opposite to serial) processing of information, greater simultaneous (as opposite to successive or sequential) processing, and greater functional dependencies among processing. Highly arousable individuals process information in an opposite way to the Type T personality individuals. Type T personality individuals respond quickly with no careful examination, and they make frequent errors. Highly arousable individuals, on the other hand, evaluate problems and possible solutions slowly, and they commit few errors. Research shows that this reflection and impulsivity dimension is stable in elementary school children. Reflective individuals are low stimulation-seekers, and they are less active out of doors, less distractible in a classroom, and less impulsive in problem-solving situations than impulsive individuals. In contrast, impulsive individuals are high stimulation-seekers, and they are more restless than reflective individuals (Kagan and Rosman 1964).

Various Kinds of Type T Personality

Farley (1986) indicated that national differences in Type T personality can be identifiable, and the United States can be characterized to "Type T nation." Farley explained that Type T personality is more biologically based than psychologically. They are driven by temperament to a life of constant stimulation and risk-taking. Farley suggested that Type T personality includes T-mental, T-physical, and T-balanced: A T-mental is for an individual whose stimulation seeking is cognitive or psychological, a T-physical is for an individual whose stimulation seeking is physical, and a T-balanced is for an individual who is balanced in the relative role of mental versus physical stimulation seeking. Farley also discussed T-positive and T-negative personalities. Both socially useful (positive) and socially appalling (negative) Type T personality individuals reject the strictures and rules, pursuing the unknown or uncertain. They seek thrills, stimulation, excitement, attention, and arousal. They are risk takers, unruly, and get into more trouble. Thus, Type T personality leads to specific human behaviors including creativity, aesthetics, crime, drinking and drug taking, human sexuality, and others.

Jung's Personality Types and Type T Personality

Research shows that intuitive type individuals have a positive attitude and higher degrees of tolerance for complexity and that they enjoy using their mind and open-ended instructions. Type T personality is related to Jung's *intuitive* type in that these individuals are drawn to complexity and novelty, which are important features of the Type T personality.

Introversion-extroversion is a way of relating to an object, the world, and people. Extroverts are not necessarily stimulation-seekers but rather are defined as having an objective view of the world. Farley explained that *extroverts* are high risk-taking, frequent alternation behavior, greater alcohol and cigarette consumption, greater extent of physical movement, less stimulus-deprivation tolerance, and greater pain tolerance as compared to introverts. With greater inhibitory potential of the extroverts compared to the introverts, the extroverts seek arousal-producing stimuli in order to maintain some optimum level of arousal potential, whereas introverts attempt to avoid arousal-producing stimuli. Jung suggested that especially the extroverted intuitive type, rather than the introverted intuitive type, feel imprisoned by the very activities and projects that may have earlier been so satisfying, and that neither reason nor fear would prevent them from pursuing a new challenge (Myers and Myers 1980). This disposition is similar to

Type T personality. Jung believed that the extroverted intuitive types are very important because of their initiative and ability to promote new enterprises. However, he was concerned that some extroverted intuitive types misspent their energy.

Additionally, the *perceptive* type individuals also are related to the Type T personality in that the perceptive type individuals prefer a flexible and spontaneous way of life to a planned, decided, and orderly one (Myers and Myers 1980). Type T personality also has the preference for change and variety.

Creativity with Positive and Negative Type T Personality

Eisenman (1991) explained that people usually think of creativity as a good thing, but creativity can help a few individuals and can hurt others, which is similar to Type T-negative personality. Creativity involves being different or doing something different than what is done by most people. Deviance can be positive and negative because it means being different and thus, the deviance inherent in creativity can be stigmatized and its perpetrator dealt with in a negative way, receiving punishment and scorn. Arousal influences both creativity and delinquency, and the relationship between arousal and stimulation seeking strongly influences behavior and cognitive processes. Therefore, the very qualities that cause creative individuals to have problems facilitate their creative accomplishments.

The characteristics of creative people can be viewed as positive or negative. For example, is a creative person imaginative or bizarre? Robert Frost, society has decided, was imaginative, but in school, he daydreamed and he was eventually dismissed. Also imaginative, Frank Lloyd Wright daydreamed so much that often people had to shout at him just to get his attention. Albert Einstein is remembered for some of his bizarre behaviors. Are creative people persistent or stubborn, high energy or hyperactive, verbally expressive or overbearingly talkative, emotionally sensitive or emotionally unstable, stubborn and rebellious, curious or annoying, spontaneous or impulsive? In her day, Madame Curie showed the very unlady-like traits of both stubbornness and rebelliousness – without which her creative potential would never have borne fruit. Thomas Edison experienced problems in school, in part because of his high energy. Samuel Taylor Coleridge demonstrated restlessness and verbal diatribes. Virginia Woolf talked too much. Van Gogh is remembered for some of his emotionally unstable behaviors. Nikola Tesla's tendency to act out of curiosity and spontaneity found him plunging from the roof of a barn clutching an umbrella, being chased by angry hogs, and nearly drowning in a vat of hot milk, among other misadventures.

Creative Personality in Schools

The above approaches to examining creativity consider the question from the perspective of relationships, scientifically measured, between certain types of personality and creativity. The connection between the two can be considered at a more day-to-day level: in schools, students who are creative are often considered "troublemakers." Teachers who fail to recognize the highly creative capacity of certain children and instead labeling these children as problems may be making the situation worse, both for the teachers and for the students.

As currently constituted, most schools function to homogenize students; schools have industrial timetables, uniform curricular expectations, and numerous rules that children are expected to follow. One of their primary goals is to be a place where the culture and values of society are transmitted to students; those students who most quickly and thoroughly adopt these values tend to excel in the school environment, both among teachers and peers. Teachers themselves have particular personality biases that reflect the conservative and self-reinforcing nature of schools. According to the Myers-Briggs Type Indicator, a commonly used personality preference test based upon the theories of Carl Jung, 56 % of American teachers are "SJs." SJ reflects a bias toward *Sensing* and *Judging* and, as a personality type, reflects a preference for rules, order, stability, and maintenance of the status quo. Even though SJs make up only 38 % of the general population of American society, 56 % of teachers in American public schools are SJs, reinforcing the conservative, convergent nature of schools (Duck 1996). Thus, when children come to school, regardless of their creativity or tendency toward divergent thinking, they are confronted with a system designed to homogenize and teachers largely eager not to challenge the system but to reinforce it. In this context, many creative children are isolated or, worse, labeled "problem children" because they buck the system, try to evade the rules, or take pleasure in seeing exceptions to the rule.

Teachers often make this situation worse. Despite having completed teacher training programs, many teachers in public schools are given woefully limited time to reflect on the purposes of education and the assumptions of educational philosophies. As a result (and especially reinforced because of their tendency to be SJs), classroom instruction tends to be essentialist in philosophy, direct instruction in approach. For mature, focused, and motivated students, such instructional approaches may be satisfactory. However, for any student who struggles to "sit still" (that is, is high energy), unfocused (has a divergent thinking tendency or tendency to imagine things), or who has lost motivation (because of years in schools that have not rewarded their tendency), contemporary American schools challenge them to the very core of their being. For their high energy, they are punished and forced to "sit still"; for their divergent personalities and minds, they are labeled "trouble" in a social context, "wrong" in an authoritarian Essentialist intellectual context. Finally, these students are viewed as lazy or unmotivated. In other words, creative students or students with tendencies toward creativity do not fit in and are often labeled "problem children."

Instructional practices of teachers tend to reinforce this negative labeling process. Despite decades of research demonstrating that teachers should frequently use alternatives to direct instruction models, many teachers today continue to rely on instruction grounded in the idea that the purpose is to deliver information. Students are expected to sit and listen, take notes, and regurgitate information. Students for whom such approaches are not a comfortable fit, due to personality, maturity, or creativity, often are perceived as problem children. Boys, in particular, who generally lacked the maturity of girls and who are not in the same degree socialized *to please*, often find these instructional approaches difficult to bear. As a result, many boys have been identified as problems, an appellation that has led to a proclaimed "boy crisis" in schools (Thompson 1999, 2009; Pollack 1998). However, creativity in instruction and honoring creativity in students can diminish the perception of the problem, raising the question whether the problem inheres in the students or in the teachers. In a multiyear, empirical study based upon schools in six countries, Reichert and Hawley found that if teachers are creative in their instruction, boys feel greater attachment to learning (2010). Identified were three factors that give meaning to instruction, enhance student responsiveness, and lead to greater achievement: transitivity, elicitation of student responsiveness, and positive relationships (mentorship). From this perspective, the problem is not the boys (and their energetic or creative behavior), but rather the intentional efforts of teachers to suppress boys' energy and enthusiasm and the structures of schools that seek to homogenize.

Although the problem of mis-appelation may be more pronounced with respect to boys, girls who do not fit the mold are not immune from being labeled problems. That girls generally are less likely to engage in high-risk behaviors (crime, drinking and drug taking, high-risk sexual activity) does not mean that they do not experience ill effects of repressed creativity. Repression of any sort is at some level violent, and violence begets violence in a process known as *traumagenisis* (Bloom and Reichert 1998). When society, schools, teachers, and parents suppress a child, ill effects will emerge eventually, whether overtly dangerous and destructive or more subtle.

Conclusion and Future Directions

While Paul Torrance was a counselor at the Georgia Military College, he noticed that many of the boys were there because of discipline problems. However, many of these troubled students seemed to display a special quality that he later recognized as creativity. The more recent research of Pollack, Thompson, Reichert, and Hawley has borne this out. To Torrance, boys who were like wild colts (and, thus, typically labeled as problems) needed to learn to direct their creative energy in positive ways. Teachers need to take responsibility for their mentorship role. All students, not merely those who patiently sit and listen, deserve teachers' full effort. Torrance stated that creative imagination is like a wild colt roaming the prairies, unless it is used and directed into the right channels, and that if it is well directed and developed, the aptitude can lead to outstanding creative work. Torrance's career was interrupted by military service in the US Army, and he was appointed to head a task force to study factors in fighter interceptor effectiveness in Korea with particular emphasis on the jet aces. He found that the outstanding aces had once behaved like wild colts, but had learned discipline and adapted successfully in the Air Force.

A powerful implication of these findings is that the "diagnosis" of a child as creative or troubled is partially in the eyes of the beholder. Given that, beholders – parents, teachers, psychologists, counselors – have a responsibility to recognize creative potential and nurture it constructively rather than work to suppress "misbehavior" by punishment or medication. One means to nurture creative potential is through mentorship. Identifying numerous practical strategies to reach boys, Reichert and Hawley nonetheless identified relationships with boys as crucial to their success. Torrance did too. In his 40-year longitudinal study, Torrance (2002) followed participants from 1958 through 1998, and he found that successful creative individuals had at least one significant mentor who recognized, understood, and supported their creative potentials. Therefore, exposing children to intrinsically motivated, creatively thinking adults is critical to encourage invention, innovation, and entrepreneurship. Introducing children to creative inventors or entrepreneurs is necessary to inspire creativity. Books, videotapes, and movies describing creative individuals are helpful for children who exhibit creative behaviors with regard to developing their self-understanding, self-acceptance, and self-esteem. This kind of attention can help make the difference between a problem behavior and a creative behavior by satisfying the children's social and emotional needs.

Torrance also identified the effect of various environmental climates including home, peer, school, society, and culture that either encourages or discourages creative behavior. The most important requirement for successful creativity is creative climate that fosters creative attitude and creative thinking. The environment or climate controls how individuals think and behave as well as whether their product is useful or useless. If group climate is encouraging the creative attitude, the members of the group are lucky. Schools today rarely foster this environment. To the contrary, the climate is killing the creative attitude of students. Educators and parents, then, should do their best to try to change the climate. After they have done their best, if it still does not change, then they should leave the environment before it changes them.

Cross-References

▶ Creative Behavior
▶ Divergent Versus Convergent Thinking
▶ Measurement of Creativity
▶ Science of Creativity

References

Bloom S, Reichert M. Bearing witness: violence and collective responsibility. New York: Haworth Maltreatment and Trauma Press; 1998.

Duck L. Understanding American education: its past, practices, and promises. Burke: Chatelaine Press; 1996.

Eisenman R. From crime to creativity: psychological and social factors in deviance. Dubuque: Kendall/Hunt; 1991.
Farley FH. Psychobiology and cognition: an individual differences model. In: Strelau J, Farley FH, Gale A, editors. Biological bases of personality and cognition. New York: Hemisphere; 1983.
Farley FH. The big T in personality. Psychol Today. 1986;20(May):44–52.
Kagan J, Rosman BL. Cardiac and respiratory correlates of attention and an analytic attitude. J Exp Child Psychol. 1964;1:50–63.
Myers IB, Myers PB. Gifts differing (special anniversary edition). Palo Alto: Consulting Psychologists Press; 1980.
Pollack W. Real boys: rescuing our sons from the myths of boyhood. New York: Random House; 1998.
Reichert M, Hawley R. Reaching boys teaching boys: strategies that work – and why. San Francisco: Jossey-Bass; 2010.
Thompson M. Raising cain: protecting the emotional life of boys. New York: Ballantine Books; 1999.
Torrance EP. The manifesto: a guide to developing a creative career. West Westport: Ablex; 2002.

Creative Personality

Gregory J. Feist
Department of Psychology, San Jose State University, San Jose, CA, USA

Synonyms

Innovation; Temperament

Introduction

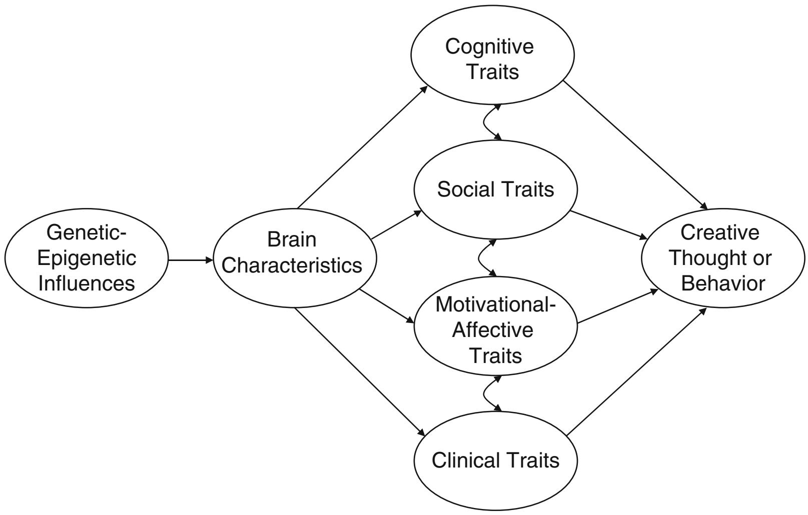
Does creativity stem from nothing? Of course not. All new ideas, products, art and music pieces, and works of literature owe their origin to ideas or products already in existence. Often these previous ideas and art forms directly inspire the future creator and innovator. Newton's well-known adage that he was "standing on the shoulders of giants" was not simply false humility. Even for someone as great as Newton, creativity only springs forth from things already in existence. Personality is one of those conditions that makes creative and innovative thought and behavior more likely in some people and less likely in others.

Creativity comes in many different forms, shades, and hues. First, the creativity of great artists and scientists is what attracts most attention, and for good reason. These enterprises are cornerstones of culture and provide mileposts of our cultural development and progress. And yet, not everyone who is an artist or scientist is equally creative nor are all creative people either artists or scientists. Some are creative in business, in their understanding of other people, or simply in living. In short, creativity's qualities that are both fascinating and yet frustrating is its complexity and variability. In this contribution, Feist reviews the current (last 15 years of) research on personality and creativity that mostly support but sometimes modifications in the model he proposed in both qualitative and quantitative reviews (Feist 1998).

Personality and Creativity Defined

Many people assume, especially artists, that creativity is inherently unknowable, mysterious, and immeasurable. Hence, the argument continues, that researchers cannot agree even on what creativity means. It may be true that creativity is difficult to measure and to quantify, but it is not impossible and it is false to say no consensual definition has emerged on how to define it. In fact, creativity researchers have for the last 60 years been nearly unanimous in their definition of the concept (e.g., Simonton 2008): Creative thought or behavior must be both novel/original and useful/adaptive. It is easy to see why originality per se is not sufficient – there would be no way to distinguish eccentric or schizophrenic thought from creative. To be classified as creative, thought or behavior must also be socially useful or adaptive. Usefulness, however, is not meant in merely a pragmatic sense, for behavior or thought can be judged as useful on purely intellectual or aesthetic criteria.

What about personality? How do we define that? When psychologists use the term



Creative Personality, Fig. 1 Functional model of the creative personality (From Feist (2010) reprinted with permission from Cambridge University Press)

"personality," they are referring to the unique and relatively enduring set of behaviors, feelings, thoughts, and motives that characterize an individual. There are two key components to this definition. First, personality is what distinguishes us from one another and makes us unique. Second, personality is relatively enduring, or consistent. In sum, personality is the relatively enduring unique ways that individuals think, act, and feel. As it turns out, recent research has begun to demonstrate that unique and consistent different styles of behaving (i.e., personalities) are found within many different species of animal, from octopus and mice to birds and horses. Personality is not just a trait of humans, but of most mammals and some birds, reptiles, and fish.

Functional Model of Personality and Creativity

As Feist proposed in the late 1990s, personality influences creativity by lowering behavioral thresholds. In his model, genetic differences influence brain structures and temperamental differences, which lead to personality variability (social, cognitive, and motivational-affective, and now clinical traits), which finally effect creative thought and behavior. The idea was and still is that a particular constellation of personality traits functions to lower the thresholds of creative behavior, making it more rather than less likely. The part of the model that has been most intensively investigated over the last decade since the model was first proposed is biological foundations component, especially genetic and neuroscientific. However, one component of the model is completely new, reflecting even greater growth in research, namely, the clinical personality traits of psychoticism, schizotypal personality, latent inhibition, negative priming. Hence, this entry will give more weight to these components than the others.

Feist's functional model builds ties between biology and personality variability and argues for the causal primacy of biological factors in personality in general and the creative personality in particular. To be clear, the updated model of the creative personality includes six main latent variables, in order of causal priority:

- Genetic and epigenetic influences on personality
- Brain qualities
- Cognitive personality traits
- Social personality traits
- Motivational-affective personality traits
- Clinical personality traits

By combining the biological and the function of traits arguments, Feist presents in Fig. 1 an updated model for the paths from specific biological processes and mechanisms to psychological dispositions to creative thought and behavior.

The basic idea is that causal influence flows from left to right, with genetic and epigenetic influences having a causal effect on brain influences. Brain-based influences in turn causally influence the four categories of personality influence: cognitive, social, motivational, and clinical. These traits individually and collectively lower thresholds for creative thought and behavior, making each more likely in those individuals who possess that cluster of traits. For sake of space, however, in this contribution, the focus here is only on the psychological traits and the interested reader may find the biological details elsewhere (Feist 2010).

Personality Influences on Creativity

In fact, the causal nature of brain influences is precisely what the model of creativity assumes. These brain differences function to make creative traits more or less likely, which in turn make creative thought and behavior more or less likely. So personality traits mediate the relationship between brain and creative thought and behavior. By having genetic dispositions that create CNS differences that facilitate creative thinking, highly creative people also develop a set of personality traits consistent with their biological dispositions.

Building upon the qualitative and quantitative reviews of personality and creativity from 10 years ago, the personality traits most consistently connected to creativity are clustered into cognitive, social, motivational-affective, and clinical groups. Clinical traits are new to the model and therefore will get more attention than the other three classic trait dimensions.

Cognitive Personality Traits. Feist classified particular traits as "cognitive" because they deal with how people habitually process information, solve problems, and respond to new situations. Chief among the cognitive personality traits is "openness to experience." Open people tend to be imaginative and curious, and so it is not surprising that open people are more creative. This is not just a theoretical connection but an empirical one. In addition to the large empirical literature supporting this claim up until the mid-1990s, much recent research continues to build the case for the association between openness and creativity.

A recent representative study of personality and creativity was conducted with college students. It examined the Big Five personality dimensions and their relation to creativity. The participants are told that an artist started the drawing and they are asked to "continue with this drawing. You are allowed to draw anything you wish" (Dollinger et al. 2004, p. 38). Results showed that none of the personality dimensions, with the exception of Openness, consistently correlated with the creative personality scales, creative behavior, and the creative drawing task. The only other personality dimension that had some reliable association with creative production, behavior, and personality was Extraversion.

Social Personality Traits. Social traits of personality involve first and foremost behaviors and attitudes that concern one's relationships to other people, such as questioning or accepting what authority figures say, being comfortable or uncomfortable around strangers and large groups of people, being warm or hostile toward others, and believing one is better or worse than others. The trait terms that summarize these tendencies are norm-doubting, nonconformity, independence, extraversion-introversion, aloofness, hostility, coldness, and dominance/self-confidence/arrogance.

As Feist made clear with the meta-analysis on personality and creativity, the general factor of extraversion does not quite reflect its accurate relationship with creativity. When one splits extraversion, however, into two of its main components, sociability-gregariousness and confidence-assertiveness, a clearer association emerges. Highly creative people are generally not sociable and outgoing, but they are independent, confident, and assertive. The recent angle on confidence and assertiveness has morphed into research on self-efficacy and creativity.

Conservatism and conformity continue to conflict with creativity. Conservatism is the opposite pole of norm-doubting and reflects a tendency to value tradition and authority. Rubinstein (2003), for instance, examined authoritarianism and creativity in Israeli college students (design, behavioral science, and law). Rubinstein found strong negative relationships between creativity and authoritarianism as well as a linear relationship between career choice (major) and authoritarianism. Law students were more authoritarian than behavioral science students who were more authoritarian than design students. Others have reported that the more politically conservative students were less likely to have reported creative hobbies or accomplishments and their photo essays and drawings were judged as less creative than the liberal students. Highly creative people doubt, question, and often reject norms, traditions, and conservative ideology. Indeed, one could argue these findings validate both constructs, for creativity concerns producing novel and unusual ideas and conservatism/authoritarianism values tradition.

Motivational-Affective Personality Traits. Motivational traits are defined by a person's desire to persist in activities and to be successful it his or her activities. Trait terms characteristic of motivation are persistent, driven, ambitious, and impulsive. That some people are driven to be creative is both undeniable and perplexing. Why do people want to create? Some people are willing to forgo social relationships and economic well-being to create lasting works.

If those who have a desire to produce works that leave a mark on the world are to succeed, they also need to be driven, focused, and ambitious. They are not the kind of person who gives up easily in the face of hindrances and roadblocks. And that is generally what the research on drive and creativity continues to show: Creative artists, businesspeople, and scientists are driven, ambitious, and persistent (e.g., Batey and Furnham 2006).

But what kinds of things motivate them? Need to know? Self-Expression? Success? Recognition? Money? Joy from the process? It could be each of these depending on the nature of the creative task. Scientists are probably driven more by the need to know and artists more by the need for self-expression. And both are often driven by the pleasure the process of discovery or expression brings, otherwise known as intrinsic motivation. Indeed, intrinsic motivation is often associated with highly creative thought or behavior and quite a body of research supports this idea (e.g., Amabile 1996). That is, when the drive and energy for carrying out a task is pleasure and excitement, then the end product often is more creative than if the drive is lacking or extrinsic. Amabile's classic work on motivation and creativity has reported that often extrinsic motivation (reward, surveillance, or recognition) has a detrimental effect on creative achievement. Experimentally, this effect has been demonstrated by offering people rewards for a creative task and comparing the creativity of the outcome to those not offered rewards for doing the task. The typical finding is the non-rewarded group produces products judged to be more creative than the rewarded group. Similarly, positive affect (feeling good) seems to facilitate creative thinking.

Yet it is clear to even those who established the intrinsic motivation principle of creativity to recognize that positive affect and intrinsic motivation do not always facilitate creative thought and extrinsic motivation does not always hinder it. Other researchers, for example, have argued that reward, which leads to positive affective, is unconnected to creativity. Eisenberger and colleagues have conducted much of this research and when they inform participants in a reward condition that they will be not just rewarded but rewarded for producing a *creative* product, then reward does increase rather than decrease the creative performance. But, reward is not reward is not reward. If told explicitly that they are being rewarded for producing something creative, reward can apparently facilitate creative thinking. Given the complex nature of the findings on intrinsic and extrinsic motivation and creativity, it is probably safest to conclude that it is drive and ambition that matter most and whether the reward is internal (pleasure) or external (reward, money, or recognition) is not as important as the drive and ambition to create something new and worthwhile.

Clinical Personality Traits. One of the biggest changes in the field of personality and creativity over the last 10 years – besides the steady rise in neuroscientific studies – is the tremendous growth in research on personality disorders, mental health, and creative thought and behavior. The influences of mental health on creative thought and behavior are so robust now that Feist recently added a new dimension to the three major trait groupings from his previous model. So now in addition to cognitive, social, and motivational-affective, he included a clinical traits group that includes the normal personality dimension of psychoticism and its related concept of schizotypy. The evidence for the connection between clinical personality traits and creativity is stronger in the arts than in the sciences (e.g., Ludwig 1995).

Eysenck's well-known model of personality proposed psychoticism to be the third of the three super-factors of personality. People high in psychoticism are cold, aloof, eccentric, hostile, impulsive, and egocentric. Moreover, Eysenck argued that psychoticism was the personality dimension most closely aligned with creative thought and behavior (Eysenck 1995). Empirical investigations continue to provide support for Eysenck's general theoretical model linking psychoticism to creative thought and behavior.

Consistent with Eysenck theory, Martindale (2007) theorized the thread that ties schizotypal personality disorder and creativity together is loose semantic processing of information in the right hemisphere. Therefore, ideas are associated in global and holistic manner rather than in a narrow and analytic way. The idea, consistent with a lot of the research on heightened right hemispheric activity in highly creative people, is that there is a relative weakening of the left hemisphere and strengthening of right-hemisphere processing. Moreover, latent inhibition and primordial thinking are commonly found elements both in creative thought and schizotypal personality. Latent inhibition is the ability to selectively attend to only the most relevant sensory experience and tune out the irrelevant. Highly creative people are often less able to tune out the irrelevant information. In this sense, failure to screen out irrelevant sensory experiences and ideas might enrich one's source for ideas, which would explain the greater ideational fluency of creative people.

Recently, some researchers have begun to question the validity of Eysenck's psychoticism dimension, especially as it relates to pathology and instead have turned their attention to a more specific (and narrower) clinical personality dimension – schizotypy or schizotypal personality disorder. A person with schizotypal personality disorder is isolated and asocial, but in addition has very odd or magical thoughts and beliefs. For instance, people with schizotypal personality disorder may believe that stories on TV or in the newspaper were written directly about them or people they do not know are saying things about them behind their backs.

During the last decade or so, many researchers have examined the connection between schizotypal personality disorder and creativity. Creative artists, more than scientists, tend to have elevated schizotypy scores. For example, poets and visual artists are higher on schizotypy dimensions of unusual experiences, cognitive disorganization, and impulsive nonconformity than nonartists. Moreover, there is a curvilinear relationship with degree of involvement in poetry and visuals arts. Serious amateurs show the highest levels with professionals being next followed by hobbyists.

Conclusions and Future Directions

The research and theory on the connection between personality and creativity remains a vital topic of investigation for psychological scientists. The basic conclusions from 10 years still hold and yet two areas of research have grown so drastically that they deserve being added to the functional model in Fig. 1. These two areas are brain influences and clinical traits. The model proposes that genetic, epigenetic factors create conditions in the central nervous system that make particular personality traits more likely. These personality traits cluster into cognitive, social, motivational-affective, and clinical groups. Being high or low in certain personality dispositions does make creative thought and behavior more or less likely.

The literature on the genetic and brain influences has expanded as well as the clinical traits of psychoticism and schizotypy. The main conclusions from neuroscience research demonstrate the importance of frontal lobe functioning, greater neural complexity, and increased right-hemisphere activity in highly creative people or during creative problem solving. These biological markers in turn make personality traits more likely. The cognitive traits (openness and cognitive flexibility), social traits (norm-doubting, nonconformity, independence, extraversion-introversion, aloofness, hostility, coldness, and dominance, self-confidence/arrogance), motivational-affective traits (drive, persistence, intrinsic motivation, and positive affect), and clinical traits (psychoticism, latent inhibition, and schizotypy), all function to make creative thought, behavior, and achievement more probable.

One methodology that will be of most help to future researchers is true longitudinal designs whereby large groups of young children are assessed at regular points in their development up through early to mid adulthood, much like the well-known Terman studies of the intellectually gifted. The question of cause and effect – Is personality a cause or an effect of creative thought and behavior? – can only be answered with longitudinal evidence.

In the 1970s and 1980s, some psychologists argued that personality was a dying or even dead field. Personality does exist and traits are not mere hypothetical concepts with no effect on behavior. Traits function to lower behavioral thresholds – one could even say they cause behavior. Creative behavior is no exception and future researchers will no doubt continue to investigate the complex connection between personality and creativity.

References

Amabile T. Creativity in context. Boulder: Westview; 1996.

Batey M, Furnham A. Creativity, intelligence, and personality: a critical review of the scattered literature. Genet Soc Gen Psychol Monogr. 2006;132:355–429.

Dollinger SJ, Urban KK, James TA. Creativity and openness: further validation of two creative product measures. Creat Res J. 2004;16:35–47.

Eysenck HJ. Genius: the natural history of creativity. New York: Cambridge University Press; 1995.

Feist GJ. A meta-analysis of the impact of personality on scientific and artistic creativity. Pers Soc Psychol Rev. 1998;2:290–309.

Feist GJ. The function of personality in creativity: the nature and nurture of the creative personality. In: Kaufman JC, Sternberg RJ, editors. Cambridge handbook of creativity. New York: Cambridge University Press; 2010. p. 113–30.

Ludwig AM. The price of greatness. New York: Guilford Press; 1995.

Martindale C. Creativity, primordial cognition, and personality. Pers Individ Differ. 2007;43:1777–85.

Rubinstein G. Authoritarianism and its relation to creativity: a comparative study among students of design, behavioral sciences and law. Pers Individ Differ. 2003;34:695–705.

Simonton D. Scientific talent, training, and performance: intellect, personality, and genetic endowment. Rev Gen Psychol. 2008;12(1):28–46.

Creative Potential

▶ Divergent Thinking

Creative Problem Solving

▶ Promoting Student Creativity and Inventiveness in Science and Engineering

Creative Problem Solving Training

▶ Creative Thinking Training

Creative Problem-Solving

▶ Creative Styles

Creative Process

▶ Creative Styles
▶ Creativity and Innovation: What Is the Difference?
▶ Four Ps of Creativity and Recent Updates

Creative Process in Brain

▶ Creative Brain

Creative Products

▶ Four Ps of Creativity and Recent Updates

Creative Scientific Enquiry

▶ Scientific Inventive Thinking Skills in Children

Creative Styles

Igor N. Dubina
Economic Information Systems, Altai State University, Barnaul, Russia

Synonyms

Creative behavior; Creative problem-solving; Creative process; Creativity

Definition

Creative styles are individual preferences or approaches in which people are creative, solve problems, and make decisions.

A Preamble

There are many varying approaches for understanding individual differences in creative persons. Some of them seek to understand differences in levels of creativity ("to what extent is this person creative?"), while other approaches focus on differences of how individuals show their creativity. These "how is this person creative?" models incorporate the assumption of differences in approaches to creative problem-solving, or creative styles. People differ in the cognitive styles in which they are creative, solve problems, and make decisions. An approach to cognitive style is that each person expresses a preference for processing information and making decisions based on psychological patterns (Fox and Fox 2004). There are several well-known theories and corresponding instruments directly related for assessing creative cognitive styles. Three of them which got the most popularity and strongest reputation among scholars and practitioners for the last three decades are briefly described in this article.

Kirton Theory of Adaptive and Innovative Styles

According to *Kirton adaption-innovation theory* (Kirton 1999), all individuals have some preferences for an adaptive or innovative style of problem-solving, decision-making, and creativity. The adaptive style is characterized by working within the given paradigm: structure of a problem, precision, reliability, and conformity. The innovative style is characterized by approaching tasks from unsuspected angles, not to be limited by the boundaries of the paradigm, and been seen as undisciplined. These style differences, which lie on a normally distributed continuum, range from high adaption to high innovation. The more adaptive people prefer their problems to be associated with more structure, while the more innovative people prefer solving problems with less structure and are less concerned about a consensually agreed structure. Adaptors seek to solve problems by introducing change that supports the current system. Adaptors develop novelty within the existing system and expect to succeed by using the rules. Adaptors strive to provide "better" solutions rather than "different" solutions. They tend to stay within the current paradigm too long, while innovators tend to abandon the current paradigm too soon.

The value of adaptors is obvious: they provide stability for an organization. Innovators more readily perceive the radical views and solutions, although that involves more risks. The value of innovators for an organization is also obvious: they provide new opportunities. No organization can survive long without adaptors, and no organization can effectively develop without innovators. It is very important to note that adaptors and innovators can be equally creative by level, they can be equally good or bad at problem-solving, and they just do so differently (Kirton 1987).

The key point of this theory is that those differences behave stable and no life experience (becoming more mature, knowledgeable, or senior) will change them. Each of the mentioned styles has its own strengths and weaknesses, so the whole range is essential for solving the wide diversity of problems that face the organization or group over a long time, although these differences are less useful on particular problems that obviously require mostly adaptive or innovative solutions. Therefore, a diversity of problems requires a diverse team, and one of the goals of optimally managing creativity is to build an appropriate (i.e., optimal) creative team.

The organization's goals, problems, and objectives vary constantly. How can a corporation manage creative people best? One way is by understanding and using the insights gained by the study of styles. Identifying creative styles may increase the performance of a team and organization. Managers should ensure that a creative team is optimal for (i.e., suits) the organization's goal, job requirements, and problem type. For example, what is needed by the organization, stability or flexibility? In which direction is the company heading, upward or downward? If the company needs a fast retreat or repositioning in the marketplace, a flexible individual should make the best in such a situation. An innovator would be the best choice. However, if the company is in a position of steady and continuous growth, in the process of consolidation, and harvests steady profits, then the stable personality of an adaptor would make a better managerial choice. One of the most critical tasks for corporations is to match the skills of people with the demands of a job. Creative styles may be particularly important in certain areas of a business. For example, if the main focus of the business concentrates on the development of new products necessary for long-term survival, a company needs innovative problem solvers at the top levels of management who enjoy the task of creating and developing novel solutions and ideas that progress to new products. Adaptors are better suited for administering existing product lines, improving existing production and delivery systems, developing ideas into products, and "keeping things running" through administration and maintenance (Fox and Fox 2004).

As a practical realization of his theory, Kirton designed an instrument for measuring creative styles (not creative capacity), the *Kirton adaption-innovation inventory* (*KAI*). KAI is a popular, well-known, and practically used instrument. At least 78 theses and 210 articles have been written about the KAI for two decades since 1978 (Puccio and Murdock 1999, p. 511).

Basadur Model of Creative Styles

Basadur developed a concept of creative personal styles based on the stages of the creative problem-solving process. He characterizes creative problem-solving as "a continuous circular process involving two opposite ways of getting knowledge and two opposite ways of using knowledge." Based on this idea, Basadur identified eight steps for the creative problem-solving process and *Creative Problem Solving Profile* (Basadur and Finkbeiner 1985; Basadur et al. 1990).

For an organizational team, which wants to be effective in creative problem-solving, all four styles are needed. *Generators*, who are especially sensitive to the situational environment, are needed for picking up data and suggesting possible opportunities for change and improvement. *Conceptualizers* are needed to pull together the facts and ideas from the generation phase into well-defined problems and challenges and more clearly developed ideas and concepts for further evaluation. *Optimizers* are needed to find a best solution from a practical point of view. *Implementers* are needed for effectively realizing practical solutions and plans. For identifying creative styles, a particular instrument, the *Basadur Simplex*, was developed (Basadur 1997).

Puccio Conception of Creative Styles

Puccio developed another model and instrument for assessing creative styles to help individuals and/or teams for understanding better how they approach solving problems. His instrument, the *Foursight*, is designed to improve collaboration of individuals, teams, groups, and organizations in problem-solving situations (Puccio 2002). The Foursight is based on the *Creative Problem Solving* model (*CPS*). The CPS model has a history of more than 50 years of development and is being considered as one of the most widely used and best researched about creative thinking models worldwide. The six stages of the CPS model are as follows.

- Identifying a goal, wish, or challenge that requires creative thinking
- Gathering information about the goal, wish, or challenge
- Clarifying the problem by identifying the specific issues that need to be resolved
- Generating many varied and original ideas to resolve the problem
- Selecting, strengthening, evaluating, and refining promising ideas into workable solutions
- Developing a plan of action that builds on sources of assistance and overcomes potential sources of resistance

The Foursight has 37 questions, which are designed to measure with which "sections" of the CPS model a person is most comfortable with. These may be single preferences or a combination of two or more preferences. Each preference has its strengths and its potential weaknesses. Therefore, a balanced creative team depends on the diversity of styles. Single preferences are called *clarifier*, *ideator*, *developer*, and *implementer*.

Clarifiers like to spend time on clarifying the problem, because they want to be sure that the right problem is being addressed. They gather information to understand the situation and are inclined to look at the details. They may have a tendency to analyze to the extreme and keep the process from moving forward. Clarifiers are focused, orderly, serious, methodical, deliberate, and organized. In order to be effective, they need to have order, to get the facts of the problem situation, have an understanding of the history of the situation, and appreciate ready access to information.

Ideators like to look at the "big picture." They enjoy switching ideas and possibilities by stretching imagination. When solving problems, ideators take a more intuitive approach to problem-solving. They enjoy thinking in more global and abstract terms. This may cause a tendency to overlook the details. Ideators are social, flexible, independent, imaginative, and adaptable. Ideators need constant stimulation, variety, and change to be most effective.

Developers like to put together workable solutions. They enjoy thinking and planning about the steps of implementing an idea. They analyze very well and compare potential solutions and like to examine the strengths and weaknesses of an idea. Developers might get stuck in trying to develop the perfect solution. Developers are reflective, cautious, pragmatic, structured, and very planning oriented. To be effective, they need time to consider the options and develop their ideas.

Implementers like to see things happen. They enjoy focusing on ideas and solutions, which, as they feel, are workable. One potential drawback to this preference is that the person may leap to action too quickly. Implementers are persistent, decisive, determined, assertive, and very action oriented. They are the most effective when they feel that others in their group are moving just as quickly as they are. They need a sense of control and need to receive timely responses to their ideas. Committing too soon to one idea may leave other more powerful ideas undiscovered (Puccio 2002; Fox and Fox 2004).

Conclusion and Future Directions

It is important to note that all of the three conceptions and instruments, described above, identify and measure only preferences, and they do not measure abilities. Testing these instruments with hundreds and thousands of people indicates that the instruments have a good reliability and validity. They provide a method for understanding how people of different inclinations in the creative process can work together and may be organized in a balanced team to complement each other to initiate, develop, and implement new and potentially useful ideas. Understanding and measuring creative styles may help a manager and team members to identify the team's strengths and weaknesses in problem-solving, as well as to select and use training programs and techniques in accordance to the problem, they want to solve, and the contingent of participants in terms of their creative styles. Therefore, these instruments may support a manager in understanding how to organize a team for increased creativity by synergizing the team members' similarities and differences. By recognizing the potential contributions of all of the creative personality styles, organizations can build balanced, creative teams and enhance organizational effectiveness.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Behavior
▶ Creative Personality
▶ Creative Problem Solving
▶ Creative Thinking Training
▶ Creativity Tests
▶ Divergent Versus Convergent Thinking
▶ Four Ps of Creativity
▶ Measurement of Creativity
▶ Psychology of Creativity
▶ Simplexity Thinking

References

Basadur M. Basadur simplex manual. Ontario: Center for Research in Applied Creativity; 1997.
Basadur M, Finkbeiner CT. Measuring preference for ideation in creative problem-solving training. J Appl Behav Sci. 1985;21:37–49.
Basadur M, Graen G, Wakabayashi M. Identifying individual differences in creative problem solving style. J Creative Behav. 1990;24:111–31.
Fox JM, Fox RL. Exploring the nature of creativity. 2nd ed. Dubuque: Kendall/Hunt; 2004.
Kirton MJ. Kirton adaption-innovation inventory (KAI) manual. 2nd ed. Hatfield: Occupational Research Centre; 1987.
Kirton MJ. Adaptors and innovators: a description and measure. In: Puccio GJ, Murdock MC, editors. Creativity assessment: readings and resources. Buffalo: Creative Education Foundation Press; 1999. p. 121–32.
Puccio GJ, Murdock MC (Eds.). Creativity Assessment: Readings and Resources. Buffalo: Creative Education Foundation Press; 1999.
Puccio GJ. Foursight manual. Buffalo: International Center for Studies in Creativity; 2002.

Creative Teaching Methodologies

▶ Creative Pedagogy

Creative Thinking

▶ Creative Mind: Myths and Facts
▶ Creativity and Innovation: What Is the Difference?
▶ Method for Creating Wisdom from Knowledge

Creative Thinking Education

▶ Creative Thinking Training

Creative Thinking in Music

▶ Creativity in Music Teaching and Learning

Creative Thinking Techniques

► Creativity Training in Design Education

Creative Thinking Tests

► Creativity Tests

Creative Thinking Training

Blair Miller[1], Jonathan Vehar[2], Roger Firestien[3] and Robert P. Eckert[4]
[1]Blair Miller Innovation, Evanston, IL, USA
[2]Center for Creative Leadership, Greensboro, NC, USA
[3]Innovation Resources Inc., Buffalo, NY, USA
[4]New & Improved, LLC, Paul Smiths, NY, USA

Synonyms

Creative problem solving training; Creative thinking education; Innovation training

Introduction

Kirkpatrick (1967) noted four levels of evaluation of training:

- Level 1: *Reaction*. How well did the participants like the program?
- Level 2: *Learning*. What principles, facts, and techniques were learned?
- Level 3: *Behavior*. What changes in job behavior resulted from the program?
- Level 4: *Results*. What were the tangible results of the program in terms of reduced cost, improved quality, improved quantity, etc.?

Impact research focused on creative thinking and creative problem solving (CPS) programs details levels two and three, plus less common level four, evaluation (Firestien 1990; Firestien and McCowan 1988; Keller-Mathers 1990; Miller 1992; Neilson 1990; Puccio et al. 2006; Reid 1997; Vehar 1994; Vehar et al. 2000). In addition to published research, there are unpublished proprietary impact studies for companies ranging from large publishing companies to large consulting firms.

In the majority of courses delivered by the authors, feedback forms are administered asking participants to provide a level one evaluation of the components of the course as well as various aspects of the entire program both quantitatively and qualitatively. As additional anecdotal evidence, the authors also regularly receive feedback from participants about the aspects of courses that they find to be particularly impactful. This feedback takes the form of conversations, phone calls, emails, and letters. All of these items are used to address a common research question that has been under discussion for as long as the authors have been working together which is, "how might instructional designers and trainers improve the stickability of our training?" In other words, how might trainers increase the likelihood that the participants will remember and apply what they have learned?

Individually and collectively, the authors have worked with hundreds of organizations ranging from the largest corporations (according to *Fortune's* list), to fast-moving growth companies, to small family-owned enterprises, to not-for-profit organizations and governmental departments and agencies. They have worked with most of their clients multiple times, and so have had the opportunity to refine and develop their programs for each organization. Since each organization has unique strengths and challenges, the authors engage in some degree of customization of the training programs to meet their needs. Having noted that, there are common elements that show up in almost all of their creative thinking programs.

The authors have undertaken regular discussions over the past 15 years, both formal and informal explorations of the fundamental principles of their work. While working together and separately, they have come to a shared conclusion that there are four key principles responsible for most of the value of a training program in creative thinking, whether that course lasts for an hour, a day, a week, or a semester. The purpose of this entry is to discuss these four principles and to provide examples of their impact in various organizations. This is not meant to be an exhaustive study of impact, but rather reflects the culmination of years of working with individuals and groups to help them think more creatively.

The Four Key Principles of Creative Thinking

Here are the four key principles. While there are many elements of a creative thinking training program, the authors often begin and end a program by focusing on these four:

1. Phrase problems as questions, using statement starters, or what Parnes (1981) called, "invitational stems," such as, "How to...," "How might...," "In what ways might...," and "What might be all the...."
2. To get good ideas, generate a lot of ideas.
3. Evaluate all ideas positively with Praise First: POINt.
4. Take personal responsibility for your own creativity.

In the pages that follow, each of these four principles will be explained in more depth, along with anecdotal stories that reflect their application in the workplace.

Phrase Problems as Questions

The first of the core principles is a key component of the "Clarify the Problem" or "Problem-finding" stage of Osborn-Parnes Creative Problem Solving (CPS) and its many variations (Miller et al. 2004; Parnes 1981, 1992). What is a slight, yet specific, use of language in CPS – phrasing a problem or obstacle in the form of a question – in practice beyond the process becomes a fundamental shift in the way in which people approach challenges. More than just a technique, it operates in a way that requires people to shift from viewing something as a limitation, or something that cannot be done, into an inquiry in how something might be done (Eckert and Vehar 2007; Miller et al. 2004; Osborn 1948).

Using this technique, one would take a problem such as "I don't have any money," and turn it into a question starting with one of four statement starters: "How to...," "How might...," "In what ways might...," or "What might be all the...." Examples of possible questions include the following:

- How to obtain sponsorship?
- How might we lower the cost?
- In what ways might we reduce spending?
- What might be all the ways to get money?

Success Stories: Phrasing Problems as Questions

At a large consumer products company, two direct-reports walked into the manager's office and explained that because there was not enough money, the research that had been planned to have consumers taste and provide feedback on a particular product needed to be canceled. The senior manager listened to the assistant brand managers and applied the principle of phrasing problems as question by asking them, "How might we make sampling a reality?" Her two assistant brand managers stared blankly back at her and repeated that the vendor's price was too high making the sampling impossible. So she rephrased her question as, "In what ways might we make the sampling a reality?"

This time, the managers understood what they were being asked. With the reframing of the challenge the managers began to see a new course of action. In minutes, the three had generated ideas for a solution that was ultimately successful with no increase in budget. What unlocked this situation for the senior manager was her ability to step back from the situation, to keep the overall objective in mind, and to start phrasing the problem with questions that invited solutions.

In another notable example, a chemist at another consumer products company solved a vexing 77-year-old consumer problem by using the same approach. For more than seven decades scientists in the R&D department had tried and failed to fix a glitch that generated more than 50 % of all consumer complaints on a popular product. The scientists and some colleagues spent more than a man-year trying to find their own solutions – until the chemist decided to apply a lesson learned in a creative thinking training session and challenge the accepted problem statement. In 15 min, he set up a crude experiment which 2 weeks later validated his answer to the problem that the company had worked on for so long.

To Generate Good Ideas, Generate a Lot of Ideas

One of the major contributions to the study of creative thinking made by Alex Osborn was an emphasis on generating a large number of ideas *before* selecting the best one to move forward, thus separating the generation from the evaluation phase of idea generation (Osborn 1993). His four guidelines for brainstorming, or divergent thinking, emphasize a focus on quantity to generate quality. The research of Firestien and McCowan (1988) demonstrated the value of generating many ideas as a strategy to generate high quality ideas, along with the positive improvements in the communication behaviors of the participants. Most famously, Linus Pauling, the chemist who earned two Nobel prizes is quoted as saying, "If you want to have good ideas you must have many ideas" (cited in Crick 1995).

During training programs, the authors emphasize many tools and techniques to help develop the skill of seeking a large quantity of ideas. The authors emphasize the point that Pauling made, and encourage participants to take this on not only as a deliberate technique, but also as an approach to generating solutions for the challenges they face.

Success Stories: Generate a Lot of Ideas

A Training Project Manager at a large daily newspaper facilitated a creative thinking session focused on how to develop a system to check the paper for accuracy before printing. That afternoon, after generating hundreds of ideas, the production team went back to the composing room and refined the ideas down to a comprehensive checklist. By using the list that very night, the team caught an error in a full page color advertisement that would have cost $22,000 to fix. The manager noted that, "We made our money back on the first day!"

In another situation, the Director of Consumer Promotions at a consumer products company was assigned by her Vice President to structure a division-wide brainstorming session for 300 people that would deliver millions of dollars in savings during the remaining months of 1998 and throughout 1999. Rather than sequester the cost cutting to the offices of a few high-level directors, the division took a vastly different approach. The director set up a day on which 29 teams generated ideas on the challenge. The thousands of ideas went through a feasibility screen manned by director-level managers whose job was to "reality check them." Even after a critical screening, the ideas totaled up to millions of dollars in potential savings. Unfortunately, the group fell short of its year-end target for the current year since there was not enough time left in the year to implement them. But the following year cost cuts were a different story. The group more than doubled the targeted amount for the following year. Not only did the participants generate thousands of ideas, but the division, in one day, pocketed ideas worth millions of dollars in potential savings.

Evaluate Ideas Positively with PRAISE First: POINt

The third key principle is that of evaluating all ideas positively. The authors specifically recommend a tool called Praise First: POINt (Miller et al. 2004). POINt is an acronym that represents the four specific aspects that should be examined in each idea that is being evaluated:

- Pluses: What is good about the idea right now?
- Opportunities: What are the good things that might result if the idea were to be implemented?

- Issues: What are some of the issues, concerns, or things that need to be improved about the idea?
- New thinking: For each of the significant issues, what are some new ideas that will overcome the issues identified?

While the concept of examining the advantages and disadvantages of an idea is hardly new, it was Synectics (1979) that identified Itemized Response as a systematic approach for evaluating ideas, and the work of Foucar-Szocki, Firestien, and Shephard who first coined PPC (Pluses, Potentials, and Concerns), an earlier version of Praise First: POINt (Firestien 1996; Miller et al. 2004).

Success Stories: Evaluate Ideas Positively with Praise First: POINt

An international consumer products company required a group of plant managers to attend a 2-day creativity training. After the first day, the participants were given homework: to apply POINt to a work situation before coming to class the next morning. One seasoned plant manager shook her head saying, "I am not paid to be creative. My job is to run the plant efficiently and keep my workers safe." She went on, "I don't like new ideas. It's just more work for me." But she dutifully took on the homework assignment, and called a worker who was always offering new ideas. During their conversation, the plant manager forced herself to first reflect the positive aspects of the worker's new idea and articulate what positive outcomes might happen if the idea was implemented. The next morning, she reported back to the class. "That idea is going to save my plant $5,000 a week!" She further admitted that if she hadn't used POINt, she would never have had the patience to hear the idea through.

In another application, a peer in a meeting – not a manager or facilitator – shifted the way a group was evaluating ideas worth millions of dollars. A large pharmaceutical company created a governance committee to evaluate proposals from teams challenged to look for ways to speed both drug development or promising compounds and the decisions to stop development earlier on dead-end projects. A member of the committee noticed that his peers on the governance committee were reacting to each proposal by looking for what was wrong or weak with the idea. Finally, after noticing this pattern among his team members, he made a subtle intervention by asking the team to first look for the pluses. His peers agreed, and rather than killing the idea, worked through a process of searching for pluses, then opportunities and next identified issues, before turning it back to the team to fix the issues and then implement the solution. The idea was one that could save 3 days on drug development for any drug that made it to the 3-year mark in development, which equates to about $3 million on each drug in development. One person interviewed said that without the use of the Praise First: POINt technique, this solution was headed where all the other ideas headed: a binder on the shelf never to be implemented.

Take Personal Responsibility for Your Own Creativity

Trainers regularly hear people leave training programs saying something like, "these are good tools and methods, but my boss/peers/direct-reports/etc., won't let me be creative." Or later participants would say, "that was a good course, but no one's using it on my team." The authors interpreted this to mean that there was a lack of responsibility being taken for implementing the course learnings, in spite of the fact that the organization, and in some cases the participants themselves, were paying good money for, and spending valuable time in, the training. The principle of taking personal responsibility for creativity is an invitation to people not to wait around, but rather to make it happen on their own at whatever level they can manage.

Frankl (1984) pointed out the importance of choosing one's own attitude to make a difference, and this is what participants are directly asked to do. Neilsen (1990) and Keller-Mathers (1990) pointed out the need for this in their impact research, and Vehar (1994) pointed in this direction as well. The authors were confident that their courses could change the way that an organization works, and had also heard from people through the years that the course and the content changed their lives. What was notable about those whose lives were changed is that they took the responsibility to implement what they had learned.

Success Stories: Take Personal Responsibility for Your Own Creativity

At a large multinational corporation's R&D facility, a mid-level member of the organization took on the responsibility to share these key principles with other members of her team who had not attended the training. She specifically mentioned the need to take personal responsibility for improving the climate for innovation and communication on the team, which fostered excitement and numerous conversations about ideas for implementation, many of which were subsequently implemented. To keep these conversations energized, she created an ongoing support group that sent out weekly reminders of the tools and mental attitudes to drive innovation.

A large publishing organization conducted a week-long executive leadership program that focused on having participants craft real solutions to difficult organizational challenges. One participant, an assistant corporate counsel, was charged with working on organizational diversity. During dinner early in the week, he confided to one of the trainers a grave concern: that if, at the end of the week, he presented to the Chairman of the company what he *really* needed to hear, it might spell the end of his career. The participant and trainer discussed the need for personal responsibility around creativity. The next day, the participant reported that he was going to tell the Chairman the difficult news and propose the challenging solutions that needed to be heard. Plus, he had already called the Chairman to tell him who else among the executive team needed to attend his presentation at the end of the week. The participant was subsequently promoted in the organization, and 2 weeks after the presentation, on the front page of *the Wall Street Journal*, the Chairman was quoted talking about the importance of the company changing and improving their diversity efforts in order to be more competitive.

Recommendations

The authors are strong advocates of helping people remember these four items by repeating them often in their programs, by using posters that focus on these items, by giving away reminder cards that people can keep handy, and by reinforcing the principles in follow-up newsletters.

Focusing on these four principles, rather than on every page in the manual, allows for the most effective transfer of learning. While other items in the course build on and enable the principles, the four key principles are the foundation on which the courses – and their ultimate impact – are based.

As people who enjoy generating ideas and are always finding new things to add to their presentations, the authors regularly have to remind each other that, "less is more." That is why they focus on the four key principles that after a half, full, or two-day training program are critical that people remember and apply. These things will create the most value, and are worth remembering.

Conclusion and Future Directions

While these four key principles seem fairly basic, they are quite profound. In the words of Etienne Verber, the former President of Nutra-Sweet, "a lot of this stuff seems basic, but the fact is, when you apply the principles again and again, the results are amazing" (Schoen 2000). In the collective experience of the authors, they believe the four keys reflect the Pareto principle that: 80 % of the value comes from 20 % of the course

(Retrieved April 8 2008 http://www.gassner.co.il/pareto/), which is not to say that the other 80 % of the course is worthless, but in fact reinforces the four key principles. Effective creative thinking course content serves to provide additional tools and techniques that aid these four principles such as: (1) ways to help determine what are other questions that frame the problem, (2) tools for generating more ideas, (3) techniques for searching for the value of new ideas, and (4) ways to help people in their efforts to apply their creativity.

These four keys are also immediately implementable. They do not require additional time, money, authority, staffing, or a change in context. These are all suggestions that can be applied in all types of situations, from the second that the course is over to many years down the road as principles to guide life-long development.

Yes, the principles are easy to understand and harder to apply. Is it possible to teach these principles in 5 min? Yes. However, it takes considerably longer to help people move from cognitive understanding to habitual practice. This is the challenge on which the authors and the field in general are still working.

Note

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Cross-References

▶ Brainstorming and Invention
▶ Business Creativity
▶ Convergent Versus Divergent Thinking
▶ Corporate Creativity
▶ Creative Collaboration
▶ Creative Leadership
▶ Creative Problem Solving
▶ Creativity Techniques
▶ Divergent Thinking
▶ Divergent Versus Convergent Thinking
▶ Ideas and Ideation
▶ Imagination
▶ Research on Creativity
▶ Strategic Thinking and Creative Invention
▶ Thinking Skills, Development

References

Crick F. (1995). The impact of Linus Pauling on molecular biology. Retrieved April 8, 2008, from the website: http://oregonstate.edu/dept/Special_Collections/subpages/ahp/1995symposium/crick.html.

Eckert R, Vehar J. More lightning, less thunder: How to energize innovation teams. 3rd ed. Paul Smiths: New & Improved; 2007.

Firestien RL. Effects of creative problem solving on communication behaviors in small groups. Small Group Res. 1990;21(4):507–21.

Firestien RL. Leading on the creative edge: gaining competitive advantage through the power of creative problem solving. Colorado Springs: Pinon; 1996.

Firestien RL, McCowan RJ. Creative problem solving and communication behaviors in small groups. Creativ Res J. 1988;1:106–14.

Frankl VE. Man's search for meaning. 3rd ed. New York: Simon & Schuster; 1984.

Keller-Mathers S. Impact of creative problem solving training on participants' personal and professional lives: a replication and extension. Unpublished Masters Project, Center for Studies in Creativity, State University College at Buffalo, Buffalo, NY; 1990.

Kirkpatrick DL. Evaluation of training. In: Craig RL, Bittel LR, editors. Training and development handbook. New York: McGraw-Hill; 1967. p. 87–112.

Miller BJ. The use of outdoor-based training initiatives to enhance the understanding of creative problem solving. Unpublished Masters Project, Center for Studies in Creativity, State University College at Buffalo, Buffalo, NY; 1992.

Miller BJ, Vehar JR, Firestien RF. Creativity unbound: an introduction to creative process. 4th ed. Evanston: THinc Communications; 2004.

Neilson L. Impact of creative problem solving training: an in-depth evaluation of a six-day course in creative problem solving. Unpublished Masters Project, Center for Studies in Creativity, State University College at Buffalo, Buffalo, NY; 1990.

Osborn AF. Your creative power: How to use imagination. New York: Charles Scribner's Sons; 1948.

Osborn AF. Applied imagination: principles and procedures of creative problem solving. 3rd ed. Buffalo: Creative Education Foundation; 1993.
Parnes SJ. The magic of your mind. Buffalo: Creative Education Foundation; 1981.
Parnes SJ. Visionizing. Buffalo: Creative Education Foundation; 1992.
Puccio GJ, Firestien RL, Coyle C, Masucci C. A review of the effectiveness of creative problem solving training: a focus on workplace issues. Creativ Innovat Manag. 2006;15:19–33.
Reid DG. Facilitating creative problem solving: a study of impact and needs an internship experience. Unpublished masters project, State University of New York College at Buffalo; Center for Studies in Creativity, Buffalo, NY; 1997.
Retrieved April 8, 2008 http://www.gassner.co.il/pareto/
Schoen R. Winning the race to market: a case for creativity coaching. Unpublished manuscript. Evanston: THinc. Communications; 2000.
Synectics. Innovative teamwork program: course workbook. Cambridge, MA: Synectics; 1979.
Vehar JR. An impact study to improve a five-day course in facilitating creative problem solving. Unpublished Masters Project, Center for Studies in Creativity, State University College at Buffalo, Buffalo, NY; 1994.
Vehar JR, Doebler C, Eckert RP. Innovation training as profit center? Yes! A 750 % return on investment. Unpublished manuscript; available at: http://www.newandimproved.com/roi/ (2000). Accessed October 8, 2012.

Creativity

▶ Analogies and Analogical Reasoning in Invention
▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Creative Styles
▶ Creativity, Experiential Theories
▶ Creativity Training in Design Education
▶ Experiential Learning and Creativity in Entrepreneurship
▶ Gender and Innovation
▶ In Search of Cognitive Foundations of Creativity
▶ Innovation System of India
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Invention and Modification of New Tool-Use Behavior
▶ Interaction, Simulation, and Invention
▶ Systems Theory and Innovation

Creativity Across Cultures

Igor N. Dubina[1] and Suzanna J. Ramos[2]
[1]Economic Information Systems, Altai State University, Barnaul, Russia
[2]Department of Educational Psychology, College of Education & Human Development, Texas A&M University, College Station, TX, USA

Synonyms

Cross-cultural creativity

Creativity and Culture: A Preamble

Creativity is a multifaceted phenomenon. This phenomenon can be illustrated by diverse research studies in the field of creativity. One view is that creativity is an attribute of individuals (e.g., Davis 1989). Other studies include the analysis of creative production (e.g., Besemer and Treffinger 1981) as well as creativity as a cognitive process (e.g., Ward et al. 1999). Apart from the people, product, and process, creativity is also understood within a social context (Mayer 1999). This suggests that the concept of creativity is inextricably linked with the social, cultural, and historical milieu.

One controversy in the creativity literature concerns whether the concept of creativity has a universal meaning or is perceived differently in various cultures. For example, some researchers believe that there is a universal understanding of the concept of creativity while another group suggests that people in different cultures perceive creativity differently.

There seems to be a major breakthrough where theories of creativity have been established based on the latter point of view. Although the fundamental idea of creativeness seems to be deeply rooted in all cultures, definitions and attributes of creativity, the level of creative activity, and the domains in which creativity is promoted, vary across cultures. Culture plays a fundamental role in defining creativity. Creativity is not only influenced by organizational factors (i.e., organizational culture) but also greatly depends on the surrounding (societal) culture as a whole (Weiner 2000).

Arieti (1976) was one of the first to suggest that potentially creative persons and creativogenic cultures are essential facets of creativity. He introduced the term "creativogenic society" to describe a type of society that enhances creativity. These sociocultural factors are (1) availability of cultural means (i.e., an elite that has access to materials, equipment, etc.); (2) openness to cultural stimuli (cultural stimuli are not only present, but requested, desired, or made available); (3) stress on becoming and not simply on being; (4) free access to cultural media; (5) freedom (or even retention of moderate discrimination after severe oppression); (6) exposure to different and contrasting cultural stimuli; (7) tolerance for and interest in differing views; (8) interaction of significant persons; and (9) promotion of incentives and awards.

The Dichotomy of "the West" and "the East"

From the literature, the dichotomy of "the West" and "the East" is one of the most popular approaches in the characterization (at a surface level) of differences in understanding and defining creativity. However, it is not obvious what these terms exactly mean and these terms are sometimes used rather stereotypically. The term "East" usually refers to East Asian countries like China and other countries influenced by its culture like Japan or Korea. Most published works on cross-cultural studies involve this group. Some researchers include in this group another Asian country that is not East Asian, and that is India. These mentioned countries possess general similarities in terms of the social and cultural aspects distinct from "Western" countries. One of these similarities is the tradition that traces its origin from Asian thought like Buddhism, Confucianism, Taoism, and Hinduism. The term "Western," although can be used broadly, usually refers to the USA, Canada, Western Europe, Australia, and New Zealand (Weiner 2000). This conception has a long association with ancient Greece and the ideas of Judaism, Christianity, capitalism, and rationality (Weiner 2000). In the next sections, the "Western" and "Eastern" views on creativity are outlined as described in the literature.

Differences in the Understanding and Definitions of Creativity and Inventiveness

In the 1960s and 1970s, the conceptual 4-P model of creativity ("person," "process," "product," "press") was suggested and developed (Rhodes 1961). However, all of these four aspects of creativity actually accent, as the most important feature of this phenomenon, the link to an observable product, which can be assessed by an appropriate group or judges, either peers or experts. For example, when creativity is considered in the "person" perspective, it is defined as the ability to produce work (*object* or *product*) that is novel and appropriate (useful, applicable, etc.). If creativity is considered in the "process" perspective, the corresponding definitions also refer to a product in the end.

The product-centered conception of creativity prevails in "the West." This conception fits with the "Western" perspective on cosmic creation (Lubart and Georgsdottir 2004; Raina 1999), which involves a linear movement toward a new point and the assessment of what was created: God created *something* and God saw that what was created thing was good. Thus, the "Western" conception of creativity stems from Judaic and Greek views of producing the universe by an uncreated being who brings order to the formless void (Raina 1999).

Creativity as it is understood in "the West" is rather a state of doing, not a state of being. During the last decades, creativity is considered to be a normal ability which is inherent to all normally functioning people. It is an essential life skill which includes specific cognitive, meta-cognitive, and affective skills. Creative skills can be taught and enhanced through training and can be measured, in at least to some degree. Undoubtedly, creativity is considered one of the most important and principal "Western" values of an enriched life.

In “the East,” a product-centered creativity is less valued than a process-centered creativity (Raina 1999). The typical “Eastern” conception of creativity is more focused on the process than on the result. Creativity is a personal state of being rather than an output, a connection to a primordial realm, or the expression of the inner essence of ultimate reality. Creativity is attributed less to personal factors but rather to spiritual or social forces. Such an understanding of creativity was also proper for ancient Greece (for instance, “mania” or “enthusiasm” in Plato’s sense) and, partially, for Medieval Europe but was suspended with more individualistic conceptions during the Renaissance.

In contrast to “the West,” tradition is not the antithesis of creativity. “The Eastern” creativity may take the form of intellectual or aesthetic modification, adaptation, renovation, reinterpretation, revision, reconfiguration, etc., rather than a dramatic break with tradition. For example, in “the East,” artists fully respect the traditions in striving to establish their own styles, and their creativity is expressed in a form of reinterpretation of the past (Leung et al. 2004). This conception of creativity fits with the “Eastern” view on cosmological process, which is characterized as an ongoing, developing, or unfolding process.

The dramatically different (although some exaggerated) visions of creativity in two poles, “West” and “East,” have attracted the attention of many scholars who explain them by referring to some philosophical fundamentals of “Western” and “Eastern” cultures. Comparing American and Japanese approaches to creativity, Herbig and Jacobs (1996) connect these differences with a historical and geographical context. The “Western” view of creativity refers to the generation of new or novel ideas as a result of the competitive spirit driven by a long history of rival empires in “the West.” Anything new, an idea, product, or technique, that provided a kingdom an advantage over a neighboring rival was rewarded and recognized. On the other hand, Japanese innovation refers to the application and refinement of an idea. By not having nearby rivals, cooperation, not competition, was espoused in Japan. Cooperation and conformity were crucial components to ensure the survival of Japanese society.

Philosophical, Religious, and Ethical Fundamentals

One of the themes in the context of cross-cultural creativity is the comparison of Socratic and Confucian philosophical traditions and intellectual and moral paradigms. Kǒng Fūzǐ (Confucius is a Latinized variant of his name) and Socrates imparted practical wisdom for their followers and founded the traditions which have often been considered as a basis to understand the differences between the “East” and “West.”

“Western” thought is based on Socrates’ ideas that the sole function of knowledge is self-knowledge (individualistic cognitivism), and such knowledge is the basis for a person’s intellectual, ethical, and spiritual growth. Rationality, research exploration, cross-examination, public debate, and factual information are much valued (Herbig and Jacobs 1996). On the other hand, Confucius taught that the stability of society is based on unequal status relationships between people – the family is the prototype of all social organizations. A person is not primarily an individual but rather a member of a family. Children should learn to restrain themselves, to overcome their individuality, and to maintain harmony in a family and society. Values like trying to acquire skills and education, working hard, not spending more than necessary, as well as patience, perseverance, and persistence, closely fit this principle.

Another philosophical tradition, Zen Buddhism, is clearly imprinted in Japanese creativity and inventiveness. This philosophy does not place considerable value on rational thought. Instead, it emphasizes spiritual enlightenment and intuitive understanding. The emphasis on intuitive understanding partly explains Japan’s weakness in basic scientific research where logical reasoning and systematic thinking play important roles. As a result, Japan’s base of scientific knowledge and research methods has not been fully realized compared to the “West.” This has led to entirely different meanings of enlightenment and discover in the two cultures. "*Eurek*a (West) refers to the discovery of rational scientific principles while *satori* (East) means personal enlightenment" (Herbig and Jacobs 1996, p. 68).

Differences in Attributing Creativity and Inventiveness

In the context of what has been discussed so far, creativity in the "West" is associated with breaking or rejecting traditions; it is considered a discontinuous, revolutionary, relatively rapid, and insightful process. Creativity is based on and involves individual traits; it is expressive, emotional, and somewhat spontaneous. Creativity is often understood as creative thinking, which should be task and method focused. Creativity is contextually pragmatic in the area of problem solving, and it often tends to look outward toward "progress."

Creativity in the "East" is associated with respecting traditions and does not run contrary to them. It is considered to be a continuous, evolutionary, and slow process requiring much effort, hard work, repetition, attention, and a strong knowledge base. Creativity is based on and involves collective effort and a more structured, team-oriented approach. Creativity is understood to be socially utilitarian since the aspects of social influence on creativity are most important – creativity should help society, improve society, and contribute to society. For example, the Chinese prefer a more practical, utilitarian conception of creativity, and, as a consequence, politicians are considered the most common examples of creative individuals in China (Leung et al. 2004).

Differences in Valuing Creativity and Inventiveness

In addition to diverse understanding of creativity, cultures value various creativity aspects differently. Creativity characteristics as defined in "the West" are less valued and encouraged in "the East" and vice versa. The principal "Western" values related to creativity – individual freedom, less conformity, and self-reliance individuality – are rewarded and expected. As a result of cultivating such values, a "Western" individual attempts to be open, original, and innovative. "Western" societies are more likely to produce individuals who are oriented toward newness.

The principal "Eastern" values related to creativity are social order, cooperation, duty, and acceptance of an in-group authority like family, its norms and obligations; hard work and a strong knowledge base; consensus which is valued more than difference; fear of making mistakes and "losing face." As a result of cultivating such values, the tendency to delay creativity development can appear. However, the tendency of delayed creativity development and putting strong emphasis on knowledge and skills acquisition does not necessarily imply that creativity is not valued. "Eastern" societies are more likely to produce individuals who are oriented toward improvement.

Neither the cultures in the West nor the East are totally homogeneous in nature. Cultural influence can also differ between subgroups within the same culture. For example, Singapore, an Asian city, comprises three main ethnic groups – Chinese, Malays, and Indians. These groups, within an Eastern national culture, exhibit differing conceptions of what creativity entails (Ramos 2005).

Conclusions and Future Directions

Concluding this entry, the following are the key postulates and conclusions. No one model or approach to creativity may fit all cultures. Different cultures place emphasis on different aspects of creativity. The capability of a country to create and innovate is related to its culture. There are different culturally conditioned styles of creativity and innovation. However, the relationship between cultural values and creativity is complex as the impact of culture on creativity interplays with historical, political, and economic factors. Culture is important, but culture alone does not serve as a guarantee for a high level of creativity, inventiveness, and innovativeness. It is noted that most of the research in this field is speculative since there are not enough significant statistical bases for such types of studies thus far. A future research area would be to systematically examine culture, creativity, and inventiveness in their dynamics by empirically investigating the relationship between changes in values and changes in rates of inventiveness.

Cross-References

- ▶ Creativity and Confucianism
- ▶ Creativity Definitions, Approaches
- ▶ Creativity, Experiential Theories
- ▶ Creativity, Intelligence, and Culture
- ▶ Creativity: Cultural Capital in Mathematics
- ▶ Four Ps of Creativity
- ▶ Multiple Models of Creativity
- ▶ Nature of Creativity
- ▶ National Culture
- ▶ Research on Creativity

References

Arieti S. Creativity: the magic synthesis. New York: Basic Books; 1976.

Besemer SP, Treffinger DJ. Analysis of creative products: review and synthesis. J Creat Behav. 1981;15:158–78.

Davis JS. Testing for creative potential. Contemp Educ Psychol. 1989;14:257–74.

Herbig P, Jacobs L. Creative problem-solving styles in the USA and Japan. Int Mark Rev. 1996;13(2):63–71.

Leung K, Au A, Leung BWC. Creativity and innovation: east-west comparisons with an emphasis on Chinese societies. In: Lau S, Hui ANN, Ng GYC, editors. Creativity: when east meets west. Singapore: World Scientific; 2004. p. 113–35.

Lubart TI, Georgsdottir A. Creativity: developmental and cross-cultural issues. In: Lau S, Hui ANN, Ng GYC, editors. Creativity: when east meets west. Singapore: World Scientific; 2004. p. 23–54.

Mayer RE. Fifty years of creativity research. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 35–61.

Raina MK. Cross-cultural differences. In: Runco MA, Pritzker SR, editors. Encyclopedia of creativity, vol. 1. San Diego: Academic; 1999. p. 453–64.

Ramos SJ. Cross-cultural studies of implicit theories of creativity: a comparative analysis between the United States and the main ethnic groups in Singapore [unpublished master's thesis] Buffalo: State University of New York; 2005.

Rhodes M. An analysis of creativity. The Phi Delta Kappan. 1961;42(7):305–10.

Ward TB, Smith SM, Finke RA. Creative cognition. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 189–212.

Weiner RP. Creativity and beyond. Albany: State University of New York Press; 2000.

Creativity and Age

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Synonyms

Achievement and age; Achievement in life; Productivity and age; Productivity curve; Relationship between creativity and age

Creativity and Age

At present, no large-scale empirical studies exist that allow for fully supported conclusions on the relationship between age and creativity across the entire human life cycle. A further limitation on the ability to generalize about the relationship between age and creativity is the degree to which culture can influence an individual's creativity (Kim et al. 2011). Most explanations on the relationship between creativity and age have been based upon speculations from nonempirical studies or from studies with small sample sizes. The first major empirical study on creativity and age, Kim's "The Creativity Crisis" (2011), was based upon almost 300,000 scores on Torrance Tests of Creative Thinking (TTCT) administered to American kindergarten through 12th grade students and to adults between 1966 and 2008. Though Kim's study marks a breakthrough in empirically based studies, with important implications, major gaps remain in understanding the relationship between age and creativity.

After secondary schools, adults generally have enhanced cognitive capacity for certain mental functions that can contribute to creativity. However, adults generally experience diminished creativity in the late phases of the life cycle in passing through various adult stages of the life cycle. Individuals generally face pressures inhibiting development of their creative potential or practicing their creative skills. These pressures include (1) mastery of a convergent body of knowledge and skills for a vocation or profession and (2) affiliation with organizations (employers, religious institutions, civic institutions, etc.) that require some degree (in some cases, a high degree) of conformity. Eminent adults often manage to resist these pressures, and eminent adults are often creative well into advanced adulthood.

Creativity and for Children and Adolescents

Long-standing assertions on the relationship between changes in individuals' creativity and age are not consistent. Gardner (1982) argued that preschool children are highly creative. Upon entering school, however, as they learn conformity, their creativity usually declines. Their creativity starts increasing between grades 5 and 7 and continues throughout adulthood.

According to Piaget (1950), children think concretely, and only after grades 5 and 7 do they have the abstract thinking skills required for genuine creativity. By adolescence, according to Piaget, individuals can assimilate previous events and acquired knowledge with their own personal thoughts and feelings. Thus, their creative expressions increase between grades 7 and 12.

Smith and Carlsson (1983) explained that children lack the cognitive sophistication to be truly creative before grades 5 or 6. Before this age, children are dependent on accidental impressions and only the material that they have incorporated into their own private self. Thus, their creative activities are limited and inadvertent, that is, by chance. As their cognitive abilities cross a developmental threshold around grade 5, they experience high anxiety and creativity (grades 5 and 6), only then to experience, in grades 7 and 8, an increase in compulsive and compulsive-like strategies of adults and peers, which reduces creativity. Subsequently, in grade 9, adolescents' creativity slowly increases, as they learn to control anxiety better and learn to be more flexible (Smith and Carlsson 1985). By grade 11, children have generally acquired a high degree of social equilibrium. They can manage anxiety and confusion by balancing internal drives and external pressures. By this age, individuals have also developed strategies for flexibility, which also allows them to better manage anxiety. With anxiety better controlled, creativity increases.

Kim's study (2011) rested on an empirical basis, almost 300,000 TTCT scores. The TTCT measures fluency, elaboration, abstractness of titles, originality, and resistance to premature closure. The results of the study indicate that:

1. Fluency – the ability to produce many ideas. Children's fluency improves up to grade 3, plateaus between grades 4 and 5, and then decreases. This decline may indicate that at this age children are becoming aware that some ideas are socially inappropriate or that some of their ideas are inaccurate. They become more concerned about accuracy rather than aesthetic appeal. Decreases in creative thinking have some inverse relationship to preference for accuracy and evaluative thinking and for perceptions of social appropriateness.

   In the United States, many educators worry that current trends in student assessment that have emerged out of the standards movement and because of the federal legislation No Child Left Behind (NCLB) may be further decreasing students' fluency and, in general, their creativity. These assessments are almost entirely objective multiple-choice tests. To prepare students for these assessments, educational systems and teachers increasingly rely on similar types of tests, which provide no opportunities for fluency or other forms of creative expression. Moreover, one expectation of No Child Left Behind and parallel legislation in the various states is that schools show "adequate yearly progress" in test performance. To achieve continuous improvement in results, especially at schools with already strong test scores, schools and teachers are relying increasingly on convergent instruction solely to prepare students for tests. This instructional method likewise limits students' opportunities for creative expression.

2. Elaboration – the ability to think in a detailed and reflective manner.

   Children's ability to elaborate and their motivation to be creative increase steadily until high school, when it levels off and then decreases throughout adulthood. This pattern may indicate that children, rewarded for elaboration in schools, are willing to do so through their school years.

   After high school, rewards for elaboration decrease as do the motivation and, with time, the ability. This trend begins as individuals enter college or the workplace, where mastery of an established body of knowledge and skills becomes a priority in order to establish a stable life structure. An objective for many individuals becomes demonstration of competence, not creativity. Further, in the industrial era and continuing into the postindustrial era, a premium has existed on *efficiency*. Efficiency encourages economic growth by way of achieving economies of scale but inhibits elaboration, which can be perceived as an inefficient activity. Some thinkers have argued that the premium on efficiency has inhibited creativity and *effectiveness* (McDonough and Braungart 2002). Institutionally, in the name of efficiency and risk management, organizations frequently resist new and untested ideas (Baker et al. 1987).

   Resistance to elaboration may be true only for non-eminent adults and not for all adults. Eminent creative adults elaborate more with age. Simonton (1983) explained that early in their careers, eminent creative adults generate many ideas (fluency) but later elaborate on their ideas. Creative productivity increases with elaboration. Thus, for eminent creative adults, creative productivity and level of elaboration may not decrease with age (see the explanations below for eminent adult creators). For non-eminent adults, entering midlife transitions may signal a cognitive readiness for elaboration and other aspects of creativity, but the constraints of professional life may not permit such qualities to exhibit themselves (Beswinger 1987).

3. Abstractness of titles – ability to think abstractly, to synthesize and organize, and to capture the essence of the information.

   Individuals' ability in abstractness of titles increases through a lifetime, suggesting that individuals' skills and abilities for abstract thinking improve with age. Vygotsky (1990) also concluded that, with age, individuals' abstract thinking improves and that imagination and abstract thinking are integrated with each other throughout adulthood. This allows creative imagination to be transformed into creative products.

   For creativity to occur, generally someone must spend 10 years acquiring mastery before they can begin to be creative in their field. Once that mastery has been achieved, individuals can synthesize new information or imagine new possibilities. Nevertheless, working against this enhanced capacity for abstractness is a tendency for experts in specialized knowledge areas to resist concessions to (or even to combat with) experts in other areas of specialized knowledge. Even Machiavelli warned of the resistance to what is new in favor of what was tried and tested (Pavitt 2005). Thus, for individuals, an ability to think abstractly may increase with age, but "real world" contexts and constraints work against it.

4. Originality and resistance to premature closure – the ability to produce unique and unusual ideas and to have intellectual curiosity and open-mindedness. Children's' ability to be original and to resist premature closure increases up to grade 5, decreases through high school, and then increases in adulthood. Before grade 5, children are increasingly

open-minded and curious and tend to produce unique responses. After that, they trend toward conformist thinking, which lasts through high school, probably reflecting social pressure to conform in middle and high schools. At this stage, most children lose some ability to generate original ideas. This finding matches Kolberg's conventional thinking stage, the idea that adolescents feel and conform to the expectations of society and especially their peers. Many adults in the workplace participate in brainstorming activities. These activities are presumed to generate creative outcomes, though many studies have revealed weaknesses in brainstorming processes.

Creativity Slump for Children: The Sixth-Grade Slump

Torrance (1967) was the first to conclude that a child's creativity slumps in grade 4, which other studies corroborated and which has become known as the *fourth-grade slump*. Many studies have concluded that, in Western society, a large drop in creativity and curiosity occurs when socialization and conformity are initially taught, which begins in grade 4. Torrance blamed peer pressure and demands for conformity in the classroom. As a result, originality and creativity are discouraged. After grades 4 and 5, creativity scores reportedly increase.

The fourth-grade slump has also been reported not only in Western society. Torrance identified a fourth-grade slump in seven different cultures, though his results showed some variance in timing. In some cultures, the drop in creativity occurs at the end of grade 3 or the beginning of grade 4, whereas in other cultures a drop does not occur until grade 6. Further, some have disputed the fourth-grade slump. One study found a slight increase in creative thinking scores between grades 4 and 5. Another found a peak at grade 4. Another study found little change at grade 4.

Kim's "The Creativity Crisis" study (2011) found that creative thinking scores in individuals increases in general until grade 6, when it either remains static or decreases, suggesting a *sixth*-grade slump, rather than the well-known *fourth*-grade slump. In grade 6, individuals develop logical thinking and experience improved reasoning, which together might be associated with losing creative thinking. Piaget (1950) considered assimilation process in a spontaneity state as creative imagination, which does not decrease with age. However, as creative imagination is integrated into intelligence, due to the accommodation process, creative imagination may decrease.

Before grade 6, efforts should begin to preserve an individual's creativity, for which everyone has the potential from birth. The slump may originate from children's earlier experiences or lack of experiences. Childhood fantasies and play should be encouraged, as creative imagination develops from children's play. Play in grades 1 and 2 predicts creative thinking in grades 5 and 6. In addition, well before grade 6, children should reflect on the personality characteristics common to creative individuals. Children should be supported in their nonconformities and taught to embrace their idiosyncrasies. Students in grade 6 and beyond should have opportunities to exercise their creativity through choice, for example, choice of topics on academic projects. Originality, fluency, elaboration, abstract thinking, and open-mindedness should be taught instead of an exclusive focus on accuracy.

Creativity and Age for Eminent Adult Creators

In the United States, the relationship between creativity and age appears different for non-eminent adults from that of eminent adult creators in the world history (Simonton 1994). The creativity of eminent creators does not necessarily decrease, as it does for non-eminent adults. The productivity of eminent creators tends to begin in their 1920s, though it can vary depending on when the career began. In addition, career changes tend to rejuvenate eminent creators' creativity. Once the productivity starts, the productivity curve ascends quickly to an optimal near age 40. So, most creative products are generated in their 1930s. And then, after the optimum, the curve turns around and gradually descends. However, age of decline varies by domain. Research also shows that quantity is a function of quality. Thus, fluency is important for originality.

Historically, eminent political leaders peak in their career at later ages than other creators, though revolutionary leaders tend to be younger than diplomat leaders. Status quo politicians and leaders of established faiths last longer than revolutionary leaders, thus having more opportunities for creative achievement later in life. Additionally, poets tend to be younger than novelists.

Though about 80 % of most important creative contributions are completed by age 50, many eminent creators were productive late in life, sometimes well past their 1970s. Benjamin Franklin developed bifocal lens at age 78 and helped to frame the US Constitution at age 80. Goethe wrote *Faust* in his 1980s. Thomas Edison worked in his laboratory until he was 84. Titian painted his masterpieces at age 98. Henri Chevreul conducted gerontological research in his 1990s, and his last paper was written at age 103.

Conclusion and Future Directions

Kim's study shows a trend of decreasing creative thinking with age, especially the ability to produce many ideas, the ability to think in a detailed and reflective manner, and the motivation to be creative. Scholars differ about creativity among small children (roughly 7 years old or younger). After grades 5–7, cognitive capacity for abstract thought improves, thus strengthening certain capacities for improved creativity. In certain respects, creative capacity improves in high school, though students must learn how to balance needs for creativity and self-expression with social acceptance. In adulthood, despite improved cognitive abilities, most adults experience a flattening or decrease in creativity. This trend could stem from the limited rewards for creativity that many adults experience as they master their adult vocation or profession and because of various forms of institutional pressure for conformity. In later life, non-eminent adults experience a decrease in creativity. On the other hand, eminent individuals show creativity in later life and, in special cases, well into the final stages of life. In light of the central role of creativity in the contemporary global economy, countries experiencing decreases in creativity among its adulthood population could suffer economically.

References

Beswinger GL. Why corporations stifle creativity. In: Timpe AD, editor. Creativity. New York/Oxford: Facts on File Publications; 1987. p. 156–9.

Gardner H. Art, mind, and brain: a cognitive approach to creativity. New York: Basic Books; 1982.

Kim KH. The creativity crisis: the decrease in creative thinking scores on the torrance tests of creative thinking. Creat Res J. 2011;23:285–95.

Kim KH, Lee H, Chae K, Andersen L, Lawrence C. Creativity and confucianism among American and Korean educators. Creat Res J. 2011;23:357–71.

McDonough W, Braungart M. Cradle to cradle: rethinking the way we make things. New York: New Point Press; 2002.

Norman RB, et al. How management can influence the generation of ideas. In: Timpe AD, editor. Creativity. New York/Oxford: Facts on File Publications; 1987. p. 57–68.

Piaget J. The psychology of intelligence. New York: Harcourt Brace; 1950.

Simonton DK. Creative productivity and age: a mathematical model based on a two-step cognitive process. Dev Rev. 1983;3:97–111.

Simonton DK. Greatness: who makes history and why. New York: Guilford Press; 1994.

Smith GJW, Carlsson I. Creativity in early and middle school years. Int J Behav Dev. 1983;6:167–95.

Smith GJW, Carlsson I. Creativity in middle and late school years. Int J Behav Dev. 1985;8:329–43.

Torrance EP. Understanding the fourth grade slump in creative thinking. Final Report. Athens: The University of Georgia; 1967.

Vygotsky LS. Imagination and creativity in childhood. Sov Psychol. 1990;28:84–96.

Creativity and Behavior Problems

► Creative, or a Behavior Problem?

Creativity and Church

Hector Ramos
Department of Educational Psychology,
College of Education & Human Development,
Texas A&M University, Bryan, TX, USA

Synonyms

Ecclesia; Innovation

Creativity God's way is seen as an expression of His nature through His creation. Creativity without God is not meaningless as it still reflects Him since man was made in God's creative image. If man can achieve such high creative acts such as visiting the Moon, how much more will the Church be able to achieve as a coworker with God, the Moon's creator. However, the creative purpose of the Church may differ in its outcome to that of man. The Church's purpose has been established to restore a relationship with Him. God is furthermore interested in restoring all things to His purpose: A place of His peace and abundance, a place devoid of poverty, greed or sickness. This is because Creativity God's way and through the Church will always reflect His nature, His love, and His power and it is bound to surprise or *offend* us. A case in point is that Jesus Christ's death on the cross was God's creative act of salvation for mankind. Though God has shown Himself highly creative, the Church has not always followed suit. The main reason has been a misunderstanding of how God works through the Church. Instead we have worked with our efforts on His behalf. The creative result has been religion. From the religious perspective, the church is a building instead of a group of people called out by God to represent Him, His nature, and His power.

Definitions of Church and Creativity from a Biblical Perspective

From a biblical perspective, Creativity is first seen as God's activity in a vacuum. There is a creation stage where God speaks and whatever He wills happens. It is that will of God and His voice or Word which are at the origin of God's creativity. For instance, in Genesis, we hear Him speak "Let there be light" and something happens "there was light." In a survey of God's miracles and creative acts we can see them as a result of His word at the beginning. When those who hear that word obey what it says, creative acts happen: from Abraham's miracle son Isaac (Genesis 15) to Naaman's (2 Kings 5) miraculous healing dipping himself in the Jordan river seven times through the deliverance of the Canaanite's daughter (Matthew 15) or the centurion's servant (Matthew 8) by a word spoken by Jesus or a fig tree that withers it is always by a word that originates from God (Mark 11). At the center of God's creativity we see His Will carried out through the power of His Word. For instance, Psalm 36:6 indicates that by His Word God created the heavens and in Isaiah 45 He is established as the creator of the heavens and the Earth.

God's partnership with men is also seen by the creative power of His Word in man's mouth. In Genesis, Adam is instructed to name animals or declare their nature. In the same way that God spoke "Let there be light" God commissions Moses to speak a similar powerful word "Let My people go," which resulted in a miraculous deliverance. All through the Old Testament prophets speak words of restoration, judgment, healing and miracles as they are led by God to speak those creative words. In the New Testament we also find that apostles have received that creative power. In Acts 3, Peter and John speak a word of healing to a lame person who is begging. The say that they do not have money but that what they have (creative power to heal) they can give to him. God's Word of healing results in a miracle.

God's perspective on creativity as it relates to the Church is therefore not only unilateral but He seeks those who are willing by faith to engage them so that He can express His creative power through a Church that bears His Name.

The origins of the word church come from the word Ecclesia meaning the ones who have been called out. The Church is called out from a system ruled by the desires and motives of men and submits herself to the desires and motives of God acting under the same principles and dynamics that God has used before the Church started. The Church is then a foreign body in society: a group of creative people that emanate the nature and power of God. God shows repeatedly that it is by His power that we do His Will: the spiritual and physical battle that His church fights belongs to Him and He gives victory not by human wisdom but by His Spirit (Zechariah 4.6, 2 Chronicles 20). The Church is in itself a creative act by God who said "I will build my Church" (Matthew 16), a group of people that have received and continue to receive divine life by God to demonstrate Him on Earth. That is the creative purpose of the Church. Dedmon and Johnson (2012) provide a similar definition based on God's design when they state that "embracing our creative design *(originated at the heart of God)* gives us the freedom to supernaturally use that creativity to transform the lives of those around us".

Creativity and the Church: False Creativity and a False Church from a Biblical Perspective

History shows that as the church lost influence and relevance in society it was relegated to a building. Nowadays many people "go" to church, or belong to "a" church. They refer to a building or an organization. It may be the most impressive architectural feat of the century but that building, according to Scripture (Matthew 6), will never be the biblical church. Even though all that talent may be created or inspired by God, the building will never replace the biblical church: a group of born again (by His Word) believers that have faith in God, His power, and His way of creating. Those members of God's church have been born in Heaven. They belong to a different world and are strangers and pilgrims on Earth where they are agents of God's love and restoration. That is why they exhibit the creative characters and motivation of God. On the one hand it is God's love: the ability to love the destitute and the enemy. And on the other hand the ability to express God's power through God's creative acts: healings, deliverance, miracles, and wonders.

What is then the church's false creativity about? It is everything that has been achieved with man's motive and purpose, with man's ability, or for man's glory. A group of people that have invested large amounts of money for a wonderful building where they have programs in the name of a God they do not know personally. It is trying to please God with human efforts instead of the ability and power that He freely provides. The heart of the religious person is full of false creativity (from God's perspective): man wants to achieve great things for God: gather many people in one place, build big buildings, have big programs, communicate to millions of viewers over Christian TV. They have been deceived into believing that they are blessed as they equate blessings to material possessions. However, God is interested in a different creativity. He wants to anoint and empower human's talents and efforts so that men can do exploits. Exploits are creative acts that can only be explained accepting God's intervention.

The Church's Great Creative Challenge: Corporate Faith

How can the Church connect with the power of God to express His creativity?

Johnson (2006) suggests that the answer is desire according to Proverbs 13.12. He points out that "hope deferred makes the heart sick, but when the desire comes, it is a tree of life." These desires come from communion with God and His Word. Since this life must be His life, it will reveal His creativity. In the words of Jesus this is the lasting fruit that the Father provides and glorifies Him (John 15).

In His own wisdom He has refrained Himself from creating through the Church unless there is a faith on Earth that correspond to the word that comes from Heaven. Faith in this sense is the ability to receive the revelation of that creative word, trust in its power, and obey it to see its miraculous results. One of the Bible's main assumptions is that those who have faith can do exploits, for nothing is impossible for him who believes (Mark 9). The Church's challenge is to find and grow that faith to carry out God's creative will on Earth. For instance, God shows as His promises of His Word that there is no soul that God does not want to save (2 Peter 3) and no illness He does not want to heal (Isaiah 53). Therefore, the Church's ability to make a breakthrough in faith will bring a flood of God's creative acts on Earth to achieve that purpose. How can the Church access that faith?

1. If the Church positions Itself in a place of humility then It will have access to the revelation of His Word. This in itself needs an additional uncovering of truth: our present naked and destitute position: the fact that we can do absolutely nothing without Him of eternal value. Fasting and prayer should lead to true repentance and confession of a particular sin: doing a creative work on our own strength that requires no faith or power from God, a creative work that is greatly valued by men but despised by God. For instance, Abraham had an idea to answer God's promise by having a child with an Egyptian woman (Hagar) instead of Sarah, chosen by God. The name of the child Ishmael was not accepted by God as His answer to Abraham's desire. God's creative act was fulfilled in Abraham's and Sarah through a miracle baby Isaac. This process of humility is God's process of restoration (2 Chronicles 7) for healing as in Naaman's case (2 Kings 5).
2. Receiving revelation from the Word of God by the Holy Spirit. You can understand how God speaks by seeing how God has spoken through His Word. A basic perusal of the word reveals a common pattern: man's tendency to understand God within his own limitations and failings. For instance, a greedy mind-set as in Gehazi's example (2 Kings 5) cannot understand or accept the creative provision of God. Peter's warring nature leads him to cut a soldier's ear (John 18) working against the purpose of God to bring restoration through the sacrifice of Jesus on the cross. This is also called a carnal mind-set that always works against God. That is why in order to receive the creative revelation of God through the Church the humility of confession and repentance is needed. The Church may have assumed a level of holiness (accordance to God's Will and Ways) that is not real. However, God has a vision, a revelation, a plan for everybody, and for the Church as a whole that He wants to impart.
3. Obedience to the Word of God. If we understand what God has spoken to us we know what is our part in that creative process. God is looking for people who agree to what He is speaking by the way they think, the way they speak, and they way they act. This action could be something sensible or ridiculous, something that costs us nothing or everything. These actions are in God's creative acts a shaping of who we are. God calls Elisha through Elijah in 1 Kings 19. God wants to shape a prophet to fulfill a purpose: deal with the spiritual challenge of Jezebel in the nation. Elisha obeys in the following way: he sacrifices the oxen and farming tools saying to God "this is the end of my life as a farmer, I will follow you from now on." Elisha does not request from God to use a sword to put an end to Jezebel but lives step by step in obedience to God's creative power and finally sends Jehu to speak a word that brings to an end that oppressive regime.

These three points can be summarized as follows: our walk of humility allows God to show us the revelation of His will and pour His grace on us to obey whatever is required no matter the cost. This is God's strategy to make His creative acts known in the Church and through the Church.

Conclusion and Future Directions

The Future of Creativity in the Church: The Prophetic and Apostolic Challenge

The Church will continue to create and prosper: it is God's creative design. However, this will take two different shapes:

(a) A church will continue to grow that exalts everything that impresses man: greater buildings, greater numbers of people, greater finances, greater popularity.

(b) Another Church will continue to emerge. A humble unknown group of people doing exploits where God is seen everywhere, full of God's power that transforms mind-sets and therefore media, art, business, education, and the way society works. This is a Church that will be the channel of God's blessing and where people can receive a revelation of His Nature.

There is no systematic study of God's creative work through the Church. A basic and complicated obstacle is that a Godless church has already achieved many creative works that have impressed men. It is incumbent on the members of the Church to study and document God's creative acts in society that go beyond personal healing, deliverance, and provision to societal value change that is willing to lay down a human value system for God's purposes and ways.

Cross-References

► Church and Entrepreneurship

References

American King James Bible.
Dedmon T, Johnson B. Born to create: stepping into your supernatural destiny. Shippensburg: Destiny Image; 2012.
Johnson B. Dreaming with god. Shippensburg: Destiny Image; 2006.

Creativity and Confucianism

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Synonyms

Culture; Rote learning; Values

Creativity and Confucianism

Confucianism – the ideas of the teachings of Confucius (551–479 B.C.) – prescribes the practical ethics of daily life without religious considerations. Confucianism is the major cultural influence in Asian societies including China, Japan, Hong Kong, Korea, Singapore, Taiwan, and Vietnam. Confucian cultural tradition and values have served as the ethical and moral foundation for East Asian thinking, permeating every interaction, from business to social to family. Confucian values contrast sharply with Western values, which encourage individuality, individual achievement, and various means of standing out, such as displaying creativity. Confucianism, with its emphasis on rote learning, hierarchy, and inequality, has traditionally dampened creativity. Though various forces have worked to diminish Confucianism's impact in recent years (Kim and Pierce 2012), considerable differences in conceptions of creativity have traditionally existed, and continue, between East and West.

Creativity and Different Cultures

Many factors influence individuals' creativity. While some factors are unique to an individual, most have a relationship with social factors, for example, environment and culture. Creativity is more a function of cultural and social phenomena than of individuals' mental process: it is the product of the social systems that judge the product

(Csikszentmihalyi 1999). Creativity does not exist in the same form across cultures because creativity is understood differently and associated with other cultural values in different cultures. The culture, including the economic, political, social, and cultural climates, has a significant effect on contributions and evaluations of creativity. The extent to which an individual or a product is judged as creative is influenced by where the individual or the product originates, and thus, culture has a critical impact on judgments of creative individuals or creative products. Individuals from different cultures use different psychological processes when they engage in creative endeavors because of their concepts of creativity. Language may influence the development of creativity, and culture either encourages or discourages creativity (Sternberg and Lubart 1996). Thus, a focus on enhancement of an individual's creative attitude and creative thinking may be insufficient to enhance creative productivity when the individual's cultural setting does not foster creative expression and growth (Kim and Pierce 2012).

Confucianism

The principles of Confucian teaching can be summarized as emphasizing education, family system, hierarchical relationships, and benevolence (Chen and Chung 1994). In Confucianism, the purpose of education is to help people develop ideal personalities. A Confucian gentleman consciously cultivates, practices, and displays his virtues, and never flaunts individuality. The holistic and idealistic model of a human being is a well-rounded person with a perfect personality who makes a positive contribution to society (Cheng 1998). These characteristics are manifested in the citizenry through the education system, where uniform virtues with regard to each individual's role in life are instilled. Like pieces in a puzzle, individuals must fit seamlessly together to assemble the Confucian society, and if any of the pieces is misshapen, it does not fit.

The first principle of Confucianism is its emphasis on education. This principle is evident throughout Confucian societies. Confucian-influenced societies are characterized by a high degree of cooperation between teachers and parents, and parents place special emphasis on education in early childhood, engage students in learning, and support schools (Henderson et al. 1999). Positive influences from Confucianism are high motivation to acquire an excellent education, including a motivation, an expectation, and even a responsibility to obtain higher degrees and diplomas when possible (Martinsons and Martinsons 1996). In the past several decades, Confucian societies have enjoyed strong economic growth because of their educated workforce. However, Confucianism emphasizes learning in a mechanical way without thought or meaning, somewhat like a parrot which learns to mimic speech, and this emphasis has evolved to the extent that students in Confucian cultures are considered to lack abstract thinking abilities, originality, and creativity (Chan 1999).

In the West, education has historically celebrated individuality, self-expression, and capitalist values. These values are represented in various educational philosophies that prevail in the West. For example, "inquiry-based learning" seeks to awaken ideas within students and avoids inculcating established truths: it encourages divergent thinking. Teachers practicing inquiry-based learning in their classrooms need to be open-minded, tolerant, and intellectually non-authoritarian. These teachers act as experienced co-learners, rather than as authorities with the "correct" answers. This type of teaching environment would not work in a Confucian education system because Confucian societies have historically been based on examination systems where the goal of schooling is to prepare students to pass examinations. However, this narrow reliance on standardized testing for educational assessment forces schools to emphasize rote learning and memorization; it encourages convergent thinking. Traditionally in the West, many students reject the value of standardized testing and scholastics and seek instead to develop other characteristics and abilities, such as their artistic abilities, interpersonal skills, senses of humor, and abilities to get along with many types of people. These skills traditionally lead to success in the West, where employers share these same values and have historically rewarded original and useful thinking. In contrast, Confucian employers have historically punished individuality, and original and useful thinking. Exhibiting traditionally Western characteristics in a Confucian society may lead to social ostracism, pillory, and ineffective efforts to succeed.

The second principle of Confucianism is the family system. Confucian teachings consider Confucian society itself as a large family, in which the father comes first and the eldest son comes second. The unquestioned obedience of the son to the authority of the father is essential (Fah 2002). Confucianism is a social bond that fixes family members in the network and roles of their hierarchical relationships. Furthermore, Confucian concepts of filial piety, obedience, and loyalty practiced in the family are transferred to social organizations, where customs of disciplined subordination and acceptance of authority are cultivated. The concept of filial piety has no comparable concept in non-Confucian cultures. Filial piety is not only the supreme principle of Confucian life, but it is also the most essential value to East Asians (Hwang 1999). According to filial piety, obedience to parents is so important that a son cannot even stop his parents from doing wrong (Fah 2002). East Asian parenting practices are very restrictive in what is acceptable behavior, and children must accept all advice and demands from parents without question. The Confucian hierarchy also inflicts upon its subjects a rigid system of inequitable obligations, thus hindering human potential. Confucianism dictates an inequitable status for women especially, which forces them into submissive roles as servants to their husbands' families. Confucianism states that all women are to be obedient: a woman is to be obedient to her parents in childhood, to her husband and his family in marriage, and to her oldest son in old age Chung 1994).

The third principle of Confucianism is that of hierarchical relationships. Confucius philosophized that all relationships are between people of unequal power. He described five basic relationships: ruler/subject, father/son, husband/wife, older brother/younger brother, and between friends. The parties to these relationships are presumed to be both unequal in status and complementary, in that neither can exist without the other (Hwang 1999). In the rigid hierarchical society of Confucianism, age is a mark of personal prestige and social authority. One positive aspect of the hierarchical code is the respectful treatment accorded to elders. As a result, the older generation can exercise discipline and control over the young.

The last principle of Confucianism is benevolence. Benevolence includes self-discipline, brotherly love to elders, loyalty, personal duty, and positive interpersonal behaviors among society members (Chen and Chung 1994). Research shows that the principle of benevolence negatively influences creativity by suppressing emotion, minimizing verbal interaction, and imposing conformity. The principle of benevolence requires self-control of emotional expressions in all relationships. Even affectionate expression to loved ones is considered inappropriate and must be internalized to conform to collectivist ideals. This cultural value denies people natural freedoms of expression and individuality. Confucianism restricts verbal interactions, especially for males, and being a talkative man is considered to be inappropriate. A man's words hold more authority than women's, so restraint is taught to boys because talking too much diminishes the man's power.

Relationship Between Creativity and Confucianism

A review of the four principles of Confucianism demonstrates the ways they conflict with creativity. The first principle of Confucianism is its emphasis on education, which inhibits creativity through rote learning and extreme competition. The second principle of Confucianism is the family system, which blocks creativity through rigid parent–child relationships, an overemphasis on obedience, filial piety, and loyalty, and strict gender role expectations. The third principle of Confucianism is the hierarchical relationships, which decrease creativity through unequal relationships, rigid social structure, gender role expectations, and authoritarian relationship between teachers and students. The last principle of Confucianism is benevolence, which stifles creativity through suppression of emotion, the silence ethic, an extreme value of humility, conformity, and stigmatized eccentricity.

In Western societies, liberal moral-political values emphasize individual rights and self-determination, but Confucianism in East Asia emphasizes collective good and harmony, along with self-cultivation and self-regulation. In Eastern societies, the welfare of the group is seen as inseparable from that of the individual, but Western societies emphasize the rights of the individual, even at the expense of the group. In Eastern societies, adherence to group interests for the sake of achieving harmony is often justified at the expense of individual interests (Chung 1994). Students seek to avoid appearing different from others, individuals learn to restrain themselves in order to maintain group harmony, and the fear of making a mistake or embarrassment keeps many students silent. These expectations are related to their propensity for compromise and conflict avoidance (Martinsons and Martinsons 1996).

Western culture is based on the ideals of individuality, democracy, and freedom, whereas Eastern culture is based on the ideals of collectivity, interdependence, conformity, and authoritarianism (Rudowicz 2003). This difference is evident in many ways. When evaluating artistic expressions, Western culture tends to be flexible, reflecting values of individualism and the personal preferences of the artists or judges, but the standards of Eastern culture tend to be consistent, reflecting collectivism (Li 1997). These two cultures have developed different perspectives on the meaning of novelty and originality. Novelty and originality are valued more in Western culture, whereas appropriateness is valued more in Eastern culture (Rudowicz 2003).

This difference is especially evident in the long-term historical development of China. China is known as the "sleeping giant." It is home to one billion of the world's seven billion people. China could have exerted itself as a world force but has chosen not to do so even in its own geographical backyard, leaving smaller countries like the Koreas and Japan autonomous. The Chinese came to view unfamiliar people and new ideas with suspicion.

During much of the Common Era, the West had a remarkably less impressive cast about it. After the Roman Empire in the West collapsed, Europe became divided into a number of competing polities, a situation that has sometimes been referred to as a long civil war. The economy weakened, as did the use of advanced Roman technologies. Even education – so prized in Confucian cultures – barely survived; the literate tradition was maintained only by a small group, mostly monks, who preserved Roman and Greek culture by copying the few remaining Ancient texts.

In the long run, however, the West has been a greater commercial success than the East. Because the West was fragmented politically political with multiple poles of power (Emperor and Pope, Kings, high-ranking nobility, independent cities, and comparatively independent universities), Westerners had a far more open disposition to new ideas. Each competing power was searching for a way to excel, which had a transformative impact on society. This transformation received the social and economic impetus for a breakthrough with the Black Death (1347–1349), which set Europe off on a path of autocatalytic change, innovation, and creativity. This autocatalytic process of change allowed the West to surge ahead of China. By 1800, Westerners were breaking new boundaries of human achievement when many Chinese officials were insisting that access to status and power in China be based upon knowledge of the Confucian classics. The Chinese could not compete with this transformative Western society, and the Chinese Confucian imperial regime eventually collapsed.

Today, the relationship between Confucianism and creativity remains strained. On the one hand, because of traditional Confucian values, the Chinese and Asians generally demonstrate remarkable qualities related to achievement, especially a high regard for education and a strong work ethic. This positions students from Confucian societies to have mastery, which is required for the creative to bear fruit. On the other hand, because of traditional Confucian values, Chinese and Asian students show many of the traditional qualities that constrained creativity: passivity, silence, and conservatism. In light of the highly competitive economic world today that has resulted from globalization, it is uncertain whether China will break out from its Confucian past to harness the amazing human and intellectual capital it possesses, or will the Chinese return, following decades of Communism, to its Confucian values. Time will tell.

Confucianism and Invention and Innovation

Ancient Chinese society was known for its advanced inventions, including fireworks and paper. Later, because Confucian society did not value creative production, few people, if any, were encouraged to be creative. According to Confucianism, education is a much more important quality for a leader to have than technical competence or professional expertise. In this sense, education itself is an essential component of the virtues (Chan 1999). Confucian education valued mostly abstract values from the classics as something to be memorized instead of developed. In addition, the Confucian educational philosophy prioritizes the teaching of ethics. School curriculum in East Asia still places great importance on subjects related to ethics, offering and emphasizing classes such as ethics and manners (Chen and Chung 1994) which, again, are memorized not explored or debated.

However, given the changing needs of today's organizations and the growing demand for flexibility in dynamic work environments, creative problem solving and decision making are more important than loyalty and obedience, which are emphasized by Confucianism. Overemphasis on following rules and traditions at work creates organizational barriers to creative innovation. Creative potential can be realized in work situations where employees can influence decision making and communicate new ideas.

Despite the cultural weight against innovation and creativity in Chinese-influenced societies, Confucian countries face an opportune moment. Creativity in the United States, the major engine of creativity and innovation in West in the last 100 years (Kim and Pierce 2012), is demonstrably in decline (Kim 2011). Chinese-influenced societies may now have the incentive to make cultural adjustments that foster creativity.

Conclusion and Future Direction

Confucianism, which supports a constellation of values and ideas based upon the writings of Confucius, has had a strong influence on the culture of Asian societies, including China, Japan, Hong Kong, Korea, Singapore, Taiwan, and Vietnam. Confucianism fosters a set of hierarchical values that generally diminishes creativity. Its emphasis on education, for example, has created a culture that cherishes education, but a type of education that reinforces hierarchy and traditional values. In this system, creativity has virtually no place. This cultural setting contrasts sharply with the West, where individuality, self-expression, and capitalist values are nurtured, even celebrated. These values partially explain how the West became so technologically advanced in the early modern and modern eras. Mainly as a result of its Confucian culture, the East has discouraged creativity and change. Today, in the global economy, in which Confucian countries are important participants, pressure exists for them to become more flexible and to foster a greater spirit of innovation; it must if it is to remain a force in the world economy. Time will tell whether that transformation occurs and, if it does, how it will happen. Confucian countries possess much strength because of their cultural influences.

If they can retain those strengths and become more flexible and foster creativity, the great potential of Confucian countries could be fully realized.

Cross-References

- ▶ Divergent Versus Convergent Thinking
- ▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
- ▶ Techno-Globalization and Innovation

References

Chan S. The Chinese learner – a question of style. Educ Train. 1999;41(6/7):294–304.

Chen G-M, Chung J. The impact of Confucianism on organizational communication. Commun Q. 1994;42(2):93–105.

Cheng KM. Can educational values be borrowed? Look into cultural differences. Peabody J Educ. 1998;73:11–30.

Csikszentmihalyi M. Implications of a systems perspective for the study of creativity. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 313–35.

Fah YC. The spirituality of Chinese social obligations. Transformation. 2002;19(1):34–6.

Henderson BB, Marx MH, Kim YC. Academic interests and perceived competence in American, Japanese and Korean children. J Cross-Cult Psychol. 1999;30(1):32–50.

Hwang K-K. Filial piety and loyalty: two types of social identification in Confucianism. Asian J Soc Psychol. 1999;2(1):163–83.

Kim KH. The creativity crisis: the decrease in creative thinking scores on the Torrance Tests of Creative Thinking. Creat Res J. 2011;23(4):1–11.

Kim KH, Pierce RA. Torrance's innovator meter and the decline of creativity in America. In: Shayinina LV, editor. The international handbook of innovation education. London: Taylor & Francis/Routledge. In press 2012.

Li J. Creativity in horizontal and vertical domains. Creat Res J. 1997;10:107–32.

Martinsons MG, Martinsons AB. Conquering cultural constraints to cultivate Chinese management creativity and innovation. J Manag Dev. 1996;15(9):18–35.

Rudowicz E. Creativity and culture: a two way interaction. Scand J Educ Res. 2003;47:273–90.

Sternberg RJ, Lubart TI. Investing in creativity. Am Psychol. 1996;51:677–88.

Creativity and Emotion

Carol R. Aldous
School of Education, Flinders University, Adelaide, SA, Australia

Synonyms

Affect; Feeling; Mood; Novelty

Key Concepts and Definition of Terms

While the field of study concerning the relationship between *creativity* and *emotion* is comparatively small, the fields of *creativity* and *emotion* as distinct areas of research are vast. Each area is replete with theory abounding in differing perspectives and orientation. Consequently, the number of definitions for each term is large, many of which may only be deeply understood in the light of theoretical orientation from which the definition is derived. This is particularly the case for the term emotion, whose definitional efforts have historically been elusive, despite its frequency of use.

For the purposes of shared understanding and this entry however, the terms *creativity* and *emotion* are defined as follows:-

The term *creativity* is derived from the Latin *creatus* "to make or produce" and in more recent canon is defined as "the production of effective novelty." It is used in scholarly writing of psychology in much the same way as in popular writing but with some refinement. The word "production" implies that some act or action is required. Thus, within the cognitive orientation, the act of creation or the "creative process" is studied. However, within other orientations such as the personality perspective of individual differences, the "creative person" is studied, while within the psychosocial perspective, the press of the environment or the "creative environment" is studied and within the psychometric perspective, the "creative product" is studied. Central to each orientation is the assumption that the novelty produced is both useful and meaningful and that its operation lies within the moral domain. Thus, for example, the creation of a new method in mathematics is considered useful, and the creation of an artistic work is meaningful.

The term *emotion* is derived from the Latin *emovere* "to move, to excite, to stir up, or to agitate" and is often used to describe any of a number of subjectively experienced affect states. In this sense, the term emotion in scholarly writing is used in much the same way as that in popular writing. However, in everyday language, emotions are often equated with feeling, whereas in psychological literature, emotions are considered to encompass much more than feeling. While not all feeling originates in emotion, all emotions generate feeling. Emotions are acute, relatively short-lived affective episodes that are accompanied by high levels of arousal and momentary desires to act. They arise in response to information perceived in both the internal and external environments of the body. The emotions of happiness, sadness, fear, disgust, surprise, and anger are said to be "universal," "primary," or "basic" since these emotions are evidenced in infants soon after birth and have been observed by anthropologists among people in remote cultures. Other emotions, such as those of shame and embarrassment which involve breaking a social or moral code, are considered to be culturally determined and are therefore called "social," "self-conscious," or "secondary" emotions. Needless to say, emotions are complex, multifaceted phenomena characterized (but not exhaustively so) by subjective experience (e.g., feeling), expressive reactions (e.g., smiling, frowning), physiological reactions (e.g., increased heart rate, flushed face, perspiring hands), responsive behaviors (e.g., fleeing, fighting, laughing), and various kinds of cognition (e.g., altered attention and thought) (Cornelius 1996).

Given the complex multifaceted nature of emotion, it is not uncommon to find disagreement arising among proponents concerning the relative importance of a given aspect. Taking the aspect of subjective experience and "feeling" as a case in point, the relative importance ranges from "not at all important" to "highly important," depending on perspective. This range of perspective reflects well the different theoretical orientations within the field of emotion. Among these are the Darwinian orientation that emphasizes the universal and adaptive function of emotions, the James-Lange orientation that focuses largely on the bodily responses, the cognitive orientation that investigates the cognitive processes of mental appraisal, and the social constructivist orientation that weighs the influence of social and environmental interactions. Considering the broad set of representations surrounding the concept of emotion, together with confusion created by its use in everyday language, the more expansive term "affect" is often times preferred.

Mapping the Four Ps of Creativity onto Emotion Research

There are some interesting relationships to be established when the four Ps of creativity (namely, person, product, process, and press of the environment) are over laid onto the field of emotion research. The Darwinian orientation which describes emotion as a trait of adaptive advantage is consistent with the person approach to creativity that seeks to identify trait characteristics of the creative personality. The James-Lange orientation that describes emotion as a bodily response (or outcome) is consistent with the product approach to creativity that frames creativity in terms of an original output or response. Not surprisingly, the terms "emotional expression," "emotional competency," and "emotional output" are found. In the cognitive tradition, emotion is framed in terms of cognitive processing which is consistent with the process approach to creativity that describes creativity as involving a set of cognitive processes that take time. Here emotion is presented as a so-called intelligence, and the terms "emotional intelligence" and "noncognitive capability" are found. Finally, the social construction approach to research in emotion may be likened to the press of the environment in studies of creativity. Within this orientation, terms such as "emotional capital" and "emotional stresses" are found highlighting the interaction that takes place between the individual and the social environment.

Further, recent technological development has allowed the advancement of other orientations particularly from within the fields of neuroscience, medicine, and brain imaging research. The hypothesized relationship of mirror neurons to social and emotional behavior is one such case.

Theoretical Background and Open-Ended Issues

Advances in understanding about the relationship between creativity and emotion have, by comparison with other fields of research, been relatively slow and the field itself comparatively new. The reasons for this are complex and require an understanding of the way in which creativity, thinking, and emotion have been framed throughout history. During the industrial age of the late eighteenth and nineteenth centuries, explanations of human functioning drew inspiration from analogies with power-driven machinery. Questions such as "what is the 'power' and what is the 'machine'?" were asked. Utilizing the notion of the instinctive *drive*, emotions were conceptualized as "power" and intelligence or reason as "machine." Thus, this mechanist conception meant that the emotionally actuated human, needed to be instrumented by reason. Indeed, in the decision-making arena, information obtained through reasoning, rather than feeling, was to be believed.

With the advent of the information age in the latter half of the twentieth century and on into the twenty-first century, and a burgeoning knowledge economy, the machine metaphor continued. This time, models of "information processing" developed, drawing as they did so on mental representations inspired by analogy with computer technology. Terms such as "brain power" and "processing speed" were used, and in more recent history, emotion is represented as "data" and "output."

Nevertheless, there have been many people in history who rejected the "mechanist" perspective and the separation of thinking from emotion. One such person was Graham Wallas (1926), who, working early last century, became well known for distinguishing four stages of control in the process of creative problem solving. These stages were preparation, incubation, illumination, and verification. However, what appears to be lesser known was that Wallas also described a substage called intimation associated with the stage of illumination. Intimation was defined as awareness, infused with affect, presenting itself in the form of a feeling or intuition that preceded and/or accompanied the "flash" of illumination. According to Wallas, if illumination were to be controlled, then intimation or feeling would need to be attended to. Just as an idea may call up an emotion, an emotion could call up an idea.

However, the semi-recognition of intimation as a mere substage within the creative process meant that its significance was over looked together with the affective dimension of creativity research. This begs the question "Is emotion (or affect) important to creativity?" and if so "How is emotion (or affect) involved in the creative process?"

Implications for Theory, Policy, and Practice

With the dropping of the atomic bomb and the unleashing of uncontrolled power in the mid last century, interest in the concept of creativity grew as nations, particularly in the west, competed for technological advantage in the ensuing cold war that followed. However, the association of emotion with power that arose out of the industrial age meant that research in the information age would target its more respectable cognitive aspects.

Using the "four P" approach as a framework, what follows is a brief overview of research pertaining to creativity and emotion. In some instances, emotion and feeling appear as the antecedents of creativity, in others as the mediators and accompaniments of creativity, while in still others as the products of creativity. The former representation predisposes the notion that emotion fuels cognition, the latter case that emotion is the product of cognition, while in the center case that emotion and cognition interact.

Affect and the Creative Person

Many of the initial studies into creativity attempted to identify the creative *person* through an analysis of personality traits. However, no single differentiated personality profile common to all highly creative people has been found capable of distinguishing them as a group from less creative people. Some personality traits identified are tolerance of ambiguity, perseverance, openness to new experiences, a preference for challenge and complexity, willingness to take risks, and courage of one's own conviction. In particular, the trait of "openness to new experience" was regarded as the strongest predictor of creativity (Feist 1999). Not only did the trait involve a willingness to try out and explore new ideas, it also predicated the qualities of aesthetic sensitivity and an awareness of one's own inner feelings.

Within the psychoanalytic tradition, the personality trait "openness to experience" is associated with preparedness to access emotion-laden thoughts and primary process thinking (Russ 1993). Primary process was conceived as being a primitive form of thinking that was heavily laden with affect, unconstrained by logic and largely unconscious. However, expression of primary process appears to be more conducive to males than females. Interestingly, access to affect-laden thoughts is related to divergent production and transformation abilities. Transformation ability involves the mental flexibility to break from old ways of thinking and to see new patterns and configurations (i.e., to break mental set). Affect-laden thinking, it is theorized, activates nodes in memory that assist in the search process enabling a wide range of associations to occur. In these representations, emotion and affect are seen as antecedents and accompaniments of creativity.

One emotional resonance model of creativity postulates the existence of endocepts, emotions attached to concepts or images in memory. These emotional memories play a role in generating creative metaphors by resonating endocepts initiating associations between attached images and concepts. Further, the presence of resonance detection thresholds influences whether a resonance-activated endocept or concept enters conscious working memory (Lubart and Getz 1997).

Another trait related to the expression of creativity and systems of affect particularly as it pertains to motivation is that of perseverance. Early historiometric work found that many eminent individuals such as Newton, Galileo, and Darwin were not only highly intelligent but also extremely perseverant. Central to the attribute of perseverance is the concept of intrinsic motivation. Intrinsic motivation is defined as the motivation arising from a personal desire to participate in an activity for its own sake, be it enjoyment, challenge, or interest. Amabile (1996) and her coworkers have done much to highlight the importance of this kind of motivation in the generation of creativity. Intrinsic motivation is accompanied by positive affect and the love of the task. Extrinsic motivation on the other hand is the motivation which arises within an individual from the desire to meet some external reward, be it a praise, prize, or fame. Early studies have found that individuals who perform a task for a reward were less creative than those who receive no reward or a reward that is not associated with the task. However, the findings of more recent studies have been mixed and may relate to the stage of the creative process at which the extrinsic motivators are applied. When interpreting the research literature however, due consideration needs to be given to the manner in which creativity is measured (e.g., whether by consensual assessment or by tests of divergent production), the type of participants under study, as well as the specificity of the domain in which the research is conducted.

Affect and the Creative Environment

Another line of research into the relationship between creativity and emotion has involved the investigation of various affect states induced by stimuli, both internal and external to the individual. In particular, the rapid expansion of business and industry into a global market place in the final decades of the twentieth century has generated a plethora of research seeking to optimize the creative *environment*. Many of these studies have involved the induction of positive or negative mood through the deployment of psychosocial and environmental factors. Specific affect states may be induced, for example, by involving participants in an enjoyable activity, watching a movie, or recounting happy or sad memories. In these experiments, emotion is seen as an antecedent to the creativity. Interestingly, in a study investigating creative problem solving, positive mood resulted in more creative solutions when compared with control groups (Isen et al. 1987). As with the previous discussion related to personality traits, positive affect was thought to cue positive memories and a large amount of cognitive and affective material resulting in a defocused state of attention. Consequently, the cueing of cognitive content enabled a wider range of associated ideas to occur.

Recent research in business organizations has also supported the view that creativity emerges from positive affect. Studies of induced positive mood lead to higher creativity, while studies of induced negative mood lead to lower creativity. When creative work contributed to a positive mood, a self-reinforcing cycle of creativity and positive affect was initiated. While the above description would at first glance appear relatively straight forward, a recent large-scale meta-analysis of mood-creativity research reveals (Baas et al. 2008) that the field is in fact highly complex. The interested reader is directed to that account.

Affect and the Creative Product

The field of affect and the creative *product* is perhaps best represented by those domains of activity in which the person and the creative product intersect. Actors, dancers, and mime artists, for example, are both simultaneously the creative person and the creative product. In the execution of their role, actors, for example, need to understand, interpret, and express emotion. Learning to act such that a smile is not forced but appears natural is not simple, as Ekman's research on emotion affirms. While some performers act the expression of an emotion, other performers will live the emotion in an authentic response of their craft. The capacity to emotionally engage an audience requires a great deal of energy and creativity. Thus, emotions may not only be mediators of the creative process but they may also be the product of the creative process. In this sense, emotions themselves are the *product*. Another example of emotions as creative product is to be found in individuals with the ability to manage emotion such that different emotions may be combined and expressed in unusual ways. To do so requires a great deal of improvisation and creativity.

Clearly, the expression of emotion as a creative product either through acting or through bodily movement would seem to contraindicate emotion and cognition operating as separate systems.

Affect and the Creative Process

Building on Wallas's classic four-stage model, there have been a number of *process* models of creativity. Some of these process models have expanded upon the number of stages given in the classic model, while others collapse them into broader categories preferring instead to describe a wider range of substages or processes. However, few of them address the affective dimension in the creative process. One model to have done so was that proposed by Shaw (1989) who, working with a group of scientists and engineers, mapped a set of affect states both positive and negative to a series of feedback loops arising between each phase of the classic model. A unipolar positive set of emotions (e.g., happy, euphoric) were identified at the illumination stage and again at the validation stage (e.g., elation) if the creative work received collective acceptance. However, a unipolar negative set of emotions (e.g., sadness, shame) were identified if the creative work were not. Further, a bipolar set of emotions ranging from the positive (e.g., excited) to negative (e.g., frustrated) were identified during the preparation and incubation phases with movement back and forth between these stages apparent. Shaw labeled cycling between preparation and incubation the Areti loop.

Another set of bipolar affect states ranging from positive (e.g., exuberant) to negative (e.g., burned out) were also identified between the elaboration and creative synthesis (i.e., outcome) stages. Shaw labeled cycling between elaboration and the outcome the communication loop. Many such loops operating simultaneously and successively were proposed to exist and whose occurrences are consistent with neural network models of the brain. Thus, emotion as represented in this model may be seen as both a mediator and accompaniment of creativity.

However, recent advances in neuroscience, on the role of feeling and emotion in human reasoning and consciousness, would seem to indicate that emotion is much more than a mediator and an accompaniment of creativity. Working with brain damaged patients, Damasio (1994) found individuals presenting with normal IQ, language ability and learning capacity, being unable to solve problems, due to impairment of the feeling function within the brain. Indeed feeling, it was found, was needed to successfully move through a decision-making space. Three kinds of feelings, notably feelings of basic universal emotions, feelings of subtle universal emotions as well as background feelings, were identified. These feelings arising from the complex interplay of the brain core (namely, hindbrain, mid brain, and limbic systems) and the cerebral cortex provide a window on the body's internal state justapositioned with information received about the external one. According to Damasio, emotion and cognition were inextricably linked and that feelings were essential to human survival and consciousness. The traditional mechanist perspective that feeling interfered with an individual's ability to solve problems failed to take cognizance of the fact that in the absence of feeling, an individual was unlikely to solve the problem at all.

At this point, it is perhaps useful to recall Wallas's view, propounded over 80 years ago, that better thinking meant attending to intimation and its associated affect. It is interesting, therefore, to note the finding of a much more recent large-scale study, which found that students who attended to a feeling approach to reasoning were more likely to be successful in solving a novel mathematics problem than those who did not (Aldous 2009).

Conclusion and Future Directions

Discussion in this entry began with the question "Is emotion (or affect) important to creativity?" This was followed with the question "How is emotion (or affect) involved in the creative process?" In light of the evidence presented above, the answer to the first question must surely be "yes." With respect to the second question, the answer may very well be "in almost every way." Emotion is not just an antecedent of creativity, nor is it merely a product of creativity, and it is certainly more than a mediator of creativity. Emotion and creativity are inextricably linked. Only now, in recent history, is the significance of the relationship between cognition, creativity, and affect being fully realized. Perhaps, a better question might be "Can creativity be studied without a study of emotion and affect?"

In his treatise the *Art of Thought*, Wallas (1926) understood the importance of providing a language for thought. More recently, Nobel laureate Daniel Kahneman (2011, p. 13) highlighted the need to "introduce a language for thinking and talking about the mind." With hind sight, it is possible to see how the language of emotion being associated with "power" and the language of mind being associated with "machine" have shaped the kinds of questions that have been asked and the sorts of decisions that have been made.

Kanheman won his Nobel Prize in 2002 for demonstrating the integrated nature of cognition and affect and for showing how the biases associated with system one (affect related) and the biases associated with system two (cognition related) have impacted human decision making particularly under uncertainty. For Wallas, intimation was the moment, to use Kahneman's language, when the interactions of system one and system two were about to reach consciousness.

Consequently, when arriving at an intimation concerning creativity and emotion, it behooves the researcher to check for biases, both affective and cognitive, be they important or not.

Cross-References

▶ Creative Brain
▶ Creative Personality
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
▶ In Search of Cognitive Foundations of Creativity

References

Aldous CR. The genesis of new ideas: models, feeling and solutions. In: Matthews B, Gibbons T, editors. The process of research in education: a festschrift in honour of John P. Keeves. Adelaide: Shannon Research Press; 2009. p. 338–66.

Amabile TM. Creativity in context: update to the social psychology of creativity. Boulder: Westview; 1996.

Baas M, Carslen KW, Nijstad BA. A meta-analysis of 25 years of mood-creativity research: hedonic tone. Activation or regulatory focus? Psychol Bull. 2008;134:779–806.

Cornelius RR. The science of emotion: research and tradition in the psychology of emotion. Upper Saddle River: Prentice Hall; 1996.

Damasio AR. Descartes' error: emotion reason and the human brain. London: Papermac; 1994.

Feist GF. The influence of personality on artistic and scientific creativity. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 273–96.

Isen A, Daubman K, Nowicki G. Positive affect facilitates creative problem solving. J Personal Soc Psychol. 1987;52:1122–31.

Kahneman D. Thinking fast and slow. Maryborough: Allen Lane; 2011.

Lubart TI, Getz I. Emotion, metaphor and the creative process. Creativity Res J. 1997;10(4):285–301.

Russ SW. Affect and creativity: the role of affect and play in the creative process. Hillsdale: Lawrence Erlbaum; 1993.

Shaw MP. The Eureka process: a structure of the creative experience in science and engineering. Creativity Res J. 1989;2:286–98.

Wallas G. The art of thought. London: Jonathan Cape; 1926.

Creativity and Environment

▶ Social Psychology of Creativity

Creativity and Innovation: What Is the Difference?

Jonathan Vehar
Center for Creative Leadership, Greensboro, NC, USA

Synonyms

Creative process; Creative thinking; Innovative thinking; Innovativeness; Invention

Introduction

Innovation is again the buzzword du jour (Kanter 2006). As such, many well-meaning practitioners use the words creative process, creativity, and innovation interchangeably, which sews the seeds of confusion and does not help the field flourish. There is a need for rigor in language, a need to be clear about what it is that people lead, research, seek, teach, and facilitate. As practitioners and researchers march down the path of making the study of creative thinking, creativity, and innovation more deliberate, repeatable, useful, and accepted, mixing words that have different meanings creates confusion which makes it more difficult to fully understand the topic at hand. When one presents research on "innovation," when they really mean a "creative process," it jeopardizes the acceptance of both by causing furrowed brows and making it easier to raise objections that derail the presentation and uptake of learning.

What Is Creativity?

So what does "innovation" really mean? And how is it different than creativity? First, it is important to define terms, starting with creativity.

The definitions of creativity are many and focus on many different areas depending upon the context and need of the research and researcher. A common and popular theme in many definitions builds from the research of Barron (1955), who noted that a creative product must be (1) "original" and (2) "adaptive to reality" or, in other words, useful or valuable. Stein (1974) summed it up by saying that "creativity is a process that results in a novel work that is accepted as useful by a significant group of people at some point in time." This entry will build on this definition later to summarize innovation.

Stein's definition agrees with MacKinnon's (1978) notion that "the starting point, indeed the bedrock of all studies of creativity, is an analysis of creative products, a determination of what it is that makes them different from more mundane products" (p. 187). Rickards (1996) boldly stated, "most creativity researchers would find no strong objections to a definition of creativity which considers the process to be one in which new and valued ideas are generated" (p. 24). Add to the mix Ackoff and Vergara's (1981) definition which focuses on a personal ability to overcome self-imposed constraints, and the researcher begins to see the structure that Amabile (1996) points out in her review of definitions of creativity where she notes that there are definitions which focus on (a) process and (b) product in addition to (c) person. MacKinnon (1978), however, adds one more aspect to Amabile's list by pointing out (d) the creative situation.

This begins to sound rather like the classic definition by Rhodes (1961), in which he conducted a meta-study of definitions in order to conclude with a definition of creativity as follows:

> The word "creativity" is a noun naming the phenomenon in which a person communicates a new concept (which is the product). Mental activity (or mental process) is implicit in the definition, and of course no one could conceive of a person living or operating in a vacuum, so the term *press* is implicit. The definition begs the questions as to how new the concept must be and to whom it must be new. (p. 305)

The Four Ps and "Teaching Creativity"

He refers to this as the "four Ps of creativity," which include (1) person, (2) product, (3) process, and (4) press. While the shorthand is useful as a teaching practice or as a way to focus efforts designed to enhance creativity in organizations, what is often missed is the fact that creativity is a "noun naming the phenomenon…" If one teaches creativity, then by definition, one teaches a phenomenon. While one can certainly teach *about* the phenomenon of creativity, what is true is that those who teach about it are really teaching a creative process to people in a press so that they can create new products. One does not teach creativity; one teaches a creative process.

Those people that study the phenomenon of creativity and teach about the research and theory can certainly be said to teach creativity, but teaching a phenomenon is not what is happening in the creative thinking classes, courses, and conferences that abound. The author would propose that "creative thinking" is a subset of Rhodes's definition focusing on the "mental activity (or mental process)," in other words, the process that is necessary for the phenomenon to occur, or as MacKinnon (1978) said it, "the creative process or processes are those that result in creative products" (p. 187). Certainly there is much evidence that this mental process can be defined by creative problem solving, TRIZ, Synectics, six hats, or other methods (Altshuller 1994; De Bono 1985; Gordon 1972; Osborn 1953; Parnes 1992; Prince 1968), yet that is beyond the scope of this entry.

It is also not the purpose here to propose yet another definition of creativity but rather to further promote Rhodes' definition as one sufficiently robust and relatively concise that encapsulates the necessary elements for fully understanding the phenomenon. A bonus is that at the time of publication, it was novel, and in practice, it is useful, which links nicely to Stein's 1974 definition.

Why Is It Important to Define Innovation?

In his article, Rhodes (1961) stated that:

> Granted, the word creativity has been overworked. And it is used loosely. Students of creativity have not yet taken the time to distinguish the strands of the phenomenon and then carefully to classify new knowledge according to the pertinence thereof to either person, process, press or product. I submit that the time has come for more precision in definition and usage, that only when the field is analyzed and organized – when the listener can be sure he knows what the speaker is talking about – will the pseudo aspect of the subject of creativity disappear. (p. 310)

The author believes that thanks to the many researchers who have been turning over this question since J.P. Guilford's call to arms for the deliberate study of creativity in his 1950 address to the American Psychological Association, this is much less true today of creativity (Guilford 1950). However, by substituting the word "innovation" for "creativity," one discovers that Rhodes provides a place to start with innovation:

> Granted, the word ***innovation*** has been overworked. And it is used loosely. Students of ***innovation*** have not yet taken the time to distinguish the strands of the phenomenon and then carefully to classify new knowledge according to the pertinence thereof to either person, process, press or product. I submit that the time has come for more precision in definition and usage, that only when the field is analyzed and organized – when the listener can be sure he knows what the speaker is talking about – will the pseudo aspect of the subject of ***innovation*** disappear.

Given the proliferation of books on innovation, from the well researched to the opinion pieces that clog the bookshelves, it is important to help break down the barriers to a common understanding of what innovation is all about.

Are Creativity and Innovation Synonymous?

The definition of creativity is useful for understanding innovation, because the former yields the latter. A traditional view of the relationship between creativity and innovation is to say that "creativity is getting the idea, and innovation is doing something about it (Firestien 1996, p. 16)".

Indeed, Davila et al. (2006) note that the words creativity and innovation are regularly used as synonyms, and they strike a blow for rigor by noting that they are distinct. They describe innovation as a combination of creativity and commercialization, indicating that innovation is bringing to life creative ideas. Puccio, Murdock, and Mance (2007) also note that "the creative product is the starting point for business innovation" (p. 24).

Kaufman (1993) goes a step further, noting that the criteria for creativity are novelty and usefulness (he used the term "validity" rather than usefulness) and that innovation adds an additional two to those criteria: increment (an addition to existing knowledge) and realization (made up of subcomponents of adoption, implementation, and diffusion).

Rickards (1996) noted that "The implicit assumptions in much of the literature suggest that innovation is a process which begins with a creative idea and ends when that idea is implemented" (p. 14). He also defined innovation as "a social problem-solving process of a non-routine kind" (Rickards 1991, p. 105). And indeed, Amabile et al. (1996) said that "All innovation begins with creative ideas. . .In this view, creativity by individuals. . .is a starting point for innovation; the first is necessary but not a sufficient condition for the second" (p. 39).

Creativity Does Not Equal Innovation

So while there are those that would use the two words interchangeably, they are in fact very different. This then requires a definition of innovation and a desire to be more robust with the definition.

Rhodes, in his research, reviewed 40 definitions of creativity (and 16 of imagination) to distill his own definition. Similarly, the author reviewed a similar number of definitions of innovation by those authors, thinkers, scholars, and bloggers who had the rigor to define their terms. Given that the number of books on innovation has been skyrocketing every year with a total of 2,425 published books alone on the subject through mid-2007 (Smith 2007), it may not be possible to find them all. However, this represents the best efforts of two researchers to find definitions that are in use, in the press, and that are public. Reviewing them required a qualitative analysis process. This process involved reviewing all of the definitions for emergent themes and then synthesizing them and building a single definition (Murdock 1994). Out of this process emerged the following themes:

- Value
- Improvement
- Invention
- Climate
- Introduction
- Process
- Renewal
- Design
- Acceptance
- Renewal
- Product-focused
- Recombinations
- New:
  - Idea
  - Approach
  - Practice
  - Object
  - Method
  - Device
  - Service
  - Program
  - Technique
  - Technology

What is notable is that while there are overlaps among these words and definitions of creativity, there are some elements that are different.

An additional analysis of the definitions provided the following words that were offered as synonyms to innovation:

- Renewal
- Invention
- Creativity
- Entrepreneurship
- Improvements
- Brand new
- Paradigm-breaking
- (Creative) destruction
- Change
- Experiment
- Take risks
- Origination
- Different
- Growth
- Value creation

Based on this analysis, and using the framework set forth by Rhodes, the following robust and bulky definition of innovation emerged:

> Innovation is a noun that describes the phenomenon of the introduction of a new product that adds value. Implicit in this definition is engaging in a creative thinking process to develop new concepts and implementation strategies, which requires a multitude of skill-sets, and thus, usually, a team. Also required for successful implementation is awareness of the internal and external press.

Core Components of the Definition

Introduction: A common theme in most definitions was that innovation was characterized by the fact that a creative product was brought forth and made available to some part of the world (however one defines the "world" given the context of the product). It could be consumers, clients, readers, patrons, a community, etc. This is what Kaufman referred to as "realization," in his definition of innovation (1993). Rather than merely fashioning a creative product, what distinguishes innovation from creativity is the notion of introducing or launching or getting it out to the social system at large. According to this explanation, a prototype of (the proverbial) new widget is a creative product, but it is not yet an innovation until the means have been devised to launch it to the marketplace. There is a focus on commercialization, as Puccio, Murdock, and Mance (2007) note when they stated that "innovation occurs when an organization has successfully commercialized a new product or implemented a new program or service" (p. 24). Perhaps this explains why business focuses on "innovation" in their taglines rather than promoting their "creativity." Roberts (1988) defined innovation using the word "exploitation" to connote this concept of introduction of the creative product, but in usage, one finds that this word has emotional baggage that blocks understanding of the concept.

New Product: Equally important in determining what is innovative or not is the notion of a new product. While introductions of products happen every day, the innovative ones are those that are new to the observer. And like Rhodes' definition of creativity, this definition begs the question as to how new the concept must be and to whom it must be new. After all, creativity, like beauty, is in the eye of the beholder. Product is used here to refer not just to tangible objects but also intangibles such as services. In other words, they are the output, results, or artifacts of the creative process.

Adds Value: Similar to the notions of usefulness and value in the definitions of creative products, whether value is defined monetarily, qualitatively (i.e., quality of life), or through utility, a key element of innovation is that it must add value through its introduction to the world.

Creative Thinking Process: For newness to happen requires a process whereby new ideas can be generated, thus a creative thinking process. Whether that process is creative problem solving, TRIZ, six hats, Synectics, summoning the muse through dance, or any other is up to the innovator.

Implementation Strategies: Implementation is easy to observe in its completed state, yet for many organizations, it is the strategies that bring forth the successful introduction that is a challenge. In most cases, implementation does not happen on its own and in fact requires a deliberate strategy for it to occur. In the case of innovations, typically it requires many applications of creative process to result in a successful launch. This may be observed at each step of the pathway to launch. Not just at the front end of the process but also in the development, production, distribution, marketing, and sales stages of an introduction.

Multitude of Skill-Sets: The introduction of something new requires many skills that are required to move from idea into the marketplace. These skills can be viewed functionally (research, operations, manufacturing, sales, etc.) from a content perspective (form, formulation, user, competition, geography etc.), a disciplinary perspective (psychology, education, engineering, anthropology, etc), or any other differentiating framework. What makes them stand out is the vast range of areas that are required for success. Typically, creativity is much more narrowly focused on one particular area or function. And while creative thinking methodologies frequently involve a group (either heterogeneous or homogeneous), the actual creative thinking comes from a connection (spark, "aha," eureka moment, or satori) that occurs within one brain (like Ackoff and Vergara's (1981) definition of creativity), while the process of introducing an innovation usually requires many brains, thus a team of individuals with different skills.

Internal Press: As Rhodes (1961) stated, "of course no one could conceive of a person living or operating in a vacuum, so the term *press* is implicit" (p. 305) for the development of an innovation. The internal press refers to the environment in which the innovation takes shape, where the team engages in the process and creates new value-creating concepts.

External Press: Is relevant since the product must enter the world in order to be launched. And for the innovation to be successfully launched, it must fit a need for an audience generally not involved in the creation process. Whether it is through "customer-centered design," "audience analysis," "consumer research," "stakeholder analysis," or any other way of gauging the needs to be satisfied by the concept, knowledge of the external environment, or press, is critical for successful innovation.

Creativity Versus Innovation

Functionally, creative thinking is a critical part of the innovation process, likely with more than one occurrence. In fact, an innovation requires multiple rounds of creative thinking throughout the

Creativity and Innovation: What Is the Difference?, Table 1 Comparison of key components of the definitions of "creativity" and "innovation"

Creativity	Innovation
Person	People (i.e., a team)
Process	Repeated creative thinking processes
Product	Product introduction
	Implementation strategies
Press	Internal press of creation
	External press of the marketplace

process leading to introduction. Rickards (1996) suggested that the traditional model of creativity and innovation trap creativity in the "front end" of the innovation process, and he argued that creativity is needed throughout the innovation process. He further "makes the case for a long-needed break with this assumption. . .Ideas and actions occur and interact as long as innovation is being pursued. Creativity continues as long as action continues" (Rickards 1996, p. 24). The act of introducing or launching a product may require creativity at all stages of the development process including research, concept development, refinement, production, marketing, sales, distribution, and more. Another way to think about it is that innovation is a combination of creative ideas. So what sets creativity apart from innovation?

In comparing the definitions of creativity and innovation, the reader will notice overlaps and differences among the key components (Table 1).

Where the creative idea can come from one person (and of course from a team), an innovation typically requires people working together to make it happen from different places in an organization or throughout its value chain (e.g., in the case of a consumer product: consumer research, product development, marketing, manufacturing, sales, distribution, service, etc.).

And while both require a creative thinking process, the innovation requires multiple applications of creative thinking processes to guide it to launch. While creativity is about sparking a creative product, the innovation requires the introduction of it frequently in multiple copies, and in order for that to occur, that requires strategies to get the innovation out to the world. Creativity takes place not in a vacuum, rather in a constrained press, and the implementation does as well. Plus it must exist in the broader external press of the marketplace that determines its success or failure.

Concise Definition

Given the bulkiness of the definition, the author has found it useful to build on the Stein (1974) definition of creativity to define innovation this way:

> Introducing something new that adds value, which requires many skill-sets (thus usually with a team).

This definition provides enough distinctness from creativity in a concise way that is useful for people to grasp quickly in order to move on to the actual work of innovating.

Conclusion and Future Directions

Given that "words mean something," it is important to distinguish between creativity and innovation and to not use the two words synonymously. Creativity is required for innovation, but is not the same thing, since the innovation goes beyond the phenomenon of the creative product to its introduction, launch, commercialization, or exploitation. Innovation is broader and the iterative use of creative thinking in order to solve the challenges associated with bringing a product to see the light of day. Certainly there is overlap between the two definitions, just as there is a gray area that separates black from white. Yet creativity and innovation are not equivalent. Although one cannot have the latter without the former, one can have creativity without innovation. The accurate researcher and practitioner will use the most appropriate term for the phenomenon that they are describing.

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Cross-References

- ▶ Business Creativity
- ▶ Convergent Versus Divergent Thinking
- ▶ Corporate Creativity
- ▶ Creative Leadership
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Divergent Versus Convergent Thinking
- ▶ Four Ps of Creativity
- ▶ Imagination

References

Ackoff R, Vergara E. Creativity in problem solving and planning: a review. Eur J Operat Res. 1981;7:1–13.

Altshuller G. And suddenly the inventor appeared: TRIZ, the theory of inventive problem solving. Worcester: Technical Innovation Center; 1994.

Amabile TM. Creativity in context. Boulder: Westview; 1996.

Amabile TM, Conti R, Coon H, Lazenby J, Herron M. Assessing the work environment for creativity. Acad Manage Rev. 1996;39:1154–84.

Barron F. The disposition toward originality. J Abnorm Soc Psychol. 1955;51:478–85.

Davila T, Epstein MJ, Shelton R. Making innovation work: how to manage it, measure it, and profit from it. Upper Saddle River: Wharton School; 2006.

De Bono E. Six thinking hats. Boston: Little, Brown; 1985.

Firestien RL. Leading on the creative edge: gaining competitive advantage through the power of Creative Problem Solving. Colorado Springs: Pinon; 1996.

Gordon WJJ. On being explicit about creative process. J Creat Behav. 1972;6(4).

Guilford JP. Creativity. Am Psychol. 1950;5:444–5.

Kanter EM. Innovation: the classic traps. Harv Bus Rev. 2006;2006:73–83.

Kaufman G. The content and logical structure of creativity concepts: an inquiry into the conceptual foundations of creativity research. In: Isaksen SG, Murdock MC, Firestien RL, Treffinger DJ, editors. Understanding and recognizing creativity: the emergence of a discipline. Norwood: Ablex; 1993.

MacKinnon DW. In search of human effectiveness. Buffalo: Creative Education Foundation; 1978.

Murdock MC. Designing and conducting qualitative research using creative analysis. Paper presented at the Eastern Education Research Association's Annual Conference and Qualitative Special Interest Group, Sarasota, FL, 1994

Osborn AF. Applied imagination: principles and procedures of creative problem solving. New York: Charles Scribner's Sons; 1953.

Parnes SJ. Visionizing. Buffalo: Creative Education Foundation; 1992.

Prince GM. The operational mechanism of synectics. J Creat Behav. 1968;2(1).

Puccio GJ, Murdock MC, Mance M. Creative leadership: skills that drive change. Thousand Oaks: Sage; 2007.

Rhodes M. An analysis of creativity. Phi Delta Kappan. 1961;4:305–10.

Rickards T. Innovation and creativity: woods, trees and pathways. R&D Manag. 1991;21(2):97–108.

Rickards T. The management of innovation: recasting the role of creativity. Eur J Work Organ Psychol. 1996;5(1):13–27.

Roberts EB. Managing invention and innovation. Res Technol Manag. 1988;31:11–29.

Smith R. Innovation alignment to maximize market penetration. Paper presented at the Innovation Network's Immersion 360 Conference, Scottsdale, AZ. 2007. Available at: http://www.modelbenders.com/papers/RSmith_InnovationImmersion.pdf

Stein MI. Stimulating creativity. New York: Academic; 1974.

Creativity and Systems Thinking

Hector Ramos
Department of Educational Psychology,
College of Education & Human Development,
Texas A&M University, Bryan, TX, USA

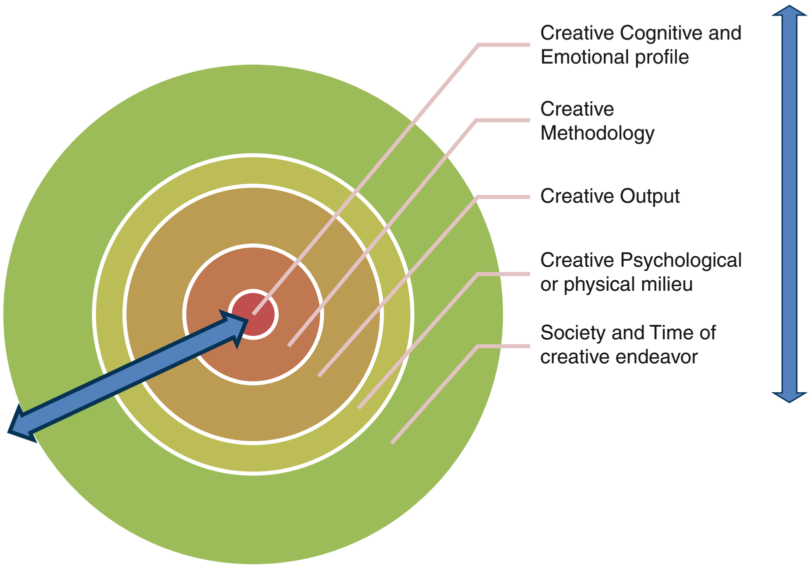
Synonyms

Innovation; Originality; Systems design

Definition

Creativity can be viewed from many different perspectives. They are interconnected in a system that reinforces each of them (Fig. 1). A definition of these perspectives is:

1. Creative cognitive and emotional profile. The innate and nurtured cognitive and emotional abilities that help generate creative ideas or products. These could be boldness, risk-taking, or flexibility in idea production.
2. Creative methodology. It can be a tool, a mechanism, a roadmap, or a process that helps a person generate, evaluate, or implement creative ideas and solutions.



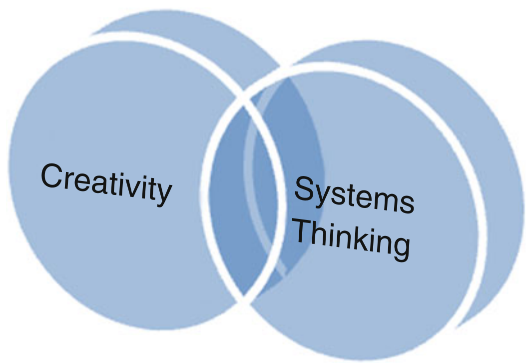
Creativity and Systems Thinking, Fig. 1 Creativity: an evolving system

3. Creative output. The characteristics of any production including ideas that add novelty or usefulness in a certain societal context.
4. Creative psychological or physical milieu where creativity happens. For instance, a company that fosters and supports new ideas.
5. Society and time context of the creative endeavor. The ability of the society as a whole to accept and appreciate that novelty.

Some examples of these relationships are as follows:

(a) Cognitive creative abilities are used to generate creative output. This could be facilitated by a creative method.
(b) Creative methodologies help sharpen creative abilities (i.e., increased fluency in idea generation through the use of thinking tools).
(c) Creative outputs are better designed through a methodology that identifies societal market needs at a certain time. For instance, people who appreciate small light products containing many songs would favor the iPod machine over a Walkman cassette player.
(d) The behavioral and cultural norms in a certain society will determine what type of novel output is accepted.

Systems thinking, as a process to understand how parts interact with the whole, provides however far more value to the field of creativity through a synergistic relationship (Fig. 2). Systems thinking helps creativity to understand the "why" question of the creative endeavor. As creativity is increasingly required to solve complex problems, there is also a great need for greater clarification and understanding of those systems where creativity will be applied.



Creativity and Systems Thinking, Fig. 2 The synergy between creativity and systems thinking

One of the simplest ways to look at this relationship is through the systems thinking concept of **reinforcing loops**. They establish a relationship and direction of movement that creates a system.

For instance, should a company wish to generate creative ideas to increase sales, a systematic understanding of the company's operation (Fig. 3)

Creativity and Systems Thinking, Fig. 3 A reinforcing loop to find the real issue affecting sales

would be useful instead of just increasing advertising expenditure. Figure 3 shows that as satisfied customers increase, so does positive word of mouth that in turn generates increased sales. On the assumption that positive word of mouth causes 90 % of the sales, then an effort to increase advertising could shift to finding ways to increase satisfied customers.

The interaction between creativity and systems thinking goes far beyond: through the systemic analysis of a complex context, the creative person can find multiple points of leverage. This in turn will help that person to enhance his creative ability to analyze and understand problems from different perspectives, which has long been considered a creative thinking ability.

Cross-References

- ▶ Creative Collaboration
- ▶ Creative Personality
- ▶ Innovation Systems and Entrepreneurship
- ▶ Product Innovation, Process Innovation

Creativity Assessment

▶ Measurement of Creativity

Creativity Assessments

▶ Creativity Tests

Creativity Crisis

▶ Decrease in Creativity

Creativity Definitions, Approaches

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Synonyms

Concept development, trends

Definition

Approaches to creativity definitions are conceptual trends on the way from the myths to the scientific reflection of creativity within the science of creativity.

Introduction: Creativity as a Phenomenon

The phenomenon of creativity and real-life people doing creative work seems simple at first glance. When people see someone who is unusually original, they say that this person is "creative." However, when one tries to describe what "creative" means in order to teach others to be creative or to research the phenomenon, it becomes difficult. The reason of the difficulty is that creativity surfaces in so many ways. Additionally, creativity is psychological. This is a challenge in itself because creativity is a complex multifaceted phenomenon. No wonder, Parkhurst noted "the confusion and lack of consensus" in the issue of defining creativity (see Parkhurst 1999). This entry is a summary of various approaches in defining creativity that finally leads to a universally applicable scientific definition.

People often think that creativity was always understood as it is today. This is simply not the case. The evolution of the concept reflecting the understanding of creativity is amazing in-and-of itself. The views on creativity and definitions of creativity have changed dramatically. They range from only God's ability for "Creatio ex nihili" – "*Creation from nothing*" – to considering poets (first only poets) creative, then artists, and in modern views also scientists, engineers, and all people too, which is expressed in the slogan, "We are all creative!" (see ► Creativity Definitions, Approaches).

This entry, however, presents the conceptual analysis of creativity on the way to forging a scientific view rather than chronological or historical analysis (see ► Science of Creativity). While doing this, as opposed to the article titled "Definitions of Creativity" in the comprehensive *Encyclopedia of Creativity* which dwells on the elements, phases, and aspects of creativity but does not offer a single definition of creativity, except the paraphrased "Creativity is 1% inspiration, 99% perspiration" (Cropley 1999), this entry operates with real names and real definitions. Clearly, out of hundreds of definitions available in literature (Aleinikov et al. 2000; Treffinger 1995), thousands of definitions published on the web, and probably millions of unpublished definitions (e.g., students in creativity classes create a few definitions each), this entry deals only with a small number of these definitions. Nevertheless, it shows tendencies or approaches to defining creativity that can be found in the field, thus helping readers to gain a general understanding of the difficulties on the way to scientific definition.

Traditional and Modern Views on Creativity

Theoretically, the volume of the notion (the set of phenomena conceived in the concept) "creativity" could be maximized, minimized, or optimized. When maximized, it approaches infinity; when minimized, it approaches zero.

Maximizing the notion of creativity volume leads to omitting the aspect of originality and equalizing the terms *create* = *creative*. It may sound like this: "God created this world, so God is creative. Nature creates plants, animals, and people, so nature is creative too. People create their homes, products, etc., so they are creative. A mouse creates stores of grain for the winter, so a mouse is creative too. Trees create leaves and fruit, so they are creative as well. Therefore, everything creates everything, everything is creative, and creativity is everywhere." Such a point of view may be called pancreationism or maxi-creationism.

On the contrary, when minimized in volume, the notion of creativity can be related only to a very specific moment of mental activity in producing new ideas. For instance, a person generated a new idea. Creativity was present only at this moment. From this restricted point of view, creativity is a short-lived and very space-limited phenomenon. Such a point of view may be called mini-creationism.

All variations between these two polar points of view, maxi- and mini-creationism, may be conditionally called opti-creationism, where the task of the researcher is to optimize the understanding of creativity to make it realistic, thus avoiding absolutism on both sides.

A very common understanding of creativity achieved by this level is the following: creativity is an ability and process of producing something new and useful.

At first sight, it looks like a good definition until you try to use it. A spider, for example, produces a web – new and useful. Is this creativity? A very able person (assume that tests showed it; see ► Creativity Tests) just sits in the corner, daydreams (produces new and useful ideas), but does nothing to make them real. In this case, can anyone prove his/her creativity? Another person is always in the process of doing something new but then immediately destroys it. Is this creativity? The third person "produces" children – all new and useful. Is this creativity? The fourth person produces ways of self-entertainment – new and useful for oneself only. Is this creativity? Questions of this type could go on and on. It is doubtful that the answers to all these questions would be "yes," but they all fit the given definition of creativity. Obviously, something must be wrong with this definition. Either it does not include all necessary features of creativity or it needs to be more specific because the features mentioned are not sufficient. It may also be missing the essence of creativity.

Within opti-creationism, there are three major approaches to defining creativity:

- Dictionary approach – explaining the phenomenon in simpler (understandable, known) terms
- Metaphoric approach – describing the phenomenon by analogies, by images, by poetic forms
- Intuitive, common sense, or neighboring notion approach – describing the phenomenon by concepts that are neither higher nor lower in the ladder of abstraction.

It is useful to analyze these before applying the scientific approach.

Dictionary Approach

In the majority of dictionaries, readers find that creativity is "the quality of being creative; the ability to create." So the reader is sent to the adjective "creative" or to the verb "create." As the reader goes on to the word "creative," the article might say, "marked by the ability or power to create; of creation." So the reader is sent to the verb "create" and the noun "creation." And finally in the definition of "create, creating," the reader may find, "to do something creative or constructive," while in the article for "creation" – something like "the act of creating." Thus, the reader is sent back to the adjective "creative" and the verb "create." Dictionaries often make such "circles" by defining concepts via each other. Stanislav Lem, a famous science fiction writer, once described the dictionary, where the term "sepulka" sends the reader to "Sepulkowate," which sends to "sepulkarium," which, in its turn, sends back to sepulka, giving practically no definition of the term.

Metaphorical (Poetic, Artistic) Approach

Creativity can have an unlimited number of metaphorical definitions:

- "Creativity is jazz without the music" (Jack Allday, Professor, Northwood University, Dallas Texas)
- "Creativity is the river that runs through our human spirit. When we hear its running waters, we are reminded who we are." (John Osborn, Senior Vice President BBDO, NY, NY, the grandson of Alex Osborn who coined the term *brainstorming* and founded Creative Education Foundation, Buffalo, NY)
- "Creativity is the child in me, screaming to get out" (David Whalen, EDS Mod-Michigan Solution Centre)
- "Creativity is. . .
  wanting to know
  listening to a cat
  crossing out mistakes
  getting in deep water
  getting out from behind a locked door
  cutting corners
  plugging in the sun
  digging deeper
  singing in my own key
  shaking hands with tomorrow" (Dr. E. Paul Torrance, "The Creativity Man," author of *Torrance Tests of Creative Thinking*)
- "Creativity is the process of mining the mind" (John Sedgwick, President of Managing imaginations)
- "Creativity. . .the febricity of the soul becoming reality" (Eleanor Pierre, Professor, Sheridan College, Trafalgar Campus, Ontario Canada)
- "Creativity occurs when we tilt the jelly dish in a different direction and force the water (information) to flow into new channels and make new connections" (Michael Michalko, the author of *Thinkertoys*, A Handbook of Business Creativity and *Cracking Creativity*, The Secrets of Creative Genius)
- "The defeat of habit by originality" (George Lois)
- "Creativity is the song that sings itself" (Jeff Pokorney, Inventor, Minneapolis, MN).

  (All definitions from Aleinikov et al. 2000)

Such definitions do not pretend to be scientific; they are poetic. These definitions are metaphors. They poeticize creativity rather than describe it. These definitions explain very little but bring good feelings and inspiration. This is what metaphors are supposed to do.

Actually, within this approach, creativity can be defined through nearly every noun. For instance, one of the exercises in teaching creativity is to define creativity via any noun. The model of such a metaphoric definition is N_1 (creativity) = N_2 (any noun) + its characteristics.

Intuitive (Common Sense or Neighboring Notion) Approach

As opposed to metaphoric (poetic, artistic) approach, there exists a more philosophical or common sense approach, where authors attempt to define creativity through the notions and concepts found in the neighboring domains. Researchers and consultants may call such definitions "working definitions, research definitions, temporary definitions, or personal definitions."

Examples of such definitions include:

- "Creativity is a continuous process of finding good problems to solve, and finding and implementing good solutions to these problems" (Min Bassadur, Founder of the Center for Research in Applied Creativity, Simplex Worldwide©)
- "The production of novel, appropriate ideas" (Teresa M. Amabile, Ph.D., Professor of Business Administration, Harvard Business School, Boston, MA)
- "We define creativity as the ability to make useful, novel associations" (S.S. Gryskievicz, Center for Creative Leadership, Greensboro, NC)
- "Creativity is the art of self-expression" (Jennifer Page, at 17, the graduate of School of Geniuses, 1996)

(All definitions from Aleinikov et al. 2000)

The main concepts employed to define creativity, as instruments or tools of defining, logically are supposed to be higher in the level of abstraction. But many of them are not. For example, in the first definition, creativity is defined as a process, but it is broader than a process. In the second definition, it is defined as production, but it is broader than production. In the third definition, it is defined as ability, but it is more than ability. In the fourth definition, it is defined as art, but it is more than art. Four definitions placed together also demonstrate the insufficiency of each. They may work for some cases but not for all the domain of creativity. The selection of the main category that creativity falls into is extremely important. It has to be able to encompass the phenomenon in all its variety.

The situation can be illustrated by analogy. Imagine a tool like a chisel made of clay. It is weaker or more fragile than the object it is supposed to affect. So it will break at the first strike. Another example: a pot made of plastic with a melting temperature lower than the temperature of boiling water. In this case, when a person tries to boil some water, the pot will melt before the water begins to boil. The same dangers exist for the process of defining creativity.

Example 1. "Creativity is an internal dialog for generating new ideas." Seemingly, this is not a bad definition. But dialog itself is a complex essence too. There are quite a few thick books on dialog. Furthermore, "internal dialog" is even more complicated and less vivid. Finally, dialog itself can be defined through the notion of creativity: dialog is communicative creativity. Therefore, the question arises, "What defines what?"

Example 2. "Creativity is the combining of earlier nonrelated ideas." At first glance, this definition looks good too. However, the word "idea" requires definition. Moreover, the word "nonrelated" in the phrase "nonrelated ideas" is very weak. It is logical to ask how these ideas were produced in the first place. One has first to create something in order to relate it to something else and to combine it later. So should the phrase "generating ideas" be added to the definition? Why then the word "combining" is needed at all?

The history of research counts numerous attempts of explaining creativity in neighboring notions and concepts. As G. Davis states in his book *Creativity is Forever* (Davis 1981), creativity has been explained in terms of:

- Psychoanalysis (Freud 1925)

- Neo-psychoanalysis (Kubie 1958)
- Gestalt (Wertheimer 1959)
- Associations (Locke 1968)
- Humanism (Maslow 1968) and
- Factor analysis (Guilford 1968).

Definitions of this type may look appropriate for some training purposes; however, they define creativity by the notions taken from the same or lower level of abstraction. When placed together, such definitions demonstrate the multifaceted character of the phenomenon, but they also corroborate the above-mentioned conclusion that the issue of instrument (tool) becomes critical.

Scientific Approach

The scientific approach traditionally compresses things to their essences in order to free the brain from excessive information (compression, though, is not equal to reduction!). The search for the essence (definition) can be hard and exhaustive, but discovering the essence is the same as discovering the formula of gravity by Newton: it explains in one manner the entire world from a falling apple to the stars and galaxies moving in far space. Defining things and concepts exemplifies the principle of economy of force in science. A scientific definition is a must for establishing a science of creativity.

While developing such a definition, one has to use the terms and methods of the established natural sciences like physics, chemistry, and biology, as well as mathematics and logic, the key attributes of any science.

Logic and Paradoxes of Creativity Nondefiniteness

While using logic one has to know the difference between formal logic, dialectical logic, mathematical logic, modal logic, deontic logic, etc. For example, if a researcher stays within one type of logic, let it be formal logic, it is easy to fall into the trap of paradoxes.

Paradoxes are logical traps or loops that cannot be solved within the same type of logic. A typical one is the paradox of a liar. Suppose you come to an island and the first person you meet at the shore says that all inhabitants of the island are liars. Is he telling the truth? If he is saying the truth, then all the inhabitants are liars. But he is an inhabitant too. So he is lying. Therefore, he is saying the truth and lying at the same time. Contradiction! Try to approach the statement from the other side. If he is telling lies, then the inhabitants are not liars – they are truth tellers. But he is an inhabitant too, so he must be telling the truth. Again, a contradiction! It does not matter whether he is lying or he is telling the truth; you are in a paradox situation. It is the formal logic that leads to a paradox.

In reality (reflected by dialectical logic – the logic that accepts contradictions as part of life), a person may lie in one case and tell the truth in some other case. Moreover, it would be very wrong to say that *all* inhabitants are liars. Some of them may be liars, but the others are not. The use of "absolutizers" like *all, everyone, every, never, forever*, etc., when they are not supported by evidence may lead to logical errors.

So while defining creativity, researchers get into logical paradoxes as well:

Paradox 1. Creativity is (nearly) everywhere. It means you can define creativity through everything (as in metaphoric and intuitive approaches above), and you can also define everything through creativity. It looks to be limitless. So while trying to define creativity (i.e., to limit, to find the finite features), people try to limit this phenomenon, which supposedly has no limits. It is a paradox.

Paradox 2. In order to define something in logic, one must go higher in the hierarchy of notions. For example, a table is a piece of furniture; a rooster is a bird, etc. In language, some words are more abstract, and some are less. So while defining creativity, one can say creativity is ability, but in reality, creativity is more than ability. One can say creativity is a process, but creativity is more than a process. Some people say creativity is originality, but it is more than originality. Seemingly, there is no term that will logically embrace creativity because these concepts are not rising to the next level of abstraction. It is the same as the word about a word is a word too. In mathematics, Bertrand Russell was the first to show this type of paradox when he asked whether the set of sets belongs to the set it includes as its components.

Paradox 3. Here is how Dr. E. Paul Torrance describes one paradoxical situation: "Many definitions have been offered and none is considered precise, yet almost all of them seem to mean essentially the same thing. I think that Aleinikov (1999b) accurately summarizes where we are with regard to defining creativity. He relates an incident that occurred at a creativity conference in Russia. A presenter reported that he had found 1,000 definitions of creativity and that it was time to stop defining it. The speaker went on to say, 'Nothing principally new can be invented.' Thus, he offered what he thought was a final definition. Aleinikov inadvertently laughed. The presenter felt embarrassed and asked why. The explanation was simple. 'You suggest that producing definitions must be stopped after 1,000; why do you offer the 1,001st?' Trying to stop further defining is the same as banning creativity because creation of a definition is creativity too, Aleinikov explained. Aleinikov went on to relate that the presenter came up to him afterwards. He then bet the presenter that he could give him at least two definitions that had no parallels in the presenter's collection. The presenter lost his bet." Then Dr. Torrance makes a conclusion, "Definitions will continue endlessly, but people will learn not to be disturbed by it and continue finding out more about creativity" (Torrance 2002).

Paradox 4. The definition, which is supposed to define, very often *un*defines the concept. For example, the definition offered by the above-mentioned presenter included 17 terms which were vague and needed to be defined in their own right.

Paradoxes are neither good nor bad, but they obviously show the limitations of formal logic and thus remind researchers of the necessity to make a leap to some other logic. Paradoxes indicate the availability of a deeper level in the paradox situation, and it is wise to be aware of them while working with definitions.

Mathematics

Ruth Noller, Distinguished Service Professor Emeritus of Creative Studies at Buffalo State College, once offered the following equation for creativity: $C = f_a(K, I, E)$, where

- C is creativity
- K is knowledge
- I is imagination (see ▶ Imagination)
- E is evaluation

As Isaksen, Dorval, and Treffinger explained, "she suggested that creativity is a function of an interpersonal attitude toward the beneficial and positive use of creativity in combination with three factors: knowledge, imagination and evaluation" (Isaksen et al. 2011).

The strength of such a definition is its symbolic form: it is easier to recall and visualize. Another plus is the attempt to use mathematics (or at least the symbolic expressions) to reflect a very complex phenomenon. However, there are some questionable issues in such a definition as well.

(a) The term *function* is as complex as creativity. Since the time it was coined by Gottfried Leibnitz in 1673, it too has acquired multiple meanings.
(b) The word *creativity* inside of the definition is used to define *creativity* as the defined concept. This is a tautology.
(c) The formula contains commas. They are not symbols of mathematical operations (like × for multiplication, + for addition, – for subtraction, etc.). So the constituents of creativity – K(nowledge), I(magination), and E(valuation) – are not functionally connected by any mathematical operations.
(d) The term "interpersonal" is not represented in the formula at all.
(e) The terms "beneficial" and "positive" are subjective. They express an opinion of a person.

Analysis, therefore, suggests that it is not a mathematical formula; this is rather a symbolic representation for Noller's understanding of creativity, some kind of abbreviation. The trend, nevertheless, is obvious: researchers begin to employ mathematical means in search of scientific definitions.

Since logic and mathematics alone do not constitute the scientific approach, the search for a scientific definition is still needed.

Scientific Terms

The fact is that well-established sciences do not use the terms like "idea" that is commonplace for dictionary and intuitive definitions. They use the terms "time, space, speed, acceleration," etc. Science also avoids such subjective terms as "useful/useless" because something that is totally useless now may be useful in the future or something completely useless for one person may be useful for another. Finally, sciences exclude any emotionally charged vocabulary so abundantly present in metaphoric definitions.

With this in mind, applying the terms from established sciences can make the creativity definitions more scientific.

As a case in point, Dean K. Simonton made an attempt to define creativity and genius in terms of Darwin theory (Simonton 1999). Numerous authors state that physical, or better called physiological, activity affects creative output. These are the samples of employing biological level terms for explaining creativity. Some researchers investigate the brain chemistry, as well as the chemical substances affecting creativity, including alcohol, drugs, etc. (Pritzker 1999; Plucker and Dana 1999). These are obviously the samples of chemical level notions employed for the explanation of creative output. There is also research and equipment employing electromagnetic fields affecting creativity (see, for instance, the Functional States Corrector by S.V. Koltsov). This is the level of physics. All these three levels are below the creativity level – the level of psychology – but psychology cannot exist without them: its existence depends on the existence of physical bodies and chemical reactions and biological processes.

The scientific research of the phenomenon of creativity is growing fast, and therefore, the need of a scientific definition of creativity itself is becoming more and more obvious.

A preliminary definition that would employ a paradox (logic), mathematics, and scientific terms may look like this: "Creativity is the search of search activity on the psychosocial level of nature's ectropy trend" (Aleinikov 1994, 1999b).

(a) The word "search" reflects the essence of creativity because people who are creative are in search of solutions. Moreover, they like the process of search (problem solving) so much that they are in search of problem to be solved (see Bassadur's definition above).
(b) The phrase "search of search" is using the basic biological term (not available on the level of chemistry) but also making it a paradox, so the paradox logical situation explained above (like "the word of word") is included. This phrase on the one hand relates creativity to natural biological search which is common for all living beings, but on the other hand separates creativity as search of search from the elementary search for food, search for partners, which hardly may be considered creative activity (see the "creative" mouse example in maxi-creationism).
(c) The other terms in the definition are physics- and psychology-based which make them scientific rather than metaphoric or any of the previous types.

The physical part of this definition deals with the term *ectropy*. The term *ectropy* (coined by mathematician and philosopher Willard Van Orman Quine) denotes the trend toward harmony. It was introduced as an antonym to the term *entropy* coined in 1875 by a German physicist Rudolf Clausius. Entropy, as opposed to ectropy, is the trend to chaos (Second Law of Thermodynamics).

There are only two trends in nature: to harmony (organization) and to chaos (disorganization). They coexist as the opposites. On the physical level, they exist as accumulation of organization (ectropy) versus loss of organization (entropy). On the chemical level, they exist as composing new substances versus decomposing existing substances. On the biological level, these two tendencies exist as birth, growth, and development versus withering and death. On the level of psychology, they function as personal development versus destruction (self-destruction).

On the level of social life, peace versus war and collaboration versus competition represent these two tendencies.

Using the term *ectropy* allows researchers to find the most general term for the phenomenon that embraces creativity as a whole, not just a part of it. Logically, therefore, creativity is first placed into a higher rank of abstraction (concept, notion) and then is restricted by the psychosocial level of this ectropy trend of nature. It means creativity, as a phenomenon, does not appear until psychology (reflecting and self-reflecting live beings) comes into existence. In other words, stars, planets, trees, worms, birds, etc., do not create – they exist, live, and reproduce.

After placing the phenomenon of creativity into a higher rank level and limiting it to the psychosocial level, its essence is further described by the phrase "search of search activity." The notion of "activity" contrasts creativity to passive fantasizing and cuts off the cases of sitting in the corner and doing nothing but daydreaming. In such a case, creativity is not seen, and therefore, its existence cannot be proven. Creativity should be expressed in order to be seen.

The complex term "search of search" also corresponds to a mathematical expression of squaring (self-multiplication, or degree, or to the power of) that on the conceptual level signals of another concept. When creativity is defined as "search of search" (Aleinikov 1994), it is understood as squared search activity (search^2). This understanding is based on the following. What is traditionally expressed in mathematics as 2^2, 3^2, 4^2. . .n^2 may be translated into language as "two of two's" (2×2), "three of three's" (3×3), "four of four's" (4×4), and finally, as "n of n's." When this regularity is applied to seemingly nonmathematical essences, like concepts, it gives "father of father" = grandfather, "child of child" = grandchild, etc. Some other notions (not all) can be self-multiplied too. However, what is most interesting for the language is that such a "squared notion," as a rule, gets another name as a concept of the next level of abstraction.

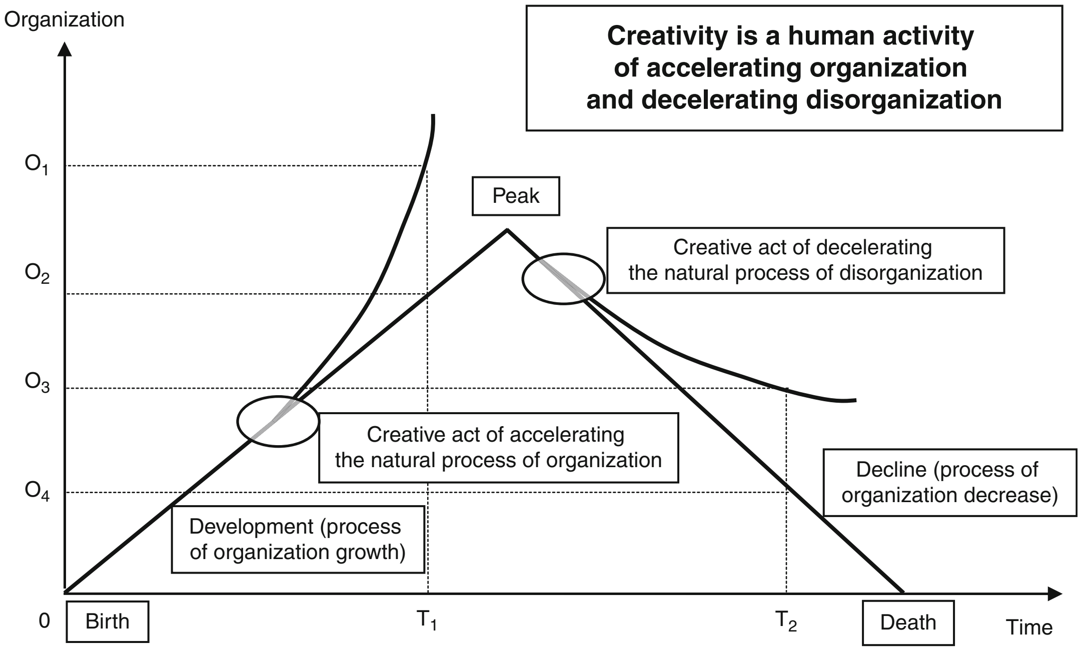
So the first attempt, the first definition of creativity is quite scientific. This definition is good for practical applications, especially for educators because it points precisely at what to teach and train for success in learning – search abilities.

The next step in developing a scientific definition of creativity is to find a more common name for the "search of search activity on the psychosocial level."

A closer look at the creativity phenomenon shows that creativity is a complex and highly regarded ability, skill, and practical activity of producing new (original, innovative) ideas, products, and problem solutions. Creativity is newness production on the psychological level, while innovation is newness consumption on the social level.

Ontologically, since ever-changing nature produces newness on all its levels (physical, chemical, biological, psychological, and social), producing newness on the psychological (individual) level is a natural process. Actually, new feelings, emotions, images, memories, thoughts, associations, as well as new movements and actions, are all natural phenomena every day occurring in intellectual beings. While constantly reflecting the newness produced by nature, human mind/intellect first learns how to produce newness by itself and then how to do it faster than nature. This accelerated process of human-produced newness that advances civilization (society, social level in general) is conceptualized as creativity. Since the results of creativity accelerate the development processes of a society over the natural speeds, the society begins to value creativity more and more until it becomes "highly regarded."

Thus, in scientific terms, creativity is not just ectropy, but an ectropy accelerator and/or entropy decelerator. In other words, it is a human activity, not just ability and/or skill, of accelerating the natural process of organization (ectropy) and decelerating the natural process of disorganization (entropy). The fact that accelerated ectropy is the process of accelerated (over natural) newness production is understood. The types, kinds, levels, layers, ranks, and amounts of newness are studied by novology,



Creativity Definitions, Approaches, Fig. 1 The essence of creativity

the science of newness (Aleinikov 2002; see also ▶ Novology).

So if the complicated expression "search of search activity on the psychosocial level" is changed to a simpler expression "human activity" and the high-level of abstraction physical terms "ectropy/entropy" are changed into more understandable to public terms "organization/disorganization," then the new definition of creativity might read as follows: **Creativity is a human activity of accelerating the natural process of organization and/or decelerating the natural process of disorganization**, or even shorter, **creativity is a human activity of accelerating organization and/or decelerating disorganization** (see ▶ Creativity Definitions, Approaches).

The following figure illustrates the essence of creativity.

Note: See how Fig. 1 shows that at a certain moment of time (T_1 or T_2), the organization level O_1 (accelerated development) is higher than O_2 (natural speed development), and the organization level of O_3 (restoration, repairing to decelerate the decline) is higher than O_4 (natural speed decline).

Gnosiologically, it is a simpler, clearer, and therefore, better definition. It looks like distilled essence.

If assumed that both organization and acceleration can be positive and negative (as in disorganization and deceleration), then the new essence can be expressed even shorter: **Creativity is organization accelerator**.

Testing Theory (New Scientific Definition) by Theory

In theory, ideally, there must be one definition for one object (process). If some definition fits several objects, then it does not define the one under analysis. This seemingly simple requirement is seldom observed in the prescientific practice. Many people say, "A chair is a piece of furniture to sit on." Seemingly, it is not a bad definition: first, the defined notion is generalized – it is sent to a higher abstraction level ("piece of furniture"), and then it is specified by function ("sitting"). Such a definition may look good until it is tested. A stool is not a chair, but it is a piece of furniture to sit on, so it fits the definition. A sofa is a piece of furniture to sit on, so it fits the definition too. These counterexamples show that the given definition of the chair is not specified enough.

The counterexample of the spider "producing new and useful things" and fitting some discussed above definitions of creativity is a book case.

Therefore, from the theoretical point of view, it is necessary to check whether some other notions or concepts fit the new scientific definition of creativity.

Maybe the concept of intellect fits it? Is intellect accelerating organization? Intellect is reflecting things, finding the organization of things, the connections and relations between them, but it is only creativity that produces new organization vision, and then intellect implements it. So the concept of intellect does not fit the definition.

Maybe the concept of fantasy fits the definition? Is fantasy accelerating organization? Fantasy is probing different organization, combining earlier noncombined elements. However, they need to be selected, developed, verified, tested, evaluated, and implemented until they become a new organization. This is what creativity does – it accelerates organization. Fantasy may be the start of creativity or the basic component of creativity but not creativity, so it does not fit the definition.

Maybe some other notions, like production or reproduction, would fit the new definition? Is reproduction accelerating organization? Reproduction is totally natural, so it goes with natural speed. No acceleration. So, no fit. Is production accelerating organization? Those who created new machines for the new processes were creative, but after the machines are done, they actually reproduce the idea of the creator. Therefore, the concepts of production and reproduction do not fit the definition of creativity.

There is a need to try something totally different. Is God accelerating organization? May be... Not proven by the science, so the term "human activity" excludes God as well as machines or aliens (not proven by science yet).

Thus, the new definition of creativity fits *only* creativity and not other phenomena. So testing theory by theory is successful.

Testing Theory (New Scientific Definition) by Practice

Any definition should be tested by practice, that is, by applying it to reality and seeing whether it works properly. Here is how this testing works for the final definition.

- In arts (considered creative activities), artists, sculptors, actors, writers, poets, etc., develop their works much faster than nature could by just random typing, random coloring, carving, burning, etc. They accelerate the harmonization (organization) of the world and decelerate the disorganization by restoring old paintings, churches, sculptures, etc.
- In science, the researchers by discovering the laws of nature accelerate the human world development (as compared to the noncreative, nonaccelerated = natural animal world development). Scientists also work on preserving the available resources and restoring the depleting ones: this is deceleration of disorganization.
- In technology, inventors and engineers accelerate the human world organization by new tools (the computer and the Internet are just a couple of examples). Inventors also work on decelerating disorganization – preservation and restoration of old planes; buildings, like the Tower of Pisa; and the millions of artifacts in museums.

Obviously the new definition works.

The preliminary (experimental) definition must be tested as well:

- Some people become artists to seek new images, new colors, new ways of self-expression, and new understanding of themselves as well as the environment.
- Some people become programmers to seek the best computer solutions.
- Some people become actors to seek the performance situations, etc.

Creative people are hungry for search. They practically lead themselves into search activities, and they enjoy these activities. It is the "search of search" that keeps them creative.

This definition also works.

By the way, as a corroboration of the correct direction this definition offers, all five steps in the original Osborn-Parnes model of creativity are expressed through a search-related word: fact-*finding*, problem-*finding*, idea-*finding*, solution-*finding*, and acceptance-*finding* (Parnes 1992).

Applying New Definitions to Real World

The new scientific definitions of creativity taken to real-world practice have proven their ability to improve it (or in new terms "to accelerate its organization") in science, technology, business, education, etc. The new scientific understanding of creativity led to:

- The new science of creativity, as well as five more new sciences and three new fields of research, like Creative Linguistics (see ▶ Creative Linguistics) and Creative Pedagogy (see ▶ Creative Pedagogy) in Aleinikov 1988, 1992, 1999a – faster than anyone in the world (top result for comparison: Wilhelm von Helmholtz – 3)
- Eleven new laws of conservation – faster than anyone in the world (top result for comparison: Johannes Kepler – 2; see also ▶ Creative Leadership)
- Six new creativity-enhancing techniques that accelerated the process many times, including to the level of megacreativity, over 1,000,000 ideas/min (Aleinikov 1999b, 2002) – faster than anyone in the world (the most famous result for comparison: Brainstorming – 1 idea/min; see ▶ Creativity Techniques)
- New measurement units for measuring objective and subjective newness, quantitative and qualitative newness, as well as the efficiency of creative output (Aleinikov 1999b; see also ▶ Measurement of Creativity, ▶ Novology)
- New tools of research, such as, a universal model of creative act (Aleinikov 1988, 1992; see ▶ Creative Linguistics)
- New educational methodologies, including the Genius Education Methodology (GEM) with 37 min to make an ideal learner, 3 days for mind setting to genius development (see ▶ Creative Pedagogy) – faster than anyone in the world
- New business organization processes, including the Guinness World Record in publishing (the book *Making the Impossible Possible* was written, printed, and published in 15 h and 46 min – accelerated over 300,000 times).

For detailed description on how the new understanding of creativity accelerates the organization of the world in science, technology, business and education, see ▶ Creative Leadership, ▶ Creative Linguistics, ▶ Creative Pedagogy, ▶ Genius, ▶ Novology, and ▶ Science of Creativity.

Conclusion and Future Directions

Approaches to creativity definitions (see ▶ Creativity) depend on the historical background, the general level of science development, and subjective preferences. To reduce the influence of the past (etymology, myths), to minimize the factor of subjectivity, thus increasing the objectivity of the definitions, a scientific approach is becoming a necessity, and scientific definitions are being developed. These scientific definitions are conscientiously built with scientific terms, logic, and mathematics – the key attributes of any science. With such an approach, creativity is defined as "**a human activity of accelerating organization and/or decelerating disorganization**." This new definition works equally well for all fields of human activities from art to science, from technology to education, from military to civilian, economic, social and political life, thus proving its universal applicability, as a true scientific definition, and laying the foundation for the science of creativity. The discovery of these new sciences and research fields, new laws, models, techniques, units, teaching methodologies not only corroborates the process of *acceleration* in science, technology, business and education development but also clearly illustrates a direct giveback from the new science of creativity to the creativity of science.

Just as any theoretical breakthroughs in any field open new horizons for future researchers and technology specialists, the new scientific definition of creativity and new science of creativity (see ▶ Science of Creativity) will lead to new investigations in theoretical and applied research. Future directions of research include applying the generic definition to all particular fields to specify its work in all human activities. New mathematical tools will be applied to measuring creative output as accelerating organization. Business and education will recognize creativity as the most powerful accelerator. The scientific definition of creativity as accelerating organization also requires a new, more structured vision of organization itself, so the development and further publications on the new sciences of organizology and intensiology are in the plans.

Cross-References

- ▶ Creative Leadership
- ▶ Creative Linguistics
- ▶ Creative Pedagogy
- ▶ Creativity
- ▶ Creativity Models
- ▶ Creativity Techniques
- ▶ Creativity Tests
- ▶ Genius
- ▶ Imagination
- ▶ Measurement of Creativity
- ▶ Novology
- ▶ Science of Creativity

References

Aleinikov AG. Sozidolinguistics for creative behavior. J Creat Behav. 1994;28(2):104–23.

Aleinikov AG. Humane creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999a. p. 837–44.

Aleinikov AG. Mega-creator: from creativity to mega-, giga-, and infi-creativity. Montgomery: MIMII; 1999b.

Aleinikov AG. MegaCreativity: five steps to thinking like a genius. Cincinnati: Walking Stick Press; 2002.

Aleinikov AG. Theoretical foundations of creative linguistics. (russ. Теоретические основания креативной лингвистики). Unpublished Doctor of Sciences dissertation. Moscow: Military University, 1992.

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Language awareness: stereotypes and creativity; 1988. Moscow: Institute of Linguistics, USSR Academy of Sciences, (russ. Креативная лингвистика (обоснование, проблемы, перспективы). Языковое сознание: стереотипы и творчество. Институт языкознания, Академии Наук СССР, Москва, 1988).

Aleinikov A, Kackmeister S, Koenig R, editors. Creating creativity: 101 definitions (What Webster never told you). Midland: Alden B. Dow Creativity Center Press; 2000.

Cropley AJ. Definitions of creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999. p. 511–24.

Davis G. Creativity is forever. Cross Plains: Badger Press; 1981.

Freud S. Creativity and the unconscious. New York: Harper; 1925.

Guilford J. Intelligence, creativity, and their educational implications. San Diego: Knapp; 1968.

Isaksen SG, Dorval KB, Treffinger DJ. Creative approaches to problem solving: a framework for innovation and change. 3rd ed. Thousand Oaks: SAGE; 2011.

Kubie L. Neurotic distortion of the creative process. Lawrence, Kansas: University of Kansas; 1958.

Locke EA. Toward a theory of task motivation and incentives. Organizational Behavior & Human Performance. 1968;3(2):157–189.

Maslow AH. Towards a psychology of being. 2nd ed. New York: D. Van Nostrand Company; 1968.

Parkhurst HB. Confusion, lack of consensus, and the definition of creativity as a construct. J Creat Behav. 1999;33(1):1–19.

Parnes SJ, editor. Source book for creative problem solving. Buffalo: Creative Education Foundation Press; 1992.

Plucker JA, Dana RQ. Drugs and creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999. p. 607–11.

Pritzker SR. Alcohol and creativity. In: Runco MA, Pritzker SR, editors. The encyclopedia of creativity, vol. 1. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999. p. 53–7.

Simonton DK. Origins of genius: Darwinian perspectives of creativity. Oxford: Oxford University Press; 1999.

Torrance EP. Future needs for creativity research, training, and programs. In: Aleinikov AG, editor. The future of creativity. Bensenville: Scholastic Testing Services; 2002. p. 1–10.

Treffinger DJ. Creativity, creative thinking, and critical thinking: in search of definitions. Sarasota: Center for Creative Learning; 1995.

Wertheimer M. Productive thinking. New York: Harper & Row; 1959.

Creativity from Design and Innovation Perspectives

Galina Medyna[1], Eric Coatanéa[1],
Francois Christophe[1], Mohamed Bakhouya[1],
Denis Choulier[2] and Joëlle Forest[3]
[1]Department of Engineering Design and Production, Aalto University School of Science and Technology, Aalto, Finland
[2]University of Technology of Belfort Montbéliard, Belfort, France
[3]EVS-ITUS UMR5600, National Institute of Applied Sciences of Lyon, University of Lyon, Villeurbanne, France

Introduction

The notion of innovation is associated with abundant literature presenting a variety of viewpoints, some complementary and others contradictory. In this literature, the concept of innovation is often associated with novelty and the added value provided by new products, processes, or services to groups or individuals. This viewpoint is clearly present in the third edition of the Oslo Manual (2005) which defines innovation as "the implementation of a new or significantly improved product (good or service), or process; a new marketing method, or a new organizational method in business practices, workplace organization or external relations." Elsewhere the same reference to novelty is used to describe creativity, "the creative process is seen as the sequence of thoughts and actions that leads to a novel, adaptive production" (Lubart 2010). This type of ambiguity and confusion in the definitions of the two concepts is often encountered in many related works.

The confusion is further maintained by the fact that research in the fields of creativity and innovation addresses similar questions. For example, the Organisation for Economic Co-operation and Development (OECD) definition of innovation defines three levels of "new": new to the world, new to a nation, and new to the firm. Thus, this raises the question of whether a product or process that is new to a particular nation, geographic, or political region can be considered innovative in the same manner as a product or process that is new to the world, and therefore obviously innovative (Holbrook and Hughes 2003). Such a question is also considered to be central in creativity research focusing on the analysis of creative products (MacKinnon 1978) and on the challenge of comparing two novel ideas to show which one is the most creative (Boden 1996). Moreover, the ambiguity between the concepts of creativity and innovation is accentuated as they seem to correspond to distinct processes, the first being the starting point of the latter (Amabile et al. 1996).

In an attempt to clarify the notions of creativity and innovation, the design process can be considered as the central process of innovation as claimed by Kline and Rosenberg, "the central process of innovation is not science but design" (Kline and Rosenberg 1986). Multiple recent studies confirm Kline and Rosenberg's statement by providing pragmatic evidence that design plays a major role in innovation. For instance, a recent survey of Swedish companies shows that firms that use design activities geared toward innovation as a strategic driver are five times more likely to develop new products as compared to firms that do not (Swedish Industrial Design Foundation 2008; European Commission 2009). Moreover, these firms increase their chances of developing radical innovation (Irish Center for Design Innovation 2007; Tether 2009).

This entry aims to explore the relationship between creativity, design, and innovation. To this end, a first part develops a short state of the art review of creativity and the point of view of creativity as a process. Then, design is presented as a process and considered in its creative character. In a third part, the link between creativity and design is made through the notion of *ingenium*. Finally, the entry introduces a new manner of considering creativity from a design-centered perspective.

Creativity as a Process

Interest in research linked to the field of creativity began to grow in the 1950s. In 1950, Guilford emphasized the scarcity of research on creativity: less than 0.25 % (only 183 among 121,000 abstracts) of the entries in Psychological Abstracts for the preceding 23 years dealt with the subject of creativity (Guilford 1950). He then went on to underline the social importance of creativity and invited his colleagues to develop research on the topic.

Since then theories on creativity have focused on a variety of aspects. Rhodes was the first, in 1961, to note that there are four fundamental areas of inquiry in creativity research. He called these areas the four Ps of creativity, referring to *person*, *product*, *place*, and *process*.

The first one focuses on the characteristics of the creative *person* which, related research shows, tends to have such characteristics as risk taking, autonomy, humor, open-mindedness, tolerance of ambiguity, curiosity, etc. Researchers have also studied creativity aspects linked to the creative *product*, "the starting point, indeed the bedrock of all studies of creativity, is an analysis of creative products, a determination of what makes them different from more mundane products" (MacKinnon 1978, p. 187). The focus on *place* considers the best circumstances which nurture creativity; these include degrees of autonomy, access to resources, and the nature of gatekeepers. The final P, *process*, examines the thinking stages occurring when people behave in a creative manner; this aspect has been principally studied in psychology and cognitive science. To consider creativity as a process means adhering to a tradition of thought that diverges from the myth of creativity being a matter of divine inspiration (Sternberg and Lubart 2005).

A way of considering creativity as a process is through a widely accepted model which was introduced by Wallas and Smith (1926) initially in the form of four stages:

1. Preparation to a problem: Focuses the mind of individuals and explores the problem's dimensions.
2. Incubation: The problem is internalized into the unconscious mind; nothing appears to be happening externally.
3. Intimation: The creative person has a "feeling" that a solution is coming.
4. Illumination: Eurêka! The creative idea bursts forth from preconscious processing into conscious awareness.

This initial model was later completed with a fifth stage:

5. Verification: The idea is verified, elaborated, and starts toward an application.

Further developments include Guilford's model which underlined the distinction between convergent and divergent thinking (Guilford 1967), and Amabile et al. (1996) who suggested that it is important to distinguish a problem-finding or problem-formulation phase, in which relevant information is gathered and preliminary ideas are proposed, from the preparatory phase. Other authors have also considered that more detailed subprocesses are involved in creativity such as perception and information encoding using heuristics as well as the process of forgetting which has been found to play a role in overcoming initial mental fixations. The process of reorganizing information as part of creative thinking has also been considered.

Furthermore, according to Mumford et al. (1991), the phases introduced by Guilford and Amabile occur in a certain kind of approximately organized sequence. In the case of problem formulation, they involve the stages of problem construction, search for relevant information, information retrieval and encoding, specification of best fitting categories of information, combination and reorganization of category of information to generate new solutions, idea evaluation, implementation of ideas, and monitoring. According to the same authors, this fuzzy organization explains, to a great extent, the variance in the creative performance during problem-solving tasks related to the study domains; these included advertising, managerial, and public policy. A model sharing numerous commonalities with the model of Mumford has been proposed by Finke et al. (1992). This model decomposes this loosely organized process into generative and exploratory subprocesses. The generative subprocess includes knowledge retrieval, idea association, synthesis, transformation, and analogical transformation. The exploratory subprocess includes interpretation of reinventive structures, hypothesis testing, and searching for limitations. These different subprocesses are combined together in the form of iterative cycles leading to creative results. The relationships between the phases and subprocesses of the creative process are complex because they operate almost always simultaneously.

The necessity of analyzing the creative process from different viewpoints and perspectives is also emphasized by Sternberg and Lubart (2005, p. 12). They note that “unidisciplinary approaches have tended to view a part of the phenomenon (e.g., the cognitive processes of creativity, the personality traits of creative persons) as the whole phenomenon; often resulting in what we believe is a narrow, unsatisfying vision of creativity.” Considering creativity from a multidimensional perspective leads to a better understanding of the creative process and to a more complete picture of its dynamic. In order to push forward this initial state of the art, the further sections focus the design process and later its interdependence with the creative process.

Design as a Process

Defining design from its results makes little sense as designed artifacts have varied characteristics. They can be produced in varying numbers (from unique large structures to mass-produced goods), vary in terms of user perception (be surprising or commonplace), be tangible or intangible (goods vs. software), be produced on varying scales (from nanoparticles to macroscopic level environments), act passively or actively, bring positive or negative additions to life, etc. This list of traits of existing artifacts is, of course, easily expandable but such a list is useless unless one wants to create an exhaustive typology or taxonomy of a set of artifacts. If design cannot be defined purely from its outcome, there is nevertheless a converging vision of design seen as a process (Design Council 1995; Love 2002; European Commission 2009).

The starting point of this process is a need (Simon 1997) that cannot be satisfied immediately by taking resources from nature, by buying or by applying traditional routines (Micaelli and Forest 2003). In other words, in order to understand what an artifact is, one should first understand its purpose, “what is it made for?” Indeed, a specific feature of designed artifacts is that their essential purpose is to be used and to serve users. The first attribute of an artifact is therefore its function rather than its organic composition or its concrete structure. The adaptation criterion is the adjustment level to a need, defined as an “external constraint.” As a consequence, a designer’s main assignment does not consist in producing perfect artifacts or artifacts that copy nature as closely as possible; it resides in producing functional artifacts that properly fit particular needs (Coatanéa 2005). To sum up, a function is seen as a connection made between the “inner environment” of the artifact and its “outer environment” by way of “interfaces” (Simon 1997). The verification of the functions of the artifact is made by the analysis of its behavior. The artifact has to fulfill an expected behavior.

For designers, this implies the use of deduction in order to select the adequate principles and avoid non-desired effects associated with physical principles. The justification of the design decisions related to artifacts has to be supported by a rational analysis. This rational approach has been developed and explored in the 1980s by the Systematic Design School (Pahl and Beitz 1984) and in a certain extent by the Value Analysis School (Gage 1967) in the 1950s and 1960s. This exploration has produced guidelines structuring the design process. These guidelines are now largely used in industry. Commonly these guidelines separate the design process into five key phases:

1. Evaluation and selection of ideas: The objective of this first stage is to use the firm’s knowledge of its market to identify a promising idea and to insert this new product idea into the firm’s “strategic objectives and business sector” (Perrin 2001, p. 117).

2. Preliminary reflection: This stage aims to understand and clarify the need, in other words, to define the problem and the design environment. This involves setting up a functional analysis process for the new product in order to list the different functions to be fulfilled.
3. Feasibility study (preliminary project study): This stage looks for possible solutions for each of the functions listed as needing to be fulfilled, and evaluates some of the possible combinations.
4. Search for a global solution by assembling solutions to each function: This stage involves some dimensioning of the product.
5. Final design: The objective is the production and verification of a final design.

The design process is an integrative process considering and merging together multiple expectations such as the functionalities, the aesthetic, security, and environmental aspects as well as, from an architectural point of view, multiple components or subsystems. Due to its complexity and to time and resource constraints, the design activity is seldom a process involving an isolated actor. It relies, on the contrary, most of the time on the cooperation of numerous designers with different expertise and competences. Design is a process where creativity plays a central role; the following section dwells on this aspect.

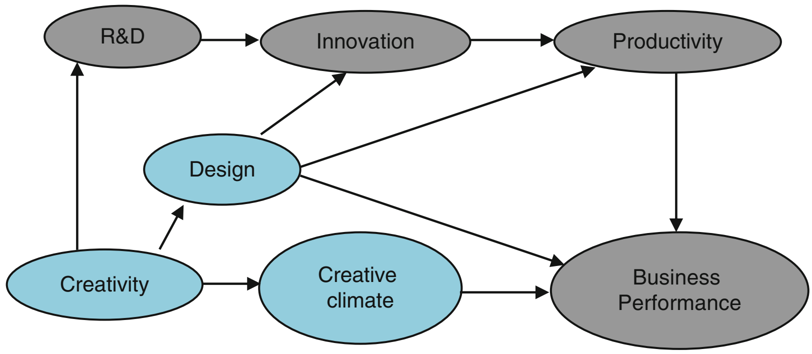
The Creative Nature of Design: Ingenium

One of the essential properties of design is its creative nature, this aspect has been clearly marked by several authors (Medyna et al. 2009): "Design involves (. . .) the presence of a creative step" (Archer 1984); "all designing is iterative, using creativity and compromise to move from a field of possibilities to one unique solution" (Roy and Wield 1986); "Design is a structured creative process" (UK Department of Trade and Industry 2005); "Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles" (ICSID 2009). Considering the creative nature of design leads to the rehabilitation of a kind of reason Western tradition seems to have forgotten (Faucheux and Forest 2011). It was recognized by Vico through his notion of *ingenium* and similar to a form of thinking the Greeks called *metis*.

In *De Nostri Temporis Studiorum Ratione* (1709), Vico defines *ingenium* as the ability to understand the relationships that exist between separate elements of reality, therefore establishing relationships between disparate things or concepts. It can be defined as the ability to associate in an effective way scattered items (concepts, things, technologies, knowledge domains. . .). As such, it is the faculty to bring together different perspectives, to make distinct domains closer, to find and explore relations that none have previously made. Creativity as a whole does not necessarily equate to *ingenium*. *Ingenium* is a way of thinking a kind of rationality, involved in design. According to Vico himself *ingenium* explains how the main Western inventions of the end of the Middle-Ages and the Renaissance (e.g., Brunelleschi's works) were created. Contemporary researchers in innovation (Nonaka 1994; Maskell 2001; Antonelli 2006; Nooteboom et al. 2007) consider knowledge combination, close to the notion of *ingemium*, as the very origin of innovation.

Contribution of a Design-Centered Perspective for Understanding Creativity from a Holistic Point of View

If creativity and the notion of *ingenium* are considered as attributes of the design process, the relationships between creativity, design, and innovation need to be clarified in new terms. This perspective modifies, for example, the viewpoint proposed by Swann and Birke (2005). In their interactive model (Fig. 1), creativity and design are linked to innovation as the first contributes to the expansion of available ideas and the second increases the chances of successfully commercializing these ideas. Furthermore, in the same model, creativity directly influences design

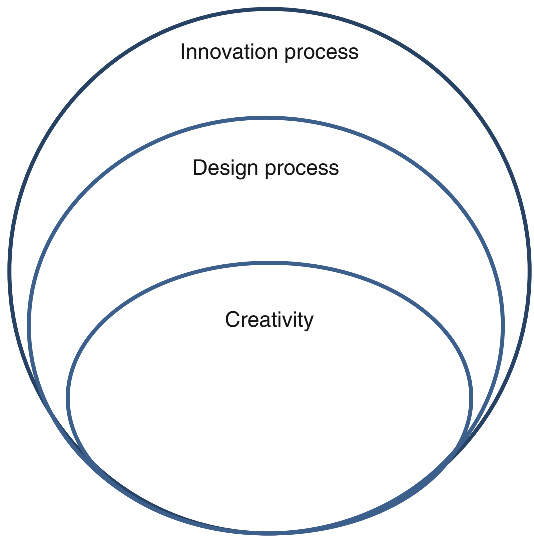


Creativity from Design and Innovation Perspectives, Fig. 1 Interactive model of the design process (Swann and Birke 2005)

and appears to be a prerequisite for it, while design similarly directly influences innovation.

Recognizing *ingenium* as the creative rationality involved in design shows, however, that design can no longer be described as a process linking creativity to innovation channeling ideas for commercial advantage. Creativity becomes a fundamental component of a more global process – the design process – which is itself the central process of the innovation process. This vision is presented in Fig. 2.

More precisely, different creative episodes occur during the design process that could be considered as sub-creative processes. The nature of the relationships built during the successive steps of the design process leads to the conclusion that *ingenium* is a way of thinking which is used during the different phases of the design process *creating* the link between the firm's knowledge and a market during the first phase of the design process, then establishing links between the future product and its outer physical environment, directly concerning functions. A third type of links is established mainly during the third phase where physical structures have to be imagined for fulfilling functions and steadily linked to those functions by the application of some form of deduction. In a fourth phase, the assembly of components is a form of *ingenium*. Finally, during the entire design process, and specifically during the last phase, problems have to be regularly considered using creative problem solving approaches (Choulier 2011).



Creativity from Design and Innovation Perspectives, Fig. 2 Creativity is part of a more global process

Conclusions and Future Directions

The previous analysis highlights the complex links between the notions of design, creativity, and innovation. Creativity can no longer be considered as separate from design but rather it must be considered as part of the different subprocesses of design and innovation. The form of creativity involved during design refers to the notion of *ingenium*, a form of rationality that establishes links between things or concepts.

Such a point of view leads to the conclusion that it is possible to enhance creativity during the design process in order to generate value for individuals, customers, companies, or other stakeholders. Another aspect is the innovation that has been analyzed only partially in this short work. It should be developed further in future entries that innovation involves a process of acceptance by the public and the users as well as a historical analysis of the outcome of the creative design process. An innovation is only considered as such if it has gone through the selection of a community of users.

Some other aspects of the links between the three notions of creativity, design, and innovation remain open. For example, is it possible to have creativity without design? Some authors seem to defend such a thesis when considering the creative process in artistic domains.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Age and Creative Productivity
▶ Convergent Versus Divergent Thinking
▶ Creative Behavior
▶ Creative Brain
▶ Creative Mind: Myths and Facts
▶ Creative Personality
▶ Creativity Across Cultures
▶ Creativity and Innovation: What Is the Difference?
▶ Divergent Thinking
▶ Divergent Versus Convergent Thinking
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Research on Creativity

References

Adam Holbrook A, Hughes L. Operationalizing definitions of innovation at the level of the firm. Centre for Policy Research on Science and Technology, working paper. http://www.Utoronto.ca/isrn/documents/holbrook1.Pdf (2003). Accessed 19 Dec 2011.

Amabile TM, et al. Assessing the work environment for creativity. Acad Manage Rev. 1996;39(5):1154–84.

Antonelli C. The business governance of localized knowledge: an information economics approach for the economics of knowledge. Indus Innov. 2006;13:227–61.

Archer L. Systematic method for designers. In: Cross N, editor. Development in design methodology. New York: Wiley; 1984. p. 57–82.

Boden M. Dimensions of creativity. Cambridge, MA: MIT Press; 1996.

Choulier D, Weite PA. Découvrir et appliquer les outils de TRIZ. Belfort: Université de Belfort-Montbéliard; 2011. ISBN 978-914279-55-0.

Coatanéa E. Conceptual modeling of life cycle design: a modeling and evaluation method based on analogies and dimensionless numbers [PhD dissertation]. ISBN 951-22-7853-7, ISBN 951-22-7852-9; 2005.

Council D. Definitions of design. London: Design Council; 1995.

European Commission. Design as a driver of user-centred innovation, SEC (2009)501; 2009.

Faucheux M, Forest J. Stimulating creative rationality to stimulate innovation. Creat Innov Manage. 2011;20(3):207–12.

Finke RA, et al. Creative cognition: theory, research, and applications. Cambridge, MA: MIT Press; 1992.

Gage WL. Value analysis. London: McGraw Hill; 1967.

Guilford JP. Creativity. Am Psychol. 1950;5:444–54.

Guilford JP. The nature of human intelligence. New York: McGraw-Hill; 1967.

ICSID. http://www.icsid.org/about/about/articles31.htm (2009). Accessed 05 Aug 2009.

Irish Center for Design Innovation. The design difference. A survey od design and innovation amongst Ireland's SME's; 2007.

Kline S, Rosenberg N. An overview of innovation. In: Landau R, Rosenberg N, editors. The positive sum strategy. Washington, DC: National Academy Press; 1986. p. 275–305.

Love T. Constructing a coherent cross-disciplinary body of theory about designing and designs: some philosophical issues. Des Stud. 2002;23(3):345–61.

Lubart T. Models of the creative process: past, present and future. Creat Res J. 2010;13(3–4):295–308.

MacKinnon DW. In search of human effectiveness: identifying and developing creativity. New York: Creative Education Foundation; 1978.

Maskell P. Knowledge creation and diffusion in geographic clusters. Int J Innov Manage. 2001;5(2):213–37.

Medyna G, Coatanéa E, Lahti L, Howard T, Brace W, Christophe F. Creative design: an initial analysis and ontology. Submitted to MCPC 2009 (Mass Customization and Personalization Conference 2009), Helsinki, Finland; 2009.

Micaelli JP, Forest J. Artificialisme. Lausanne: Presses Polytechniques Universitaires Romandes; 2003.

Mumford MD, Mobley MI, Uhlman CE, Reiter-Palmon R, Doares LM. Process analytic models of creative capacities. Creat Res J. 1991;4:91–122.

Nonaka I. A dynamic theory of organizational knowledge creation. Organ Sci. 1994;5(1):14–37.

Nooteboom B, et al. Optimal cognitive distance and absorptive capacity. Res Policy. 2007;36(7):1016–34.

Oslo Manual. The measurement of scientific and technological activities. http://www.oecd.org/dataoecd/35/61/2367580.pdf (2005).
Pahl G, Beitz W. Engineering design: a systematic approach. London: Springer; 1984.
Perrin J. Concevoir l'innovation industrielle. Méthodologie de conception de l'innovation. Paris: CNRS Editions; 2001.
Roy R, Wield D. Product design and technological innovation. Philadelphia: Open University Press, Milton Keynes; 1986.
Simon HA. The sciences of the artificial. 3rd ed. Cambridge, MA: MIT Press; 1997.
Sternberg RJ, Lubart TI. The concept of creativity: prospects and paradigms. In: Sternberg RJ, editor. Handbook of creativity. Cambridge: Cambridge University Press; 2005. p. 3–14.
Swann P, Birke D. How do creativity enhance business performance? A framework for interpreting the evidence. Think piece for DTI Strategy Unit, final report. Nottingham University Business School; 2005.
Swedish Industrial Design Foundation. 2008.
Tether B. Design in innovation coming out from the shadow of R&D an analysis of the UK innovation survey of 2005. Department for Innovation, Universities and Skills Research Report 09–12, London; 2009.
UK Department of Trade and Industry. Creativity, design and business performance. Econ Paper, 15; 2005.
Vico G. De Nostri Temporis Studiorum Ratione; 1709.
Wallas G, Smith R. Art of thought. New York: Harcourt Brace; 1926.

Creativity in Business

► Creative Management

Creativity in Invention, Theories

Thomas Kaiserfeld
Departmant of Arts and Cultural Sciences,
Lund University, Lund, Sweden

Synonyms

Change management; Creativity techniques; Innovation; Originality; Problem-solving; Radical invention

Creativity and Invention

Creativity is a capacity or trait, inherited or acquired, implying a more or less unique ability to apprehend new ideas and insights (Taylor 1988). Departing from standard definitions of creativity, the concept lies at the heart of invention. In Western history, it has thus been viewed as problematic, even heretical. Since God created the world out of nothing, *creatio ex nihilo*, any attempts to similarly create inventions out of nothing was conceit (Tatarkiewicz 1980; Perkins 1988). In research into the sources of creativity, individual characteristics are occasionally combined with environmental influences. Likewise are particular situations of insight, described by their unexpectedness and sudden effortlessness, often combined with the stressing of preparations as in knowledge accumulation (Gruber and Davis 1988; Finke 1995). The view that creativity is more the result of an enduring process has led to many attempts to identify phases of creative thinking (Funke 2009). Today, however, phases or stage models of the creative process seem dated. Instead, the focus is on multiple subprocesses of creativity such as problem finding, problem formulation, problem redefinition, generation of alternative ideas (divergent thinking), combining information, synthesis work, perception, and information encoding. In addition, it seems as if multiple subprocesses may be combined in different ways in order to lead to creative paths (Lubart 2000–2001).

Secondly, the problems of defining the concept of invention have been stressed by many researchers, an insight that has caused still more of them to refrain from it altogether (e.g., Gilfillan 1935). Here, the definition of invention will be the broadest possible and thus assumed to signify anything made different from everything already existing, any thought, practice, or material manifestation that is new because it is qualitatively different from existing or historical forms. Note that some inventions may remain as mental organizations exclusively because of their nature, whereas others may be materialized. Likewise, this definition does not limit inventions to technical novelties. Instead, any type of novelty introduced to any type of practice such as literature or art may be called an invention. Inventions as defined here may also well include ideas, explanations, and theories, as well as social institutions and organizations.

In order to be called an invention, however, it needs to be genuinely and globally new. It does not suffice to create something already existing but unknown to the inventor through so-called personal creativity. For inventions, so-called historical creativity is the more relevant form, leading to new and hitherto nonexistent entities (Csíkszentmihályi 1996; Pope 2005). Departing from this narrower definition of creativity, it is likewise important to point out that creativity is sought for and acclaimed in many different contexts, from the world of sports to literature and science. Although it has been claimed that creativity in science and art is one and the same, different institutions, that is, social mechanisms that govern human behavior, clearly promote different creative ideas in different contexts resulting in different standards regarding what is to be considered relevant creativity and what is not.

Over the past two decades, creativity research has become more refined regarding the different domains in which it is studied and it is clear that we need to also take into account the specific contexts and institutions that determine creativity in invention as understood in the domain of innovation and entrepreneurship. Thus, we here assume that differences between tasks lead to at least some differences in the creative process and that creativity to some extent is domain specific although not altogether domain general (Amabile 1996; Baer 2010). When specifically dealing with creativity in invention such as new devices, methods, or processes developed from study and experimentation, as well as in innovation, that is, the implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organizational method in business practices, workplace organization, or external relations, the applicable institutions reward creativity leading to potential realization, business opportunities, and commercialization.

It has correctly been pointed out that inventions may be abundant in a specific culture without ever being developed into innovations. One often cited example is ancient China where a lot of techniques such as paper, gunpowder, and printing were invented but more seldom implemented on a broader scale. Thus, it is possible to have inventions in abundance and still lack innovations. Nevertheless, inventions are a necessary precondition for innovations. From this perspective, creativity in invention that never ever leads to products or services with possibilities of being commercialized is thought to be of lesser value than that which does. The theories reviewed in this entry have all been selected because of their relevance from this specific perspective and thus only constitute a small subset of theories of creativity (Kozbelt et al. 2010).

The concept of innovation usually denotes the process that takes place when a new product or a new process is developed, from idea to market, while the concept of invention only denotes the process that takes place when new ideas or solutions are generated per se (Tidd et al. 2001). Thus, invention is assumed to precede innovation, which in its turn is assumed to precede implementation, that is, the process that takes place when a product or a process is adjusted and further developed to fit market conditions. Although invention is thought of occurring early in the context of innovation and entrepreneurship, creativity, departing from the broad definition used here, occurs throughout the whole area of invention, innovation, and entrepreneurship activities. The causal linearity between these entities is more of a historical construct than an empirical observation (Godin 2006).

In the literature, it is moreover common to introduce distinctions between different types of inventions such as radical versus conservative (incremental) or independent versus routine, both regarding perceived extent of change (Abernathy and Clark 1985). Here, the former denotes inventions leading to radically new forms of systems and behavior with examples as the telephone or the automobile and the latter denotes inventions or innovations that in one way or another improve existing systems and behavior (Garcia and Calantone 2002). Another common distinction is often made between product and process inventions (or innovations) regarding what is changed. Here, product inventions are seen as a new thing or service, while process inventions are seen as changes in the ways in which they are created, produced, and delivered (Tidd et al. 2001, p. 8). An important tendency regarding this distinction is that it seems as if the rate of product innovations is high and the rate of process innovations is low in the early phases of a new industrial sector or product class. Later though, it seems as if this is reversed so that product innovations become less frequent and process innovations more so (Utterback and Abernathy 1975). (Another category sometimes added on to these two is organizational invention (and innovations), which is then considered likely to be more frequent after the rationalizing of both product and process.)

When discussing creativity in invention, however, we seem to deal even more frequently with uncertain ideas that have yet to be tested and evaluated from the perspective of potential realization and commercialization. Thus, creativity in all types of invention to some extent needs to take into account the calculated consequences of the realization of the invention in question, something not always the case when discussing creativity in other areas such as art or literature. This is even more the case for creativity in innovation and entrepreneurship. So even if the concept of invention is defined in broadest possible way, the scope of creativity in invention can be narrowed down and classified according to explanations of the emergence of inventions. Most commonly, theories propose that (technical) inventions occur in the context of problem-solving as in neoclassical economic theory. Other theories point out individual creativity that can be spurred by organizational and social conditions (Vandervert 2003; Shavinina and Seeratan 2003).

Perspectives, Theories, and Models

Creativity in invention from the perspective of innovation and entrepreneurship can appear in many different forms. It can, for instance, be a novel combination to solve an old problem such as Samuel Langley's use of aerodynamics and power engines to construct a flying machine for humans rather than mimicking natural flight with muscle power as pursued by different nonhuman organisms. Or it can include the novel application of customer skills as in flat-pack furniture to achieve lower prices and avoid bulky packages as developed by IKEA.

Theories of creativity in invention range from the very broad to the very individual. At the broadest end, domain-general cultural theories are found such as anthropologist Cavalli-Sforza (2001) that cultures where the transfer of information predominantly takes place between people in the same generation – horizontal or intragenerational – which tend to be dynamic and changeable compared to cultures where the information is disseminated between generations – vertical or intergenerational – which tend to be preserved and to be less prone to change since older generations teaching the younger ones tend to conserve traditions and customs. This idea can be expanded with the insight that some basic knowledge should probably be transferred vertically in order to form the basis for a more accurate and effective exchange of knowledge, for instance, reading and writing.

In the context of creativity in invention, implications are even less clear and it is an open issue whether intergenerational transfer of knowledge about creativity promotes invention or not. In fact, theories of cultural determinism can be interpreted as implying little or no room at all for creativity in invention (McGee 1995). In conjunction to Cavalli-Sforza's theory of information transfer are ideas of creative inspiration generated by changes in the external environment, for instance, through migration to new physical and ecological environments or encounters with other cultures (McNeill 1963). The same may be true for material artifacts and systems that are transferred from one social context to another and in the process generate creativity in the new setting (Pacey 1990).

Theories of somewhat lesser scope involve institutional environments. Karl Marx, for instance, argues that capitalists invent because they are forced to do so by competition and they are able to innovate because they can draw on a stock of inventions and on science (Elster 1983). Marx also introduces the concepts of forces of production and relations of production arguing that forces of production (often interpreted as science and technology) over time always depart from being in correspondence with the relations of production. This process implies that forces of production sooner or later will become in contradiction to the relations of production. These contradictions may take many forms such as crisis or lead to too many restrictions on changes in the forces of production. The general problem for those interested in Marx' theory of invention is that the factors behind the changes in forces of production are described differently in different texts. In some, it is claimed that contradiction between forces and relations of production only appear when all productive forces for which there is room (within a set of relations) have been developed. In other texts, innovative activities are regarded as springing from the inner individual sources. Marxian theory comes in many different shapes and colors, making it hard to pinpoint views on creativity in invention, more specifically (Rosenberg 1982).

In common, however, is the idea of periodic crises of commercial activities leading to destruction of capital, production, and productive forces followed by creativity in invention generated by exploitation of new markets and new forces of production. Joseph Schumpeter (1942) for one made use of the notion of temporality in inventive activities when popularizing the concept of creative destruction and pointing out the entrepreneur as the force behind the transformation of inventions into innovations paving the way to further creative destruction and new inventions.

Institutional conditions for inventive activities are often assumed to be more specifically defined in theories of creativity in invention. A widely accepted idea is that market conditions, that is, competition between inventions, with their inherent profit motives almost guarantee a drive for creativity leading to new inventions. Demand generates powerful economic incentives for the development of new technologies – whether it solves a problem of such a scale that the invention is likely to sell itself or needs commercials to be put on the market – a notion often summed up under the concept of neoclassical economic theory. And if a technology fails to emerge, it can always be explained by the too high investments needed to realize it, for example, time machines or until recently space tourism. Thus, demand is a necessary but not sufficient condition for the realization of an invention in neoclassical economic theory.

Economist Ester Boserup (1965) has presented a variant of this idea stressing the demographic environment when analyzing new technologies of agriculture. She claims that new methods and technologies for growing provisions are invented only under pressure of lacking resources, which occur when the population grows to such an extent that existing methods and technologies do not suffice to supply the food needed using the land at hand. Boserup's originality lies in her view of the necessity of an imperative force stronger than demand to explain invention, in the case of agrarian technologies, demographic pressure.

Departing from the economic environment, economic historian Nathan Rosenberg has pointed out certain features that both promote and constrain creativity such as the existing technologies and its institutions. In reaction to neoclassical theories where scientific and technological change is entirely endogenous to economic forces (Schmookler 1966), he stressed their exogenous character (Rosenberg 1974). To some extent, scientific and technological changes are endogenous to economic factors, not the least in a world where new technologies and scientific results to a large degree depend on material resources such as laboratory equipment. On the other hand, Rosenberg argues, economic demand does not entirely decide what knowledge is acquired and what is not. There is an independent and non-negligible supply side of science and technology changing along lines determined by other factors than economic that "imposes significant constraints or presents unique opportunities which materially shape the direction and the timing of the inventive process"

(Rosenberg 1974, p. 95). Similarly, it has been claimed that market incentives leave room for scientific research carried out without motives of rent seeking, although the value of research is always created through endogenous processes (Romer 1990).

A more domain-specific feature of existing technologies that, in combination with market forces, may create enormous pressure for inventive creativity is reverse salients or bottlenecks (Hughes 1992; Hirschman 1958). No matter how the idea is labeled, the common denominator is the notion of a crucial problem that, if solved, will generate profit with high certainty. Hughes points out that technology always exists in relations to other technologies in systems that only work as well as its weakest link. If a link of a system seems to functionally lag behind other parts, there will be very high (demand-driven) incentives to improve or replace it with something that continues to match the output of other parts of the system.

An often-used metaphor for market economy as stipulated by neoclassic theory is that of natural selection. Here, inventions are metaphorically seen as genetic variation with or without involving creativity, whereas the mechanisms of decision made on a market as well as the institutions surrounding it correspond to selection pressure exercised by the environment in natural selection acting blindly on a set of inventions (Brooks 1980). Inventions are continuously tried in an existing environment and the one that on the whole is most efficient for the time being is adopted until the environment is changed to favor some other invention or new alternatives emerge that prove more efficient again.

A more sophisticated version is represented by evolutionary economic theories where a company is viewed as a phenotype that is fitted to a changing economic environment where fitness now is defined as profitability. And if the firm corresponds to the phenotype, then routines within the firm corresponds to the genotype of a particular firm (Nelson 1995; Dosi and Nelson 2010). In most evolutionary models, the company employs scientific methods and information, as well as other means to make processes and products fit existing (market) conditions better. In evolutionary economic theories, the firm may adjust their fitness (profitability) consciously and according to carefully planned strategies and tactics.

These ideas of creativity and invention as responses to problems and critical situations can be contrasted by the concept of path dependence (David 1988, 2007). Technological change is path dependent in the sense that inventions are produced in a historical context that severely limits the alternatives available for solving a specific problem or developing an idea for any other reason, no matter how strong (market and other) incentives may be. The emergence of an invention can only be understood through an analysis of the existing pool of knowledge, its possibilities, and its limitations. From this perspective, existing technologies to a large extent determine what will come, both in defining the problems that are to be solved and in supplying the solutions possible and in this way severely constrain creativity. It is hardly bold to conclude that the concept of path dependence works well when trying to explain the dynamics behind conservative inventions but usually is less satisfactory when explaining radical inventions relying on larger measures of creativity.

A different way of understanding creativity and invention is supplied by actor-network theory where it is claimed that a problem is best seen as a resource to promote an invention. Finding a problem that the potential invention may solve creates an argument and engages more resources for its realization. Here, it is stressed how inventions need engagement from different actors such as individuals and organizations and even artifacts, named actants, that cannot speak for themselves and therefore need spokespersons in order to be realized (Latour 1987). The more resources that can be mobilized, the better are the possibilities to go from idea to invention. In the end, success is depending on the engagement that can be mobilized; this is where the creativity is needed more than any other place.

Another concept mirroring institutional forces behind invention and innovation different from economic factors is technopolitical regimes (Hecht 1998). Under technopolitical regimes, creativity may be driven by a strive for satisfying some culturally defined demand valued in the regime, for example, an internationally unique solution to how nuclear power can be exploited in order to produce both electricity and plutonium for weapons. The main point is that concepts such as efficiency and functionality are extremely context dependent. Socially and culturally conditioned demand decides which inventions and innovations are created and realized even if calculated and economically motivated demand points in other directions. Functionality of an invention does not necessarily have anything to do with consumer demand or market decisions. Instead, group identity or trust may be just as important promoters of creativity in invention.

An alternative theoretical approach to inventions and innovations is the notion of systems of innovation. These come in different shapes, are most commonly defined by geographical scope or industrial branch, and thus are usually national, regional, or sectorial. But no matter of attribute, this is in essence an institutional perspective stressing both the interdependence between different actors involved in innovation activities such as firms, individuals, public authorities, and special interest groups and that creativity underlying inventions more often than not emerge in the intersection between different organizations and fields of knowledge (Godin 2009). It should perhaps be added that these ideas most effectively describe invention and innovation of capital goods, where it is often essential for a producer to cooperate closely with a customer, often a state agency.

Another concept used in order to illustrate the importance of institutional and networks as conditions for invention and innovation is development blocks. They are constituted by the factors linked to a specific industrial activity. The growth of a development block depends on the complementary investments made in other fields related to it. As a result, imbalances and structural tensions may appear within the development block, which may cause further changes and invention creativity. Imbalances may arise for different reasons, either by market signals through a drive for efficiency or by changes in network relations between firms and other organizations. They may be the result of activities within a single firm or of cooperation between numbers of actors (Lindgren 1996).

Moving down to more specific contexts, the notion of collective invention departs from the observation that invention takes place in nonprofit institutions such as universities, in profit-seeking firms, and in the mind of individual inventors. As the proponents of the model hypothesize, a collection of agents may produce collective inventions characterized by exchange and free circulation of knowledge and information among themselves creating positive feedback allowing for high innovation rates and fast knowledge accumulation (Cowan and Jonard 2003). More specifically, the componential theory of organizational environment on creativity highlights the organizational motivation, resources, and management practices of organizations to promote creativity in the work environment and the individual expertise, creative thinking (depending on independence, self-discipline, risk-taking, ambiguity tolerance, perseverance), and intrinsic or extrinsic task motivation to promote individual creativity (Amabile 1997). Individual and organizational creativity with these components are likely to promote each other.

Theories regarding innovative organizations like these tend to list features of firms and other types of organizations that promote creativity and inventiveness (e.g., Heinze et al. 2009). Such features may include specialization, professionalism, and knowledge resources as shown in an analysis of determinants for organizational innovation (Damanpour 1991). In addition to the sheer listing of determinants, conclusions regarding organizational invention may also include different importance of different determinants observed in different types of organization or for different types of inventions. For the purposes here, though, it is enough to note that the determinants analyzed can with only a few exceptions be decided upon internally within the firm, for example, through recruiting policies, decision-making processes, and external relations.

The strong focus on internally decided determinants makes the theories on organizational creativity in invention resemble theories of individual invention as, for instance, laid out by Hatfield (1933), where determinants listed as having positive influence on creativity and capacity to invent are often seen as acquired by the individual. In this sense, both theories of individual inventors and theories regarding innovative organizations are internalist in relation to their respective object. Another similarity between theories of individual inventors and theories regarding innovative organizations is the focus on the individual and organizational qualities that promote rather than prevent innovation. In the analysis of determinants for organizational innovation mentioned above, 10 out of 13 determinants were considered positive for the ability to innovate or adopt innovations in an organization (Damanpour 1991).

When considering theories of individual inventors, the stress on positive qualities is even stronger. Traditionally, the individual's abilities have often been stressed, especially in theories developed in romantic contexts stressing the importance of the individual when explaining cultural change. These types of theories are still common (Friedel 1992). The distinction between theories of processes going on inside the heads of individual actors and processes generated by the interaction of individuals is not absolute. Many theories blend components from both categories (Isaksen 2009). One classic model bridging culture and individual creativity with the help of Gestalt psychology is Usher's (1929) four-stage model with the recognition of demand reviews of existing cultural elements, critical revision of them, and creative insight of invention. However, it is striking how often the scope of a theory of invention mainly falls within one of the two categories.

The results emanating from historical studies of individual inventors point to the importance of systematic searches for both problems and potential solutions in the invention process. Systematic searches of problems almost automatically lead to specialization in order to be efficient and thus individual or collective expertise. The problems may be acquired from journals or patent statistics while the solutions may come from scientific findings communicated through journals or a highly skilled staff assigned to keep track of scientific developments. In addition, Hughes has stressed the ability to reason metaphorically, that is, to understand the similarities that are necessary to take into account and the dissimilarities that can be ignored (Hughes 1985). This is similar to the idea of inventors having abilities for remote associations (Gordon 1972). A feature making the individual inventor more inclined to radical or independent inventions in comparison to larger organizations with a large number of employees which typically have routinized the innovation process is the lack of restricting hierarchies directing inventive thinking to certain well-known problems promising high profits for a patented solution (Baumol 2002).

Another idea that has been presented as a common feature among successful individual inventors is their exclusive combination of knowledge in one specific field that proves to hold some interesting clues to the solution of an important problem in another field. Many individual inventors testify of the efficiency of such an advantage. In the development of plastics, for example, the chemist Leo Baekeland had learned of the key problems, problem-solving methods, goals, theories, and tacit knowledge of a so-called technological frame, that is, a set of the issues and knowledge in common for a relevant social group and structuring the interactions between the individuals of that group (Bijker 1995). When he then equipped with one technological frame became a member of another relevant social group connected to another technological frame, it turned out that his experiences could be used in order to solve problems of the new technological frame using insights he had already acquired elsewhere. The same type of ideas has also been proposed to be valid on a cognitive level where the ability to invent to some extent also depends on genetic inheritance (Findlay and Lumsden 1988). More broadly, it is often also claimed that creativity materialized in inventions emerges when individuals in new ways combine their earlier insights and experiences from different frames, analogical transfer, regardless of if the combination appears within the mind of one individual or in the interaction between several individuals with different but complimentary experiences (Magee 2005). On a larger scale, the same ideas appear when inventive cultures or civilizations are discussed as above.

In addition to these ideas regarding individuals' abilities to invent, there are a vast number of psychological theories of how the mind can be set to generate new ideas. One pick of these ideas may include Edward de Bono's (1970) claim that creativity stems from the ability to recognize patterns and arguing for lateral thinking in order to boost creativity. Other usually includes the importance for the individual to depart from a challenge or a problem, to document the ideas that pop up, and to work on ideas that are within the realm of one's competence (e.g., Dasgupta 1994). Yet another set of theories come in the form of tool kits with specific strategies for the individual or the organization that wants to be inventive (Drucker 1985). These have in common the notion that generation of creative inventions can be systematized on an individual or organizational level.

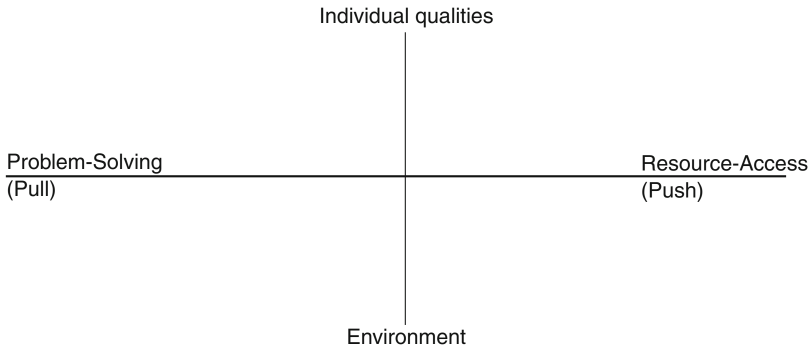
In contrast to these ideas are listings of different individual motives to invent including recognition and financial gains (Westrum 1991). Most intriguing and elusive of these are the so-called intrinsic motives, that is, those where the drive to invent cannot be identified as coming from phenomena external to the individual. Such intrinsic motives have also been claimed to result in higher creativity in comparison to when incentives are external (Amabile 1997).

In conclusion, theories of creativity in invention tend to list qualities that promote creativity rather than qualities that restrict it irrespective of the object of the theory: cultures, institutional contexts, organizations, groups, or individuals. In addition, theories in this area are seldom explicit about what qualities are to be viewed as necessary or sufficient or both (or none) in order for the individual or the organization to actually be creative enough to produce inventions. In this simple sense, theories of creativity in invention tend to be constructive rather than restrictive. In addition, theories of individual and organizational creativity in invention tend to list correlations between specific internally chosen determinants rather than external conditions such as education and practical training or the access to resources. To sum up, theories within these fields seem to aim at supplying sets of qualities and routines for successful inventing and innovation management more than anything else.

Conclusions and Future Directions

Theories of creativity in invention are often classified according to how they explain the emergence of creativity leading to inventions. Traditionally, psychological capabilities in individuals underpinning creativity have often been pointed out. Theories have to a large degree also proposed that problem-solving activities under certain circumstances and in certain contexts generate creativity and (technical) inventions. Both individual and contextual perspectives can be connected to organizational and social conditions. The distinction between theories of processes going on inside the heads of individuals and processes generated by the interaction of individuals is not an absolute one. Theories also blend components from both categories. It is, however, striking how often the scope of theories of invention mainly falls within one of the two categories.

Another dividing principle that can be used in order to characterize theories of invention is whether invention is assumed to be mainly a process of problem-solving or if the focus is on access to resources. In the first case, systematic methods and analytical approaches are generally stressed while the other usually points out the importance of different resources such as technical equipment and knowledge of relevant natural phenomena. In this context, it is important to stress that the distinctions made here are theoretic, not empirical. This means that in each single case, an invention may be accounted for by stressing problem-solving activities as well as the resources at hand. In addition, the individual efforts involved may be studied in conjunction



Creativity in Invention, Theories, Fig. 1 Dichotomized pairs of theoretical principles arranged to span a plane where theories of creativity in invention can be plotted (original graph made by author)

to the social environments in which they occur. Thus, irrespective of the data used, the perspectives outlined here can usually be found in the empirical material studied. There are no inventions without individual efforts or social environment. There are no inventions without resources or problems to be solved.

These different theoretical principles can be summed up in a graph (below) where the dichotomized pairs have been arranged along two different axes. The plane they span can then be used to classify existing theories of creativity in invention. Some theories highlight problems and individual qualities to explain the occurrence of creativity in invention, while others stress the environment (often, but not always its social character) and resources (material as well as human and others). Needless to say, there are also categories of theories stressing other combinations of the principles given here, or all of them (Jewkes et al. 1969). But there are yet no theories that include building blocks apart from individual or environmental qualities and activities characterized by the solving of problems or access to resources. A challenge for the future is of course to determine if it is possible to develop such theories and, if so, what alternative theoretical principles they could rely on? (Fig. 1).

It can be claimed that this analysis of theories of creativity in invention mirrors a historical development. Since it is often assumed that inventions tend to be more and more dependent on both systematically produced knowledge and different resources, material as well personal as for instance proposed by Gilfillan (1935), the graph presented in Fig. 1 below, a historical trend could presumably be represented by a line from the above left corner toward the lower right of the graph. Such a line would at least doubtlessly represent the development of theories of creativity in invention.

Cross-References

- ▶ Actor-Network-Theory and Creativity Research
- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Analogies and Analogical Reasoning in Invention
- ▶ Art of Innovation: A Model for Organizational Creativity
- ▶ Brainstorming and Invention
- ▶ Cognition of Creativity
- ▶ Convergent Versus Divergent Thinking
- ▶ Corporate Creativity
- ▶ Creative Behavior
- ▶ Creative Brain
- ▶ Creative Destruction
- ▶ Creative Knowledge Environments
- ▶ Creative Leadership
- ▶ Creative Management
- ▶ Creative Mind: Myths and Facts
- ▶ Creative Personality
- ▶ Creative Problem Solving
- ▶ Creative Styles
- ▶ Creativity Across Cultures
- ▶ Creativity and Innovation: What Is the Difference
- ▶ Creativity and Systems Thinking

- ▶ Creativity Definitions, Approaches
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
- ▶ Creativity Machine® Paradigm
- ▶ Creativity Management
- ▶ Creativity Optimization
- ▶ Creativity Techniques
- ▶ Creativity, Experiential Theories
- ▶ Creativity, Intelligence, and Culture
- ▶ Divergent Thinking
- ▶ Divergent Versus Convergent Thinking
- ▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
- ▶ Entrepreneurship in Creative Economy
- ▶ Four Ps in Organizational Creativity
- ▶ Four Ps of Creativity
- ▶ Freedom and Constraints in Creativity
- ▶ Imagery and Creativity
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
- ▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
- ▶ Innovator
- ▶ Interdisciplinarity and Innovation
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Invention Versus Discovery
- ▶ Inventive Problem Solving (TRIZ), Theory
- ▶ Inventive Resources
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Levels of Invention
- ▶ Mental Models and Creative Invention
- ▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education
- ▶ Models for Creative Inventions
- ▶ Multiple Models of Creativity
- ▶ National Innovation Systems (NIS)
- ▶ Nature of Creativity
- ▶ Nonlinear Innovations
- ▶ Organizational Creativity
- ▶ Organizational Slack and Innovation
- ▶ Psychology of Creativity
- ▶ Radical Invention
- ▶ Research on Creativity
- ▶ Schumpeterian Entrepreneur
- ▶ Science of Creativity
- ▶ Scientific Creativity as Combinatorial Process
- ▶ Strategic Thinking and Creative Invention
- ▶ Teaching as Invention
- ▶ Technology Push and Market Pull Entrepreneurship
- ▶ Thinking Skills, Development

References

Abernathy WJ, Clark KB. Innovation: mapping the winds of creative destruction. Res Policy. 1985;14:3–22.

Amabile TM. Creativity in context: update to. In: Amabile TM, editor. The social psychology of creativity. Boulder: Westview Press; 1996.

Amabile TM. Motivating creativity in organizations: on doing what you love and loving what you do. California Manag Rev. 1997;40(Fall):39–58.

Baer J. Is creativity domain specific? In: Kaufman JC, Sternberg RJ, editors. The Cambridge handbook of creativity. Cambridge: Cambridge University Press; 2010. p. 321–41.

Baumol WJ. The free-market innovation machine: analyzing the growth miracle of capitalism. Princeton: Princeton University Press; 2002.

Bijker WE. Of bicycles, bakelites, and bulbs: toward a theory of sociotechnical change. Cambridge, MA: The MIT Press; 1995.

Boserup E. The conditions of agricultural growth: the economics of Agrarian change under population pressure. London: Allen & Unwin; 1965.

Brooks H. Technology, evolution and purpose. Daedalus. 1980;109(Winter):65–81.

Cavalli-Sforza LL. Genes, peoples, and languages. Berkeley: University of California Press; 2001.

Cowan R, Jonard N. The dynamics of collective invention. J Econ Behav Organ. 2003;52:513–32.

Csíkszentmihályi M. Creativity: flow and the psychology of discovery and invention. New York: Harper Collins; 1996.

Damanpour F. Organizational innovation: a meta-analysis of effects of determinants and moderators. Acad Manage J. 1991;34(September):555–90.

Dasgupta S. Creativity in invention and design: computational and cognitive explorations of technological originality. Cambridge: Cambridge University Press; 1994.

David PA. Path dependence: a foundational concept for historical social science. Cliometrica. 2007;1:91–114.

David PA. Path-dependence: putting the past into the future of economics. Institute for the Mathematical

Studies in the Social Sciences Technical Report 533. Stanford (CA): Stanford University; 1988.

de Bono E. Lateral thinking: creativity step by step. New York: Harper & Row; 1970.

Dosi G, Nelson RR. Technical change and industrial dynamics as evolutionary processes. In: Hall BH, Rosenberg N, editors. Economics of innovation, Handbooks in economics series, vol. 1. Amsterdam: North-Holland; 2010. p. 52–126.

Drucker PF. Innovation and entrepreneurship: practice and principles. New York: Harper & Row; 1985.

Findlay CS, Lumsden CJ. The creative mind: toward an evolutionary theory of discovery and innovation. J Soc Biol Syst. 1988;11:3–55.

Finke RA. Creative insight and preinventive forms. In: Sternberg RJ, Davidson JE, editors. The nature of insight. Cambridge, MA: The MIT Press; 1995. p. 255–80.

Friedel R. Perspiration in perspective: changing perceptions of genius and expertise in American invention. In: Weber RJ, Perkins DN, editors. Inventive minds: creativity in technology. Oxford: Oxford University Press; 1992. p. 11–26.

Funke J. On the psychology of creativity. In: Meusburger P, Funke J, Wunder E, editors. Milieus of creativity an interdisciplinary approach to spatiality of creativity, Knowledge and Space, vol. 2. Heidelberg: Springer Science + Business Media; 2009. p. 11–23.

Garcia R, Calantone R. A critical look at technological innovation typology and innovativeness terminology: a literature review. J Prod Innovat Manag. 2002;19:110–32.

Gilfillan SC. The sociology of invention. Chicago: Follett; 1935.

Godin B. The linear model of innovation: the historical construct of an analytical framework. Sci Technol Hum Val. 2006;31:639–67.

Godin B. National innovation system: the system approach in historical perspective. Sci Technol Hum Val. 2009;34:476–501.

Gordon G. The identification and use of creative abilities in scientific organizations. In: Taylor CW, editor. Climate for creativity, Pergamon general psychology series, vol. 9. New York: Pergamon; 1972. p. 113.

Gruber HE, Davis SN. Inching our way up Mount Olympus: the evolving-systems approach to creative thinking. In: Sternberg RJ, editor. The nature of creativity: contemporary psychological perspectives. Cambridge: Cambridge University Press; 1988. p. 243–70.

Hatfield HS. The inventor and his world. New York: Dutton; 1933.

Hecht G. The radiance of france: nuclear power and national identity after World War II. Cambridge, MA: The MIT Press; 1998.

Heinze T, et al. Organizational and institutional influences on creativity in scientific research. Res Policy. 2009;38:610–23.

Hirschman AO. The strategy of economic development, Yale studies in economics, vol. 10. New Haven: Yale University Press; 1958.

Hughes TP. How did the heroic inventors do it? Am Herit Invent Technol. 1985;1(2):18–25.

Hughes TP. The dynamics of technological change: salients, critical problems, and industrial revolutions. In: Dosi G, Gianetti R, Toninelli PA, editors. Technology and enterprise in a historical perspective. Oxford: Clarendon; 1992. p. 97–118.

Isaksen SG. Exploring the relationships between problem-solving styles and creative psychological climate. In: Meusburger P, Funke J, Wunder E, editors. Milieus of creativity an interdisciplinary approach to spatiality of creativity, Knowledge and space, vol. 2. Heidelberg: Springer Science + Business Media; 2009. p. 169–88.

Jewkes J, Sawers D, Stillerman B. The sources of invention: a study of the causes and consequences of industrial innovation through the inventions of the nineteenth and twentieth centuries. 2nd ed. London: Macmillan; 1969.

Kozbelt A, Beghetto RA, Runco MA. Theories of creativity. In: Kaufman JC, Sternberg RJ, editors. The Cambridge handbook of creativity. Cambridge: Cambridge University Press; 2010. p. 20–47.

Latour B. Science in action: how to follow scientists and engineers through society. Cambridge, MA: Harvard University Press; 1987.

Lindgren H. Economic dynamism, Stockholm Business School, Institutet för ekonomiskhistorisk forskning, Research Report No 6. Stockholm: Stockholm Business School; 1996.

Lubart TI. Models of the creative process: past, present and future. Creative Res J. 2000–2001;13(3–4):295–308.

Magee GB. Rethinking invention: cognition and the economics of technological creativity. J Econ Behav Organ. 2005;57(1):29–48.

McGee D. Making up mind: the early sociology of invention. Technol Cult. 1995;36(4):773–801.

McNeill WH. The rise of the West: a history of the human community. Chicago: University of Chicago Press; 1963.

Nelson RR. Recent evolutionary theorizing about economic change. J Econ Liter. 1995;33(March): 48–90.

Pacey A. Technology in world civilization: a thousand-year history. Oxford: Basil Blackwell; 1990.

Perkins DN. The possibility of invention. In: Sternberg RJ, editor. The nature of creativity: contemporary psychological perspectives. Cambridge: Cambridge University Press; 1988. p. 362–85.

Pope R. Creativity: theory, history, practice. London: Routledge; 2005.

Romer PM. Endogenous technological change. J Polit Econ. 1990;98(5):S71–102.

Rosenberg N. Science, invention and economic growth. Econ J. 1974;84(March):90–108.

Rosenberg N. Marx as a student of technology. In: Rosenberg N, editor. Inside the black box: technology and economics. Cambridge: Cambridge University Press; 1982. p. 34–51.

Schmookler J. Invention and economic growth. Cambridge, MA: Harvard University Press; 1966.
Schumpeter J. Capitalism, socialism and democracy. New York: Harper & Brothers; 1942.
Shavinina LV, Seeratan KL. On the nature of individual innovation. In: Shavinina LV, editor. The international handbook on innovation. Amsterdam: Pergamon; 2003. p. 31–43.
Tatarkiewicz W. A history of six ideas: an essay in aesthetics, Melbourne international philosophy series, vol. 5. The Hague: Martinus Nijhoff; 1980.
Taylor CW. Various approaches to and definitions of creativity. In: Sternberg RJ, editor. The nature of creativity: contemporary psychological perspectives. Cambridge: Cambridge University Press; 1988. p. 99–121.
Tidd J, Bessant J, Pavitt K. Managing innovation: integrating technological, market and organizational change. 2nd ed. New York: Wiley; 2001.
Usher AP. A history of mechanical inventions. New York: McGraw-Hill; 1929.
Utterback JM, Abernathy WJ. A dynamic model of product and process innovation. Omega. 1975;3:639–56.
Vandervert LR. The neurophysiological basis of innovation. In: Shavinina LV, editor. The international handbook on innovation. Amsterdam: Pergamon; 2003. p. 17–30.
Westrum R. Motives for inventing. Polhem. 1991;9:2–26.

Creativity in Music Teaching and Learning

Clint Randles[1] and Peter R. Webster[2]
[1]Center for Music Education Research, School of Music, MUS 317 College of the Art, University of South Florida, Tampa, FL, USA
[2]Department of Music Studies, Henry and Leigh Bienen School of Music, Northwestern University, Evanston, IL, USA

Synonyms

Composition; Creative thinking in music; Group musical creativity; Improvisation; Individual musical creativity; Listening creativity; Performance creativity

Definition

Creativity in music refers to the divergent and convergent thought processes, enacted both in solo and in ensemble, that lead to musical products that are both novel and useful, within specific sociocultural contexts, manifested by way of specific modes of musicianship or combinations of modes that can include but are not limited to the following: improvisation, composition, performance, analysis, and listening.

Theoretical Background

Creativity in music teaching and learning is perhaps the most important area of study for both researchers and practitioners alike in the field of music education at the start of this new millennium. These sentiments can be felt in the area of the general study of creativity as well (Sawyer 2006/2012). Creative thinking in music is at the heart of creativity in music education, as all of the many ways that humans can be creative with music start and end with creative thinking. Researchers have explored this very complex construct in the field of music and music education research over the past 40 years. There are patterns in the foci of such research efforts over that time period that are important to note as this topic will likely continue to be studied in the coming decades. Adding to the complexity of creativity in this domain is the surge of new technologies that are sure to transform both research and practice as they relate to the multiple ways that creativity is manifest in music teaching and learning.

Creative Thinking in Music

Historically, music teachers have considered the word “creativity” to relate to a constellation of abilities of students to produce products related to composition or, in more limited ways, improvisation. Some of the earliest research on creativeness can be traced back to observational research by Pond in 1940s (1981) that noted the ability of children to improvise and to early work by Paynter and Aston (1970) and Schafer (1979) that featured ideas about music composition in the schools. The study of children’s creative ability with composition and improvisation continues today (Kaschub and Smith 2009) and remains a major part of the National Standards for Arts Education (2004) movement in the United States.

Newer conceptions of creativity in music teaching and learning are emerging, inspired in part by a belief that creative thinking in music occurs in many ways in music, not just in composition and improvisation (Reimer 2003; Webster, in press). One way to think about learning activities in music that involve creative thinking as defined above is to consider two broad dimensions. There are creating learning activity types that (1) deal directly with the making of music itself. There are four subgroupings: (a) playing the composed music of others (performing), (b) improvising (either using a style or in free form), (c) composing original music and/or arranging music, and (d) music listening. Each of these four involve an active role in the creation of music as art and involve creative thinking in complex ways that extend traditional views of creativity in relation to just composition and improvisation as defined historically. To this we add a large second dimension: (2) the study of music as art in terms of nonmusical dimensions. This dimension is rarely considered to involve creative thinking, yet there are rich possibilities for researchers and practitioners in considering this dimension in coming years. There are three parts to this: (a) music's technical construction (music theory, aural skills, physical representation in the air) (b) music's relation to other art forms, (c) music's relation to the context in which it is created.

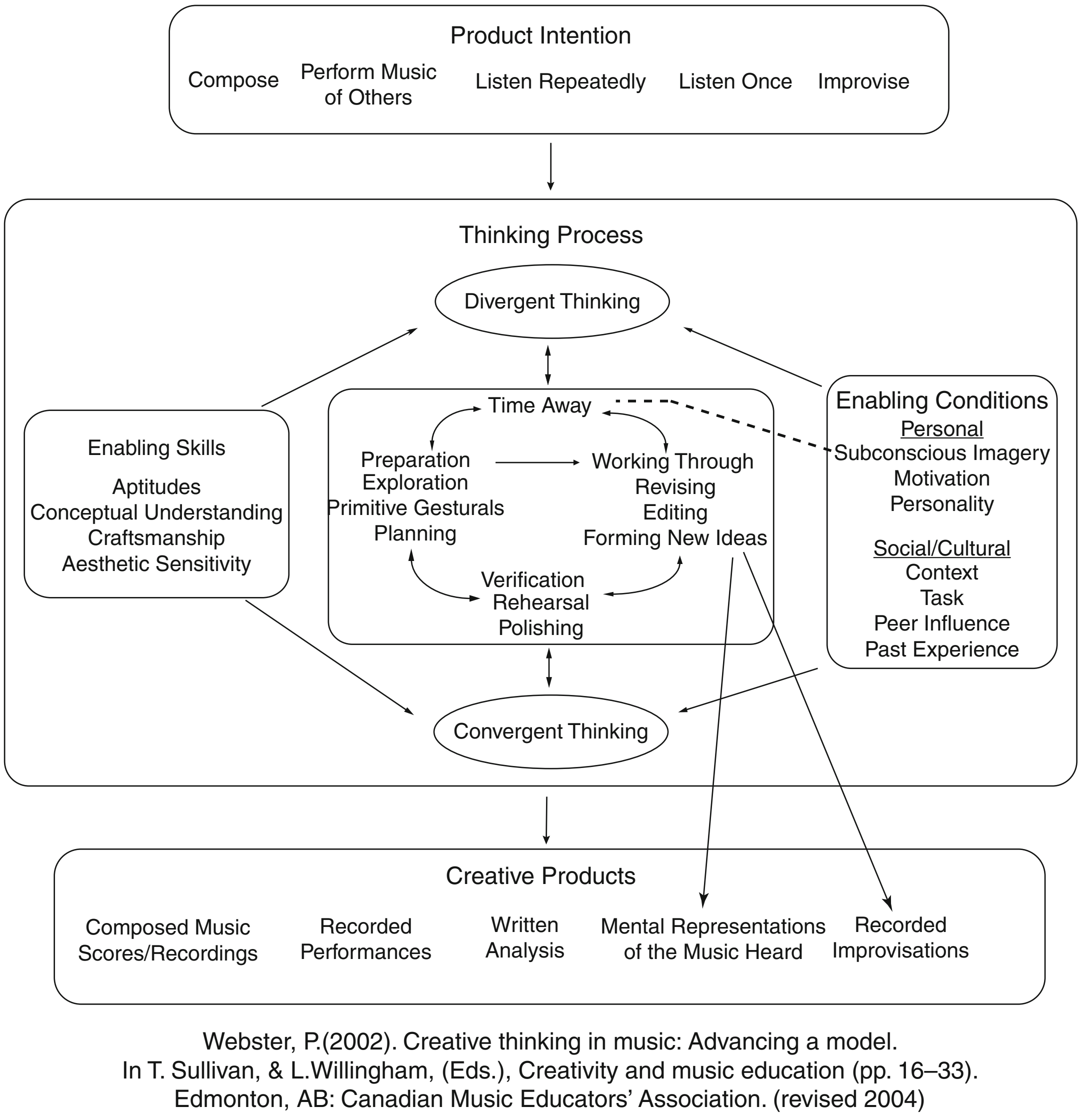
As a conceptual frame for this broader view of creativity, consider the model by Webster (2004) in Fig. 1. This descriptive model is based on a view that "creativity" in music education is best approached by considering the notion of *creative thinking in music*. This model begins with product intentions and ends with a demonstrated product. It has music listening, composition, and improvisation as important parts of the model and accounts for the role of social context.

Finally, an emphasis on the role of collaboration in creativity has emerged in recent years in the general literature on explaining creativity (Sawyer 2012). Individualist theories of creativity that have dominated the popular thinking about creativeness are now tempered with careful consideration for the role of society in framing creative output. This effects how music teachers might address the teaching of creative thinking in classrooms, rehearsal halls, and studios. Such an emphasis works well with constructivist views of music learning (Webster 2011) – an approach that has not been prevalent in music teaching behaviors to date but is growing in interest among younger practitioners. An important part of this developing pedagogy is the use of technology in the music-making enterprise in schools as noted in the *Encyclopedia of the Sciences of Learning* elsewhere online (Webster 2012).

Modes of Musicianship

Theorists in music education have explored the notion that musicality is manifested in multiple ways. Just as there are numerous ways to be intelligent (Gardner 1983/1993/2011), there are numerous ways to be musical. Reimer, based on the work of Gardner, named the different divisions of musicality, "musical intelligences" (2003, p. 219). By aligning his theory closely to Gardner's, Reimer called for a balanced music education curriculum, one that provided students' opportunities to be musical in all of the musical intelligence areas. To not offer adequate instruction in any of the "musical intelligences" would be to under-serve some members of society who might thrive if given the opportunity to exercise their specific musical intelligence strength. These divisions might also be named, "modes of musicianship." This designation places musicianship as the beginning, middle, and end of the matter, something that can be grouped, regrouped, and transformed to account for any "mode" or "modes" that exist or might exist in the future.

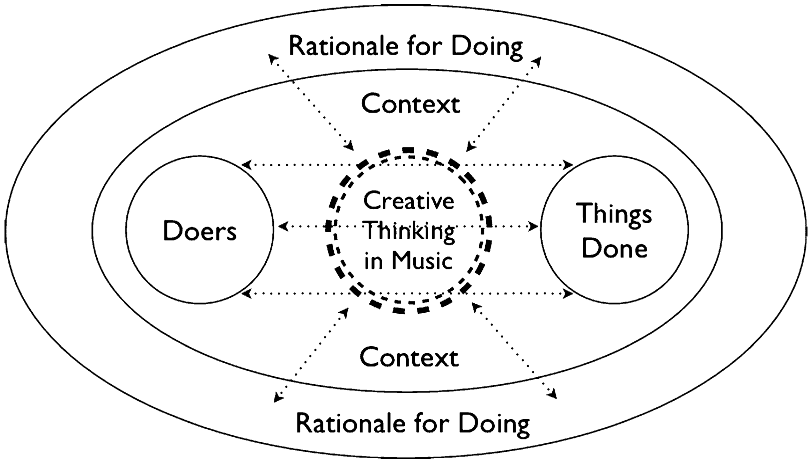
Just as there are numerous ways to be musical, there must therefore be numerous ways to be musically creative. Since being creative with music begins at the level of creative thinking, any individual could be musically creative by way of any of the modes of musicianship previously mentioned. Listening, performing, singing, analyzing, improvising, composing, arranging, and describing are all modes of musicianship.



Creativity in Music Teaching and Learning, Fig. 1 Conceptual model of creative thinking in music

Each mode of musicianship involves doers (people who would like to be musical – the person), some sort of doing (the act of being musical – the process), something done (the result of the musical exchange – the product), and the context in which all of this takes place (some authors call this "press" to keep with the "p" theme). One might think of all of these previously mentioned components of music making as being mediated by the rationale for doing – a philosophy of sorts – that both feeds the desire to make music and is fed by that same desire (see Fig. 2). One's philosophy of music is wrapped up in inter-sonic (musical) as well as delineated (nonmusical) meanings. And, of course, philosophies of music naturally lead to philosophies of music education.

Burnard suggests that the music education profession conceive of musical creativity differently, not as the lone composer, working on creating a masterwork in isolation, as many of the myths surrounding creativity would assume.



Creativity in Music Teaching and Learning, Fig. 2 Conceptual model of creative music making

Rather, she suggests that there are multiple creativities in music that must exist in real-world contexts, in specific practices. The particular creativities that she proposes are: (1) individual creativity, (2) collaborative (or group) creativity, (3) communal creativity, (4) empathic creativity, (5) intercultural creativity, (6) performance creativity in music, (7) symbolic creativity in music, (8) computational creativity, and (9) collective creativity (p. 15–16). She has written a book, titled, *Musical Creativities in Real World Practice*, that details what she means by each of these musical creativities as they exist in the "real world" (2012b).

So, be it different modes of musicianship, or the notion of multiple creativities in music, the domain of music education seems to acknowledge that there must be multiple ways of operationalizing the act of music making, and therefore, there must be multiple ways of being musically creative.

Past, Present, and Future: Research on Creativity in Music Teaching and Learning

Multiple lenses have been employed by researchers in psychology to try to understand the complex construct of creativity. Guilford's Structure of Intellect Model seemed to open the door for researchers to study creativity as a multidimensional construct. In order to better understand this topic, researchers have used multiple methodological lenses to go about their business. In recent years, some methodologies have been used more than others. In order to better understand this topic, researchers have contributed to three primary areas of understanding; these areas are, according to Webster, theoretical, practical application, and empirical (2009). It is possible to think of these three areas as being articulated by way of specific methodologies: psychometric, experimental, biographical, psychodynamic, biological, computational, and contextual. A brief review of the major accomplishments of researchers in music and music education in some of these areas is helpful. The specific areas of psychometric, experimental, biographical, and contextual are detailed here.

Psychometric

Humankind has been exploring the assessment of individual differences from as early as 2200 B.C. (China). This long history must reflect a basic human desire to sort people by differences. Researchers in general psychology in the twentieth century helped to lay the groundwork for all of the research that would follow in music education, by assessing various creative "traits" and personality characteristics of creative individuals. The push, of course, following Guilford's 1950 address to the American Psychological Association (APA), was to identify gifted and talented students so that they could be channeled into careers in math and science, as a way of keeping the United States even with the Soviets in the space race. The major accomplishment of this early psychometric work, however, was the exploration of the notion that there are individual differences, traits, or personality qualities, among all who would desire to be creative. These personal differences were considered independent of context and culture, and were realized to be unique to all individuals. This strand of thought is the "nature" side of the "nature versus nurture" dichotomy. Both contribute to one's potential to be a successful human.

Torrance explored this idea with his *Tests of Creative Thinking* (1974), a measure of general creativity, specifically divergent thinking. Tests takers took both a verbal and figural portion of the test, and were measured on their ability to generate responses to open-ended tasks that demonstrated fluency, flexibility, and originality. The Torrance tests are still widely used today, although some question the construct validity of such assessments. If one takes the position that it is possible to discover benefits to using each of the lenses available to the researcher, then there are potential utilities for such tests as tools for identifying differences in individuals with regard to creativity for the purpose of research.

Personality tests are another manifestation of the psychometric movement to better understand the creative person. These tests have been devised to measure both personality traits and personality types or "temperaments." Traits can be viewed as the "smallest units of individual variation that are consistent, reliable, and valid" (Sawyer 2012, p. 63). Certain personality traits are more or less associated with creative individuals.

Donald MacKinnon founded the Institute for Personality Assessment and Research (IPAR) at the University of California at Berkeley in 1949. MacKinnon (1978) reported that researchers at Berkeley found that various personality traits were common to most highly creative individuals. These traits included the following:

- Above-average intelligence
- Discernment, observance, and alertness
- Openness to experience
- Balanced personalities
- A relative absence of repression and suppression mechanisms that control impulse and imagery
- Pleasant and materially comfortable childhoods, although they recall their childhoods as being not particularly happy
- A preference for complexity

From the beginning, researchers have observed that tests of this nature cannot account for all that influences personality or creativity. MacKinnon writes that creativity must be a "multifaceted phenomenon" (1978, p. 46). There is not a test, neither the ones that MacKinnon and his colleagues at IPAR developed, nor any of the other tests mentioned in this text, that get it "all right," that fully describe all that makes a person creative. The construct is simply too complex to be examined via one particular lens.

Personality types or temperaments, somewhat different constructs than personality traits, are proposed to be a finite number of possible categories that can be used to sort people. The idea of temperaments can be traced back to Hippocrates as early as 370 B.C., and most notably to the work of Carl Jung and his development of archetypes. Jung coined the term "function types" and "psychological types" to describe his idea regarding fundamental differences in people. The two most widely used personality type indicators are the *Myers-Briggs Type Indicator* and the *Revised NEO Personality Inventory* (NEO-PI-R). The *Myers-Briggs Type Indicator* consists of items that have test takers choose from four pairs of alternatives, including: (1) E-Extroverted or I-Introverted, (2) S-Sensory or N-Intuitive, (3) T-Thinking or F-Feeling, and (4) J-Judging or P-Perceiving. In the end, every test taker has a combination of four letters that represent their "personality type" according to the measure. There are a total of 16 different combinations of the letters that comprise the various "personality types." The *Revised NEO Personality Inventory* measured qualities of neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. Scores on the NEO-PI-R were shown to remain constant over a period of 6 years. Developers of the NEO-PI-R believe that it is the only measure of its kind to address all five of the factors identified as contributing to personality.

Vaughan (1977) can be attributed to taking the first step toward developing a musical measure of creative thinking. Vaughan, during the time period of 1969 – 1976, asked children to improvise the following: rhythm patterns in response to both a stimulus and an ostinato, melody patterns in a similar manner, and a musical selection based on how the subject might feel during a thunderstorm. Criterion measures were (1) fluency, (2) rhythmic security, (3) ideation, (4) synthesis, and (5) total. Scoring was based largely on the Torrance tests, which is a strategy that both Gorder (1976) and Webster (1977; 1994) would also utilize in the development of their measures.

Gorder in his *Measure of Musical Divergent Production* (MMDP) (1976; 1980) asked subjects, junior and high school band students, to improvise in four tasks either using their primary instruments, their voice, or by whistling. They were given skeletal versions of melodies to improvise around. Their improvisations were evaluated by using a music content checklist that included identifying qualities of melody, rhythm, tempo, style, dynamics, timbre, expressive devices, and form. Then, the four tasks were scored based on fluency, flexibility, elaboration, originality, and quality. Gorder interpreted the areas of divergent thinking in student improvised phrases as follows: (1) fluency – number of phrases produced, (2) flexibility – the number of shifts of content character employed, (3) elaboration – the extent of the use of content character over that which was necessary to produce a varied phrase, (4) originality – the use of rarely used content items as determined by frequency count, (5) and musical quality (Gorder 1980, p. 36).

Wang's *Measure of Creativity in Sound and Music* has been used by researchers in the tradition of using measures of divergent thinking in music to assess musical creativity. Four musical tasks provided researchers with data regarding musical fluency and musical imagination. Accept for the work of Baltzer, the measure has received little attention in the decades since being developed.

Webster's *Measure of Creative Thinking in Music II* (MCTM-II) marks the most significant attempt to measure divergent thinking in music (1994). Similar to Gorder (1976; 1980), Webster's measure was built, in part, on the work of Guilford, Torrance (1974), Vaughan (1977), and on his dissertation (Webster 1977). The measure was developed for use with children ages 6–10, and includes tasks that involve three sets of instruments, a round ball, approximately 4″ in diameter, that is used for playing tone clusters on a piano, a microphone that is attached to an amplifier and speaker, and a set of five wooden resonator blocks. After a period of warm-up, participants are asked to complete 10 tasks that represent three divisions: (1) exploration, (2) application, and (3) synthesis. All tasks take approximately 25 min to complete, and are scored at a later time on four individual factors: (1) musical extensiveness, (2) musical flexibility, (3) musical originality, and (4) musical syntax. Exploration tasks include the musical parameters of high and low, loud and soft, and fast and slow, and involve images of rain in a water bucket, magical elevators, and the sounds of trucks. These parameters are then employed in the application section, where students engage with the tester in a musical dialogue through the use of each instrument individually. They make "frog" music with the ball on the piano and make the sounds of a robot singing in the shower. In the synthesis section, students are asked to engage all of the instruments in more open-ended tasks that include creating a space story told in sounds and creating a composition that has a beginning, a middle, and an end.

Psychometric studies of creativity in music education seem to have declined in the decades following the development of these measures. This trend seems to have coincided with a shift in the general focus of research in musical creativity from individual perspectives to more sociocultural perspectives. In the decades following this publication, the profession might benefit from a more balanced approach to the study of musical creativity in music and music education that accounts for both individual and sociocultural perspectives.

Experimental

While it is known that musical creativity can be manifest by way of multiple modes of musicianship, compositional and improvisational creativity have received the most attention. These experimental studies in music and music education can be categorized into research on processes and products. Webster's dissertation (1977) was a seminal start to the movement of examining musical creativity empirically in music education. His work led other researchers in music education to take up the cause. The work of Swanwick and Tillman (1986) and Kratus marked the continuation of a period of about 15 years, where the study of children's compositional processes and products seemed to intensify (Hickey 2001; Kratus 1989).

Future work in this area might explore younger ages as they interact with improvisation, and older ages as they interact with both composition and improvisation. Furthermore, the strategies for measuring the various components of compositional processes and products (Kratus 1989; Hickey 2001) might be explored with all of the other various modes of musicianship. For example, music listening on a mobile listening device might be measured over a period of 10 min, as Kratus did in his 1989 study, to explore how students interact creatively with their music. Practicing musicians might be examined over a period of time to determine qualities of their divergent and convergent thinking processes. Musical products might be assessed by way of Amabile's Consensual Assessment Technique (1996), as Hickey (2001) did in her work. The future is promising for work that addresses other modes of musicianship from the perspective of musical creativity as it has been defined in the previous literature in music education.

Biographical

Pam Burnard's latest book, *Musical Creativities in Practice*, includes short biographies of 19 musicians whose creative work exemplifies Burnard's notion of how musical creativities are expressed in the everyday modern world. This work is sure to become important to the music education profession in the next few decades of the twenty-first century.

Contextual

Since this research paradigm started to gain momentum in the 1980s and 1990s, some researchers have chosen to focus more on the study of creativity in real-world educational contexts (Barrett 2006; Burnard 2000, 2002) and specifically on the sociology of musical creativity. This movement seems to have coincided with Csikszentmihalyi's detailing of his *Systems Perspective for the Study of Creativity*, where creativity he says should not be viewed "exclusively as a mental process," but rather as an interplay of psychological and sociological factors (1999, p. 313). Csikszentmihalyi asserts that the momentum for a shift in the research paradigm to include sociological components has been building in the past few decades. There seems to be a growing concern for examining the cultures, including parents, peer groups, and teachers, the individuals that surround students and facilitate their creative work (Wiggins 2011). Ruthmann (2008) discovered through qualitative case study evidence for the existence of a complex interplay among teacher feedback, learner agency, and students' compositional intent, and suggested that teachers take these factors into account when they design opportunities for students to compose. In a related study, Randles (2009a) discovered some evidence to suggest that teachers who compose or arrange music for their ensembles may foster creative cultures where students desire to pursue composition and arranging themselves. In another study, where the creative cultures of participants of an Honors Composition Competition in Michigan, United States, were examined, Randles (2009b) found that teachers played the largest role in students' development of a creative identity, more than parents or peer groups.

At the same time that Ruthmann and Randles were doing their work in the United States, researchers in England and Spain were examining teachers' perceptions of creativity as a way of understanding how to foster creativity in their countries' national curricula (Odena and

Welch 2007; Odena et al. 2005). The results of this work suggest that teachers must have experiences composing and improvising, and engaging with multiple musical genres, if they are to be successful teaching musical creativity in their jobs as future music teachers.

Although much of the work related to the sociocultural side of musical creativity in music education has primarily been qualitative, Randles, in conjunction with Smith and Muhonen has employed various quantitative techniques to compare what he calls creative identity among preservice music teachers in the United States and England (Randles and Smith, in press) and the United States and Finland (Randles and Muhonen, in press). He discovered that future music teachers in England report being able to compose their own original music to a greater extent than their counterparts in the United States, and report significantly higher perceptions of their ability to teach music composition in the schools than future music teachers in the United States (in press). Randles cites primary and secondary socialization as a possible cause for the differences. In another study, Randles used exploratory factor analysis to uncover four latent variables that contribute to what he called "creative identity" (in press). The factors were (1) creative music self-efficacy, (2) value of creative music making in the context of the school curriculum, (3) willingness to allow time for creativity in the curriculum, and (4) value of popular music performing and listening in the school curriculum. He found significant differences favoring the Finnish future music teachers with all factors except Factor 3 (willingness to allow time for creativity in the curriculum). These results suggest that teachers in the United States were willing to include activities that included improvisation and composition, if they were allowed to develop these skills in their socialization as a music teacher, in their experiences in the school music system, as well as in their experiences in music teacher preparation. These findings are supported by the work of Odena and Welch (2007). This branch of the literature is still emerging. Future work in this area is certainly warranted.

Conclusions and Future Directions

Conceptions of creativity in music teaching and learning are changing as music, social contexts, and the students themselves change. Teacher education programs are changing, albeit very slowly, to embrace experiences that better prepare young professionals to teach a wider varieties of music and to do so in ways that engage a more comprehensive set of musical activities. We predict that the older notions of a "general music" teacher that only engages primary school children in singing and movement activities will give way to more specialized music experiences that will engage children at greater depth with performance, composition, improvisation, and music listening using a wider range of traditional and nontraditional musical instruments and with a wider variety of musics. We also predict that the older models of "band," "choral" or "orchestra teacher" will give way in secondary schools to a much richer selection of ensembles drawn from all sorts of musical cultures. What is certainly going to change is that music teachers will be held accountable for a wider music audience at the secondary level and that students will be expected to be far more creative in their exploration of music as an art form that holds deep personal meaning. Our understanding of creativeness will certainly evolve through research and practice and our overall understanding of creative music education will improve as we take advantage of new technologies and new paradigms for learning.

Cross-References

▶ Cognition of Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Behavior
▶ Creative Mind: Myths and Facts
▶ Creative Personality
▶ Creativity Tests
▶ Creativity, Intelligence, and Culture
▶ Divergent Thinking
▶ Divergent Versus Convergent Thinking
▶ Four Ps of Creativity

▶ In Search of Cognitive Foundations of Creativity
▶ Models for Creative Inventions
▶ Psychology of Creativity
▶ Research on Creativity
▶ Social Psychology of Creativity

References

Amabile T. Creativity in context: update to the social psychology of creativity. Boulder: Westview Press; 1996.

Barrett M. 'Creative Collaboration': an 'Eminence' study of teaching and learning in music composition. Psychol Music. 2006;34(2):195–218.

Burnard P. Examining experiential differences between improvisation and composition in children's meaning-making. Br J Music Educ. 2000;17(3):227–45.

Burnard P. Investigating children's meaning making and the emergence of musical interaction in group improvisation. Br J Music Educ. 2002;19(2):157–72.

Burnard P. Musical creativities in real world practice. New York: Oxford University Press; 2012.

Csikszentmihalyi M. Implications of a systems perspective for the study of creativity. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 313–35.

Gardner H. Frames of mind: the theory of multiple intelligences. New York: Basic Books; 1983/1993/2011.

Gorder W. An investigation of divergent production abilities as constructs of musical creativity [Unpublished doctoral dissertation]. University of Illinois; 1976.

Gorder W. Divergent production abilities as constructs of musical creativity. J Res Music Educ. 1980;28(1):34– 42.

Hickey M. An application of Amabile's consensual assessment technique for rating the creativity of children's musical compositions. J Res Music Educ. 2001;49(3):234–44.

Kaschub M, Smith J. Minds on music; composition for creative and critical thinking. Lanham: Roman and Littlefield; 2009.

Kratus J. A time analysis of the compositional processes used by children ages 7 to 11. J Res Music Educ. 1989;37(1):5–20.

MacKinnon D. What makes a person creative? In: MacKinnon DW, editor. In search of human effectiveness. New York: Universe Books; 1978. p. 178–86.

National Standards for Arts Education. Reston, VA: Music Educators National Conference; 1994.

Odena O, Welch G. The influence of teachers' backgrounds on their perceptions of musical creativity: a qualitative study with secondary school music teachers. Res Stud Music Educ. 2007;28(1):71–81.

Odena O, Plummeridge C, Welch G. Towards an understanding of creativity in music education: a qualitative investigation of data from English secondary schools. Bull Counc Res Music Educ. 2005;163:9–18.

Paynter J, Aston P. Sound and silence: classroom projects in creative music. London: Cambridge University Press; 1970.

Pond D. A composer's study of young children's innate musicality. Counc Res Music Educ Bull. 1981;68:1–12.

Randles C. Student composers' expressed meaning of composition with regard to culture. Music Educ Res Int. 2009a;3:42–53.

Randles C. That's my piece, that's my signature, and it means more: creative identity and the ensemble teacher/arranger. Res Stud Music Educ. 2009b; 31(1):52–68.

Randles C, Muhonen S. Validation and further validation of a measure of creative identity among United States and Finland pre-service music teachers. Br J Music Educ. (in press).

Randles C, Smith GD. A first comparison of pre-service music teachers' identities as creative musicians in the United States and England. Res Stud Music Educ. (in press).

Reimer B. A philosophy of music education: advancing the vision. 3rd ed. Upper Saddle River: Prentice Hall; 2003.

Ruthmann SA. Whose agency matters? Negotiating pedagogical and creative intent during composing experiences. Res Stud Music Educ. 2008;30(1):43–58.

Sawyer K. Explaining creativity: the science of human innovation. New York: Oxford University Press; 2006/2012.

Schafer R. Creative music education. New York: Schirmer; 1979.

Swanwick K, Tillman J. The sequence of musical development: a study of children's composition. Br J Music Educ. 1986;3(3):305–40.

Torrance EP. Torrance tests of creative thinking: norms-technical manual. Princeton: Personnel Press/Ginn; 1974.

Webster P. A factor of intellect approach to creative thinking in music [Unpublished doctoral dissertation]. Rochester, NY: Eastman School of Music, University of Rochester; 1977.

Webster P. Measure of creative thinking in music-II: administrative guidelines [Unpublished manuscript]. Evanston, IL: Northwestern University; 1994.

Webster P. Creative thinking in music: advancing a model. In: Sullivan T, Willingham L, editors. Creativity and music education. Edmonton: Canadian Music Educators' Association; 2002. p. 16–33.

Webster P. Children as creative thinkers in music: focus on composition. In: Hallam L, Cross I, Thaut M, editors. The Oxford handbook of music psychology. New York: Oxford University Press; 2009. p. 421–8.

Webster P. Constructivism and music learning. In: Colwell R, Webster P, editors. MENC handbook of research on music learning, vol. 1. New York: Oxford University Press; 2011. p. 35–83.

Webster P. Technology in music instruction and learning. In: Seel NM. editor. Encyclopedia of the sciences of learning. 2012. Retrieved from http://www.springerlink.com/content/j6qk79t23373w541/fulltext.html

Webster P. Music composition intelligence and creative thinking in music. In: Kaschub M, Smith J, editors. Composing our future: preparing music educators to teach composition. New York: Oxford University Press (in press).

Wiggins J. When the music is theirs: scaffolding young songwriters. In: Barrett M, editor. A cultural psychology for music education. New York: Oxford University Press; 2011. p. 83–113.

Creativity in Neuroscience, Studies

► Creative Brain

Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Ömer Akın
School of Architecture, Carnegie Mellon University, Pittsburgh, PA, USA

Synonyms

Design; Expert; Façade design; Frame of reference; Musical composition; Mutilated checkerboard puzzle; Nine-dot puzzle; Novel; Novice; Periodic table of elements; Puzzle; Scientific invention; Sudden mental insights; Valuable; Writing

Introduction

There are many definitions of creativity. Here, one based on commonly held beliefs about creativity and observations from studies designed to unravel its secrets will be used (Akin and Akin 1996): creativity is the act of producing *novel* and *valuable* things. A creative product is different from existing ones on account of one or more *features* and adds exceptional *value* to human purposes. Creativity is readily associated with art. Caravaggio's realism, Van Gogh's impressionism, and Vermeer's depiction of light are just a few examples. In the annals of human civilization, some of the most valued human products include not only artistic but also scientific ones. Hence, developing a unifying theory of the creative process is illusive. This essay will identify a common denominator based on human cognition and its pre- and post conditions that appear to be responsible for the creative act in three domains: puzzles, scientific discoveries, and design.

Understanding Creativity in Puzzles, Scientific Discovery, and Design

Early work on creativity focused on general behavioral tendencies of individuals (MacKinnon 1967). While these point to probable correlations between personality traits and creative people, they offer little about how creativity actually works. What cognitive capabilities underlie the behavior that is commonly known as creativity? How can one measure or predict this behavior?

However limited, research on *expertise* in a number of domains, including chess, music, painting, and poetry, addresses some of these questions. Hayes' work on musical composition (Hayes 1989), linking cognition to expertise and creativity, highlights the importance of cognitive "chunks." He confirms that the *Time at Task* hypothesis that sets the minimum amount of time at one's task of mastery to 10 years holds even for musical prodigies like Mozart and Beethoven and 40 other grand masters of Western classical music. Studies in the areas of painting, poetry, and architecture have also shown how indispensable cognitive chunks are for task mastery.

Some of the most memorable accounts of creativity include statements directly from universally accepted creative individuals, like Tchaikovsky:

> Generally speaking the germ of a future composition comes suddenly and unexpectedly. If the soil is ready – that is to say, if the disposition for work is there – it takes root with extraordinary force and rapidity, and

> shoots up through the earth, puts forth branches, leaves and, finally, blossoms

Tchaikovsky reveals something about that which arrives in the mind and how it reaches fruition. He implies that what arises so suddenly does so due to substantial cognitive preparation that anticipates and evokes the idea in the first place. There is no doubt that the soil upon which Tchaikovsky's sudden realization of a creative idea has blossomed has been properly and painstakingly cultivated. This phenomenon observed in many cognitive task domains is commonly known as the *Aha! response*, *eureka moment*, or *sudden mental insight* (SMI). Puzzles are one of the most elementary forms of complex cognitive activity exhibiting the SMI response.

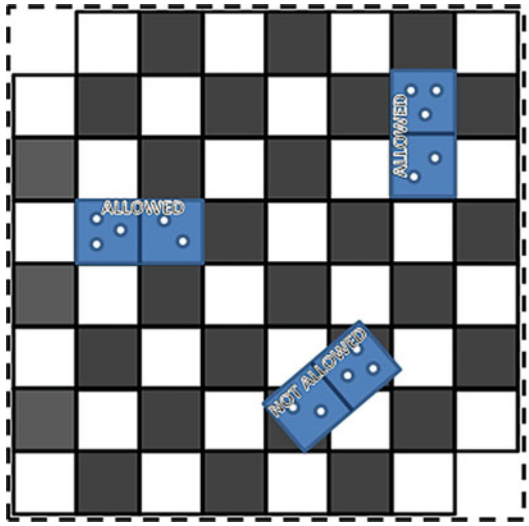
The Creative Nature of the Mutilated Checkerboard Puzzle

The Mutilated Checkerboard Puzzle (MCP) employs a standard 8 × 8 checkerboard (Fig. 1), two of whose diagonally opposite corners have been removed (Kaplan and Simon 1990).

> Imagine placing dominos on the board so that one domino covers two horizontally or vertically (but not diagonally) adjacent squares. The problem is either to show how 31 dominos would cover the 62 remaining squares, or to prove logically that a complete covering is impossible

The MCP is difficult to solve and the solution usually involves the sudden onset of the idea about the proof upon realizing the *Parity Principle*. This principle states that each domino piece needs to cover a pair of black and white squares regardless of where it is placed while the mutilated board has an *un*equal number of black (32) and white (30) squares.

Kaplan and Simon (1990) systematically delineate and classify the *clues* found in the problem context or in the subjects' long-term memory, as well as the *hints* provided by the experimenters, which help induce the recognition of the Parity Principle. They go on to describe the cognitive components needed to develop the solution proof for the puzzle: (1) the sudden onset of the Parity Principle; (2) the three sources of information: puzzle features, relevant knowledge, and hints about the colors of missing squares; (3) the



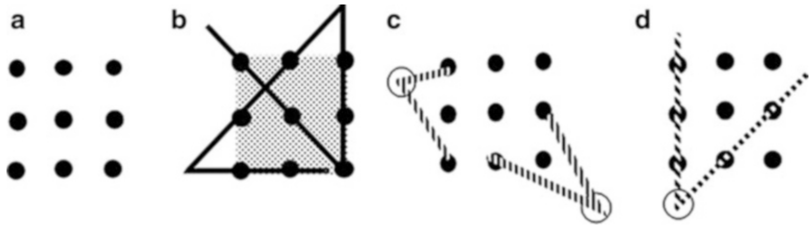
Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Fig. 1 The mutilated checkerboard puzzle (Source: Akin 1986)

development of a new problem space; and (4) a new problem space based on the invariant features of the puzzle.

The Creative Nature of the Nine-Dot Puzzle

The Nine-Dot (NDP) is another puzzle identified with the SMI research (Akin and Akin 1996; Newell and Simon 1972). It involves graphic manipulations on a sheet of paper based on nine regularly spaced dots on a 3 × 3 grid (Fig. 2a). The goal is to draw four straight lines that are connected end to end so that each dot has a line going through it (Fig. 2b). In order to successfully solve the problem, subjects must realize that they should extend a line beyond the square-shaped area formed by the nine-dots (i.e., the box; Fig. 2.2, shaded area). This is often the moment when a subject exclaims "Aha!" or experiences the SMI response.

However, most subjects attempting to solve this puzzle restrict themselves to *the box*, which is called the *frame of reference* (FoR) in SMI literature. This makes the solution impossible to attain since two intersection points in the solution lie outside of the box. Typically, subjects solving this puzzle fall into three categories: (1) those who solve it without help (Table 1, Type A); (2) those solve it after assistance is given to help



Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Fig. 2 The nine-dot puzzle (Source: Akin 1986)

Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Table 1 Cognitive thresholds to solve the nine-dot puzzle (Source: Akin 1986)

Subject category	Operations				
	Removing the FoR (self)	Removing the FoR (by hint)	Drawing lines outside the FoR	Aligning vertices of the lines	Puzzle solved
Type A	√	N.a.	√	√	√
Type B	x	√	√	√	√
Type C	x	√	x	x	x

them lift the FoR – usually in the form of an instruction: "you may go outside of the 'box' of dots, if it aids you in finding the solution" (Table 1, Type B); and (3) those who cannot solve the puzzle even with the instruction to remove the restricting FoR (Table 1, Type C). Hence, solving the NDP requires more than just removing the FoR: operations that enable drawing lines outside of the FoR (Fig. 2c) and aligning the vertices (Fig. 2d). Those who solve puzzle on their own do so by satisfying all three conditions (Table 1, Type A or Type B). Those who are given the hint to go outside of the FoR solve the puzzle by achieving the remaining two conditions after receiving the hint (Table 1, Type B). Those who are not able to solve the puzzle are unable despite the hint proved (Table 1, Type C).

For both puzzles (MCP and NDP), it is possible to solve them only after removing the FoR, and more importantly defining the requisite problem structure for the solution state without the restricting FoR. The development of these new operations is an example of the cognitive dimensions of creative behavior. While these are not at the level of the creativity displayed by, for example, Leonardo da Vinci, Caravaggio, or Vermeer, structurally they serve the same cognitive role in reaching creative results. The obstacle in applying these findings to the larger domain of human creativity is to be able to scale them up to other domains like scientific discovery and design (Akin and Akin 1996; Newell and Simon 1972).

Creative Nature of Scientific Discovery

History of science is full of accounts of brilliant discoveries that have changed the course of society, such as Fleming's discovery of penicillin, Salk's discovery of the polio vaccine, Mendeleev's formulation of the periodic table of elements, Newton's formulation of the general law of gravitation, or Einstein's law of relativity. These novel formulations of knowledge have proven to be of enormous value to mankind, altering the way of dealing with health, science, and technology. There should be little doubt that these are also creative acts of enormous magnitude.

Arguably, the cognitive mechanisms responsible for them are no different than those that assist in more mundane tasks like puzzles or more artistic ones like design. Most anecdotal accounts of scientific discovery are embellished with dramatic events that resemble the SMI moment. Did Newton really think of the law of gravity after an apple fell on his head? Did the periodic table appear to Mendeleev in a dream? Or was Archimedes really taking a bath when he finally figured out the principle of volume measured by a solid displacing liquid, running out into the street yelling "*Eureka*!?" In studying scientific creativity, however, one must look beyond the public exclamation to uncover the hidden SMI moment and the cognitive processes that induce them.

Kedrov's meticulous study of the circumstances around Mendeleev's formulation of the *periodic table of the elements* (Kedrov 1966–1967) helps unravel the conditions that give rise to the SMI in the sciences. In 1868, Mendeleev was busy with constructing the table of contents of the second volume of his new textbooks on chemistry. Having completed the first two chapters of the second volume, Mendeleev was scheduled to go on a long journey the next day and, consequently, was hard pressed to determine the next group of elements to include in the following chapters of the second volume. He had already covered the halogens and the alkaline metals. It was not clear as to which group of elements should be covered next. In the absence of a logical structure to organize the 64 known chemical elements of the day, this was a difficult decision, the exploration of which eventually would lead Mendeleev to the discovery of the periodic table.

Medeleev's exploration began with a search for a pattern that could be applied to all of the known elements. First, he compared the atomic weights of the elements. While this was a good start, there were two big obstacles: the number of comparisons with all pairs of atomic weights was far too numerous to undertake exhaustively, and the chemical elements not yet discovered at the time created gaps and made it difficult to see the global pattern in the data. Next, Mendeleev compared groups of elements based on their atomic *properties* and ordered them according to their atomic *weights*. This reduced the space of comparisons, considerably yielding some consistent patterns. His second breakthrough came when he made a modification in his representation of the elements, motivated by the limited time he had to complete his task. Writing lists of the elements by hand was just too cumbersome. Thus, he decided to use cards to represent elements ordered in a two dimensional matrix space, with one dimension representing the ordering of atomic weights and the other general chemical properties of the elements.

Kedrov speculates that this analogy, marking an SMI moment for Mendeleev, presented itself because he was an avid fan of the card game *Patience* (Kedrov 1966–1967). The cards containing the identities of chemical elements were organized in the same orthogonal fashion as the playing cards of Patience, according to suit and value. Through this, Mendeleev reduced the amount of clutter present in his problem representation. In spite of the unknown elements, the new representation also made clearer the organizational principle that the "properties of elements stand in periodic relationship to atomic weights." It took Mendeleev several days to find the logical basis for organizing the elements, setting aside some elements, which were not yet well calibrated in terms of weights and properties, for future exploration. This future task, turned out to be one of the greatest contributions of the periodic table to the field of chemistry.

The substance of scientific discovery is clearly very different from that of puzzle solving. The domain of knowledge applicable to the former is vast. The time frame and number of scientists that contribute to it are enormous. Commensurately, the impact of its results is far reaching. Nevertheless, there are remarkable similarities between these domains. While the emotional response "Aha!" may mark the moment of triumph for any discovery, it has little to do with explaining the creative process. It turns out, however, that the cognitive steps that must be taken in order to fit data to mathematical functions versus selecting new problem spaces in the MCP are remarkably alike (Newell and Simon 1972). Likewise the creative processes that are necessary for breaking out of the restrictive FoR in a puzzle bear an uncanny resemblance to those of scientific problem solving. In summary, these are:

- *General Criteria*. Creativity is based on the recognition of the novelty and value of its results, in temporal space.
- *Shift in Problem Space*. A shift in the problem space that results from the discovery of a new *principle* (periodicity of elements), a new *representation* (playing cards of the game of patience), or a new *I* (comparing the atomic

weights of the entire set of groups of elements) is needed.

- *Heuristic Search*. Any one of the above effects is the result of a heuristic search process.
- *Knowledge Base*. Owing to the imprecise nature of heuristic search methods, considerable background knowledge and concerted effort are a must.
- *Odds of Success*. Yet, the search space is too vast and the contextual factors too complex to ensure success.

Creative Nature of Design in Writing

Design is a rich concept that has been adopted by many disciplines. The cognitive processes observed in these design disciplines closely resemble processes that play a role in a number of the traditional art fields such as music, writing, painting, and sculpture.

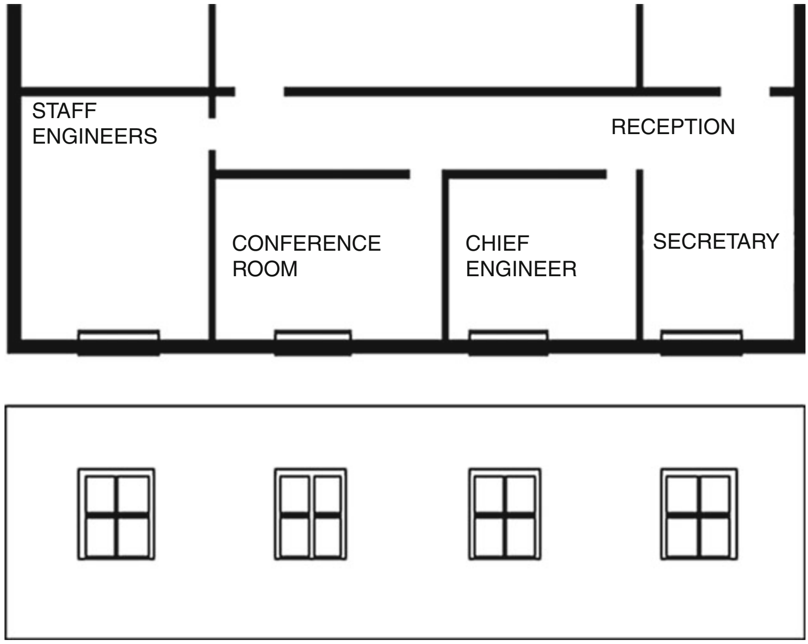
Some argue that human intelligence and creativity have developed to high levels due to their ability to encode ideas in stories and narratives. Cognition in verbal composition has been studied extensively with the goal of improving writing skills. Writers' initial task representations are as important for success, as they would be in puzzles or scientific discoveries. Hayes and Nash (1996) discuss the "nature of the planning activity" in writing. They point out that writers *interleave* planning and writing tasks in an effort to balance their global and local goals. This kind of approach to writing has many practical benefits including the assisting of memory during the execution of complex plans and discovery of new tasks or the consolidation of multiple tasks into one. In calibrating the quality of the writing tasks performed by both experienced and inexperienced writers, Hayes and Nash found that the amount of abstract planning positively correlated with quality. These results from the writing literature converge to make a case for the proper coupling of global and local skills toward creativity, which will be covered next in the context of architectural design.

Creative Nature of Design in Architecture

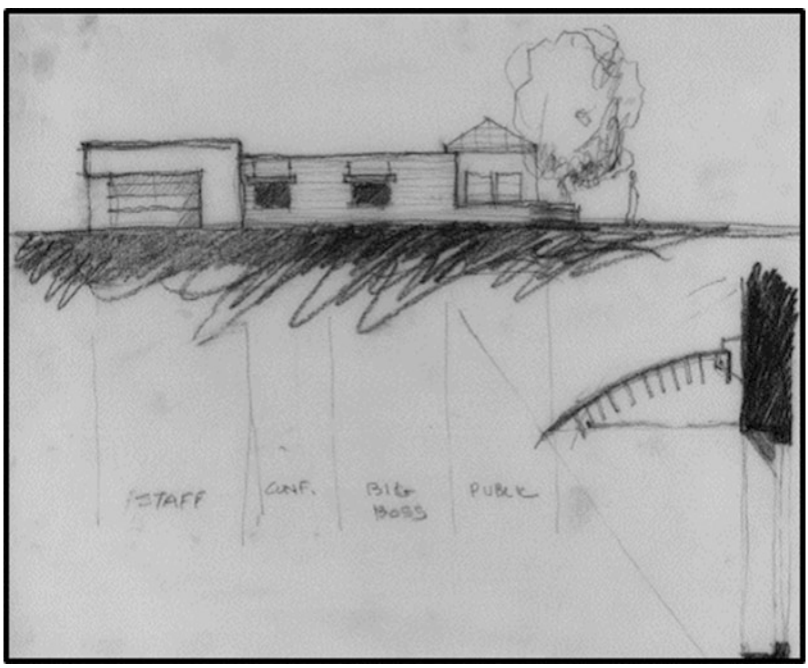
Other fields that have adopted design as a central vehicle for creativity include graphics, industrial products, architecture, landscape architecture, engineering, and urban and regional planning. Attempts at understanding and describing the design process and the underlying structure of the architect's creativity by way of expertise go back to the early 1970s (Eastman 1969). Subsequently direct evidence about the relationship of expertise and creativity in architectural design has been provided by Akin (1986). More recently, important steps have been taken toward modeling creativity in engineering design and assessing the role of metaphors and analogies in inducing the SMI response (Casakin 2007). While these have provided important insights about the nature of the design task and how humans deal with it, no comprehensive theory of creativity has yet emerged.

A study specifically directed at the SMI phenomenon in architectural design compares cognitive processes of expert architects and novices (Akin and Akin 1996). In the architectural design problem, subjects are asked to design a façade for a given floor plan of an office suite containing five rooms: reception, secretary, conference, staff engineers, and chief engineer (Fig. 3). The restricting FoRs in this task are shown in the lower part of the figure and involve five categories: size, proportion-location of windows, number of stories, wall construction, and floor height(s). The expert designer arrives at SMIs following a variety of conditions: exhausting all alternative solutions within the given FoR, trying heuristic rules to leap out of the existing solution cycle (like inverting the orientation and value of design elements, trying an entirely new visual pattern), redefining the FoR based on specific domain knowledge (balancing the elements of a composition), or designing insights resulting from these conditions.

Through this process, the expert designer (Fig. 4) breaks out of six FoRs. The first FoR from which the subject breaks out is the regularity of the windows. This is not surprising since façade design hinges upon the placement and proportions of windows. She refers to the existing window geometry as "repetitive" and "deadening" (Table 2, FR1-1). She also speaks of specific design operations to fix this problem: infusing



Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Fig. 3 Plan (*above*) and FoR facade (*below*) (Source: Akin 1986)



Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Fig. 4 Façade designs by an expert designer (Source: Akin 1986)

variety, hierarchy, and other grouping strategies. In achieving this breakout, she relies on a well-known principle of composition, *bookends,* that achieves an accentuation of the windows at the extreme ends of a linear façade layout. This principle has the effect of freeing her to experiment with patterns that are not necessarily in conformance with the floor plan (Fig. 4). This effect is also evident in some of the other design features: roof form, materials, and solar shading

Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Table 2 Breakout from frames of reference (FoRs) by expert designer (Source: Akin 1986)

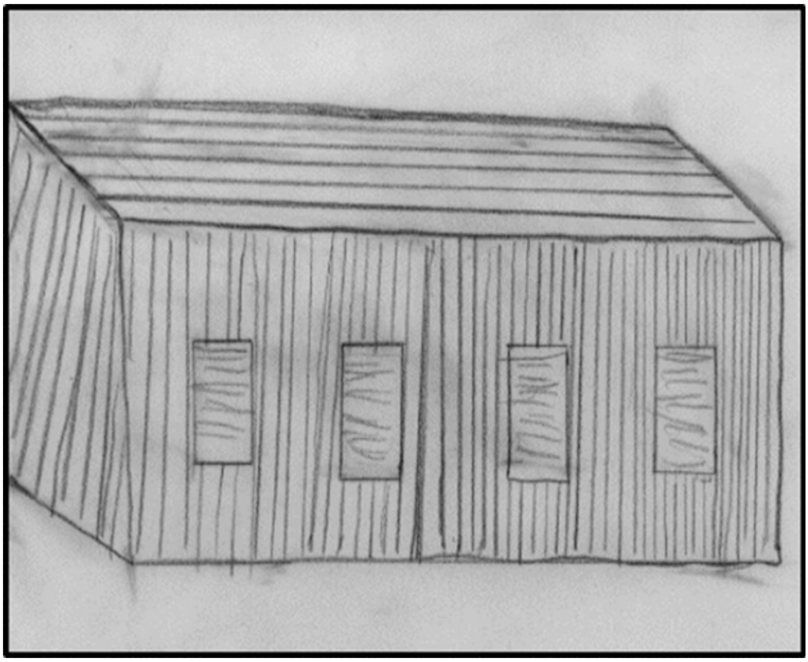
FoR category	FoRs in subject's own words	Source of the FoRs	Breakout from FoR moves	Source of breakout moves
Window geometry	FR1-1: "(these are) repeated windows"	*External*: plan view	Vary end-conditions of façade layout	*Recall*: composition principles
Ceiling height	FR1-2: "(assume) 12' ceiling heights"	*Recall*: building standards	Show functional allocation by ceiling height variation	*Recall*: spatial design principles
Ground floor location	FR1-3.1: "(locate) on ground floor."	*Recall*: general assumption	Assume ground floor location	–
Single story building	FR1-3.2: "(locate) on ground floor."	*Recall*: general assumption	Assume single story building	–
Relief in building façade	FR1-4: ". . .some relief (is needed)"	*External*: plan view	Create projecting shading devices	*Recall*: Subject-1's earlier designs
Façade construct'n	FR1-5: "(give) texture, contrast to materials"	*Recall*: knowledge of construction	Use a variety of building materials	*Recall*: composition & construction in tandem

Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Table 3 Breakout from frames of reference (FoRs) by novice designer (Source: Akin 1986)

FoR category	FoRs in subject's own words	Source of the FoRs	Breakout move	Source of breakout move
Window geometry	FR2-1: "want to make (these) window(s) bigger"	*External*: plan view & assumption of normal sill height	Lower the assumed window sill height	*Recall*: general heuristic
Main access	FR2-2: ". . . don't see any doors"	*External*: absence of information	*None*	*Not applicable*
Ceiling form	FR2-3: "nice big curvy ceiling like roof"	*External*: absence of information	Place hipped roof gable	*Recall*: typical "house" image
Construct'n materials	FR2-4: "maybe (the wall) could be brick"	*Recall*: general assumption	Place brick on the façade	*Recall*: typical "house" image

devices. By balancing the asymmetrical roof forms on the opposing ends of the building, the expert designer reemphasizes the two ends of the façade. The "eyebrows" placed above the middle windows as shading devices (Fig. 4, section at the bottom right side) also help balance the differences between middle and end windows. Juxtaposition of the shading devices' metal construction against the heavy, earthy textures of the brick wall presents an attractive material selection decision.

In the case of the novice designer (Table 3), a small number of FoRs are observed and an even smaller number are broken out of. Her solution (Fig. 5) is the same as the normative solution (Fig. 3, facade). The window patterns are the very first FoR from which the novice designer tries to break out. She remarks "I mean if you're looking in, I don't know that I would necessarily see anything. If I stand outside all I pretty much see is windows. . . right?" However, the features used to achieve this breakout are standard features found in *normalized* house images. The roof is a simple gable, the walls are brick, and the windows are regularly proportioned and spaced. The only two pieces missing from the standard image are the entrance (Table 3, FR2.2) and the chimney. The materials (brick and shingles) are selected, once again, in conformance with the idealized house image to which she refers in



Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon, Fig. 5 Façade designs by a novice designer (Source: Akin 1986)

the protocol as part of a childhood model building activity.

These differences between the two subjects point to the same phenomenon observed in puzzles: recognizing the need to break out of FoRs is not sufficient to reach a creative solution. One also needs the procedural knowledge that is necessary to actually implement each breakout. The novice designer, due to a lack of training in design, does not have the technical and experiential background that enables the expert designer with the skills to assemble façade compositions, spatial compositions, sun shading devices, and construction details.

Toward a Unified Theory of Creativity

One of the first things that can be stated regarding the creative process is its kinship to most other cognitive processes. The evidence considered in this entry suggests that cognition of creativity shares a great deal with ordinary cognitive acts such as heuristic search, recognition, and problem solving. In addition, an indispensable factor in the creative process appears to be a shift in the structure of the task at hand, called the SMI. Observations in puzzles, scientific discoveries, and design show that a new construct consisting of both a specific problem representation and operations applicable in the domain of this representation must be created.

The fact that the creative process requires the discovery of a new problem space necessitates that the creative individual must have skills not just for problem solving but also for defining new *problems*. This latter skill has been described in various contexts. Problem seeking, puzzle making, problem restructuring, and problem formulation are some of the related concepts that have recently appeared in expertise and creativity literature.

Conclusion and Future Directions

One of the most important aspects of the process of *searching for new problem spaces* has to do with domain knowledge. As observed in puzzles, inventions, and designs, the knowledge of the creative agent plays a key role in their creative achievements. In the case of the architectural design problem, it is evident that the novice designer does not possess this skill while the expert designer does. Finally, it is important to underscore once again that the SMI or Aha! response is a related but inessential manifestation of creative acts. It seems to be more important for the sociopsychological aspects of discoveries and creative inventions than for the cognitive psychology of creativity.

Several important areas of research that are indicated by this review of research in puzzles, inventions, and design are:

1. Do creative acts always involve the SMI or the "Aha!" response?
2. Is the SMI relevant only in the initial act of creative revelation?
3. If they, or the moment of discovery filled with surprise, are absent in subsequent acts that are identical to the initial act, should they still be considered creative? For example, is Picasso creative when repeating one of his breakthroughs for the *n*th time?
4. Since the differences between novices and experts seem to correlate with the SMI condition, can it (therefore can creativity) be achieved through training?
5. Is expertise a necessary and a sufficient condition for creativity?
6. Since it is culturally regarded as a mysterious process, is there a tautological impediment to uncovering the secrets of creativity? That is, even if one can describe creativity precisely, is it not a forgone conclusion that the culturally accepted notion of what it is would shift?

Cross-References

▶ Analogies and Analogical Reasoning in Invention
▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Cognition of Creativity
▶ Creative Behavior
▶ Creative Mind: Myths and Facts
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity in Invention, Theories
▶ Creativity from Design and Innovation Perspectives
▶ In Search of Cognitive Foundations of Creativity
▶ Psychology of Creativity
▶ Science of Creativity

References

Akin Ö. Psychology of architectural design. London: Pion Ltd; 1986.
Akin Ö, Akin C. Frames of reference in architectural design: analyzing the hyper- acclamation: "a-h-a-!". Des Stud. 1996;17(4):341–61.
Casakin H. Metaphors in design problem-solving: implications for creativity. Int J Des. 2007;1(2):23–35.
Eastman C. Cognitive processes and ill-defined problems: a case study of design. In: Walker D, Norton LM, editors. IJCA''69, International Joint Conference on Artificial Intelligence; San Mateo, CA: Kaufmann; 1969. p 669–90.
MacKinnon DW. Creativity and the expression of possibilities. In: Kagan J, editor. Creativity and learning. Boston: Houghton Miflin; 1967.
Hayes JR. The complete problem solver. 2nd ed. Hillsdale: Lawrence Erlbaum; 1989.
Hayes JR, Nash JG. On the nature of planning in writing. In: Levy CM, Ransdell S, editors. The science of writing: theories, methods, individual differences, and applications. Mahwah: Lawrence Erlbaum; 1996. p. 29–55.
Kaplan CA, Simon HA. In search of insight. Cogn Psychol. 1990;22:374–419.
Kedrov BM. On the question of the psychology of scientific creativity. Soviet Psychol. 1966–1967;5(2):16–37.
Newell A, Simon HA. Human information processing. Englewood Cliffs: Prentice Hall; 1972.

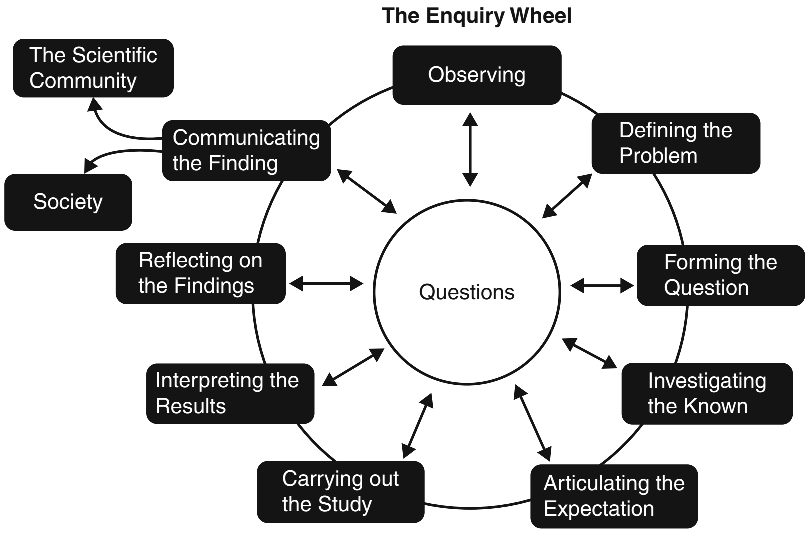
Creativity in Research

Kevin Byron
Queen Mary, University of London, London, UK

What is Research?

Research is a form of enquiry that aims to find answers to questions that would fill a gap in an existing knowledge base, resolve anomalies in that knowledge base, or add to the existing

Creativity in Research, Fig. 1 The enquiry wheel (Harwood et al. 2004)



stock of the knowledge base. Here the knowledge refers to any subject or discipline or combination thereof.

Depending on the stage of the research enquiry, different types of questions are asked, and answers sought through different actions. Some of these questions require a greater emphasis on the critical appraisal of existing knowledge and observations, and data. Many other questions are speculative and open ended, requiring a more creative approach to address them. All stages however require some measure of both types of thinking (see Appendix 1: Creative Behavior).

The various stages in the research cycle are shown schematically in Fig. 1 below (Harwood et al. 2004). This is based on the views of a number of scientists who were asked how they thought research is conducted. This is a much more pragmatic and flexible view of research than that described by historians and philosophers of science as "The Scientific Method." Some if not all of the stages of Fig. 1 map on to research methods in other disciplines such as the social sciences and humanities.

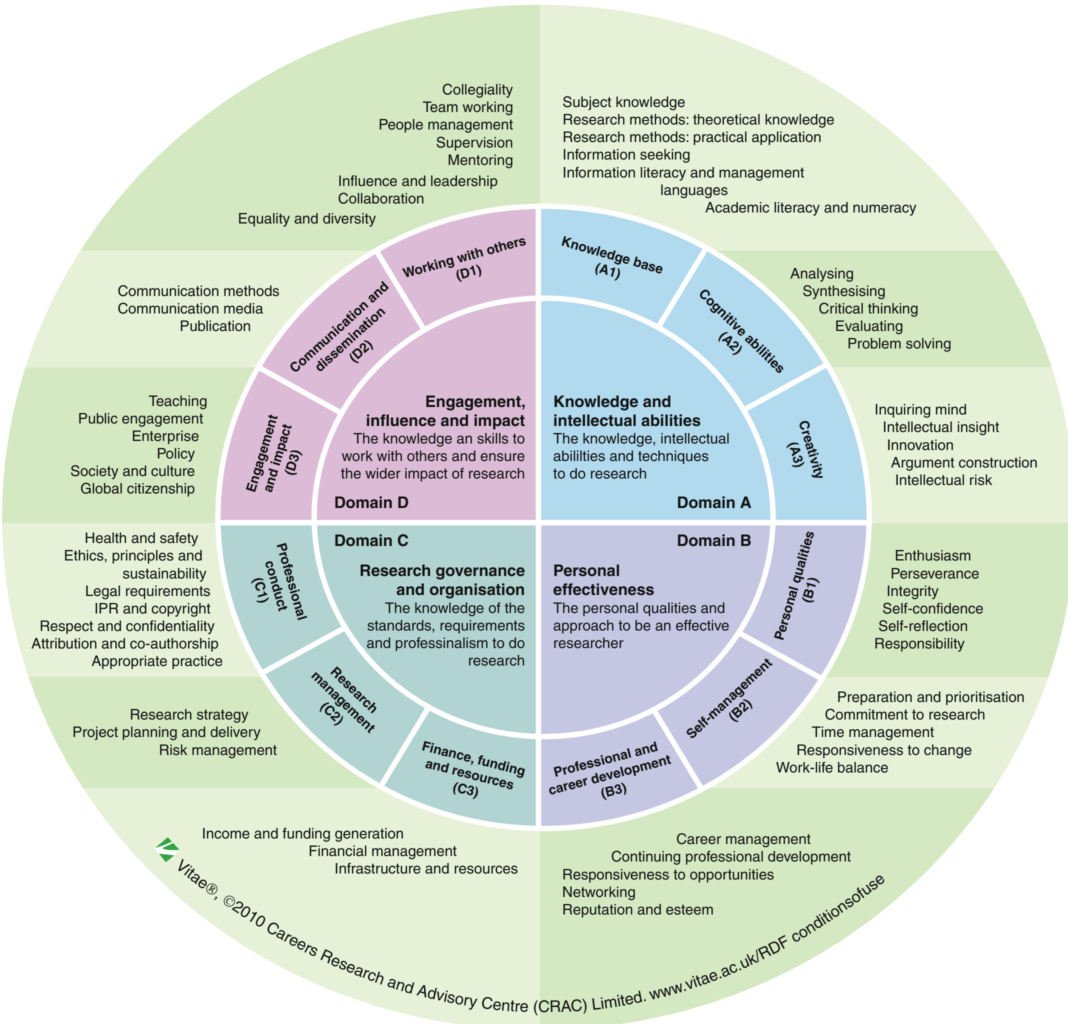
In addition to noting from Fig. 1 that research is not a linear activity, it can start at different points on The Enquiry Wheel, and it may be necessary to jump back across the wheel at times to re-appraise earlier assumptions and hypotheses, redesign the research methods, etc. Questions are at the hub of this wheel and progress can be helped or hindered by the way the questions are framed.

While The Enquiry Wheel describes the main activity of doing research, and creative and critical thinking are at the heart of progress in this framework, it is important to note that being a good researcher requires the development of a much broader range of skills and knowledge. These have been detailed by the organization Vitae in their Researcher Development Framework (RDF) (Vitae 2009) shown in Fig. 2 below.

Where is the Creativity?

Creativity is shown as one of the sub-domains of the "Knowledge and Intellectual abilities" domain in the RDF in Fig. 2. However, in contrast with critical thinking and knowledge, creativity is notoriously difficult to define unambiguously, and the role played by creative thinking in research is not always clear at least in the way it is communicated and perceived by the public.

Most academic research describing new ideas that contribute to knowledge and understanding is reported through publications in the form of papers in journals, monographs, theses, and presentations at conferences. Other forms of research output are patents, installations, designs,



Creativity in Research, Fig. 2 The Vitae researcher development framework (RDF) (Vitae 2009)

and practice-based work, though in common with publications, all such works generally referred to as "intellectual property" are required to be approved by an anonymous peer review process before they can be made publicly available. The main criterion of acceptance in the peer review process is that the research output contains original results or ideas. Given that one of the more enduring definitions of creativity is: "Ideas that are original and of potential value," it is clear that creativity is at the heart of doing research.

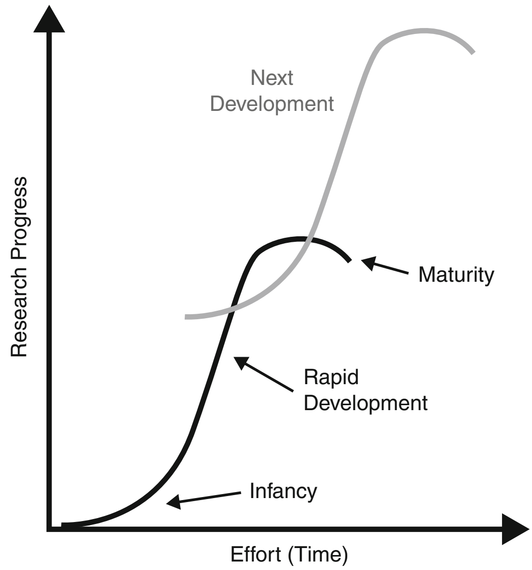
This underpinning of creative thinking in research however is not clear to see to the lay person or research novice (e.g., a PhD student). Reported accounts of research in a particular field over the previous decade or so are summarized in published reviews in academic journals or books. These publications give an impression of seamless and continuous progress in the research field by the researchers who appear to know exactly what they are doing, and where the research is headed. The false-starts, wrong or null hypotheses, unsuccessful experimental design, and all the reworking that is so much a part of doing research are not reported. Given that one of the hallmarks of creative behavior is risk-taking, there is a high probability that many research ideas at various stages of The Enquiry Wheel will not work out when put to the test. If the reader has no sense of these setbacks, it can make research look like it is a very well-structured process that progresses unhindered. A more accurate picture of what it is like doing research (at least some of the time) was offered by the pioneering rocket scientist Wernher von Braun when he said: "Research is what I'm doing, when I don't know what I'm doing."

To add to this earlier impression, researchers are often portrayed in the media as mainly logical thinkers who painstakingly analyze huge amounts of data from which they can infer clear conclusions through the application of critical thinking. This data is often the outcome of months of meticulous, and often, repetitive work. Depending on the discipline, it may be gathered through hundreds of very similar experimental measurements, months of computer modeling time, dozens of interviews with sample populations, months of "field work" or spreadsheets filled with records acquired from volumes of archive material. The problem here is that researchers are often discussing what they did in retrospect, not how they got the ideas to do it in the first place. Another reason that reported research appears to lack creativity is that the discipline of academic writing demands an objective style describing only the facts without any mention of the human drama that is an integral part of any research venture.

How Research Progresses

Support for the aforementioned notion of continuous progression in research can be found in the publication: "The History and Present State of Electricity with Original Experiments published in 1767" written by the scientist and theologian Joseph Priestley (1767). Here he describes the progress of the new electrical technology as follows:

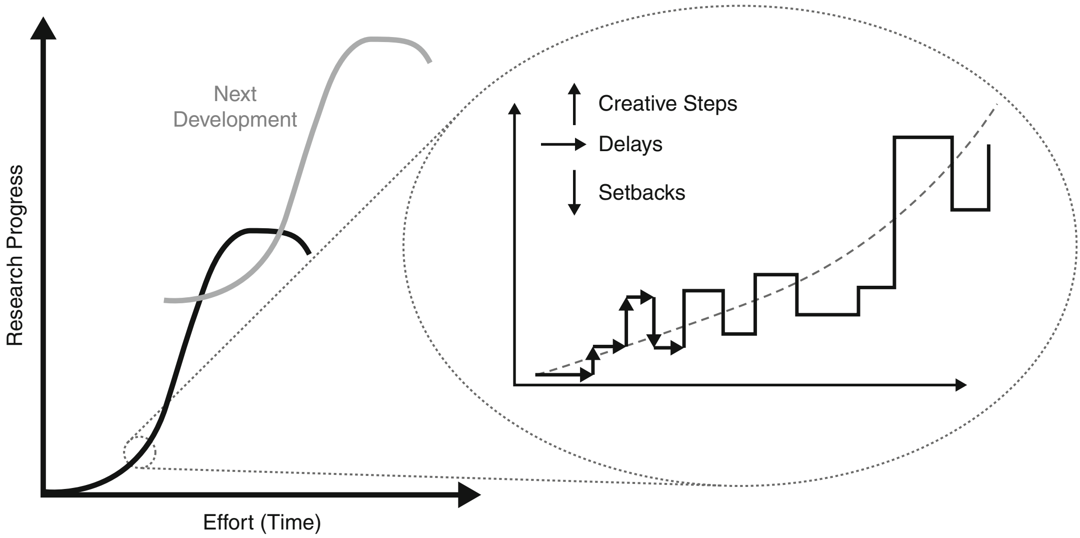
> The History of Electricity is a field full of pleasing objects, . . .Scenes like these in which we see a gradual rise and progress in things, always exhibit a pleasing spectacle to the human mind. . . For an object in which we see perpetual progress and improvement is, as it were, continually rising in its magnitude: and moreover, when we see an actual increase in a long period of time past, we cannot help forming idea of an unlimited increase in futurity



Creativity in Research, Fig. 3 The sigmoid curve of research progress

This alleged continuity of research progress can be described with reference to the smoothly rising "sigmoid" (or "S") curve shown in Fig. 3 below (Byron 2009). It is represented as showing a smooth transition through the three stages of growth described below:

1. *Infancy*: This is when a new line of enquiry or field of research opens up. It is often referred to as "basic" or "blue skies" research. Progress is usually slow because the ideas may be speculative, there will be little evidence supporting the theory, and relatively few people will be engaged in the work at this early stage. There is also some inertia to overcome in convincing funding bodies that the research could lead to something useful.
2. *Rapid development*: Here the new ideas, methods, theories etc have started to gain acceptance, similar results have been obtained elsewhere, and as a result of published work, progress accelerates. Funding is now easier to obtain because the chances of success are much



Creativity in Research, Fig. 4 A magnified portion of the sigmoid curve

higher. The territory into which the new underpinning theory, model or methodology can be applied successfully is expanded during this phase, but ultimately because there is no theory of everything, new anomalies will start to appear where the new theory cannot be applied.

3. *Maturity*: At this final stage, these new anomalies or gaps in knowledge start to be more widely recognized. This launches a new trajectory of basic research that aims to accommodate these new anomalies, etc. The older model is no longer driving the new research field. That does not mean to say it or even the earlier theories were wrong, but rather that they cannot be generalized to all situations. An example of this in science would be the transition from classical mechanics to quantum mechanics at the turn of the twentieth century. The classical Newtonian mechanics remains intact where it applies, but it was not able to explain effects at very small scales of size.

During the transition between the previous and the next development curve in many fields of research, there is usually much controversy between competing models or theories. The gap between these two curves represents a large discontinuity that requires researchers make a creative shift in their thinking. These transitions do not have to represent paradigm shifts that signal revolutions in knowledge and understanding, they could represent new research directions. More importantly, these transitions are not the only places where the creativity of the researcher is needed. If just one small part of the alleged smooth curve of Fig. 3 is magnified, many more discontinuities that contribute to progress can be seen as illustrated in Fig. 4 (Byron 2009).

The upward steps in Fig. 4 represent the original contributions to progress. They are discontinuous because such insights or mini-breakthroughs are not predictable from the knowledge available at the time. In patent law used to protect inventions, they are defined as "inventive steps" and this is described as something that would not be obvious to someone "skilled in the art." Without an inventive step, a patent cannot be filed. The other features on the inset portion of the curve in Fig. 4 are also worth discussing here because they do relate to creativity, particularly the horizontal arrow defined as a "delay."

Research is a pretty inefficient business in terms of the time and effort put in, and the aforementioned delays stem from two sources. Firstly, there is the innovation aspect of the research in terms of how well the project is managed. Here delays can be due to various factors such as allocation of resources, equipment, support, development and training time, other demands on the researcher, etc. These are all external factors in terms of the person doing the research, but the other contribution to the delay concerns the researchers' own thinking time. This is partly due to the study necessary to understand the relevant concepts, to keep abreast of the published work, etc., but there is another important delay that is often unaccounted for and this concerns creative insights.

Generally speaking, new ideas do not occur at the time that a research problem or challenge has been identified, and four stages have been identified in the process of creative thinking. These were defined by Graham Wallas in 1926 (Wallas 1926) and are listed below with a brief description of their application in the context of research.

1. *Preparation* – This refers to the assessment and clarification of a research challenge that requires both creative and critical thinking. This is often neglected and can lead to delays when underlying assumptions have not first been identified. Sometimes a challenge can be too ambitious or general and needs to be honed down to a set of smaller challenges that represent specific instances of these larger generalities. For example, the challenge statement in educational research: "How might improvement be made on the evaluation of students' knowledge other than by written examinations?" contains assumptions (e.g., to what extent do written examinations fail to provide an adequate evaluation of students' knowledge?), and is not specific enough. Other questions related to this would need to be answered first, and then included in the challenge statement, (e.g., which group of students are involved? what subjects? when does this occur? and so on).

   On the other hand, if a challenge is too specific, it can inhibit creativity, resulting in solutions that are routine. An example here might be the research challenge: "How might a better website be designed?" The "adaptive" approach would be to look at existing websites, and incorporate ideas that improve the existing website design, and eliminate ideas that are regarded in other websites as bad design. The result would be a step-wise improvement in the design of the website. However, if instead of following this line of enquiry, the challenge is broadened out by abstraction, new creative possibilities arise.

   Abstraction is facilitated by asking "why?" and transforming the answer into a bigger challenge. So in this case this leads to: "Why is it necessary to design a better website?" and the answer to this might be: "In order to communicate the content of the website more effectively." If this is transformed into a new challenge it becomes: "How might the content of the website be communicated more effectively?" and this open up new possibilities that would not be found by looking at existing websites such the use of blogs or Facebook, or perhaps authorship of a booklet or other publication, or maybe an invited meeting of key stakeholders and so on.

   In summary, research can be made more efficient by shaping a challenge first before diving into finding ideas for its current formulation. All too often in research after a particular challenge has been set without examining assumptions or shaping it, a few days later in a casual conversation, someone might be heard saying: "What we are really trying to do is. . .. . .!". When a research challenge has been properly prepared so that it is ready for new creative solutions and no immediate resolution has been reached, the next phase of incubation comes into play.
2. *Incubation* – This is an alleged period of unconscious activity facilitated by conscious disengagement from the challenge.

   See Appendix 1 also.
3. *Insight* – This refers to the "Eureka" moment where a breakthrough idea emerges into conscious awareness. This often occurs away from the place where the challenge was identified and can even occur in a dream.
4. *Elaboration* – The commencement of "Innovation" where the original idea is refined, shaped, communicated, and put into practice.

Apart from the first recorded "Eureka" moment of Archimedes, there are many other examples of other great insight stories in the history of the sciences and the arts. Such famous names as Descartes, Mozart, Wagner, Coleridge, Max Ernst, Poincare, Einstein, Hamilton, Nikolai Tesla, Denis Gabor, Otto Loewi, and Cary Mullis all reported "Eureka" insights at times when they were away from the office, studio, laboratory, workplace, etc. Of course, not all original ideas arise in this way and many do take place while doing research without requiring a long incubation period. These are sometimes precipitated by a timely clue. For example, it took Sir Alex Jeffries only 30 min after examining an X-Ray film of a DNA sample to realize its potential for a unique form of fingerprinting. This is also a good example of someone who makes a creative connection between their highly specialized field and another completely different field (forensics).

Discoveries

It is important to discriminate between original ideas inspired by the researchers themselves, and discoveries which are in some sense independent of the researcher even though they represent originality.

Discoveries appear in different ways and are never planned or predictable from the knowledge available at the time, and as such are not the direct result of any individuals' creative thought or action. However, someone has to witness such events. When Alexander Fleming said: *"Chance favours the prepared mind"* he was referring to certain characteristic of a creative mind, that include curiosity, open-mindedness, a willingness to suspend judgment and challenge assumptions, and an ability to take risks. Given that it is not likely when a discovery is made that the researcher will have previously been looking for what they observed, or what the observation could mean, the requirement for a creative mind-set in doing research is clear.

Nurturing Creativity

Creativity is associated with the appropriate use of the imagination and though it is not difficult to imagine the impossible, research is more concerned with "The art of the soluble" to quote the great zoologist Sir Peter Medawar (Medawar 1967). On the other hand, it was the scientist and writer Arthur C Clarke who said (Clarke 1973): *"Every revolutionary idea evokes the following three stages of reaction" :*

> "It's completely impossible — don't waste my time";
> "It's possible, but it's not worth doing";
> "I said it was a good idea all along."

Revolutions apart, creative ideas do sometimes require a certain amount of risk-taking by the person proposing them in that they may appear crazy in the eyes of others. Apart from the risks in dealing with criticism from others, more benignly, this concerns allowing oneself to leave the security of existing habits of thought.

Another way in which creativity can be nurtured is in the development of a tolerance to ambiguity. This concerns the ability to be comfortable with unresolved issues, problems, or challenges for longer periods. It is relatively easy to take the "adaptive" step-by-step approach described earlier to find resolution to such challenges – however, this does not tend to lead to new ideas or open up interesting new lines of enquiry, and is often only a temporary fix.

The more creative approach requires the researcher to be in the mess of an unresolved problem for longer. This can be practiced (provided deadlines are not compromised) by withdrawing from the specific problem at times and trusting in the incubation process described earlier.

Intuition is defined as a form of knowledge or experience unaccompanied by conscious, reasoned thinking. Conscious thought draws on rationality as a guide and deals with tasks in a linear, sequential way. The hidden, intuitive mind has two main influences that determine how it processes thoughts – or rather what become thoughts in the conscious mind. The first process is association which is a pattern-matching process, and the second one is based on heuristics or innate and learned rules of thumb that are shortcuts through repeated association (see, for example, Kahnemann 2012).

Intuition is developed by new knowledge, action, and experience but it is not infallible and shortcuts applied inappropriately can lead to misperceptions or illusory thinking. This is constantly experienced in doing research and many new ideas appear to be counterintuitive until new knowledge is acquired (Byron 2008).

The mismatch between what is sometimes seen to be intuitively correct and what turns out to be true calls again on the need for a more flexible creative attitude to solving problems. This is facilitated by checking assumptions, even reversing them, or trying a number of different approaches and suspending judgment until other options have been explored.

Finding Ideas

New ideas in research can be seen as transforming the existing knowledge base and understanding of the subject, and this is driven much of the time by published work in peer-reviewed journals and conference presentations. A brief look at the history of any area of research will soon reveal that much of the time new ideas simply build on what is already there. This is the basis of what was defined earlier as "adaptive" research. Certain transformations however can also lead to big insights that revolutionize research fields. For example, many of the developments in the early history of microscopy can be seen as adaptive improvements on the first microscope of Anton Van Leeuwenhoek in the seventeenth century (e.g., better lenses, better illumination, better specimen holder, etc). However, when Max Knoll and Ernst Ruska came up with the idea of substituting photons for electrons with the invention of the electron microscope in 1931, this represented a major creative transformation of microscopy (Byron to be published).

When two different disciplines coalesce, another form of transformation takes place where ideas are combined. Examples of this in recent years are bio-informatics, evolutionary psychology, neuro-ethics, social philosophy each of which now has one or more specialized academic journals associated with the new research field.

The study of new ideas in different disciplines reveals that there are only seven kinds of transformation that lead to progress (Byron 2009). It is held that by deliberately applying these transformations to a challenge, many more ideas emerge than would be found by random associative thinking.

The seven kinds of transformation have been summarized in a memorable way with the acronym SCAMPER. This tool was first developed by Bob Eberle in the 1950s and the letters of SCAMPER stand for Substitute, Combine, Adapt, Modify (i.e., Magnify, Minify, Multiply), Put to other uses, Eliminate, and Reverse. Each transformation is prefaced by examining the challenge and asking "What if we.......?" This tool can be applied to any discipline or activity in which there is change. Examples from the world of technology are given below (Byron and Adams 2011).

SUBSTITUTE: Copper cable for Optical fiber – This revolutionized the telecom business.

COMBINE: The telecommunication company "Agilent" Combined planar optical waveguides with an Adaptation of ink jet technology to produce an optical switch.

ADAPT: The microwave oven was an adaptation of magnetrons used in radar systems.

MODIFY (Magnify/Minify): Alastair Pilkington Magnified the phenomenon arising from surface tension of flat oil drops floating on water. He substituted the materials for liquid glass floating on liquid tin and this was how float glass was developed.

PUT TO OTHER USES: Velcro was invented when the attachment mechanism of cockle-burrs was put to another use (after substitution for another material.)

ELIMINATE: The computer industry has been driven by the need to eliminate space on silicon chips by reducing the size of logic elements in order to increase their density and hence their processing power. Wireless technologies eliminate electrical cables.

REVERSE: By creating artificial opals (closely packed silica spheres) and in-filling the gaps then dissolving the spheres we are left with an inverted Opal. This has potential application for photonic circuits (Circuits using light instead of electricity).

Creative tools like SCAMPER enable the researcher not so much to find new ideas, but to ask more questions relating to a particular challenge that could then lead them to finding new ideas. Having available the full range of possible transformative "What If?" questions can also help a researcher to break habitual habits of idea generation and seek more possibilities.

Conclusion and Future Directions

At a time of unprecedented challenges arising from the impact of global warming and population growth on the sustainability of the environment, food supplies, and health provision, the need for productive research and big new ideas has never been greater. To quote the futurist Gaston Berger: *"We must no longer wait for tomorrow, it has to be invented."*

Creativity is the engine that drives progress in research, yet it is largely taken for granted in the recruitment of new researchers that people who have demonstrated a high level of knowledge and understanding of a particular discipline (e.g., achieving a high grade in a bachelors' degree) will be productive researchers. Although, knowledge and understanding are necessary for doing good research, they are not sufficient. Creative skills, unlike critical thinking skills, are less well defined, and in a sense, not directly teachable. Furthermore, the capacity to exercise innate creativity varies considerably from person to person irrespective of their knowledge or indeed intelligence.

The traditional way in which these skills are acquired is through immersion for at least a year or so in doing research, working with other researchers and the research community, and through a great deal of critical study of existing publications. Eventually patterns begin to emerge through these studies that enable a researcher to identify gaps in knowledge, and having familiarized themselves with the entire cycle of research, albeit under guidance, they begin to acquire the confidence to find creative solutions themselves to fill these gaps. From initially being an apprentice, the researcher through hard-earned tacit skills and knowledge eventually becomes an autonomous researcher with barely a mention of the word "creativity." The rate of progress however is very varied, and is highly dependent on the quantity and quality of guidance received from the supervisor or manager through this process.

Transferable skill training programs in research institutes can help researchers acquire these essential skills in a more efficient and effective way. Here the acquisition of slowly learned tacit skills can be accelerated through attendance at specialized workshops focused entirely on these topics (e.g., Creative Problem Solving), and the researchers can gain confidence more quickly through working more closely with their peers.

While creativity cannot be taught directly, it can be "caught" by working in an environment where it is more openly acknowledged and understood as an important part of research activity, rather than being regarded as potential that will make its appearance as a tacit skill over an extended period of time.

In conclusion, it is proposed that to complement the conventional 1:1 supervision process for researchers, the deliberate development of creative skills in new researchers through workshops and courses in research institutes is a key requirement for the next generation of researchers seeking the big ideas needed to address global challenges. To achieve this, considerable effort will be needed by those who develop researchers to fully understand the creative tools and techniques that really work for researchers, and to develop effective development interventions illustrated with relevant subject-specific case studies. In this respect, the transformative idea generation tool described here is one example of a technique that can enable the researcher to find more ideas to meet a research challenge, and to help develop their own creative skills.

Appendix 1: Creative Behavior

In the context of the skills for doing research in any field, it is useful to refer to a spectrum of creative behaviors. At one end of the spectrum is an everyday form of unconscious creative behavior that would include the ability to form the next few words to be expressed verbally. Another example might be when a solution is sought for an existing problem in a routine way by drawing on memories of earlier solutions (e.g., stabilizing a table by placing a folded beer mat under one of the legs). At the other end of the spectrum are the big insights or "Eureka" moments that lead to breakthroughs and possibly progress in research.

The former end of the spectrum may be defined as small "c" creativity and the other as large "C" creativity. "c" creativity in the first example cited earlier is the continuous generation of relatively small ideas (words and phrasing) about something that is required to be communicated, and these ideas are coupled to syntax and other cognitive, noncognitive, and physical mechanisms that make communication possible. All of these small ideas are in themselves unoriginal, but collectively they constitute a unique event in the sense of something being spoken by a certain person at a certain time, and in a certain place.

"C" refers to big ideas or discontinuities in current thinking and the temporal relationship to other measurable processes taking place in parallel is quite different. "C" creativity in the example cited earlier occurs mostly (but not always) at unusual times, and in unusual places often away from the environment (e.g., the laboratory, the studio, the library, the office, etc.) in which the original challenge that led to the insight was first articulated. These "Eureka" moments appear to arise unbidden and without conscious effort, and are a delayed (sometimes after a period of years) response to an earlier unresolved challenge or problem.

Though it has not been verified experimentally, the general consensus is that these ideas arise after a period of prolonged unconscious incubation. That is to say at the time the idea arises in conscious awareness, the person – though not aware of any earlier effort being expended on seeking the idea – is working away on solving it in the background as it were. It is difficult to prove whether or not the incubation process is actually taking place because some random reminder of the problem or challenge may equally have stimulated the idea instantaneously.

Occupying the region in between these two extremes on the spectrum are forms of deliberate creative behavior and examples of this occur on the following occasions:

- When the focus of attention is on a specific problem or challenge, and ideas are sought in real time to solve it
- When working with others to find ideas (e.g., in a group brainstorm or in an academic argument)
- When creative tools and techniques are applied in a deliberate way (e.g., SCAMPER, Forced Connections, TRIZ) to find ideas

Consistent with the extremes of the aforementioned spectrum of creative behavior, deliberate creative thinking (the default process of which is thinking by association) is an unconscious activity but the difference here is that the researcher is consciously aware of the questions that are asked at the same time ideas to answer them are being sought.

With the possible exception of the "Eureka" end of this spectrum, it is important to note that creative thinking does not exist in isolation but has a symbiotic relationship with a cluster of other cognitive abilities generally referred to as critical thinking (e.g., analyzing, rationalizing, synthesizing, evaluating, inferring, judging, deciding, etc.). This symbiosis is driven by a certain degree of emotion that provides the motivation to solve problems in whatever form they take.

Strictly speaking, the processes of critical thinking cannot be separated from creative thinking – ideas emerge from questions posed in both these modes of thought – but there are times when seeking new ideas, it is beneficial to temporarily suspend the critical faculties and let the imagination take the driving seat.

References

Byron KC. Counterintuition. The Institute for Cultural Research. Monograph series No 53. 2008

Byron KC. The creative researcher. 2009. http://www.vitae.ac.uk/policy-practice/1393-189241/The-creative-researcher.html

Byron KC. To be published. Creativity in research. In: Greenfield T, editor. Research methods for postgraduates.

Byron KC, Adams JD. Effective learning in the life sciences: how students can achieve their full potential'. Wiley on-line Library. 2011

Clarke CA. Profiles of the future: an enquiry into the limits of the possible. New York: Harper & Row; 1973.

Harwood WS, Reiff R, Phillipson T. Voices from the frontline: scientists' conceptions of scientific inquiry. J Chem Edu. 2004

Kahnemann D. Thinking, fast and slow. London: Penguin; 2012.

Medawar P. The art of the soluble: creativity and originality in science. London: Methuen; 1967.

Preistley J. The history and present state of electricity with original experiments. 1767.

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Wallas G. The art of thought. New York: Harcourt, Brace; 1926.

Creativity Machine® Paradigm

Stephen Thaler
Imagination Engines, Inc., St. Charles, MO, USA

Synonyms

Autonomous bootstrapping of useful information (DABUI), device; Autonomous generation of useful information (DAGUI), device; Imagination engine; Perceptron-imagitron pairs

Introduction

Although the definition of the term "creativity" widely varies, recent developments in the field of artificial neural networks (ANNs) lend a highly comprehensive model to all accounts of this highly prized cognitive process. From this bottom-up, computational perspective, seminal idea formation results from a noise-driven brainstorming session between at least two neural assemblies. In effect, ongoing disturbances both to and within such nets serve to drive a sequence of activation patterns in a process tantamount to stream of consciousness. At sufficiently intense disturbance levels, memories and their interrelationships degrade into false memories or *confabulations*, any of which could be of potential utility or appeal. If another ANN is provided to make this value judgment, we form an inventive neural architecture called a "Creativity Machine" (*US Patents 5,659,666, 7,454,388, and related US divisional and foreign filings).* Within such contemplative computational systems, the latter network may be allowed governance over the statistical placement and magnitudes of such disturbances, so as to induce the highest turnover of potentially useful or meaningful confabulations.

According to this simple, elegant, and working model, creativity may be attributed to the failure of biological neural networks to reconstruct memories of direct experience when exposed to nature's ubiquitous disordering effects, as other "wetware" opportunistically exploits such mistakes and pragmatically perfects the underlying network flaws.

Fundamental Concepts in Creativity Machine Theory

Neural Network

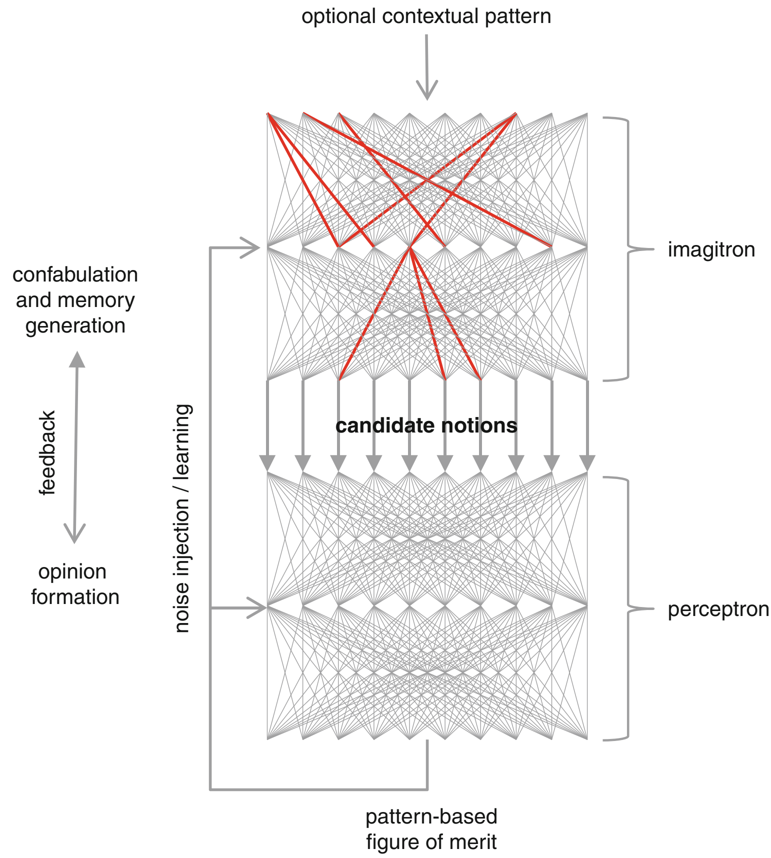
For the purposes of this discussion, the term "neural network" refers to any collection of switching elements, either real or computer-simulated, that wire themselves together so as to write arbitrarily complex input-output programs called *mappings*. In a process called *training*, the wiring strengths between such switches, known as *synapses* or *connection weights*, self-organize so as to decompose the entire body of input patterns into their statistically dominant themes or *features*. Other connection weights within these nets likewise self-organize so as to absorb the inherent statistical interrelationships between such tokenized input space features.

Concepts central to this notion of a neural network are enumerated below, sparing mathematical details and connecting more with introspective analogies to human cognition:

- Artificial neural network – Either a neural network implemented from hardware-based, parallel processing units and physical interconnects, or sequential simulations thereof on digital computers.
- Perceptron – A particular kind of artificial neural network that emulates the non-contemplative and reflexive aspects of perception wherein raw numerical input patterns, tantamount to electromagnetic, acoustic, and contact sensations, are mapped to associated patterns that represent the resultant memories and sensations activated within the brain in response to entities or scenarios observed by it in the external world.
- Exemplars – Raw numerical patterns, typically consisting of input and output components that are presented to a perceptron as it adapts its connection weights to capture the intrinsic mapping between such input-output pattern pairings.
- Environment – In the case of a perceptron, the body of all potential input patterns tantamount to the brain's observable universe.
- Synapse – For an ANN, a numerical value, here synonymous with the term connection weight, used as a mathematical multiplier of raw signals communicated between neurons. Emulating short- and long-term potentiation within the electrochemical synapses of the brain, such connections are responsible for absorbing an understanding of the exemplar patterns through the binding of neurons into colonies that form token representations of the principal features of the external world and then forming connections between such islands that reflect largely spatial and temporal correlations between the represented entities. For all intents and purposes, the *synaptic organization* of a neural network, either biological or simulated, is regarded as the network itself, since connections typically far outnumber neurons, the latter representing the same, repeated mathematical transformation.
- Pattern completion – The neural network process wherein missing components of incomplete or corrupted environmental patterns are filled in based upon learned relationships stored within the network's synaptic connection weights. In effect, this process is tantamount to our staring at clouds and imagining animal or human forms, or reading a misspelled word and perceiving its correct form.
- Associative memory – Usually a perceptron that is trained by example to replicate whatever input patterns are applied to it. By making such *auto-associative* networks recurrent, constantly recycling the generated output patterns back to the input layer, the network is able to accept incomplete data patterns as "clues" to the information sought, thereby enabling the reconstruction of sought knowledge through perfective cycles of pattern completion. Such recursion is tantamount to the time evolution of a biological neural net as it settles into a persistent and stable activation state we regard as a *memory*.

Creativity Machines

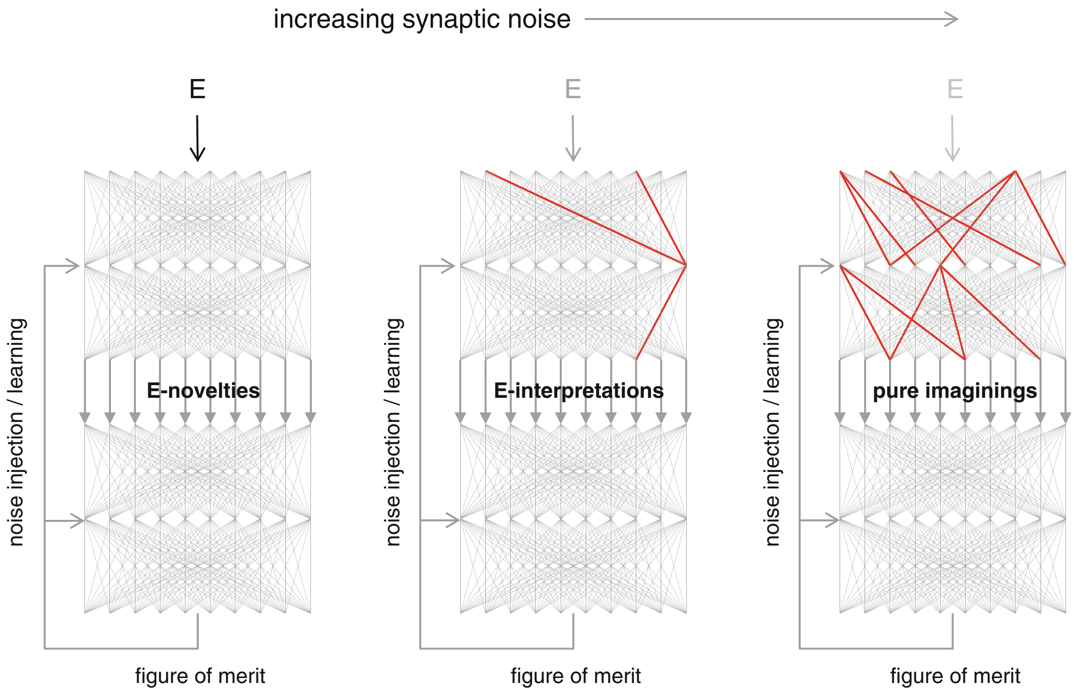
Neural network practitioners often build what are known as *hierarchical cascades* in which one or more preliminary networks accept input patterns from the environment, relaying their output patterns in turn to downstream networks that carry out subsequent pattern-based computations. Similarly, Creativity Machines consist of such cascades (Fig. 1), but the patterns initiating the propagation of information do not necessarily originate in the external environment. Instead, these "seed" patterns have either a complete or partial genesis within the gateway nets of the cascade and are nucleated by all manner of entropic disturbances to these assemblies' neurons and synaptic interconnects. In effect,



Creativity Machine® Paradigm, Fig. 1 *A simple creativity machine, US patents 5,659,666 and 7,454,388*. Transient disturbances within a neural net called an "imagitron" generate confabulatory patterns that are judged for utility or value by a monitoring network traditionally regarded as a "perceptron." Feedback effects between both networks accelerate convergence toward useful solution patterns, oftentimes absorbing them into both networks' cumulative learning (*Red weights* represent those being momentarily perturbed)

such random or chaotic perturbations can drive the turnover of memories as if actual environmental stimuli are being presented to the nets' sensory input layers (Thaler 1995a, b). Appropriately tuned, such disturbances succeed in morphing tokenized entities and relationships collectively stored within such perturbed networks' synapses into plausible to semi-plausible notions the cascade has never directly experienced. The resulting phantom experience within such perturbed networks, coined *imagitrons*, emulates a broad range of virtual, cognitive experiences, ranging from hallucinatory effects to the parade of memories and ideas we commonly regard as contemplation and creative thought. By using downstream networks within these cascades that associate a pattern-based figure of merit with these confabulatory patterns and using such perceived worth to further control the disturbances applied to upstream nets, new and often useful concepts spontaneously emerge.

Figure 2 emphasizes the role of environmental inputs to the Creativity Machine architecture. When both networks of this simple cascade are quiescent (left), the imagitron can serve as a novelty filter that can detect anomalous environmental patterns (E-novelties) through comparison with its stored memories, subsequently recruiting the perceptron to detect any such patterns offering utility or value. As the mean synaptic disturbance level increases (center), the imagitron generates alternative interpretations of any applied environmental pattern (E-interpretations), allowing the perceptron to bias the input pattern's meaning through feedback noise, with the system now fulfilling a sense-making or disambiguation role. Finally, at sufficient levels of perturbation (right), any internal noise swamps out the influence of environmental patterns,



Creativity Machine® Paradigm, Fig. 2 *Growing insensitivity to environmental input, E, with increasing synaptic noise*. As the perceptron injects increasing levels of synaptic noise (*red weights*), the system becomes "attention deficit," first forming alternative interpretations to environmental stimuli and then becoming aloof to the surroundings as it freely imagines, drawing only upon stored memories and derivative confabulations

allowing the system to carry out an "eyes-shut" invention or discovery process.

Creativity Machine accomplishments over the last 23 years have spanned areas of creative interpretation, concept generation, and adaptive control (Table 1). They have often been built from numerous neural modules, so as to combine distinct conceptual spaces into compound discoveries and inventions. The individual neural assemblies therein have automatically recruited each other into complex topologies and recurrencies, subjecting each other to noise levels sufficient to generate a succession of promising juxtapositional concepts or strategies. Equipped with both sensor and actuators suites, such synthetic brains have served as improvisational control systems for various types of military and space flight robots that must often ad-lib behaviors to fit newly arising environmental challenges.

Because of the diversity of Creativity Machine types, objectives, and ties with human cognition, an extensive vocabulary has arisen to prescribe both architecture and function of these systems. Those terms germane to this discussion include:

- Imagitron (a.k.a., Imagination Engine) – Any synaptically connected architecture involving one or more perceptrons that are perturbed by any form of random, semi-random, or systematic disturbances so as to drive the generation of potential ideas.
- Perceptron – In the context of the Creativity Machine, one or more pattern-associating neural nets that link themselves into associative chains and loops in response to the patterns generated by imagitrons. To liken this process to human cognition, a novel pattern issuing from an imagitron can initiate a chain of pleasant associations indicative of the "goodness" perceived. Alternately, notions lacking promise can generate an associative gestalt of negative memories, "badness," that may involve recollections of past physical pain.

Creativity Machine® Paradigm, Table 1 Some creativity machine accomplishments

Accomplishment	Year
Generation of alternative Christmas carols	1989
Generation of 11,000 musical hooks	1995
Design of new personal hygiene products	1996
Prediction of new ultrahard, supermagnetic, and superconducting materials	1996
Invention of novel and useful neural architectures that became patents	1997
Autonomous control of communications satellites	1997
Autonomous generation of hypothetical facial portraits	1997
Autonomous writing of computer code for data compression	1998
Generation of two million new potential English words	1999
Semantic interpretation of web content	2000
Military resource allocation and logistics	2000
Complex hexapod robots invent their own behaviors and ad lib responses to novel scenarios	2001
Creative, communal intelligence for robotic swarms	2002
Autonomous recruitment of neural network modules to grow complex synthetic brains for robotic control	2002
Album of original musical compositions	2006
Growing of brain-like neural pathways for automotive machine vision applications	2006
Autonomous rendezvous and docking of space vehicles	2007
Hardening of spacecraft hull designs to hypervelocity impact	2011

- Perturbation – A mathematically describable disturbance to any element of a connectionist architecture, alternately referred to herein as noise or cavitation.
- Cavitation – A term that has been applied to the perturbations occurring within the "cavity" of a trained neural network, in which random variations are being applied to a dense, quasi-continuous matrix of synaptic connections. The chance aggregation of multiple perturbations among one or more neighboring synapses may be likened to bubble formation within a boiling fluid or "bubbles" of cortical activity observed in functional brain scans.
- Perceptron-imagitron pairs – The permanent or transient combination of a generative imagitron and an evaluating perceptron that forms the basis of a Creativity Machine, with or without the crucial feedback connections. In complex cascades consisting of multiple perceptrons and imagitrons, a subset of the perceptrons may momentarily lock on to notions emerging from some subset of the imagitrons. Transiently, the "resonant" imagitrons and perceptrons form compound Creativity Machines.
- Prosody – The rhythm or temporal distribution of idea generation, characterized herein by its fractal dimension.
- Thalamocortical loop – A representative example of Creativity Machine Paradigm in neurobiology wherein the thalamus is attentive to noise-seeded notions generated within cortex. Putatively, reentrant connections to cortex as well as global neurotransmitter release following an associative gestalt (see perceptron definition) provide the feedback connection depicted in Fig. 1.
- Creativity Machine – A neural architecture involving at least one assembly of nodes and interconnects, subjected to all manner of random or systematic disturbances so as to produce patterns representing potential ideas and/or plans of action, such notions being communicated to an algorithm of any kind that evaluates these candidate concepts for novelty, utility, value, or appeal. In the

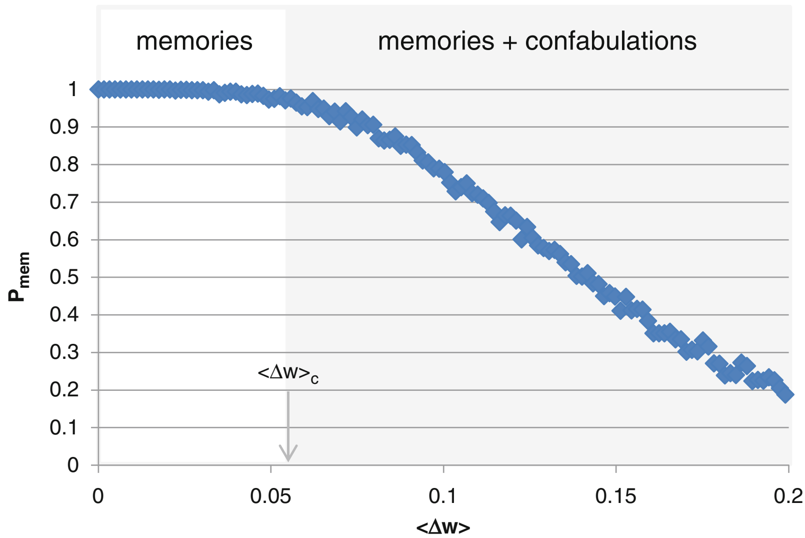
preferred embodiment used in scientific discussion (Fig. 1), the cascade takes the form of one synaptically perturbed imagitron that is both monitored and oftentimes controlled by the response of a perceptron.

- DAGUI – An acronym standing for "Device for the Autonomous Generation of Useful Information," a non-learning Creativity Machine.
- DABUI – An acronym standing for "Device for the Autonomous Bootstrapping of Useful Information," an adaptive Creativity Machine capable of learning from the effectiveness of any of its generated ideas or strategies.

Historical and Theoretical Background

Early Creativity Machine research (1974–1985) focused primarily upon damage mechanisms within associative memories that generated interesting or unusual notions. The first published work on this subject dealt with near-death simulations using trained artificial neural networks wherein the network degradation involved progressively increasing levels of simulated cell death (apoptosis) that resulted in the nullification of synaptic connection weights (Thaler 1995a). In summary, all NDE simulations generated similar results, no matter how large or complex the synaptic organization of the neural network: In the early stages of network degradation, the net activated into intact memories of its training exemplars in a manner reminiscent of life review. At advanced stages of network destruction, the neural assembly output, whimsical and often plausible patterns, oftentimes creating interesting and useful information, as in one classic experiment in which a perceptron-based associative memory was trained on numerous Christmas carols. At confabulatory levels of destruction, the net output novel lyrics that revealed their pedigree in the training exemplars, such as "In the end all men go to good earth in one eternal silent night," or "Deck the halls with last year's follies." In effect, the network had learned the implicit linguistic rules behind such holiday lyrics, beginning at the granularity of letters and words, and was able to interchange frequently encountered entities in a way that formed coherent statements of potential intrigue to human perception. Early published papers (such as Thaler 1995b) dealt largely with the role of low levels of synaptic damage in generating phantom inputs from the environment. The first mention of the practical use of such confabulatory neural nets monitored by evaluation algorithms appeared in 1997 with both a paper on computational creativity (Thaler 1997) and the relevant patent, US 5,659,666.

Early on, it became quite evident that the same system, namely, a synaptically perturbed neural network, could provide creative possibilities within any conceptual space. Thus, an associative memory that had been cumulatively exposed to valid chemical formulas produced both novel and plausible theoretical chemistries (Thaler 1998). A perturbed perceptron shown numerous design specifications for consumer products generated plausible new merchandise concepts (Plotkin 2009). A cavitating associative memory that had witnessed the kinematics of a complex robot generated totally new and physically realizable movement strategies to improvise new behaviors to deal with unanticipated scenarios (Patrick et al. 2006). In short, in just a few moments, a neural network could quickly absorb a conceptual space and with the addition of synaptic misinformation, if you will, generate a stream of potential ideas applicable to that realm. By attaching a monitoring perceptron, trained by example to recognize useful or appealing confabulations, the extraction of useful information from a perturbed neural net's ideational stream was now automated. To further accelerate the process, the perceptrons were allowed to modulate the statistical average of perturbations applied to the synapses of the imagitrons, allowing the combined networks to self-optimize the turnover rate of useful ideas. As these nets equilibrated, they typically selected cavitation levels near the phase boundary ($<\Delta w>_c$) of Fig. 3, separating memory and confabulation generation within the imagitron. The idea-generating efficiency near this transition is characteristic of what Partridge and Rowe (1993) have called *multi-stage search*, the "holy grail" of computational creativity wherein conceptual



Creativity Machine® Paradigm, Fig. 3 *The phase boundary between cavitation-induced memory and confabulation generation*. The plot depicts the fall off in the probability of rote memory generation, P_{mem}, as mean synaptic perturbation level, $<\Delta w>$, is ramped up within a representative associative memory. Useful confabulatory patterns typically emerge near $<\Delta w>_c$

patterns generated represent a balance between a rigid search as through a preprogrammed decision tree ($<\Delta w> \ll <\Delta w>_c$, neo-Lamarckian search) and totally unconstrained pattern production ($<\Delta w> \gg <\Delta w>_c$, neo-Darwinian search) as in a genetic algorithm.

Research in 1997 (Thaler 1997) not only demonstrated how such brainstorming neural nets could qualitatively emulate the inventive processes inherent to neurobiology but how they could be used to quantitatively model the prosody with which thoughts and ideas were generated in the brain. In summary, these studies strongly suggested that the evolution of human thought, creative or not, could be modeled as the state transition rate of a representative thresholding neuron nested within a network subjected to random synaptic disturbances. Through both empirical and theoretical studies, a revealing relationship emerged between the "microscopic" synaptic perturbation rate of an average neuron and the "macroscopic" pattern turnover of the network as a whole,

$$\rho = \kappa \Delta t^{-D_0} \tag{1}$$

where ρ is the average time rate of change of synaptic weights to this representative neuron, Δt the time required for the overall network to activate into a required number of distinct patterns (ideas), D_0 the fractal dimension of the succession of such patterns, and κ a dimension preserving proportionality constant.

In assessing the validity of Eq. 1, numerous, trained perceptrons were subjected to successive cycles of synaptic perturbation, steadily increasing the mean cavitation level, ρ. Within each such cycle (consisting of multiple experiments at the same cavitation rate), the number of synaptic perturbations, n, and their magnitudes, σ, were randomly varied with their product maintained constant, with the average synaptic perturbation, $<\Delta w>$, evaluating to nσ/N, where N represented the total number of network synapses. With ρ identified as nσ/Nδt, δt was set to 300 ms, the characteristic bubble formation time observed in functional brain scans, thereby bringing fits of Eq. 1 to both human cognition and Creativity Machine function into close agreement. Qualitatively, it was found that sparse and intense synaptic fluctuations (σ or n large) corresponded to novel concept formation (i.e., creativity) while more uniformly distributed perturbations (σ and n small or intermediate) appeared associated with rote memory recall.

Dramatic results were observed in 1998, when adaptive neural nets were used as the building blocks of Creativity Machines, allowing them to test their concepts and strategies on either the environment or themselves through a variety of sensing and actuator schemes, enabling them to reinforce the memories of notions they associated with success, while weakening the recollection of those they deemed non-useful. Through successive cycles of idea generation, evaluation, and reinforcement learning, such self-bootstrapping Creativity Machines (DABUI, US Patent 7,454,388) running on a single personal computer were able to arrive at solution patterns within unprecedentedly large conceptual spaces having tens of millions of attributes, in just minutes.

Correspondence with High-Level Models of Creativity and Innovation

A useful nomenclature for describing not only Creativity Machine architectures but also human creativity (Thaler 1996) appeared in 1996, wherein E represents all potential patterns generated ultimately by the energetics of the environment. Within this descriptive symbolism, the letter O is used to denote perceptron stages, suggesting their roles as observing neural networks. Imagitron stages are labeled by either the letters U, V, or W, depending upon the levels of synaptic noise injected into them:

- U-Mode – Generally, U represents an imagitron into which minimal noise has been introduced ($<\Delta w> \, < \, <\Delta w>_c$, referring to Fig. 3), thus driving it to visit a series of rote memories that have been drawn from the network's previous training experience, its universe, so to speak.
- V-Mode – Imagitrons operating at the critical noise level, near $<\Delta w>_c$, are depicted as V, suggesting that they are producing virtual memories of potential things and scenarios that could be part of the net's external environment, but hitherto have not been directly experienced by it through training.
- W-Mode – Finally, W denotes an imagitron driven by noise levels far in excess of those injected in the critical regime ($<\Delta w> \, > \, <\Delta w>_c$). As a result, most of the constraint relationships characteristic of the conceptual space have been destroyed leading to the generation of predominantly meaningless noise, in a mode reminiscent of the *blind watchman* allegory.

Connecting with this formalism, the process of *incubation*, the temporary break from problem solving that can result in insight (Smith 1991), can be explained on the basis of the general diffusional release of stress-related neurotransmitters and neurohormones within the brain that serve to progressively transition imagitrons from U to V, and possibly W mode, during which time, new concepts are created and learned at a "subconscious" level (outside the purview of perceptrons). Following the hiatus from intense imaginative ideation, the concentration of such perturbative agents recede, leaving the perceptron stage in a more tranquil and lucid state, allowing it to recognize the utility of such freshly created and memorized concepts, as the imagitron's noise levels increase again into the U regime.

A perceptron observing multiple U-mode imagitrons jointly activating into a novel concatenation of memories (a $U_1U_2U_3 \ldots U_N$-O process) models the blending of information from multiple conceptual spaces into juxtapositional inventions and discoveries. Similarly, some imagitrons within this juxtapositional string may be operative within the V regime, allowing for the injection of hypothetical entities and scenarios into the composite pattern, leading to $U_1U_2U_3 \ldots U_M V_1 V_2 V_3 \ldots V_N$-O discovery. In many respects, such U_iU_j-O and U_iV_j-O discovery modes may very well represent the high-level concept of *bisociation* (Koestler 1964) wherein facts from entirely different frames of reference are combined to provide promising syllogisms, scientific theories, artistic creations, and amusing juxtapositions offering comic import, with the significance of any of these conceptual blends being generated through the perceptron's input-output mapping.

Overall, the Creativity Machine Paradigm falls into correspondence with many high-level, introspective models of seminal cognition, while possibly expanding the definition of creativity itself. If all of cognition may be modeled via the noise-driven brainstorming session between at least two neural networks wherein novel patterns generated by some are recognized as valuable by others, then the definition of what exactly is creative boils down to the perception of what is deemed "novel" or "useful," the province of neurobiological perceptrons. Indeed, the fruits of so-called H-creativity (Boden 2004) are considered novel from a societal perspective wherein many weakly coupled sense-making Creativity Machines (i.e., sundry brains) come to a consensus regarding the originality and usefulness of a given ideational pattern. P-creativity emerges as strongly coupled perceptrons within an individual's brain perceive utility to an anomalous neural activation pattern representing a concept already known to other individuals.

Herein, we have alluded to the fact that much of non-seminal cognition is dominated by the Creativity Machine Paradigm, including the more visceral mental activities occurring outside of conscious awareness, wherein the brain invents, for instance, a succession of eyeball movements to visually examine its environment in the well-known process of *foveation*. Owing to the fact that memories of where we have previously looked are effectively rediscovered through synaptic noise and relearning, we could regard such relatively trivial neural activity as visceral or "V-creativity." Included within this class of minimal creativity may be the process by which we unconsciously attach subjective significance (i.e., pattern associations) to the sum total of neural activity within our brains in a process we call *consciousness*.

Conclusion and Future Directions

The main conceptual barrier to understanding the Creativity Machine principle is that everything in the world may be represented by, and arguably is, a numerical pattern. That the patterns activated within the brain seem so much like the entities and scenarios from the environment, and not like numbers, is that the neural networks therein have habituated to each other, rapidly decrypting and intuitively recognizing these token representations of the world as equivalent to the "real" thing. When damage occurs within these systems, in particular to the synaptic connections, they generate false memories that can either transmogrify these token entities and/or their interrelationships to produce stable patterns of activation previously unknown to the nets therein. These novel, ideational patterns, deemed useful by monitoring nets, span the range of all things considered creative, whether the conceptualization of a sculpture, a concerto, a joke, or the clever interpretation of a painting or book. In the same way, fundamental analogies, bound within neural assemblies, may transiently interconnect themselves into new theories and logical conclusions. These systems may be convergent, stopping when they are satisfied with a given novel pattern, or be divergent, amassing any number of such ideations by converting them into memories. In effect, the Creativity Machine Paradigm could very well serve as a unifying theory of creativity, and perhaps even consciousness, wherein meaning is invented reflexively, not only to what is observed or imagined but to what is intrinsically just the succession of on/off neural activation patterns inexorably taking place within the neurobiological networks of the brain.

Cross-References

- ▶ Cognition of Creativity
- ▶ Creative Brain
- ▶ Creativity in Invention, Theories
- ▶ Creativity, Experiential Theories
- ▶ Divergent Thinking
- ▶ Ideas and Ideation
- ▶ Imagination
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Models for Creative Inventions
- ▶ Nature of Creativity

References

Boden MA. The creative mind: myths and mechanisms. New York: Routledge; 2004.

Koestler A. The act of creation. New York: Penguin; 1964.

Patrick MC, Thaler SL, Stevenson-Chavis K. Demonstration of self-training autonomous neural networks in space vehicle docking simulations, 2006, NASA-MSFC. Available at http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20070018815_2007018767.pdf.

Plotkin R. The genie in the machine. Stanford: Stanford University Press; 2009.
Rowe J, Partridge D. Creativity: a survey of AI approaches. Artif Intell Rev. 1993;7(1):43–70.
Smith SM, Blakenship SE. Incubation and the persistence of fixation in problem solving. Am J Psychol. 1991;104(1):61–87.
Thaler SL. Death of a gedanken creature. J Near Death Stud. 1995a;13(3). Spring 1995.
Thaler SL. "Virtual input" phenomena within the death of a simple pattern associator. Neural Networks. 1995b;8(1):55–65.
Thaler SL. Predicting ultra-hard binary compounds via cascaded auto- and hetero- associative neural networks. J Alloys Compd. 1998;279(1998):47–59.
Thaler SL. A proposed symbolism for network-implemented discovery processes. Proceedings of the World Congress on Neural Networks; 1996; Mahwah, NJ: Lawrence Erlbaum & Associates; 1996. p. 1265–68.
Thaler SL. A quantitative model of seminal cognition: the creativity machine paradigm. Mind II Conference, Dublin, Ireland, 1997. Available from http://imagination-engines.com/iei_seminal_cognition.htm

Creativity Management

▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies

Creativity Management Optimization

Igor N. Dubina
Economic Information Systems, Altai State University, Barnaul, Russia

Synonyms

Creative management; Creativity optimization; Innovation management; Managing creativity

Definition

Creativity management is a system of principles, methods, techniques, practices, and instruments for managing employee creativity in order to get the maximum effect for the organization according to its goals, objectives, employee contingent, and available resources.

Functions and a Special Status of Creativity Management

As a result of increased interest of business in creativity, the management of creativity appeared as a special theoretical and practical discipline in the end of the 1980s. This interdisciplinary movement partially grounds on creativity psychology, HR management, organizational psychology, R&D management, innovation management, and other adjacent disciplines. The term "creativity management" has been used constantly for the last 2 decades, and significant experience has been accumulated in this field, but there is no theoretical or practical consensus on a definite understanding of goals, functions, and methods of creativity management yet.

A definition of creativity management may be specified by allocating its main objectives and functions (Dubina 2006, 2007):

- Development of techniques for the production and evaluation of new ideas
- Support, facilitation, and development of employee creativity
- Encouraging and fostering employee creativity
- Assessment employee creative styles
- Creative team building
- Organizing, monitoring, and directing employee creativity
- Assessment of the effectiveness of different programs for employee creativity development
- Assessment of creative climate in a company
- Construction of an optimal environment for creativity
- Elimination of constraints against creativity

The comparison of the mentioned functions with the main function of R&D management (organizing basic and applied research, inventing and developing inventions into working prototypes, testing and modifying products) demonstrates overlaps in the field of organizing the process of generating and evaluating new ideas. Comparing the major functions of innovation management (facilitating a company's innovative culture, assessing the prospective efficiency of new ideas and inventions, work planning, project scheduling, estimating and assigning resources) delineates the intersection in the field of organizing a supporting climate for generating and developing new ideas. But in general, creativity management, R&D management, and innovation management are complementary management approaches; they have their own status according to their own objects, objectives, and functions. Understanding creativity management only as an initial component of R&D or innovation management narrows down the field of a manager's view on creativity potentials and limits the possibilities of mobilizing employee creativity in all business processes.

Optimally Integrating Approaches to Managing Creativity

The research conducted by Banks et al. (2003) demonstrates significant variations in managers' understanding of creativity management. Based on this research and other works, it is possible to allocate five different approaches to creativity management (or five groups of managers who cultivate such approaches) (Dubina 2006).

The first group rejects and even suppresses creativity as a useless factor in business. Many managers often decry creativity as unpredictable and uncontrollable, like the weather. Therefore, they do not want to invest in creativity development programs; they do not want their employees exhibiting creativity, because, in their opinion, employees must follow instructions to complete their work on time and within budget.

Managers of the second group consider creativity as rather important, but not a crucial factor or a primary determinant of competitive advantages. They also understand creativity as something that cannot be managed; therefore, it demands no special attention or nurturing. The main principle of this approach is nonintervention.

The third group accents creativity facilitation by providing appropriate workplace conditions. The fourth group focuses on intensive fostering and developing creative skills. These two approaches are most popular among managers and are often associated with the whole system of creativity management.

The fifth group emphasizes the need to direct and control employee creativity; this is not, certainly, an overall control and prescriptive procedure but a form of "soft" organizing, focusing, and directing. These managers acknowledge the necessity of creativity harmless for business processes; therefore, it must be monitored and controlled and sometimes even constrained to ensure realization of the company's objectives. This point of view is rarely recognized or acknowledged, because such words as controlling, organizing, and optimizing in conjunction with creativity sound like something of a paradox.

It is an obvious and almost trivial postulate that the efficient development of actual business systems is currently precluded without creativity and change. However, creativity is opposed to the cyclical repetitions and actions in a business system, because creativity presumes the violation of routine repetition and the introduction of new elements; creativity is disruptive in its very nature. In the case of repetitive activity, an employee operates within the rules established by the regulation system, and in the case of creative activity, he or she transforms the existing standards, combines the assigned rules, and creates new ones, thus changing the status and level of the managed system. Uncontrolled creativity of employees may be detrimental for a company, if employee creativity is not adequately engaged in the organizational context. Therefore, the assessment of the level of probable change and, consequently, the evaluation of the level of admissible creativity are required. This is the rationalization behind setting up the questions of searching for the optimal range of employee creativity, as well as an optimal program for creativity development and actualization: What programs for creativity development and creative climate improvement should be carried out, which resources should be invested in that program, and what results will be obtained? Intuitive decisions and qualitative analysis are often not successful, especially for medium and large business structures requiring more reliable and effective tools for decision making in this field.

Managers often consider creativity as an instrument for problem solving. Hence, they often turn to employee creativity when confronted with a problem. De Bono (1993) characterizes such an approach to creativity as "a huge waste of thinking capacity," because "the most progress comes from thinking about things that are not problems." Creativity focused on solving current problems can ensure survival for a company, while creativity focused on searching for new opportunities can ensure successful development. Managers should encourage their employees to think creatively not only to solve a problem but also to seek out new opportunities for the workplace, the department, or the company.

It is not uncommon, as Tan (1998) notes, to find managers working hard to ensure that their organizations have a nurturing environment to encourage creativity. But even if creativity management is carried out in a company, it is often implemented in a nonsystematic way: Managers may occasionally organize some training or workshops on creative decision making for the employees or supervisors, conduct creativity sessions to find a solution for some business problem, make some changes in the reward system to encourage creative suggestions, and so on. Therefore, managers very often pay attention to some single approach, for example, creativity training or creativity motivation system improvement, and fail to take into consideration other aspects and approaches of creativity management, such as creativity evaluation, creativity outcome control, assessing the work environment for creativity, or searching for an optimal strategy for creativity mobilization.

A Conception of Optimally Managing Creativity

The idea of "optimally managing creativity" follows from the conception of a balance between *stability* and *development* (Dubina 2005). It resembles an obvious and almost trivial postulate that the efficient development of actual business systems is currently precluded without creativity and change. However, creativity opposes the cyclical repetitions and actions in a business system, because creativity presumes the violation of routine repetition and the introduction of new elements; creativity is disruptive in its very nature. In the case of repetitive activity, an employee operates within the rules established by the regulation system, and in the case of creative activity, he or she transforms the existing standards, combines the assigned rules, and creates new ones, thus changing the status and level of the managed system. Uncontrolled creativity of employees may be detrimental for a company, if employee creativity is not adequately engaged in the organizational context. Therefore, assessments of the level of probable change and, consequently, the evaluation of the level of admissible creativity are required. This represents the rationale for setting up questions of searching for the optimal range of employee creativity as well as optimal programs for creativity development and actualization: Which program for creativity development and creative climate improvement should be carried out, which resources should be invested in that program, and which results will be obtained?

In practice, such speculations are realized, for instance, in the context of building a balanced creative team which includes people with different *creative styles*, for example, adaptive styles which are targeted at improving the existing paradigm and innovative styles which are disruptive for the paradigm.

So, the first basic idea of optimizing creativity management is based on the statement that the successful and efficient development of actual business systems implies *both* repetitive and creative functions in the working activities of employees. The paradox (and the problem) focuses on the opposition of creativity versus the cyclical repetition of some actions and results in the function of a business system, because creativity displays a disruptive nature and supposes the alteration (violation) of routine repetitions and the introduction of new elements into the system. At the same time, the prolonged development of any business system is not possible without creativity and change.

The second idea of optimally managing creativity associates the costs of creativity development with the obtained results. If an employer implements activities for the employee's creativity development (e.g., tailored training programs, purchasing special software for creative decision support, changing an organizational climate to encourage employees to submit new ideas), he or she may increase the employee's performance with the same wage level, because the employee's creativity is being leveraged. However, this approach requires additional resources, so the problem of the effectiveness of the investment in creativity arises. It is obvious that this investment should be less than performance augmentation to ensure the profitability of the implemented creativity program.

Therefore, the problem of optimally managing creativity may be phrased in the following questions:

- How (in what way) to use and mobilize employees' creativity to ensure the best result for *this* company?
- Which interventions in employees' creativity and organizational climate, and to which extent, are required to maximize the positive effect of these activities for *this* company?
- What is the range and effectiveness of different interventions and programs that can develop creativity and improve creative climate (taking into account the specificity of a company)?
- What is the range of influence of employee creativity and creative climate characteristics on work performance?

It would be naive to expect universal and general answers to these questions. However, the recent amount and quality of research on assessing creativity and creative climate, as well as accumulated management experience in the fields of creativity training and improvement of the work environment, assume that these questions may be solved.

An optimizing creativity management represents not a mechanistic approach to precisely predicting and regulating creative activities. The main principle of optimizing creativity management can be formulated as follows: *Even if it is not possible to predict exact results from interventions for facilitating and fostering creativity, it is possible to select and implement the interventions which provide the best results for a given company in a present situation* (Dubina 2006, 2007).

An approach of optimizing creativity management is an element of the realization of a "total system approach" to the management of creativity as being proclaimed by Tan (1998) for holistically managing creativity in a company. The system approach should ensure that all organizational rules, routines, and procedures, as well as the organization subsystems (organizational culture, workplace environment, management structure, reward system, etc.), mutually support one another in order to develop and use creativity resources most effectively. In practice, the principles of optimizing creativity management are realized in team building, creativity training, and improving organizational climate (Dubina 2007).

Conclusions and Future Directions

Presently, in the sphere of both practical management and management scholarship, there is consensus about creativity as a valuable and inexhaustible business and economic resource.

All business processes of a company should involve creativity, but, at the same time, employee creativity needs to be properly organized and monitored. A too narrow understanding of creativity management (only as an improvement and development) predominates in the management theory and practice, but effective creativity management should not only support, develop, and encourage employee creativity but also assess, organize, and direct it. The management of creativity refers not only to creativity development but addresses also aspects of assessment and optimization.

This entry argues for the necessity of optimizing creativity management in a company/organization in order to mobilize the resource of creativity more effectively. Optimizing creativity management is considered as an evolutionary stage and component of the development of the "total system approach" proclaimed by Tan (1998) to holistically manage creativity in a company. A company needs creativity management optimization in order to mobilize the resources of creativity more effectively. Optimizing creativity management presumes effectively organizing resources and interventions for developing creativity and improving the work environment for creativity.

One of comparatively new approaches to optimally manage creativity is the application of mathematical optimization models to the systems and processes of organizing and stimulating creative and innovative activities. In particular, such a research direction is developed in Dubina (2012) on the methodological basis of game theory.

The approach of optimally managing creativity indicates prospective directions both for theoretical investigations and practical techniques to manage employee creativity more systematically, methodically, and relevantly to the specificity of an organization, its goals, and resources.

Cross-References

▶ Business Creativity
▶ Corporate Creativity
▶ Creative Management
▶ Creative Styles
▶ Creativity and Innovation: What Is the Difference?
▶ Four Ps in Organizational Creativity
▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index
▶ Measuring Organizational Climate for Creativity and Innovation
▶ Simplexity Thinking

References

Banks M, Eliott M, Owen J. Managing creativity and competitive advantage in SMEs: examining creative, new media firms. In: Jones O, Tilley F, editors. Competitive advantage in SMEs: organizing for innovation and change. Hoboken: Wiley; 2003. p. 120–34.

De Bono E. Sur/petition: creating value monopolies when everyone else is merely competing. New York: Harper Business; 1993.

Dubina IN. Game-theoretic models and methods of the organization of creative and innovative activities. Dissertation of habil. Dr. of Sci. in Economics. Novosibirsk: Novosibirsk State University; 2012 (in Russian).

Dubina IN. Managing creativity: theoretical approaches to employees' creativity regulation. Int J Manag Concept Philos. 2005;1(4):334–49.

Dubina IN. Optimising creativity management: problems and principles. Int J Manag Decis Mak. 2006;7(6):677–91.

Dubina IN. Optimally managing creativity in organizations. In: Carayannis EG, Chanaron JJ, editors. Managing creative and innovative people: the art, science and craft of fostering creativity, triggering invention and catalyzing innovation. Westport: Praeger; 2007. p. 143–69.

Tan G. Managing creativity in organizations: a total system approach. Creativity Innov Manag. 1998;7(1):23–31.

Creativity Models

▶ Multiple Models of Creativity

Creativity Optimization

▶ Creativity Management Optimization

Creativity Research

▶ Psychology of Creativity
▶ Research on Creativity

Creativity Slump

► Decrease in Creativity

Creativity Spillovers

► Entrepreneurship in Creative Economy

Creativity Techniques

► Creativity in Invention, Theories
► Strategic Thinking and Creative Invention

Creativity Techniques: Use of Creativity Techniques in Innovation Processes

Horst Geschka[1] and Andrea Zirm[2]
[1]Geschka & Partner Unternehmensberatung, Darmstadt, Germany
[2]Hochschule für Angewandte Wissenschaften (HAW), Wentorf, Hamburg, Germany

Creative Ideas as a Starting Point for Innovations

Basis of any innovation is a creative thought. It may be that, prior to the creative impulse, reflections and analyses have been made to develop new products or services in a certain customer segment or to solve identified problems or challenges. When a task or even a pressure to develop an innovation is imposed to individuals, very often, concrete ideas are not emerging. A creative idea must arise in a motivated person's brain; then it must be formulated accurately, technically developed, and finally launched as a new product or new service to the market.

A creative concept typically ignores common solutions and structures. Instead, it relies on new approaches. Usually after a creative concept has been generated, laborious work of verification, development, and implementation follows.

Looking at current real innovations, it is obvious that not only one single "brilliant" idea led to the innovation, rather additional, more detailed and complementary ideas compliment the new product development. Thus, multiple creative inputs foster the whole formation process and lead to an innovation. An innovation is of course initiated by a fundamental creative impulse. However, in the course of the development process, numerous other creative inputs are added.

These creative inputs for innovation can come from entrepreneurs, managers, or employees in R&D; they may arise in innovation units or in other departments as a result of personal thinking. These valuable creative contributions are not predictable. As innovation processes in companies nowadays are structured with respect to results and deadlines, specific tools are needed to help generating ideas strategically and within a manageable time frame. Creativity techniques comply with these requirements. They serve as an important tool in addition to the individual creative contributions of employees or proposals from external sources (open innovation).

Creativity Techniques

Basis and Overview

Related to innovation creativity is understood as the human ability to combine elements of knowledge and experience from different areas in an unconventional way, thus triggering new ideas for products or services to solve problems or challenges. Thus, established structures and thought patterns are overcome.

Creativity techniques support the genesis of ideas. They consist of a set of thinking and behavior rules, which stimulate as an overall effect a group or an individual to generate ideas. The most practiced creativity techniques are designed

Techniques of Free Association
- Brainstorming
- Circulating cards technique
- Ring Exchange Technique
- Mindmapping

Techniques of Structured Association
- Walt Disney Method
- Six Hats Method
- Semantic Intuition

Imagination Techniques
- Try to become the problem*
- Take a picture of the problem*
- Fantasy Journeys*

Confrontation Techniques
- Synectics Excursion*
- Stimulating Word Analysis
- Visual-Confrontation-in-the-Group
- Picture Cards Brainwriting
- TRIZ Invention Principles

Configuration Techniques
- Morphological Tableau
- Morphological Matrix
- Attribute Listing*
- SIT (Systematic Inventive Thinking)*

* Techniques that are less suited for application in innovation processes (see sect. "Less suitable Creativity Techniques for Innovation Tasks")

Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 1 Grouping of creativity techniques

for application in a group; there are only few techniques designed to be applied by just one person. In heterogeneous groups, synergy effects take place, resulting in an extension of the search field, in a deepening of the search quality, and in cross-disciplinary exchange of solution approaches.

Concerning the rules of the individual techniques certain principles are specified, they are usually not recognized as such in the descriptions of the techniques. These principles are primarily:

- Idea-stimulating principles: association, combination, transfer of structures, analogy formation, confrontation
- Keeping individual barriers down: no constraints, no criticism, crazy ideas are welcome, anonymity of ideas written down, no names in the minutes
- Establishing a pleasant session atmosphere: stimulating physical environment, sensitive facilitators, informal behavior, encouragement of intuitive thinking, welcoming humor

Meanwhile, there are many creativity techniques; worldwide one can collect over 100 techniques. Quite often, some listed methods are very similar; they differ only in details or are named differently while following the same approach.

Some creativity techniques can be used in all areas that require creative inputs. On the other hand, there are methods especially suitable for certain applications (e.g., in advertising, for social issues, for technical inventions). Furthermore, in certain regions based on regional, cultural habits, specific creativity techniques are preferred (e.g., brainwriting methods in Japan, visual stimuli in China, less structured methods in the USA, contemplative techniques in Germany).

Creativity techniques can be distinguished according to idea inspiring principles (see Fig. 1). In Fig. 1, techniques are shown which have attained a certain dissemination in Europe. The following brief descriptions are limited to the techniques listed in this figure.

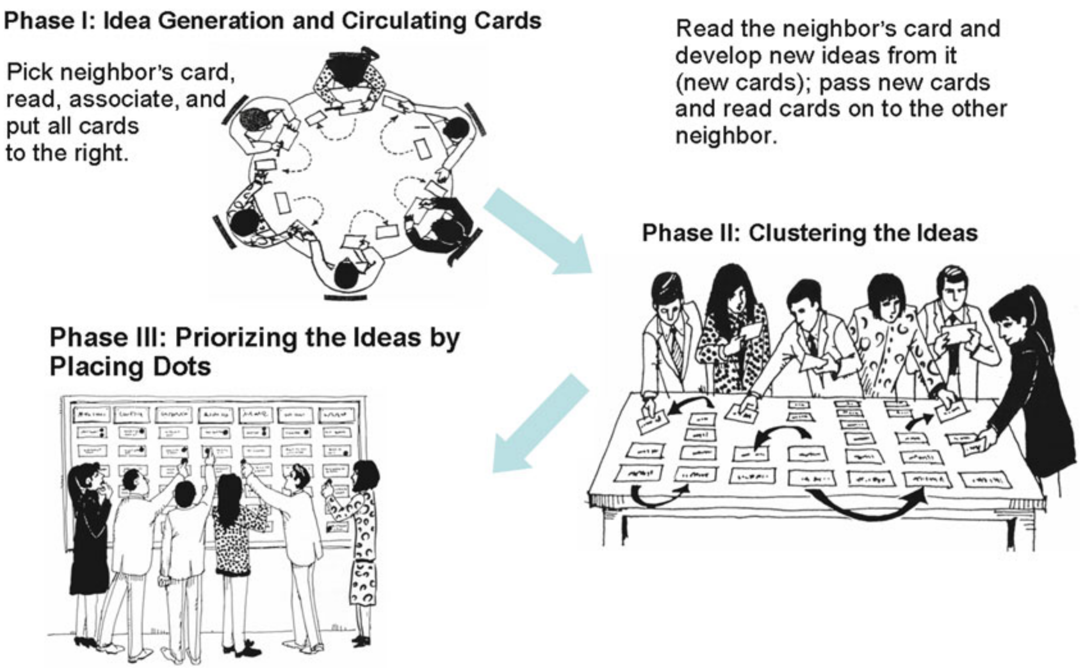
Description of Common Creativity Techniques

The following brief descriptions follow the outline in Fig. 1.

Techniques of Free Association

Idea generation in **brainstorming** sessions is mainly based on reciprocal-free associations of ideas within a group (Osborn 1953). All ideas brought up should be adopted by other participants (cross-fertilization). The following basic rules generally apply to all other creativity techniques:

- No criticism of the ideas is allowed.
- Even crazy ideas coming to one's mind should be expressed: they may stimulate other participants to realistic ideas.



Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 2 Idea generation with circulating cards technique

- As many ideas as possible should be generated. The more ideas produced, the greater the probability to find a few really good and original ideas.

A brainstorming session is practiced in a group of five to eight participants and should take no longer than half an hour.

Brainstorming is normally considered to be a simple method and is therefore very widely applied. However, experience has shown that the rules are not properly obeyed. The role of the moderator is especially difficult; there is no distinct structure in the process that supports the moderation.

In the **brainwriting techniques**, speaking is replaced by writing; the participants write the ideas on sheets or cards. Apart from that, the basic principles are the same as for brainstorming. The stimulation of the participants is achieved by exchanging the described sheets or cards. The use of different page formats and exchange mechanisms caused in the course of time some brainwriting variants.

In the **ring-exchange technique**, standard stationary sheets are divided into three columns. Each participant writes three ideas in the first line, one in each of the three columns. After about 5 min, the sheets are passed on to the neighbor in a defined direction. The neighbor tries to further develop the ideas written in the first row and notes new ideas in the second line under the respective ideas of its predecessor. If no associations come to their mind, the participants are of course free to write down any idea they have. This procedure is repeated five times. With six participants and all sheets filled in completely, 108 ideas are recorded within about 30 min. Then, these ideas will be screened down and further developed.

The technique was introduced under the name "Method 635" by Rohrbach and further developed by Geschka (1986).

The **circulating cards technique** (see Fig. 2) uses the advantages of pin cards (Geschka et al. 1973). The ideas are written down on cards with thick markers. Each participant writes one idea

Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 3 Color symbolism of the six hats method

- White Hat: objective information: numbers, data, facts, experience
- Red Hat: emotional and intuitive reactions, feelings
- Black Hat: concerns, difficulties, problems
- Yellow Hat: advantages, positive perspectives
- Green Hat: creative improvements, ideas, alternatives
- Blue Hat: moderation, task management, coordination of the other "hats"

on a separate card and places the cards on the right side to be picked up by the neighbor. The neighbor picks them up when he or she wants further stimuli from others. All participants pass their cards in the same direction. The cards circulate around the table. In this phase, nobody should speak. After about 20 min, idea generation may be stopped. A group of six participants generates normally 50–70 ideas. The idea cards are then clustered on a table; duplicates will be eliminated and the selected idea cards will then be finally pinned on a board. An initial evaluation of the ideas will follow via placing adhesive dots spontaneously on the cards. This approach reveals the most promising suggestions quickly.

To overcome the linear and well-established structures of thinking and writing the concept of **mindmapping** promotes an opening and widening of thinking. All thoughts, ideas, and other relevant issues are recorded in a tree-like structure (Buzan 1986). In the drawn tree structure, ideas and other aspects are characterized by terms, pictures, symbols, and colors. Through this structure and visualization, one receives a new insight of the solution field. Ideas emerge during developing the tree but also hereafter when the designed overall structure is interpreted.

Techniques of Structured Association

Applying the techniques of structured association, idea generation proceeds in defined steps: The problem solvers are guided through several stages of contemplation and the group is led into different lines of thinking – one after the other. This steered parallel thinking is more efficient then controversial discussions. These techniques allow coming up with positive and skeptical remarks as well as with rational and emotional thoughts.

The **Walt Disney method** (Dilts et al. 1991) arose from the Walt Disney's approach of developing new projects. In a role-play, three thinking attitudes are taken sequentially on different chairs or in different rooms by a person or a group: The dreamers consider future developments and goals with no restrictions; it may be spun dreamed. In the second room, the implementation area and the visionary ideas are reviewed in relation to its implementation, pursuing a positive attitude. In the area of criticism, the suggestions are examined in a constructive manner in order to overcome resistance and obstacles.

The **six hats method** of De Bono (1985) leads systematically to a change of perspective: Symbolized by hats in different colors, different modes of thinking are consecutively conducted in a group (see Fig. 3). All statements are put down under the respective "hat." A clear separation between the "hats" is important. The reactions to the thinking hats should be spontaneous and quick. The method should take not longer than 30 min.

Many everyday objects and inventions have a descriptive name; they are often composed of two words. Examples are hair curler, heating pad, corkscrew, and ignition key. The method **semantic intuition** (Geschka et al. 1973) turns the parts of the terms around: Any word combination formed suggests a possible device or process; one has to interpret what the new word combination could mean. In this manner, ideas for new products or services arise (e.g., curled cork; pad screw).

How to work through this method? Before starting names of existing products related to a function or subject area are collected, nouns of objects are separated into their components (e.g., corkscrew is divided into cork and screw).

Parameters	Options, alternative solutions					
Drive	Manual	Electric, power cord	Electric, battery driven	Combustion engine		
Cutting unit	Single blade (straight or curved)	Several scissors (like or rotating blades)	Cutting chains (revolving or back-and-forth motion)	one or several saw blades	Cutting or sawing disk	Cutting beam
Carriage unit	Telescope	Folding structure	Stationary carriage	Insert (add-a-unit design)		
Guidance of carriage unit	Manual	Rails	Cross-span adjuster	Optical guide beam	With distance control	Electronic
Range of action of cutting unit (single run)	Part of the hedge fron (not complete height)	Complete hedge front	Top of the hedge	Hedge fron plus top	Allround clipping	

Combination I Combination II

Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 4 Example of morphological tableau for a hedge clipper

Additionally, one can use object words from another area (e.g., kitchen equipment for the search field gardening equipment).

In small groups, unfamiliar two-word combinations are formed spontaneously and systematically; based upon those combinations, new product ideas are considered. The subgroups will present their ideas to the other groups and develop them together.

Configuration Techniques

Configuration techniques are subsumed as creativity techniques that generate new solutions by compiling solution elements (newly configured) in a new way. This may be either a new combination of elements or omitting or adding elements.

The **morphological tableau** (morphological box) is the most known method of morphology (Zwicky 1966). The underlying concept is to divide a complex problem into subproblems (parameters). These parameters must be independent from each other; a solution for one parameter may not fit to solutions of other parameters. The parameters are put down in the first column of a table. Regardless of the overall problem, possible solutions for each parameter are listed line by line. By combining single solutions of each parameter, solutions for the overall problem are obtained (see Fig. 4).

The identification of the relevant parameters of the overall problem is crucial for the development of a meaningful morphological tableau. One has to sort out requirements, selection criteria, dependent factors, and also parameter suggestions which indicate just modifications. The optimal number of parameters is six to eight.

In **attribute listing**, easily changeable features of a product in sale are chosen as parameters. In a table, the actual states of these features are described and then innovative variations listed in the same line. A combination of the new attributes will result in suggestions for new appearance or functional improvements. Such product variations are an appreciated input for product relaunches.

The **morphological matrix** relates the most important parameters of a problem one to another in a systematic scheme. The matrix suggests establishing a relationship between the two parameter variations for any matrix field. This may be a synergy, a problem, an opportunity, or any other creative interpretation. The **morphological matrix** is particularly useful when there are two important factors that need to be worked on systematically and intensively.

The most important principle of the **SIT** methodology (systematic inventive thinking) (Sickafus 1996) is to develop new solutions, preferably without accessing to external resources within an existing framework (closed world). **SIT** operates with five thinking tools: division, subtraction, multiplication, task unification, and attribute dependency. It begins with an existing product and modifies it according to these specific principles until a new concept with additional benefit is created. Another guideline is always go the paths of greatest resistance, in order to find really original ideas. This technique is especially useful when a company wants to simplify and reduce costs of products.

Confrontation Techniques

Confrontation techniques use functional and structural principles hidden in objects outside the problem field as stimuli for creative idea development. Before this process starts, the problem solvers are led out of the problem area; then, the confrontation takes place by external impulses to be transferred into bold ideas for the given task.

As a first step, a proper clarification of the problem should be done. In all variants of this approach, a short brainstorming on the defined problem follows in order to get rid of familiar resp. known solutions. This methodological step helps to free the participants' minds from preconceived thoughts. Only now the confrontation process starts: The participants are asked to consider presented confrontation objects like pictures, words, or technically principles.

The **synectics excursion** is an element of the synectics problem-solving strategy. To develop innovative solutions, different analogies on the problem are formed in several stages. Confronting them with the problem enables the participants to derive solutions (Gordon 1969).

Stimulating word analysis (Geschka et al. 1973) uses terms of things that are unrelated to the problem as confronting elements; they are compiled randomly. The inherent principles, structures, and functions of these terms are worked out and possibly transferred into solution ideas.

In **visual confrontation**, pictures are presented as confrontation elements (Geschka 1993). The images on cards or picture projections are analyzed and then ideas are derived. There are several variants of this approach.

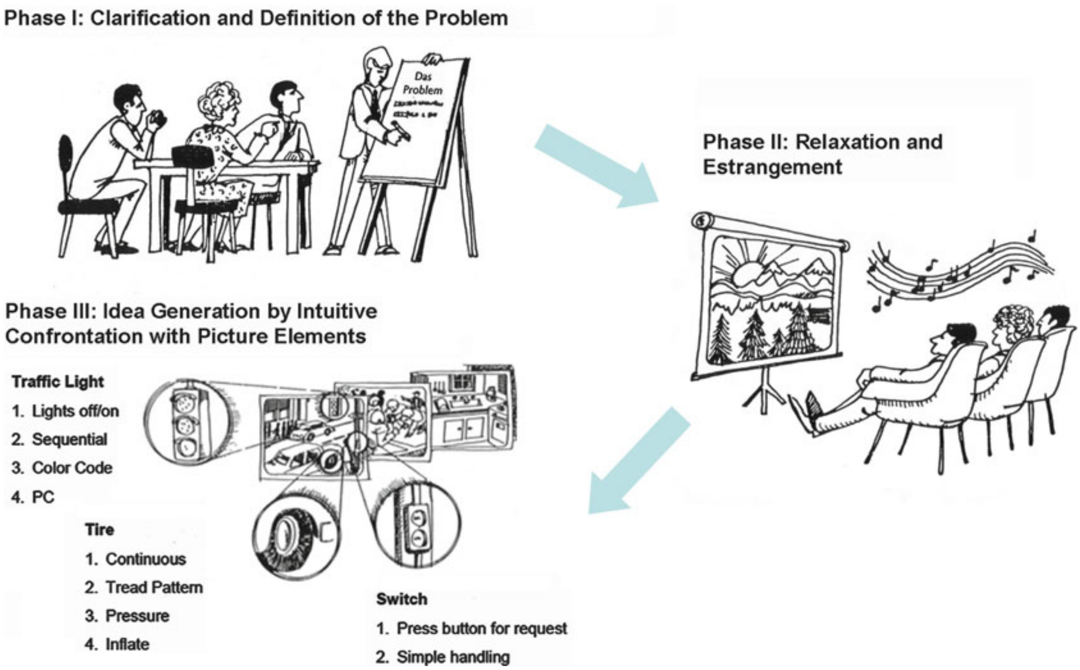
The **visual confrontation in the group** is built on verbal confrontation with pictures and additionally on mutual association by the participants (see Fig. 5). After the phase of purging of known and obvious ideas, five to six soft pictures are projected to the participants for the sole purpose to relax and get away from the problem; this process is supported by relaxation music. The following pictures show tangible situations in different areas of life; the participants are requested to develop solutions from picture elements.

Picture cards brainwriting works with picture cards to stimulate new ideas. The participants work individually with the cards; they should study each picture intensively and try to derive solution ideas from the identified principles in picture elements. The ideas are written down on pin cards. Seven to eight picture cards are worked through in this manner. After about 20 min, the idea cards are passed around the table for further associative idea generation. After all, the ideas are structured and scored.

The 40 **TRIZ invention principles** (Altschuller 1984) can be used as confrontation elements in sessions aiming at innovative technical solutions.

Imagination Techniques

The central elements of imagination techniques are pictorial imaginations occurring in one's mind. These techniques help the problem solver to come up with solutions triggered by purely mental constructs. An intuitive examination of the problem area is assisted by these methods; an in-depth understanding of the problem is arising and giving room for new solutions. The **imagination techniques** are not very common.



Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 5 Flow of visual confrontation in the group

Applying the method **try to become the problem** (Van Gundy 1981), the problem solver puts himself/herself in the problem situation and simultaneously becomes an element of the problem as follows: "What do I experience in the problem situation?" Solution ideas will result from this "immersion" into the problem.

The technique **take a picture of the problem** analyzes the problem in a way that can be compared with looking through the viewfinder of a camera (Van Gundy 1981). Several problem elements are focused and observed from different perspectives. The problem solver's "observations" sharpen the understanding of the structure and the impacts of the problem situation, thus revealing new approaches.

The **guided fantasy journey** helps to reduce stress, to open up an inner balance, and to promote imagination and creativity. A moderator guides the participants through a stream of consciousness, which inspires them to develop inner stories and images. These images are supposed to stimulate problem-solving thoughts (Martin and Henry 1991).

The Innovation Process

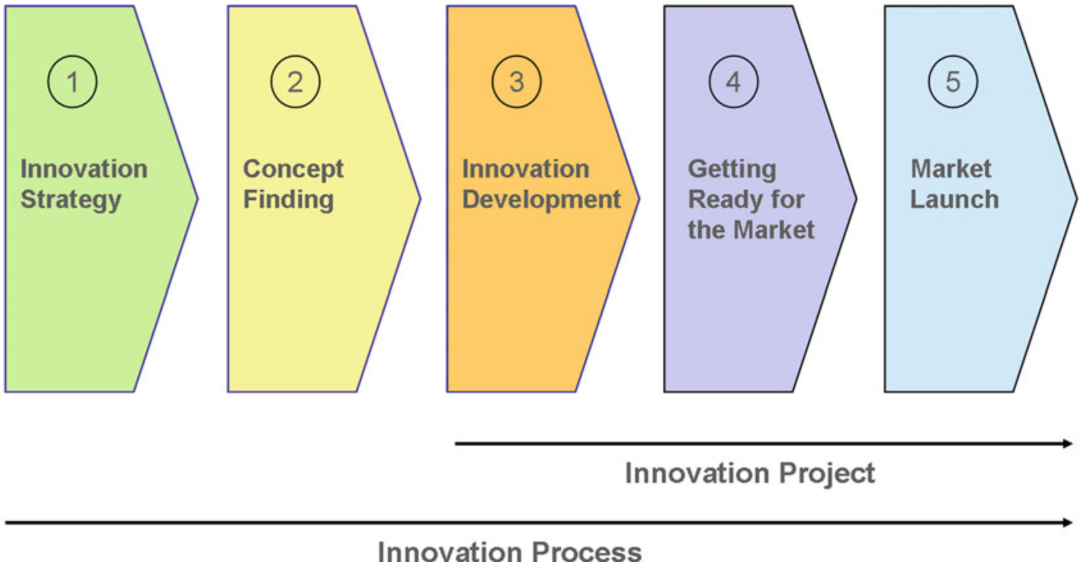
In the following, the question is considered how to utilize creativity techniques in the process of innovation. Therefore, first, the innovation process in companies is outlined.

The process of innovation in firms can be understood as a management process. Taking this into consideration, the process does not begin with a sudden inspiration or an idea finding workshop. Preceding this process is a strategic phase consisting of analyses and considerations in order to determine the direction for the search of innovations. This strategic phase basically exists, but its intensity differs among companies.

Both literature and practice offer different structures of the innovation process. Preferably, a five-phase flow model comes into place, which is based on significantly different blocks of tasks (Geschka and Zirm 2011) (Fig. 6).

The five phases of product innovation can be characterized as follows:

Phase 1: Innovation Strategy. Based on conducted analyses directions, guidelines,



Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 6 The phases of the product innovation process

search fields, and corridors for innovation search are determined.

Phase 2: Concept Finding. Following the requirements of the first phase, ideas are generated and collected from internal and external sources. Usually, a large number of ideas can be compiled; they need to be evaluated and selected in a process of several stages based on specific criteria. As a result of this idea management, quite a number of innovative concepts are developed. A superior management committee decides which of the concepts should be realized; they are transferred to the R&D department for further evaluation.

Phase 3: Innovation Development. This phase includes product and process development as well as the specification of all other functions or modules that directly or indirectly become part of the new product.

Phase 4: Getting Ready for the Market. In this phase, the new product's manufacturing facilities are set up. Furthermore, all other functions necessary for a market launch have to be conceptualized and prepared: contracting of suppliers, installing of external and internal distribution logistics, implementation, testing and integration of IT systems, training of the marketing staff, and prelaunch activities (print orders, agency contracts, awards to designers, etc.).

Phase 5: Market Launch. The new product is announced to potential customers by using appropriate marketing actions. The logistics have to be installed simultaneously in order to ensure that the new product is available for customers.

Physical products and services are quite different because of their inherent characteristics. Concerning the innovation process itself, however, only the phases 3 and 4 differ clearly. The phases 1, 2, and 5 of the service innovation process basically have equal tasks and goals as those of the product innovation process. Phases 3 and 4 are different; they are described as follows:

Phase 3 (Service Innovation Process): Detailed Concept Development. The proposed new service is analyzed in its sequence and differentiated into all details. The dependencies of the partial steps of performance with each other and the frame conditions are considered. The determined structures and processes are illustrated (often graphically) in a plan (blueprint).

Phase 4 (Service Innovation Process): Getting Ready for Performance. The concept developed in phase 3 is implemented. A set of activities needs to be processed, for example, award of contracts (software, equipment, special technical facilities, etc.), cooperation agreements, internal testing, training of staff, testing with customers, and final adjustments. Particular attention is given to quality assurance since services cannot be made undone, replaced, or repaired.

All five phases require creative inputs for the development and implementation of the product or service as well as for subprocesses, optimization, and speeding up of processes and for marketing and sales measures. Thus, creative techniques can be applied in all phases. However, from the variety of techniques, not all are suitable for enterprises in respect to the creativity-stimulating approach and the frame conditions of application.

Creativity Techniques in the Innovation Process

Less Suitable Creativity Techniques for Innovation Tasks

For the development and implementation of innovations, the skills of internal experts are of high value and importance. Group work leads to synergy effects which promote creative thinking; moreover, participants from different departments provide different knowledge and views on a given problem. Individual techniques or techniques with strong individual parts without communication and exchange are less applicable for a specific problem-solving task. Therefore, the **imagination techniques** are not recommended for innovation processes.

The **synectics excursion** procedure is quite complicated; an experienced moderator is required for this technique. Since it also contains a high proportion of individual thought processes, it is not recommendable for regular application in innovation processes.

Creativity techniques that are intended for a limited application barely come into consideration for innovation activities. The techniques **SIT** and **attribute listing** are not intended to be used in development of innovations, as they focus on product improvement, respectively, on relaunch of products.

Brainstorming is the oldest and most common creativity technique and should be particularly considered. In combination with professional moderation and motivated participants, it is a powerful technique. However, other techniques with special focus in application are superior to it. Concerning most of the tasks within the innovation process, brainstorming can always be viewed as an alternative method when by any reason specific techniques should not be used; however, it is not a preferred technique in the innovation process.

Hence, there remain a comprehensive number of creativity techniques that can be assigned to the phases of the innovation process. In Fig. 1, the less suited creativity techniques are marked with an asterisk (*).

Creativity Techniques in the Phases of the Innovation Process

Creativity Techniques for Strategic Orientation

As discussed in Section ▶ The Innovation Process in the phase strategic orientation, analyses and perspective considerations are undertaken. Guidelines and search fields for innovations have to be found and set. In order to do so, information about customer needs, market trends, new technologies, etc., and determined goals have to be considered. Identification and formulation of guidelines and search fields, however, require a creative exploration and treatment of this information.

Therefore, techniques aiming at spontaneous creativity are less applicable in this phase compared to structured and contemplative approaches. The **morphological matrix** should preferably be applied in the form of a search field matrix, as shown in Fig. 7. The matrix structure can also be formed with quite different parameters.

Also, the **Walt Disney method** is to be recommended for this phase. It starts with broad visions which of course are of a strategic

Example: Development of innovation fields for a supplier of metal processing

Core capabilities → / Market segments ↓	Mech. solution with little demand on floorspace	Solutions for detachable connections	Solutions for fastening	Mass production of small parts	Die cutting of accurate small parts	Automatic assembling of small parts	Handling and packaging of mass products	Potential new innovation fields
1 Sports		I_1						ΣI_1
2 Domestic home								-
3 Communication	I_3					I_3		ΣI_3
4 Events	I_4					I_4	I_4	ΣI_4
5 Private security								-
6 Do it Yourself	I_6	I_6						ΣI_6
7 Garden								-

Working with the matrix should be line wise (=> line by line)

Creativity Techniques: Use of Creativity Techniques in Innovation Processes, Fig. 7 Morphological matrix for innovation fields

character and proceeds in two further steps of evaluation, concretization and critical analyses to innovation concepts. It is very well a starting method into the innovation process.

Circulating cards technique can be used in this phase, too. It is well suited to collect perspective ideas as well as to combine and to further develop them; this technique offers time to think about business and innovation strategies without distraction.

Creativity Techniques for the Concept-Finding Phase

In the concept-finding phase, ideas for new products or services are to be found based on the guidelines and requirements of the innovation strategy. Workshops are the proper approach for this task. Several (two to three) creativity techniques are applied successively. One should start with a broad collection of ideas; for this step, the **circulating cards technique** is especially suited. After an evaluation and a preselection, certain ideas or solution directions are immersed and further developed by applying confrontation techniques. Especially, **stimulating word analyses, visual confrontation in the group**, and **picture cards brainwriting** may be applied in this stage.

In case of a broad search field with open definitions of functional requirements and technology, **semantic intuition** is an interesting alternative. This technique can be recommended especially when searching for new consumer goods or new personal services.

Part of concept finding is idea selection, which should be done in three to four steps. First, a broad screening is recommended. In the second or third selection step, when there are only few ideas remaining and have already taken shape, a detailed consideration and consolidation is an adequate next step. **Six hats method** is a helpful technique in this situation. It creates revealing insights, extensions and complements are recognized, and the innovation concept gets tuned.

Creativity Techniques for Innovation Development

During the development phase, the designed concept is elaborated functionally and technically and is made ready for production. The approaches within the various industries differ considerably; they are determined by the different technologies and final applications: design methodology in engineering and related industries, software development principles in IT-related companies, and chemical engineering in corresponding sectors. Overall, the creativity techniques **morphological tableau** and the **TRIZ invention principles** can be applied in order to support and complete the development work.

In this phase, usually, discussions in small groups of developers and experts take place to develop solution ideas and concepts which show characteristics of **brainstorming** without being formally named so.

Creativity Techniques for Getting Ready for the Market Resp. Getting Ready for Performance Phase

In focus in this phase is the setup of the production process resp. the final arrangements of the service process (including testing and training). Also, the prerequisites of market introduction have to be established. However, creating design ideas is no longer necessary in this stage, as the entire creative design work was done in the preceding phase of development. Problems occurring due to lack of consideration or unexpected alterations (e.g., suppliers cannot deliver in time, new requirements of important customers, new legislative regulations) may happen in this stage. For these ad hoc problems, it is suitable to carry out **brainstorming** sessions to find solutions. As these problems can be of various kinds, a specific technique is not recommended.

Many activities in this phase run in parallel and are interconnected. To provide an overview and to avoid disruptions, a **mindmap** may be drawn for the entire process of implementation; it should also include alternative and backup solutions. This can be interpreted as a creative preventive contemplation. The created mindmap also helps to guide the processes and to coordinate the activities.

Creativity Techniques for Market Launch

The market launch marks the completion of the innovation process. The conceptual and preparatory activities already begin during the preceding phase. These activities may be considered as one flow of actions up to being effective in the market: A whole bunch of measures is to design with each measure in turn opening a wide range of refinements. In order to obtain creative input, companies make substantially use of external marketing agencies (e.g., communication designer, writers, photographers). These specialists often work individually or in small teams without support of creativity techniques.

In case the concepts and measures are developed by the company itself (partially or entirely), a combined application of the **circulating cards technique** and **visual confrontation in the group** or the **stimulating word analysis** in workshop settings is recommended.

For the development of slogans, the **ring-exchange technique** has evolved as an appropriate method.

Conclusions and Future Directions

A creative idea is the starting point for innovations. The sources for those ideas are diverse. Creativity is a precondition for generating new ideas. Creativity is basically understood as the human ability to combine elements of knowledge and experience from different areas in an unconventional way. Creativity techniques support the genesis of ideas. They consist of a set of thinking and behavior rules, which stimulate as an overall effect a group or an individual to generate ideas. Meanwhile, many creativity techniques have been developed and proven successful in terms of different application. Quite often, some methods are very similar; they differ only in details or are named differently while following the same approach.

Some creativity techniques can be used in all areas that require creative inputs. On the other hand, there are methods which are particularly suitable for specific applications, such as idea generation within an innovation process. This entry comprises on the one hand some basic, most often used and proven successful creativity techniques and on the other hand those techniques which are especially useful for finding solutions within the different phases of the innovation process, for example, to collect ideas in the early stage of an innovation process or later on, that is, during the market launch phase.

As for the future development, a challenge can be seen in finding the appropriate techniques to support the idea generation for value-added services. Additionally, the application for the online use of creativity techniques within the world of social networks needs to be further explored.

Cross-References

- ▶ Brainstorming and Invention
- ▶ Corporate Creativity
- ▶ Creative Behavior
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Divergent Thinking
- ▶ Divergent Versus Convergent Thinking
- ▶ Ideas and Ideation
- ▶ Invention and Innovation as Creative Problem-Solving Activities

References

Altschuller GS. Erfinden – Wege zur Lösung technischer Probleme. Berlin: VEB Verlag Technik; 1984.

Buzan T, Buzan B. Kopftraining. Anleitung zum kreativen Denken. 3rd ed. München; 1986.

De Bono E. Six thinking hats. Toronto: Key Porter; 1985.

Dilts RB, Epstein D, Dilts RW. Tools for dreamers. Strategies for creativity and the structure of innovation. Capitola: Meta Publications; 1991.

Geschka H. Kreativitätstechniken. In: Staudt E, editor. Management von innovationen. Frankfurt: FAZ-Verlag; 1986. p. 147–60.

Geschka H. Visual confrontation. Developing ideas from pictures. In: Geschka H, Moger S, Richards T, editors. Creativity and innovation. The power of synergy. Darmstadt: Geschka & Partner; 1993. p. 151–7.

Geschka H, Zirm A. Kreativitätstechniken. In: Albers S, Gassmann O, editors. Handbuch Technologie- und innovations management. 2nd ed. Wiesbaden: Gabler; 2011. p. 279–302.

Geschka H, Schaude G, Schlicksupp H. Modern techniques for solving problems. Chem Eng. 1973;80(18):15–63.

Gordon WJJ. Synectics. New York: Harper & Row; 1969.

Martin JNT, Henry J. Problem solving by manipulation of imagery. In: Rickards T et al., editors. Creativity and innovation. Learning from practice. Delft: TNO; 1991. p. 183–8.

Osborn AF. Applied imagination. 3rd ed. New York: Charles Scribner's Sons; 1953.

Sickafus EN. Structured inventive thinking. A conceptual approach to real-world problems. Ind Phys. 1996;2(3):18–20.

Van Gundy AB. Techniques of structured problem solving. New York: Van Nostrand Reinhold; 1981.

Zwicky F. Entdecken, Erfinden, Forschen im Morphologischen Weltbild. München: Droemer-Knaur; 1966.

Creativity Testing

▶ Measurement of Creativity

Creativity Tests

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Synonyms

Creative thinking tests; Creativity assessments; Divergent thinking tests

Introduction

Over the past half century, numerous creativity tests have become available and several have earned scholarly confidence in their reliability and validity. Researchers developed these tests because of growing interest in creativity and because of limitations with non-testing methods for judging creativity. There are three main categories of testing for creative potential: (1) Creative Climate Tests, questionnaires that evaluate Creative Climate (the psychological and physical environment and biographical backgrounds of individuals that is conducive to creativity), (2) Creative Attitudes Tests, inventories based on studies of the personalities and attitudes of creative individuals and that evaluate personality, creative motivation, and creative interests, and (3) Creative Thinking Tests, assessments in which participants freely list all of their ideas they can think of in response to open-ended questions.

Creative thinking tests stem largely from the work of J. P. Guilford, who in the 1950s developed tests for what he called this process: divergent thinking and its opposite, convergent thinking (1967). Guilford argued that divergent thinking has three components of divergent thinking: fluency, flexibility, and originality. Torrance (1962) and Meeker (1969) built on the work of Guilford and further developed creativity tests. Today, the Torrance Tests of Creative Thinking (TTCT) is generally considered the best measure for assessing creativity. The TTCT measures creative attitude, creative thinking, and other problem-solving skills. The work of Torrance has received considerable attention in recent years, as its measures, according to Kim (2011), reveal a decline in American creativity since 1990.

Non-testing Approach: Judgment of Actual Products

Creativity can be assessed through non-testing and testing approaches. An example of non-testing approach is judgment of actual products. Identifying creative individuals by actual products encompasses any domains. In order to judge actual products, Amabile's (1982) first developed Consensual Assessment Technique: Expert judges rate the creativity of products in a particular domain, such as stories, essays, collages, poems, research designs, or theories in science, artistic creations, musical compositions, and other artifacts. Each participant is given identical basic instructions and materials for creating a product. Then expert judges working independently assess the creativity of the products, rating the creativity of the products on a 1.0–5.0 scale. The judges do not explain or defend their ratings in any way. Rather, they use only their expert sense of what is creative in the specific domain to rate the creativity of the products in relation to one another. Standard principles of assessment apply. For example, judges use the full scale. The ratings are compared only to the artifacts being judged by a particular panel of judges. This method of assessment compares creativity within a single group of participants (Baer and McKool 2009).

This method of evaluating creativity has some theoretical and practical limitations. Expert judges might have failed to identify the creativity of such eminent individuals such as Albert Einstein, Thomas Edison, and Vincent Van Gogh when they were children. This limitation may stem from judges' vested interests in the status quo or because children often lack production in the domain of their future success. Further current ability may not indicate latent potential. Other limitations are practical. Expert judges can be expensive and are hard to find, especially in rural areas. Therefore, the needs for creativity tests are apparent.

Testing Approach

The testing approach assesses three areas: creative climate, creative attitude, and creative thinking. These areas can be further divided. For example, individuals are exposed to numerous *climates* (family, school/group, etc.). Creative *attitudes* or dispositions toward creativity are viewed differently by different people. Finally, there are many subcategories of thinking that relate to creativity. What follows is a descriptive inventory of the most trusted tests of all three areas of creativity (climate, attitude, and thinking).

Creative Climate Tests

Creative climate tests examine family climate, school/ group climate, and culture climate. Biographical inventories ask about family background, experiences, and activities that are related to creative family climate. Climate questionnaires ask about psychological and physical atmospheres that to creative school/group climate. Cultural questionnaires ask about how much individuals believe in certain cultural norms related to creative culture climate.

Family Climate

The Biographical Inventory Form U

Tests measuring individuals' childhood experiences and activities can show family climate. Based on his studies on scientists in military research centers, NASA, industrial organizations, and universities, Taylor (1959) developed the Biographical Inventory Form U. It consists of 150 multiple-choice items about an individual's characteristics and background including childhood activities and experiences, academic experiences, attitudes, interests, values, self-descriptions, and sources of derived satisfactions and dissatisfactions. Administration of the test takes an hour, and participants use a machine-readable separate answer sheet. The Biographical Inventory Form U has been translated into other languages and is used worldwide. Its results include a measure of relative strengths in the following areas: Academic Performance, Creativity, Leadership and Artistic Potential, plus two bonus scores for Vocational Maturity (indication of how mature a participant is in regard to choosing a vocation) and Educational Orientation (indication of future academic success).

The Biographical Inventory Creativity (BIC)

Schaefer (1967) developed another biographical inventory, the Biographical Inventory Creativity (BIC). It consists of 165 items grouped into five sections (physical characteristics, family history, educational history, leisure-time activities, and others). Research shows that the scores on the biographical inventories are a better predictor of future success than the judgments of the fellowship committee members.

School/Group Climate

The Creativity Climate Questionnaire (CCQ)

Ekvall et al. (1983) developed the Creativity Climate Questionnaire (CCQ), which measures group conditions encouraging or discouraging creativity. The CCQ has 50 questions covering 10 dimensions (five items each). The 10 dimensions can be grouped into three areas of Resources (High Idea Time, Idea Support, and Involvement), Motivation (High Dynamism, Trust, Playfulness, and Low Conflicts), and Exploration (High Freedom, Debate, and Risk-taking). The 10 dimensions that are conducive to creativity are as follow (Ekvall et al. 1983):

1. *High Freedom climate*: The degree to which individuals feel free to express their thoughts, try out ideas, and voice their opinions. A high degree of freedom occurs when individuals have the independence (behavioral autonomy and resources) to define much of their work and considerable discretion in their day-to-day activities. The opposite of high freedom are climates in which people work within strict guidelines and roles and carry out their work in prescribed ways with little room to redefine their tasks.
2. *High Dynamism climate*: The degree to which the climate is dynamic and inspiring so that individuals find joy and meaningfulness in their work. In a high dynamism climate, individuals have opportunities (and take the initiative) to acquire and share information about their work. The opposite of high dynamism are climates in which individuals lack interest in their work, and interpersonal interactions are dull and listless.
3. *High Trust climate*: The degree to which individuals feel that they are emotionally safe and that relationships are open and characterized by honesty and teamwork. People

in these climates trust each other, get on well together, and work toward a common goal. Petty politics and conflicts are absent, and, counting on each other for professional and personal support, individuals sincerely respect one another and give credit where due. In the opposite climate, people struggle to communicate honestly with each other and suspiciously guard their plans and ideas.

4. *High Playfulness climate*: The degree to which individuals display spontaneity, ease, good-natured joking, and laughter. In these environments, individuals work in a professional yet a relaxed atmosphere and laugh and joke in a good-natured way with each other. They have fun at work. The opposite of a High Playfulness climate is where the atmosphere is stiff, serious, gloomy, and cumbrous, and where jokes and laughter are considered as improper and intolerable.
5. *High Idea Time climate*: In these environments, individuals have time: to think things through, to elaborate new ideas, to develop new ideas, and to discuss and test suggestions not included in the task assignment. The climate has flexible timelines so that people can explore new avenues and alternatives. In the opposite climate, every minute is booked and time pressure makes thinking outside the instructions and planned routines impossible.
6. *High Debate climate*: The degree to which expression and consideration of different viewpoints, ideas, and experiences occur. Here, individuals can raise and actively debate issues without fear that certain subjects are *taboo*. Individuals encounter different viewpoints, ideas, experiences, and knowledge. Many voices are heard, and people are keen to put forward their ideas for consideration and review. In the opposite of a High Debate climate, people follow authoritarian patterns without questioning them.
7. *Low-Tension climate*: Climates with little to no personal and emotional tensions. In a low-tension environment, people behave in a mature manner and have psychological insight and control of impulses. People accept and deal effectively with diversity so that there are little personal and emotional tensions. In the opposite climate, people dislike and may even hate each other. Personal differences yield gossip, slander, plots, traps, power, and territory struggles.
8. *High Idea Support climate*: The degree to which new ideas and suggestions are attended to and treated in a kind manner. Individuals actively put forward new ideas, which are received in an attentive and professional way. People listen to each other and encourage initiatives and are constructive and positive about trying out new ideas. The atmosphere emphasizes individual, team, and organizational learning through environment scanning and networking. The opposite of a High Idea Support climate is where idea support is low; “no” is prevailing, and faultfinding and obstacle-raising are responses to ideas.
9. *High Involvement climate*: The degree to which individuals are emotionally involved, committed, and motivated. The climate empowers individuals. With sufficient opportunity to find information, show initiative, and make their own decisions, individuals are involved in the setting and achievement of their daily operations, common long-term goals, and visions. In the opposite climate, individuals are not engaged and feelings alienated and apathetic.
10. *High Risk-Taking climate*: The degree to which individuals are prepared and have the courage to take risks in implementing new ideas. They display spontaneity and ease in actions and tolerance of uncertainty and ambiguity so that bold initiatives can be taken even when the outcomes are unknown. In the opposite climate, individuals are cautious and hesitant. They try to be on the safe side or *to sit on* problem matters. They set up committees and cover themselves.

Culture Climate

The Eastern-Western Perspective Scale (EWPS)

Kim (2004) developed the Eastern-Western Perspective Scale (EWPS) to measure individuals’ degrees of Confucian ideals and to compare them to level of their creativity. The EWPS measures the extent to which individuals' views align with East Asian culture. A total of 49 items are based on the four principles of Confucianism: (1) Importance of education, including devaluing play, drawing a sharp distinction between work and play, and emphasizing heavily education and competition; (2) Family System including filial piety to parents and obedience and loyalty to the authority; (3) Hierarchical Relationships, including gender inequality and gender-role expectations; (4) Benevolence, including conformity, self-effacement, and suppression of expression. Higher total scores indicate a bias toward an Eastern cultural perspective and lower total scores indicate a bias toward a Western cultural perspective. Research shows that higher Eastern culture scores are negatively related to creativity, especially high scores on suppression of expression, gender inequality, gender-role expectations, and filial piety.

Creative Attitude Tests

Creative attitude, interest, affect, and personality are measured by self-reported measures as well as teachers' and others' ratings who have had sufficient opportunities to observe the individual. Parents, teachers, and counselors who are aware of creative attitudes can capitalize on the information to identify creative potential in students. However, although there are many common characteristics that creative individuals share, not all creative individuals will show all creative attitudes, interests, or personalities. In addition, there are problems with teachers' evaluations of students. Some teachers will not recognize characteristics of creativity in students. Research shows that teachers tend to overlook disruptive, overactive, or unconventional creative students; that they prefer students who are low in creativity; that they identify students who are achievers or teacher pleasers as gifted students; that they overlook students who think or dress oddly, ignore rules and conventions, ask too any questions, do poor work when not interested, or be radical or rebellious. Even worse, some energetic and unconventional students are seen as having attention deficit hyperactivity disorder. Some teachers are more likely to recommend consulting a psychologist or psychiatrist than to identify these students as creative. On the other side, there are students who feign creativity by dressing and acting the way they believe eccentric creative people are supposed to dress and act. Thus, using creative attitude tests requires caution.

The Group Inventory for Finding Talent (GIFT)

Rimm (1976) developed the Group Inventory for Finding Talent (GIFT) to measure attitudes and values related to creativity. The items ask about individuals' curiosity, independence, flexibility, perseverance, breadth of interests, and past creative activities. Three levels of Group Inventory for Finding Talent are available: primary for Grades K to 2 (32 items), elementary for Grades 3–4 (34 items), and upper elementary for Grades 5–6 (33 items). Within each of this from, 25 items are common.

The Group Inventory for Finding Interests (GIFFI)

Rimm and Davis (1979) developed the Group Inventory for Finding Interests (GIFFI) to measure individuals' attitudes and interests related to creativity. It consists of 60 items and claims to identify students with attitudes and interests associated with creativity including independence, curiosity, perseverance, flexibility, breadth of interests, risk-taking, sense of humor, and other traits and attitudes. It produces a total creativity score plus five subscale scores including confidence, challenge-inventiveness, imagination, creative arts and writing, and many interests.

The Khatena-Torrance Creative Perception Inventory (KTCPI)

Khatena and Torrance (1998) developed The Khatena-Torrance Creative Perception Inventory (KTCPI), which is a self-reported measure of creativity comprised of two subtests: Something About Myself (SAM) and What Kind of Person Are You? (WKOPAY). The SAM measures artistic inclination, intelligence, individuality, sensitivity, initiative, and self-strength. The WKOPAY covers five factors of acceptance of authority, self-confidence, inquisitiveness, awareness of others, and disciplined imagination.

The Scales of Rating the Behavioral Characteristics of Superior Students-Revised (SRBCSS-R)
Renzulli's (Renzulli et al. 2002) 10-item creativity rating scale is a part of the Scales of rating the original Behavioral Characteristics of Superior Students (SRBCSS, 1976), which is used by teachers to rate students' creativity at any age. Translated into several languages, it is the most widely used teacher-rating instrument. The SRBCSS is designed to measure 10 creative characteristics including curiosity, fluency of idea production, risk-taking, humor and intellectual playfulness, emotional and aesthetic sensitivity, nonconformity, and critical evaluation. There is no composite score (the 10 subscales remain separate), and specific scales may be used independently.

Creative Thinking Tests

Guilford's theories (1967) spawned an array of divergent thinking tests and creative thinking tests, such as the Torrance Tests of Creative Thinking-Figural and Verbal, Thinking Creatively with Action and Movement, Wallach and Kogan Divergent Thinking Tasks, and others. Among these, the TTCT-Figural is the most widely used and is considered to measure creative thinking, and not merely divergent thinking.

Torrance Tests of Creative Thinking (TTCT)

Torrance designed a test to score responses for Guilford's four divergent thinking factors of Fluency, Flexibility, Originality, and Elaboration. The TTCT has two versions: the TTCT-Verbal and the TTCT-Figural. The TTCT can be administered as an individual or group test for any age and development level, beginning with the kindergarten level. The tests require from 30 to 45 minutes working time, so speed is relevant. The tests require some drawing ability, but artistic quality is not required to receive a credit. Torrance recommended the creation of a game-like and *fun* atmosphere to avoid the threatening situation associated with testing. The TTCT has been translated into over 35 languages and is the most widely used test of creativity. Research shows that among all of the creativity tests, the TTCT predicts creative achievement the best. As indicated by Torrance's 40-year longitudinal study, scores on the TTCT are good predictors of adult creative performance.

Torrance Tests of Creative Thinking (TTCT)-Figural

The TTCT-Figural has two parallel forms, A and B, and consists of three activities of picture construction, picture completion, and repeated figures of lines or circles. The TTCT-Figural is comprised of five norm-referenced measures so that the numbers of points earned are relative to the norm group. These measures are Fluency, Originality, Elaboration, Abstractness of Titles, and Resistance to Premature Closure. In addition, there are the 13 criterion-referenced measures of Creative Strengths so that the credit is given depending on whether the criterion appears in the responses. Fluency shows an ability to produce a number of ideas; Originality shows an ability to produce uncommon or unique ideas; Elaboration shows an ability to produce a number of ideas added beyond the minimum details; Abstractness of Titles measures the degree a title is expressed beyond obvious labeling of the pictures drawn; and Resistance to Premature Closure measures the degree of psychological openness. The 13 Creative Strengths measure various creativity personalities including: Emotional Expressiveness, Storytelling Articulateness, Movement or Action, Expressiveness of Titles, Synthesis of Incomplete Figures, Synthesis of Lines or Circles, Unusual Visualization, Internal Visualization, Extending or Breaking Boundaries, Humor, Richness of Imagery, Colorfulness of Imagery, and Fantasy.

Torrance Tests of Creative Thinking (TTCT)-Verbal

The TTCT-Verbal consists of six activities. The stimulus for each task includes a picture to which people respond in writing. Five or 10 minutes are taken for each activity. For Activity 1–3, an ambiguous picture is presented to ask and guess. Activity 1 (Ask Questions) is asking questions about the picture; Activity 2 (Guess Causes) is guessing causes of the action in the picture; and Activity 3 (Guess Consequences) is guessing consequences, immediate or long-term about the picture. For Activity 4 (Product Improvement), the task is to improve a toy so that it is more fun to play with. Activity 5 (Unusual Uses) is a task to think of alternative uses for a common object like a brick. Activity 6 (Just suppose) hypothesizes about an improbable situation. Scoring Components are Fluency (the number of relevant ideas), Originality (the unusualness of the ideas), and Flexibility (Shifts: the variety of different types of ideas).

Thinking Creatively with Action and Movement (TCAM)

Torrance (1979) developed the Thinking Creatively with Action and Movement (TCAM) to measure Fluency, Originality, and Imagination in preschool and primary aged children ranging from ages 3 to 8. It was developed based on the assumption that kinesthetic, rather than verbal, modality is the most appropriate for eliciting the creativity of these age-ranged children. The TCAM is administered individually, and it takes between 10 and 30 minutes, but no time limit is imposed. The examiner is to record all responses made by the child as completely and accurately as possible and to record responses in movement, in words, or in a combination of both. Before an examiner administers the TCAM, warm-up activities and some familiarity are necessary so that children can relax and engage in the activities without restraint. The TCAM is also used with special test subjects including children with emotional impairment and deaf children. The TCAM is also used as a teaching tool using creative movement and creative brainstorming techniques.

The Wallach and Kogan Divergent Thinking Tasks

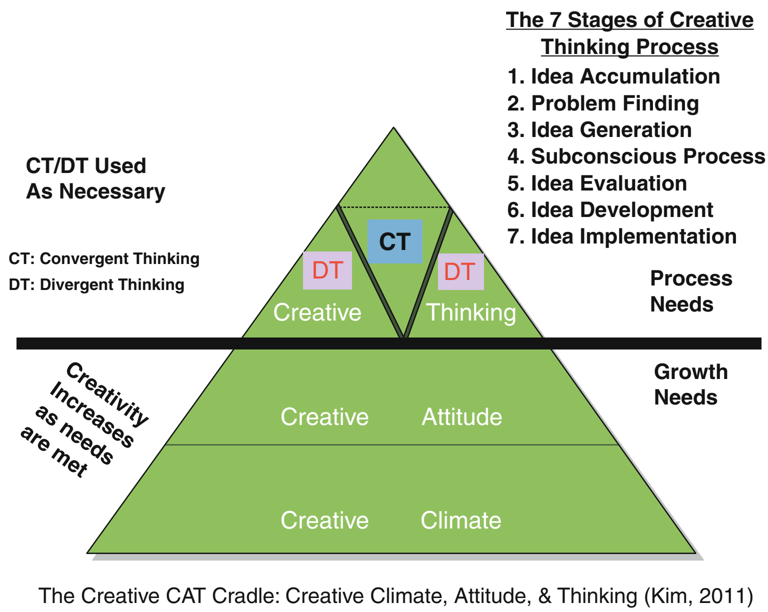
Wallach and Kogan (1965) developed a battery with five tests: three verbal and two figural divergent thinking tests. Each test is scored for Fluency (the total number of ideas listed) and Uniqueness (the number of ideas that are not given by any other individual in the testing group). The Uniqueness score will be dependent on group size with a smaller sample size with a higher Uniqueness score. The entire tests appear in *Modes of Thinking in Young Children* with directions for administration and scoring so that they can be used for free. Verbal divergent thinking tests include (1) the Instances test (Name all the *round* things you can think of; things that make noise; square things; and things that move on wheels), (2) the Alternate Uses test (List the different ways you could use a chair, knife, key, button, newspaper, cork, shoe, and automobile tire), and (3) the Similarities test (Find as many commonalities as possible between two verbally specified objects). Two figural tests use visual materials and include (1) the Pattern Meanings test (Respondents list possible meanings or interpretations of eight abstract visual designs) and (2) the Line Meanings test (it is the same as Pattern Meanings except the stimuli are more abstract and not clear patterns). The administration procedures of the Wallach and Kogan Divergent Thinking Tasks also emphasize a relaxed and game-like atmosphere, and it is an un-timed test. These game-like and un-timed conditions reduce the influence of intelligence on the creativity scores. Research shows that among all of the divergent thinking tests, the Wallach and Kogan tests are found to have the least relationship with IQ.

Conclusion and Future Directions

Creative potential can be assessed using non-testing and testing methods. With testing, there are three different categories of measuring creativity: Creative climate, creative attitude, and creative thinking.

As Fig. 1, the Creative CAT Cradle, shows, Creativity requires three conditions. First, a creative climate must exist. A creative climate refers to an environment characterized by a high degree of freedom, dynamism, trust, and playfulness. In a creative climate, individuals have the time to explore ideas and are free to disagree. Though ideas are debated, new ideas are welcomed and are treated seriously. Individuals in

Creativity Tests, Fig. 1 The creative cat cradle: creative climate, creative attitude, and creative thinking



a creative climate get along, genuinely support one another, are involved, and are willing to take risks.

Creativity also requires a creative attitude, a disposition of individuals within the environment. Creative attitudes include qualities that are sometimes perceived negatively, including high energy, independence, curiosity, perseverance, flexibility, breadth of interests, willingness to take risks, humor, and imagination. These qualities are sometimes perceived negatively. Teachers, for example, often prefer students who sit still, follow rules, and accept authority. Students with creative attitudes, however, often show opposite attributes, which teachers then try to suppress or, at the least, label negatively.

With both creative climate and attitude, more is better. With the final condition of creativity, creative thinking, the key is the right balance and the right timing: There are appropriate stages for divergent thinking and its many facets, but also appropriate stages – not too soon in the process – to begin to evaluate possibilities and bring closure (convergent thinking).

The 7 Stages of Creative Thinking Process shows that:

1. Creative thinking begins with idea accumulation – accumulating a long list of ideas, knowledge, skills, information, experiences, and others on a particular problem or question. Idea accumulation can be speculative or more scientific (cataloging existing ideas on the problem).
2. Once ranges of ideas are accumulated, the thinker then starts to consider or notice problems with the ideas, knowledge, skills, information, experiences, and others: finding weaknesses, flaws, exceptions, and limitations.
3. New ideas then need to be generated in response to those flaws. Ideas generated could include nuances or subtle changes to existing ideas or could include wholly new solutions.
4. Then, time and freedom need to come into play: The ideas must be allowed to percolate subconsciously. Adages such as *sleep on it* or *take time to think about it* ring true to this stage of creative thinking – individuals need time to reflect both consciously and subconsciously.
5. After this roughly hewn, slow process of reflection, individuals must then subject ideas to critical, conscious evaluation and apply rigorous and exacting evaluative processes. Here convergent thinking comes into play, as the thinker starts to move away from the open

phase of accepting ideas but rather to the critical phase of rejecting those of lesser potential.

6. A genuinely creative idea then requires idea development, an iterative divergent-convergent process to figure out how to transform the provisionally best solution (Stage #5) into an idea for a new *solution*. The process plays back-and-forth between how to make the provisionally best solution (convergent thinking) even better (divergent thinking).
7. Finally, the idea must be implemented, which requires wholly new creative processes on a microscale. In implementation, the entire 7 stages of Creative Thinking process may have to be repeated, according to the scale of the problem.

Unlike climate, which draws creative dispositions out of individuals, and creative attitude, the sum of those dispositions, with creative thinking, more is not necessarily better. Individuals must think divergently, generating multiple ideas, and then bring closure through convergent thinking, deciding on the best solution or answer.

Torrance was concerned that because of the lack of availability of creativity detection instruments, creative individuals would be overlooked and even undermined psychologically. For children scoring poorly on IQ or achievement tests, creativity tests open doors. Creativity tests should be used to help find more students whose abilities are not usually found on traditional IQ or achievement tests. Research shows that creativity tests are more culturally neutral than most IQ tests. Creativity tests will yield additional information on many children who do not show their achievement academically. Their creative potential might otherwise go unnoticed, especially in children from culturally diverse and lower socioeconomic backgrounds.

Individuals can be creative in an infinite number of ways. A person may also be highly creative in just one area but less able in others. Other people may be creative in many areas. Identifying creative potential can be difficult and prone to error because of the inherent complexity of creativity and creative people. Motivation and opportunity are two other important factors that influence individuals' creative achievement, in addition to their creative potential. Test conditions can influence creativity test scores by removing the time limits and by preceding the testing with a brief warm-up activity.

No measure of creativity assessment, testing or non-testing, is so reliable and valid that just one measure will produce a highly accurate and dependable estimate of creative potential for invention and innovation. At least two different measures of creativity should be used together. Creative abilities can be assessed, can be nurtured, and their growth can be measured, which should be done, because we cannot know what the future will bring, but we can open our students' minds toward it.

Cross-References

▶ Convergent Versus Divergent Thinking
▶ Creativity Across Cultures
▶ Creativity, Intelligence, and Culture
▶ Divergent Versus Convergent Thinking

References

Amabile TM. Social psychology of creativity: A consensual assessment technique. J Pers Soc Psychol. 1982;43:997–1013.

Baer J, McKool SS. Assessing creativity using the consensual assessment technique. In: Schreiner C, editor. Handbook of research on assessment technologies, methods, and applications in higher education. Hershey: Information Science Publishing; 2009. p. 65–77.

Ekvall G, Arvonen J, Waldenstrom-Lindblad I. Creative organizational climate: construction and validation of a measuring instrument. Stockholm: Swedish Council for Management and Work Life Issues; 1983.

Guilford JP. The nature of human intelligence. New York: Wiley; 1967.

Khatena J, Torrance EP. Khatena-Torrance creative perception inventory. Bensenville: Scholastic Testing Service; 1976.

Kim KH. The creativity crisis: the decrease in creative thinking scores on the Torrance Tests of Creative Thinking. Creat Res J. 2011;23:285–95.

Kim KH. Cultural influence on creativity: the relationship between creativity and confucianism [doctoral dissertation]. Athens: The University of Georgia; 2004.

Renzulli JS, Smith LH, White AJ, Callahan CM, Hartman RK, Westberg KL. Scales for rating the behavioral

characteristics of superior students-revised edition. Mansfield Center: Creative Learning Press; 2002.
Rimm SB. GIFT: group inventory for finding talent. Watertown: Educational Assessment Service; 1976.
Rimm SB, Davis GA. Group inventory for finding interests. Watertown: Educational Assessment Service; 1979.
Schaefer CE, Anastasi A. A biographical inventory for identifying creativity in adolescent boys. J Appl Psychol. 1968;52:42–8.
Taylor CW. The 1955 and 1957 research conferences: the identification of creative scientific talent. Am Psychol. 1959;14:100–2.
Torrance EP. The torrance tests of creative thinking – norms-technical manual research edition – verbal tests, forms A and B – figural tests, forms A and B. Princeton: Personnel Press; 1966.
Torrance EP. Administration, scoring, and norms manual: thinking creatively in action and movement. 4th ed. Athens: The University of Georgia, Georgia Studies of Creative Behavior; 1979.
Wallach MA, Kogan N. Modes of thinking in young children. New York: Holt, Rinehart & Winston; 1965.

Creativity Training in Design Education

Kung Wong Lau
Institute of Textiles & Clothing, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Synonyms

Creative thinking techniques; Creativity; Design education; Training methods

Theoretical Foundation

Creativity Training Between Design Education and Other Disciplines

The classical creativity training model and approach were established by Alex F. Osborn in the 1950s and Ellis P. Torrance in the 1970s, respectively. Early empirical research suggested that creativity training is effective to help students to produce quantity and quality of creative ideas. Despite the fact that some researchers have questioned the effectiveness of creativity training for enhancing students' creativity, most have highlighted the important role of creativity training in releasing students' creative potential. In view of the creativity training in design education, design students are required to develop strong creative thinking skills, techniques, and methods to solve problems innovatively. Therefore, the underlying principle of creativity training in design education is to equip design students with diverse thinking skills as well as the creative design process in order to release and/or enhance their creative potentials. Furthermore, as Sternberg (2003) pointed out, students are able to develop five underlying learning behaviors through creativity training: (1) willingness to redefine problems, (2) willingness to take risks, (3) willingness to accept criticism, (4) willingness to value others' creative ideas, and (5) believing everyone has potential to be creative.

Creativity training is an essential component of facilitating creative design processes in design education. However, it is important to note that the diversity of interpretations of creativity among design institutes hinders the effective implementation of such pedagogy. Creativity training is, indeed, not concerned with design students' creativity but with helping them to develop their diverse intellectual abilities, such as problem identification skill, critical thinking, risk taking, and curiosity, which eventually lead them to be able to generate creative ideas and solutions to problems.

The Role of Creativity Training in Design Education

A very simple definition for *design* is problem solving, and each solution is indeed unique and creative. Prior research on creative design studies has identified the linkage between design and the development of creative thinking. Design is indeed concerned with creating novelty for people to experience. One of the well-known classifications of creativity is from Margaret Boden in her book called "The creative mind: myths and mechanisms" in 2004. She introduced the categories of H-creativity (historical creativity) and P-creativity (psychological creativity). H-creativity is regarded as creating and/or designing original solutions resulting in new and novel ideas. Comparatively speaking, P-creativity is only regarded as some creative notions for personal satisfaction. In design history, there are numerous original and creative examples that are regarded as classics with timeless qualities. These classic designs are often drawn on as cases for teaching and learning purposes in creativity training in design education. In this case, if the main purpose of design is creative novelty, then studying classical examples in design education may be the “dilemma” of creativity (Kneller 1965). Similarly, some researchers also argued that giving good examples to students can obstruct their motivation to explore new possibilities and creative ideas. In other words, design students will be over-influenced by classical examples if they are keen on researching prior successful design cases. This hinders their creative thinking in particular to seeking new and novel solutions. Of course, designers should continuously doubt, criticize, and evaluate past results scientifically in order to solve problems confidently and foresee future needs of society.

Knowledge and experience are equally essential to enhance students’ creativity in design education. Creative thinking is nurtured by the prior internal and external experiences of design students. Therefore, the essence of good design education is a balance between fostering students’ creative thinking processes for novelty and guiding them to enrich their experiences. As Green (1974) stated, earlier *design education* needs to develop students’ critical minds to understand human needs and human experiences.

Numerous research studies have supported the significant role of design activities in facilitating students’ creative thinking skills. Creative learning activities and/or creative thinking techniques should be designed and arranged deliberately in creativity training subjects in design education in order to release the students’ creative potential. An effective curriculum design for creativity training should consider six factors: (1) understanding and identifying design students’ thinking habits, (2) facilitating and developing their intrinsic motivation by fun activities, (3) encouraging and developing positive and forward thinking, (4) enhancing and building up their self-determination and confidence, (5) acknowledging and managing their emotions, and (6) removing obstacles to their creativity.

Nonetheless, to develop creativity training in design education is not only about giving students classical examples but also providing them with integrated thinking skills, creative thinking techniques, and creative thinking/design processes as well as good learning behaviors consisting of risk taking, having fun, and being open to unexpected solutions.

The Development of Creativity Training in Design Education

To understand the creativity training in design education, it is necessary to review the early developments in art and craft education. This field of education began in the British technical schools in the 1880s. The objectives of these early art and craft subjects emphasized practical training for art careers instead of the development of concepts and creativity. Otto Salmon, one of the pioneers in the early development of design education in the 1890s, listed the objectives of craft education by dividing the learning focus into (1) the formative focus and (2) the utilitarian focus. The formative focus emphasized developing students’ independence, sense of forms, and self-reliance in order to develop physical abilities in craftsmanship, while the utilitarian focus aimed to giving students proficiency in the use of tools. This revolutionary concept of developing students’ intrinsic competencies in art and craft brought the education into a new era of conceptual development. It was followed later by some craft teachers who developed more intellectual methods of using and exploring the application of materials and tools.

A remarkable early movement of curriculum reform began in the 1960s. The Nuffield Foundation and School Councils in the United Kingdom started to evaluate the existing curriculum and the role of craft education in schools, which caused the development of a new subject domain, *design education*. This great change has raised arguments and discussions about the use of materials in creative problem solving as well as the need to clarify the concept of the design process. Nonetheless, art and craft teachers have put effort into exploring the new knowledge of design education and introduced a new set of theoretical domains in art and design, namely, creativity, initiative, and adaptability. The Design and Craft Education Project, introduced by the University of Keele in the late 1960s and early 1970s, was an influential project providing a clear framework for the further intellectual or creative developments in design education. The emphasis of this framework is that design subjects should be constructed by the combination of intellectual and practical activities. Design education in Britain underwent a tremendous change after this project, from focusing on students' practical skills to intellectual development. This was followed by various British universities making revisions to their design subject curricula, including Goldsmiths' College (1969–1972), Exeter University (1968–1973), Loughborough College of Education (1967–1972), and the Royal College of Art (1973–1975). These actions triggered the entire development of design education in the early 1970s and shaped the skeleton of design education by focusing on the integration of theoretical knowledge and practical skills. Creativity training became one of the key focuses in developing students' theoretical and intellectual knowledge.

Indeed, the creativity training in professional design education (within institutes aiming at training professional designers) was developed even earlier in Europe and America in the 1910s. Some design educators, namely, Moholy-Nagy, Klee, and Kandinsky, insisted that design education should be a combination of artistic exploration and practical function. This notion eventually caused the establishment of the Bauhaus school in Germany in 1919. The curriculum of German Bauhaus school demonstrated a perfect combination of intellectual and practical development for students to balance creativity and skills. This curriculum also provided later design schools with references for pedagogical frameworks and structures. In the 1930s, Moholy-Nagy, with the help of Charles Morris, a philosopher from the University of Chicago, developed a revolutionary curriculum in design education which focused on enriching the design students' sense and knowledge of art, science, and technology. The intellectual development of design education dominated the traditional skill-based art and craft education. All in all, based on the numerous revolutionary reforms in design education since 1880, the curriculum and pedagogical structure of design education had changed from crafts training to design education. Creativity training became a major domain in developing design students' competencies for the design profession.

Furthermore, the Bauhaus school was one of the pioneers encouraging design students to pay attention to the creative thinking and design process instead of the design outcome. Be specific, the Bauhaus emphasized the sound development of the creative and design process leading to develop their concepts of simplicity and purity of forms. Despite the criticism concerning Bauhaus' pedagogical approach, that it was too academic and therefore hindered the students' explorations of fundamental design, the Bauhaus shaped the entire design education from skill-base craft training to a higher intellectual exploration of art and design by enriching the students' creative thinking and design process.

The Creative Design Process and Creativity Training

Numerous studies have been applied to study the design process and creativity of professional designers or design-related professions. Based on these studies, some creativity and design thinking methodologies have been developed. Eggleston (1976) outlined some major features of the design process: (1) the decision-making process emphasizing the development of new ideas and modification of old ones, (2) the interplay of understanding and knowledge by comparing and evaluating ideas, (3) the needs of the social context of human behavior by studying societies, cultures, and clients, and (4) the meaningful way of using various skills in design.

The importance of the design process encourages students to make things in different ways. In this sense, design education emphasizes the creative design process highly in order to generate appropriate design solutions. In other words, design education is a means of teaching the design process for seeking appropriate solutions to problem-solving activities. The creative design process is essential in helping designers to understand the articulation between creative notions and actual design outcomes. This should also be the concern of creativity training in design education. Design students should be able to handle a sound creative design process by preparing problem materials, research, idea development, implementation, and evaluation. These stages are the actual articulation between creative notions and final design outcome.

Further details about the creative thinking process arose from the earlier creativity research. For example, Wallas (1926) structured the creative thinking process into four stages: (1) preparation – identifying the problem and relevant data, (2) incubation – isolating the problem by allowing the individual to sink into his/her unconscious mind, (3) illumination – finding new relationships and generating ideas, and (4) verification – evaluating the possibilities of executing ideas to solve a problem. Similarly, Stein (1967) divided the creative process into three phases: (1) hypothesis formation, (2) hypothesis testing, and (3) communication. These three phases were more or less similar to the four stages described by Wallas. Some similar descriptions of the creative thinking process were proposed by other researchers. By comparing diverse creative thinking processes, Lau and his colleagues (2009) proposed four key stages for arranging the learning process for creativity training in design education: (1) preparation, (2) incubation, (3) evaluation, and (4) implementation. Clearly, in summary, the creative process consists of diverse stages such as problem identification, conceptual combination, and idea generation.

Again, the creative design process is crucial to design education, and creativity training is undoubtedly one of the key components of training design students in sound creative design processes. However, it is important to note that diverse design domains have their own discipline specifics and exclusive design processes in spite of some argument that there must be some similar mechanisms for conducting creative design processes in diverse design disciplines. Indeed, all experts have their own domain specifics, thus continuously creating a diversity of thinking and working processes. Nonetheless, while the design process might be in different forms based on domain specifics, the creative thinking process is the common mechanism throughout all creative disciplines. In other words, the creative thinking process is one of the commonalities in the design process for all design disciplines. In this sense, creativity training in foundation design education should be more or less similar without domain specifics.

Creativity Training Techniques for Design Education

There is hitherto limited research on studying the classification of creativity training techniques for design education. Bulter and Kline's (1998) study was possibly the earliest to categorize creativity techniques for creativity training. They classified various creative thinking techniques into three groups, namely, (1) brainstorming skill, (2) hierarchical techniques, and (3) skills for changing perspectives. Although Bulter and Kline had not intended to study creative thinking techniques for facilitating design education, their research has helped design educators to understand and design their students' creativity training in a systematic manner.

There have been thousands of existing creative thinking skills and procedures applied in diverse educational situations, namely, foundation education, business, product development, and advertising. Whatever the domain is, it is a must to select and arrange appropriate techniques carefully to consolidate comprehensive creativity training in design education. Lau and his colleagues (2009) classified various creative thinking techniques into five main categories: (1) identifying and mapping attributes, (2) making possibilities, (3) changing and shifting perspectives, (4) making associations and analogical thinking, and (5) probing emotions and the subconscious. This categorization was intended neither to compare the various techniques nor to find out the best technique. A systematic classification of various thinking techniques does provide design educators with a framework for course design. The classification facilitates the curriculum design of creativity training for design education by understanding and gathering diverse functions of creative thinking techniques. Table 1 shows the details of this classification of creative thinking techniques.

In addition, currently the Theory of Inventive Problem Solving (in Russian, the acronym for this is TRIZ) has become one of the key thinking tools for facilitating students' creative thinking skills. TRIZ is based on various principles of problem solving such as logic, data, and research. In view of design education, TRIZ helps students to organize creative thoughts and structure their creative thinking processes in a systematic manner.

All in all, creative thinking is a process of thinking instead of having an idea from nowhere. This means, therefore, that creativity training in design education involves a deliberate arrangement of learning activities and creative thinking techniques. Certainly the design educator is always playing an important role in designing teaching and learning strategies.

Measuring Creativity in Design Education

Francis Galton published the "Inquiries into Human Faculty" in 1883, which raised the concerns about assessing human creativity, and this publication has inspired relevant studies in subsequent decades, for instance, the divergent thinking, imagination, and invention tests that were designed by Binet, Henri, and Whipple around the 1900s. The psychometric approach of assessing human creativity became important post 1950. Guilford made a significant distinction in human thinking between convergent and divergent thinking modes. According to Guilford, convergent thinking focuses on finding a single best and correct answer, while divergent thinking seeks novel and unexpected answers. Based on this, some creativity tests such as the Tests of Divergent Production (TDP) and Creative Behavior Inventory (CBI) were introduced between the 1960s and 1970s. However, it is important to note that some subsequent researchers argued that human divergent thinking is not similar to creativity since it can be affected by structural and motivational factors. Some researchers criticized that these tests could only assess human abilities in general but not the diverse abilities that an individual needs to integrate for creative thinking. Nonetheless, any creative and mental test tries to standardize the conditions, and all these standard tests inherently fail to assess human creativity. Creativity has no standard measurement criteria at all. This is true in design education; students from the fashion design domain are more focused on artistic and cultural exploration for generating creative ideas, whereas those from the advertising design domain emphasize strategic and market-driven solutions. Any standardization of assessment tool inherently fails to assess students' creativity in design education.

It is always difficult to develop a generic assessment tool for design students' creativity and problem-solving skills as well as their creative outcomes due to the diverse content specifics in design education. Design education is a form of education rather than pure creativity enhancement. It involves a systemic creative thinking process to generate solutions for problems. Therefore, design education focuses on assessing students' learning processes and outcomes in creativity training subjects instead of human creativity. Criterion-Referenced Assessment (CRA) is one of the useful assessment tools for measuring students' learning outcomes. CRA helps design students to realize their strength and weakness in creativity training subjects.

Conclusion and Future Directions

There is no subjective judgment regarding good or bad taste in design outcomes, since it is always about appropriate or inappropriate solutions to design problems (Green 1974). Therefore, it is essential for a professional designer to use effective design thinking processes to obtain appropriate design solutions to a specific problem. In this case, creativity training in design education is

Creativity Training in Design Education, Table 1 The five categories of creative thinking techniques

Genre	Description	Existing techniques
Identifying and mapping attributes	This type of creative thinking technique works as a cognitive organizational tool for defining the problem nature and relevant factors by either mapping notes or critical analysis	Mind mapping technique
		Concept map
		Hierarchical method
		Algorithm of inventive
		Problem-solving techniques
		Analysis of interactive decision areas
		Attribute listing technique
		Boundary examination technique
		Card storyboards skill
		Critical path diagrams
		Hexagon modeling
		Progressive hurdles technique
		Etc.
Making possibilities	This type of creative thinking technique helps students to generate numerous ideas and possibilities which may or may not result as solutions. This kind of tool is not going to solve a problem directly but can generate more alternatives for further consideration	Brainstorming technique
		Random access technique
		Brain sketching technique
		Brute think technique
		Collective notebook technique
		Heuristic ideation technique
		Ideal final result
		Imaginary brainstorming technique
		Paraphrasing key words technique
		Pictures as idea triggers technique
		Random stimuli technique
		Trigger method
		Think tank technique
		Wishing technique
		Etc.
Changing and shifting perspectives	This type of creative thinking technique seeks diverse perspectives in tackling a problem. Divergent thinking is an essential skill for solving a problem creatively; thus, these tools mainly provide divergent views for students in generating ideas and solutions	Six thinking hats
		Empathizing and dynamization
		Alternative scenarios technique
		Concept fan technique
		False faces technique
		Fresh eye technique
		Help-hinder technique
		RoleStorming Technique
		Etc.
Making association and analogical thinking	This type of creative thinking technique helps students to associate with more possibilities and work for Eureka. Making stimulations from cultural and current issues is also significant in facilitating students' associations and imaginations	SCAMPER procedure
		Lateral thinking technique
		Analogy and speculative imagination
		Circle of opportunity technique
		Escape thinking technique
		Exaggeration technique
		Force-fit game
		Paired comparison technique
		Similarities and differences technique
		Talking pictures technique
		Etc.

(*continued*)

Creativity Training in Design Education, Table 1 (continued)

Genre	Description	Existing techniques
Probing emotions and the subconscious	This type of creative thinking technique makes use of the power of the subconscious and emotions in creating possible ideas as well as making creative decisions	Hunch and intuition
		Doodling technique
		Lucid dreaming technique
		Controlling imagery technique
		Focusing technique
		Keeping a dream diary technique
		Neuro-linguistic programming
		Etc.

crucial in developing students' creative competencies for making sound creative design processes.

Creativity cannot be taught, however creative thinking techniques and process can be. This is the underlying principle of designing creativity training in design education. Creativity training in design education is a systematic arrangement of teaching and learning diverse thinking skills and creative thinking processes as well as developing students' learning behaviors with respect to creative thinking. It is, therefore, quite clear that creativity training is essential in design education.

Cross-References

- ▶ Brainstorming and Invention
- ▶ Creative Personality
- ▶ Creativity in Invention, Theories
- ▶ Freedom and Constraints in Creativity
- ▶ Imagination
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Invention and Modification of New Tool-Use Behavior
- ▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education

References

Butler DL, Kline MA. Good versus creative solutions: a comparison of brainstorming, hierarchical, and perspective-changing heuristics. Creativity Res J. 1998;11:325–31.

Eggleston J. Developments in design education. London: Open Books; 1976.

Green P. Design education: problem solving and visual experience. London: B T Batsford Ltd.; 1974.

Kneller GF. The art and science of creativity. New York: Holt, Rinehart and Winson; 1965.

Lau KW, Ng MCF, Lee PY. Re-thinking the creativity training in design education: a study of creative thinking tools for facilitating creativity development of design students. Art Design Commun High Educ. 2009;8(1):71–84.

Sternberg RJ. Teaching for successful intelligence: principles, practices, and outcomes. Educ Child Psychol. 2003;20(2):6–18.

Wallas G. The art of thought. New York: Harcourt Brace; 1926.

Creativity Versus Intelligence

▶ Divergent Versus Convergent Thinking

Creativity, Discourses

Adele L. Schmidt
School of Education and Professional Studies, Griffith University, Brisbane, QLD, Australia

Synonyms

Education, discourses; Scientific creativity, discourses

Introduction

The importance of sociocultural influences in contextualizing and contemporizing approaches to creativity is a recurrent theme in all areas of education, enterprise, and research. To understand, and analyze, how sociocultural factors direct and inform our perceptions of what it is, and what it means, to be creative, it is useful to deploy the concept of discourses as ideoethical constructs that we use to identify and articulate our emotional and intellectual relationship to others and other ways of being.

Application of discourse analysis allows identification of four distinct, but overlapping, discourses of creativity that draw upon, and influence, various aspects of teaching, learning, and management theory (Fig. 1).

The Developmental Discourse

Developmental discourses of creativity operate on an assumption that all individuals are capable of at least some form of creative output. This perception draws upon classical, Piagetian notions of cognitive development as a linear process mediated via the complementary functions of accommodation (interpretation of new experiences in relation to existing mental schemata) and assimilation (modifying existing mental schema to include new information). Within this framework, individuals pass through four primary developmental stages: beginning with an ability to coordinate sensory input with motor responses (sensorimotor stage) and culminating in a capacity for extrapolation of concepts and ideas to unfamiliar situations (formal operations stage).

In a developmental discourse, differences in creative ability are primarily attributed to differences in cognitive development, and it is assumed that the capacity for creative output exists in all individuals who reach the formal operations stage.

The developmental discourse is supported by empirical studies that show positive correlations between post-formal cognition and divergent thinking and readily translates to education and training programs based on practices that emphasize personal or individualized learning outcomes (Fig. 1).

The most significant limitations of developmental approaches discourse arise from evidence that, while the neurobiological structures and processes that determine cognitive capacity (and therefore creativity) are, to at least some extent, genetically determined, individuals who generate creative output also display complex, and highly variable combinations of social, psychological, and intellectual traits/characteristics. A lack of attention to affective and environmental factors therefore means that developmental discourses are unable to adequately account for the subtle, but crucial interplay of personal and social factors that enable or impede creativity in individual cases.

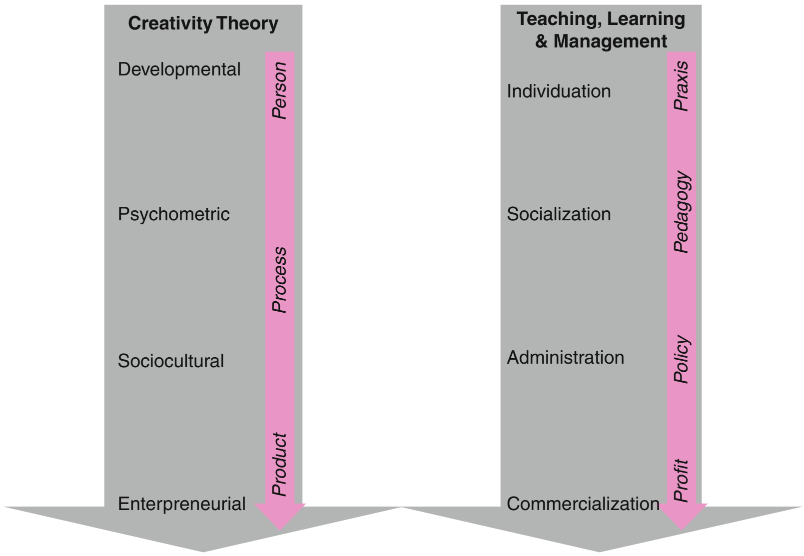
The Psychometric Discourse

Psychometric discourses frame creativity in terms of internal and external networks of traits, characteristics, and events that can be measured, manipulated, or exploited to predict/calculate or control (to a greater or lesser extent) an individual's likelihood of generating creative output. This view of creativity as a function of interactions between social, psychological, and intellectual traits/characteristics tends to dominate in settings where actualization of creativity is dependent on interactions between individuals.

The psychometric approach focuses on interplay of four intrapersonal domains: (a) a genetic domain composed of what one is biologically capable of doing well or poorly; (b) a domain of momentary, sensory memory, or experience; (c) a skillscape, in which the individual interprets and reacts to the events they are experiencing; and (d) a wordscape formed from the ability to articulate and share understanding of events and experiences.

For individuals and organizations wanting to engineer environments that are conducive to creativity, this has practical relevance, but weaknesses of the psychometric approach include a tendency to facilitate output only from individuals that represent extremes of social/intellectual variation and a lack of relevance and/or practicality in creative products.

Creativity, Discourses, Fig. 1 Discourses of creativity (Modified from Schmidt (2011) © SciRes)



The Sociocultural Discourse

Where those operating within developmental and psychometric discourses tend to be motivated by a desire to develop practices and create environments that facilitate creative output of individuals and groups, sociocultural discourses are concerned with the interaction of social, cultural, and economic factors that stimulates, refines, and sustains interest in creativity in the first instance.

This approach is not confined to the field of creativity studies, but extends across all or most fields of human endeavor and offers an important line of defense against policies and practices with the potential to generate or perpetuate social and economic inequity. In an educational context, the movement has its genesis in the early-to-mid twentieth century work of John Dewey, but its relevance and utility is enhanced (rather than diminished) in contemporary societies, where global forces drive recurrent cycles of growth and recession, leaving individuals vulnerable to recurrent periods of unemployment and in need of recurrent retraining.

In terms of practical application, however, sociocultural discourses are generally focused on problematization to such an extent that they rarely give rise to strategies or practices that can facilitate or enable creativity *per se*.

The Entrepreneurial Discourse

Organizations and individuals that operate within entrepreneurial discourses of creativity emphasize the products of creation. The entrepreneurial ideal is establishment and maintenance of policies and practices that identify and reward those that generate the most, or most valuable, creative output.

In purely commercial settings, entrepreneurial systems are self-regulating; in that overt discrimination against any particular sociocultural group is untenable because it constrains market size and limits profit. In these environments, the entrepreneurial approach can be implemented in ways that emphasize constructive, rather than competitive, social interactions.

In other settings, such as education and training, where the value of various products and practices cannot be represented in financial terms, however, an entrepreneurial approach can lead to arbitrary imposition of subjective, rather than objective, measures of creative output. This occurs because emphasis on production rather than creation leads to a focus on competitive attainment, which in turn leads to breakdown of moral and ethical frameworks.

Conclusion and Future Directions

Determining which conceptualization of creativity has greatest relevance and utility in any given setting is not straightforward. Insistence that creativity is an ephemeral, nebulous trait personified in a relatively small subset of élite individuals is dysfunctional at a societal level because there is not, and cannot be, delineation of single creative archetype. Creativity in any domain of human endeavor correlates with a wide range of personal traits and characteristics, and its actualization is the product of complex, dynamic interplay between personal and societal factors. Translation of theories of creativity into praxis in any given domain of human activity should therefore be based upon a dynamic, flexible combination of developmental, psychometric, sociocultural, and entrepreneurial perspectives.

Cross-References

- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Age and Creative Productivity
- ▶ Cognition of Creativity
- ▶ Corporate Creativity
- ▶ Creative Mind: Myths and Facts
- ▶ Creative Pedagogy
- ▶ Creative Personality
- ▶ Creative Potential
- ▶ Creative Process
- ▶ Creativity Definitions, Approaches
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Four Ps of Creativity
- ▶ Psychology of Creativity
- ▶ Research on Creativity
- ▶ Science of Creativity
- ▶ Scientific Creativity as Combinatorial Process

References

Claxton G. Thinking at the edge: developing soft creativity. Camb J Educ. 2006;36(3):351–62.

Clegg P. Creativity and critical thinking in the globalised university. Innov Educ Teach Int. 2008;45(3):219.

Dewey J. Chapter 23: vocational aspects of education. In: Democracy and education. New York: The Free Press; 1916.

Schmidt AL. Creativity in science: tensions between perception and practice. Creat Educ. 2011;2(5):435–45.

Sigelman CK. Life-span human development. 3rd ed. Boston: Brooks/Cole Publishing Company; 1999.

Simonton DK. Scientific creativity as constrained stochastic behavior: the integration of product, person, and process perspectives. Psychol Bull. 2003;129(4):475.

Simonton DK. Creativity as blind-variation and selective-retention: Constrained combinatorial models of exceptional creativity. Phys Life Rev. 2010;7:156–79.

Creativity, Experiential Theories

Bence Nanay
Centre for Philosophical Psychology, University of Antwerp, Antwerp, Belgium
Peterhouse University of Cambridge, Cambridge, UK

Synonyms

Creativity

Introduction

Most theories of creativity focus on the distinctive functional/computational mechanism that accounts for what makes creative mental processes creative. They disagree about what this functional/computational mechanism is supposed to be (whether it is the recombination of old ideas or the transformation of one's conceptual space, etc.) but they are in agreement about the kind of explanation to be offered – a functional/computational one. Experiential theories of creativity question this assumption that what makes creative mental processes creative is a distinctive functional/computational mechanism. According to these theories, creativity of creative mental processes is to be explained with reference to the way in which this mental process is experienced.

Creativity Versus Originality

Creativity and originality are often used as synonyms. Arguably, this is a mistake. Being original is usually contrasted with being derivative: An idea, for example, is original if it is not derived from someone else's idea. A scientific discovery or an artwork is original if it is not derivative. Whether a scientific discovery or artwork is original says relatively little about the nature of the mental process of the person who produced it. Originality is a property of normally publicly observable entities (not just of physical objects, but also of styles, utterances, and behavior).

Creativity, in contrast, is not normally publicly observable. It is a feature of mental processes. Being creative is not contrasted with being derivative, but with being mechanical (see, for example, Gaut 2003, pp. 150–151). Whether a mental process is creative says nothing about what kind of entities (if any) it produces. Some artists' and scientists' mental processes are creative, but so are many of those who are solving crossword puzzles or killing time at the airport with a difficult sudoku.

There is no simple connection between these two notions. Creativity is neither necessary, nor sufficient for originality. A scientific discovery can be original and still be the product of a purely mechanical mental process, which is, by definition, not creative. Goodyear's often quoted discovery of vulcanization is a possible example. Another example is the following. If you write a letter of recommendation for a student and emphasize how original her work is, you do not thereby also comment on her mental processes. You do not know much about the functional/computational structure of her mental processes, but you do know their outcome: that her research is very original.

Conversely, the products of a creative mental process can be completely banal and derivative. Suppose that you are in high school and you are trying to solve a math problem. There is a mechanical way to solve it: You have to try out all the natural numbers between 1 and 999 one by one, and one of them will be the solution. But there is also a creative way of solving it. If you manage to solve it in the creative manner, your mental process is creative (it is not mechanical), but the product of this mental process is not original at all: All the other students in your class solve the very same math problem, after all.

It is often claimed that novelty is a necessary feature of creativity. The contrast between creativity and originality is supposed to highlight that there may be no need to accept this as an unquestionable assumption. The concept of novelty is indeed very important for characterizing creativity, but in a less straightforward way than it is normally assumed. In contrast, novelty is clearly necessary for originality.

The distinction between creativity and originality could be thought to be a version of Ian Jarvie's distinction between subjective and objective creativity (Jarvie 1981, p. 117). Similarly, Ian Jarvie talks about subjective and objective creativity: subjective creativity, as he puts it, is "a property of persons or their minds," whereas objective creativity is "a property [. . .] of created works" (Jarvie 1981, p. 117). But it is important to note that while Jarvie claims that subjective creativity is "of no interest" in and of itself (Jarvie 1981, p. 117), much of the literature on creativity in the last three decades has been trying to understand the difference between (subjectively) creative and noncreative mental processes.

Creativity, in this sense, is quite a banal phenomenon: It is not to be restricted to the mental processes of a select few: Beethoven, Einstein, and the like. It is something much more common and much less mysterious. Originality, in contrast, is much rarer. There are many fascinating questions about originality that are usually discussed as questions about creativity (Carroll 2003), but for the purposes of this entry, these will be left on the side.

The Experiential Theories

There are two influential strategies to talk about the difference between creative and noncreative mental processes. The first one is to claim that this difference is a functional/computational difference. Say, creative mental processes are those types of mental processes that transform one's conceptual space, whereas noncreative ones are the ones that do not (Boden 1992, 1994 – note that this is Boden's account of radical creativity, not of creativity per se). Or, creative mental processes are bisociative ones and only these mental processes are bisociative (Koestler 1975). It is important to note that these explanations explain a mental process-type (creative mental processes) in terms of a functional/computational process type (bisociation, transformation of conceptual space, recombination, etc.) and this functional/computational process is supposed to be the one that is causally responsible for the emergence of the creative idea/thought.

The second strategy is to deny that any psychological explanation is possible. There are many versions of this claim (Feyerabend 1987; Jarvie 1981). It has been argued that the difference between creativity and noncreative mental processes cannot be explained at all, maybe because creativity is a one-off phenomenon, where every token of creativity is different, and therefore, no mental process type that would be responsible for creativity can be identified (Jarvie 1981). Another, old and influential, version of this view is that although this difference can be explained, it is not a psychological difference: It is not a matter of what the subject does, but either a result of divine intervention (as Plato claims) or of the mysterious subconscious (as Freud does). In other words, even if there is an explanation for creativity (say, divine intervention), this explanation is not a psychological one.

An advantage of, and the main inspiration for, the functional/computational account is that it would make it possible to build creative computers. If creativity is a matter of instantiating a functional/computational process, then computers can do it as much as humans can. And, conversely, some of the claims about the impossibility of a psychological account of creativity are fuelled by doubts about computer creativity.

Experiential theories of creativity claim that the difference between creative and noncreative mental processes is a psychological difference, but not a functional/computational one. In short, this difference is constituted by the way these mental processes are experienced.

Thus, experiential theories of creativity make a negative and a positive claim. The negative claim is that what is distinctive about creativity is unlikely to be a functional/computational process type. The positive claim is that what is distinctive about creativity is still something psychological: the way these mental processes are experienced.

The negative claim of the experiential theories of creativity is that what is distinctive about creativity is unlikely to be a functional/computational process type (Weisberg 1993 argues for a version of this claim). A simple fact to notice is that no functional/computational account proposed so far is without counterexamples. Here are two of the most influential such theories. Margaret Boden's account, according to which (radical) creativity implies the transformation of one's conceptual space, has been criticized for not covering some clear cases of creativity (Novitz 1999, pp. 68–70). Novitz's account, according to which creativity implies the mere recombination of old ideas (Novitz 1999), in turn, also fails to cover all cases of creativity (including the ones Boden was focusing on).

The experiential theories of creativity favor a more pluralist approach. Creative mental processes can be implemented by more than one functional/computational process. Boden is (partly) right: Her functional/computational explanation for the emergence of creative ideas is the right kind of functional/computational in some cases of creative mental processes. But Novitz is also (partly) right: His account identifies the right way to explain some *other* cases of creative mental processes. But neither account is satisfactory as a general account of the difference between creative and noncreative mental processes.

Not all mental phenomena form a functional/computational natural kind. Being in love, for example, is unlikely to be a functional/computational natural kind. The same goes for being happy. The claim is that creativity is also unlikely to be a functional/computational natural kind. What is in common between the diverse mental processes that are taken to be creative is not something functional/computational, but something experiential.

It is important that the experiential theories of creativity are not denying that for each token creative process, there is (or at least can be) a functional/computational process that implements this creative process. What the experiential theories of creativity deny is that there is anything interesting in common between these token processes (besides the fact that they all implement creative processes). Creativity comes in different (functional/computational) forms: Some creative mental processes involve a mere recombination of old ideas. Some others involve a radical transformation of one's conceptual space. The functional/computational level is not the right level of analysis if the aim is to explain the difference between creative and noncreative processes.

Does this make creativity miraculous? Definitely not. Each token creative mental process is realized by a token series of neuron firings. So are token instances of happiness or of being in love. The point is that what is in common between these neural events is unlikely to be captured in functional/computational terms. But, like in the case of happiness and being in love, it can be captured in experiential terms.

A functional/computational and an experiential explanation of a creative mental process are not exclusive of one another. A full explanation of creative mental processes would presumably require both. But the main claim of the experiential theories of creativity is that the experiential description captures something about creative processes in general, whereas the functional/computational description does not. And many important features of creativity can be explained by the experiential explanations (rather than the functional/computational ones).

Many thinkers have toyed with ideas about creativity that could be taken to belong to the experiential approach. Here two such thinkers will be discussed in detail (but note that they by no means exhaust the logical space of the experimental theories of creativity): Robert Musil and Bence Nanay.

Robert Musil's Experiential Theory of Creativity

Robert Musil was not a philosopher, but a novelist, although he did have a Ph.D. in philosophy. This is the account he gives of creative mental processes in his classic and very philosophical novel, *The Man without Qualities*:

> The solution of intellectual problems comes about in a way not very different from what happens when a dog carrying a stick in its mouth tries to get through a narrow door: it will go on turning its head left and right until the stick slips through. We do pretty much the same [. . .] the slipping through comes as a surprise, is something that just suddenly happens; and one can quite distinctly perceive in oneself a faintly nonplussed feeling that one's thoughts have created themselves. (Musil 1930/1979, p. 128)

This is clearly a version of the experiential theory of creativity. What makes creative mental processes creative is the element of surprise – an experience. What makes them creative is not the functional/computational mechanism that underlies these creative mental processes but the way they are experienced. Musil does not elaborate on what this experience is like – besides noting that the experience of surprise, of "a faintly nonplussed feeling" is a crucial element of this experience.

Bence Nanay's Experiential Theory of Creativity

A more recent exploration of the experiential approach to creativity is Bence Nanay's account (Nanay 2012). The starting point of Nanay's version of the experiential theory of creativity is Margaret Boden's concept of radical creativity. Boden argues that an idea is (radically) creative only if "the person in whose mind it arises could not (in the relevant sense of 'could not') have had it before" (Boden 1994, p. 76). There are notable difficulties spelling out what is meant by the "relevant sense of could not" and there may be some questions about whether this account could apply in the case of all instances of (radical) creativity (see Novitz 1999, pp. 68–70). But Nanay rephrases Boden's definition in the following manner: An idea is creative only if the person in whose mind it arises *experiences it* as something she *has* not taken to be possible before.

So the claim is that it is a necessary feature for creative mental processes that their outcome is experienced in a certain way: that one experiences the outcome of the mental process as something one has not taken to be possible before. But what does it mean to say that an experience represents a mental process as something the agent has not taken to be possible before? At time t, the agent considered a number of possibilities. Later, at time t*, she comes up with a possibility that she experiences as something that is different from all the possibilities she considered at time t.

Nanay's aim is to give a necessary condition for creative mental processes. His claim is that the most that can be said about the necessary condition for creative mental processes is that they are experienced as something one have not taken to be possible before. It is important that this is a necessary and not a sufficient condition. But if a couple of further conditions are added, it may be possible to give (or at least come close to giving) a necessary and sufficient condition for creativity.

You can experience an idea as something you have not taken to be possible before, but you may be wrong: Experiences can misrepresent. You may experience an idea as creative: as something you have not taken to be possible before, but maybe you had taken it to be possible before, but you forgot that you had. Thus, if the aim is to give a (close to) sufficient condition for creativity, it would need to be added that the experience that defines creative mental processes has to be veridical: The idea in question really needs to be something you have not taken to be possible before – it is not enough if you experience it as such.

There may be some further conditions that need to be added in order to arrive at a genuine necessary and sufficient condition for creativity. But the aim of the experiential theories of creativity is not to argue for some strict necessary and sufficient condition for creativity. The aim of the experiential theories of creativity is to argue that the right level for the characterization of (and for giving a necessary and sufficient condition for) creativity is not the functional/computational level, but the experiential one.

Experiential Theories Versus Functional/Computational Theories of Creativity

It can be argued that experiential accounts have greater explanatory power in explaining some of the crucial features of creativity than the functional/computational ones – given that the most salient features of creativity are experiential ones, this claim should not come as a surprise.

I will briefly mention three features of creativity that are taken to be important enough so that any comprehensive theory of creativity must be able to explain (or at least say something about) them. There may, of course, be many more such features. But these three have played an important role in shaping the widespread conception of creativity.

(a) A theory of creativity needs to be able to explain why it is a tempting intuition that suggests that creativity is something that happens to us, rather than something that the subject does.
(b) A theory of creativity needs to be able to explain why the experience of the appreciation of other people's creativity can seem similar to the experience of one's own creativity.
(c) A theory of creativity needs to be able to explain why creative actions are taken to be genuine actions and not mere bodily movements.

It can be argued that all these three features of creativity are better explained in the experiential than in the functional/computational framework (see Nanay 2012). If this is so, then there are good reasons to explore the experiential theories of creativity.

Conclusion and Future Directions

It is important to note that the aim of the experiential theories of creativity is not to give a necessary and sufficient condition for creativity – creativity is an ordinary language concept and it may be difficult to capture its meaning with strict necessary and sufficient conditions. The aim of the experiential theories of creativity is to argue that the right kind of analysis for the concept of creativity should be about experiences (rather than functional/computational mechanisms).

Further, even if a necessary and sufficient condition for creativity could be given in terms of experiences, this does not mean that these experiences are causally responsible for the emergence of creative ideas. It is neural processes that are causally responsible for the emergence of creative ideas. The claim is that in order to capture some of the crucial features of creative processes, they need to be analyzed on the experiential level.

One important future direction in research for experiential theories of creativity would be to fill in the details of what these experiences are supposed to be in the same degree of specificity as the functional/computational theories do.

Cross-References

- ► Cognition of Creativity
- ► Creativity Definitions, Approaches
- ► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
- ► In Search of Cognitive Foundations of Creativity
- ► Mental Models and Creative Invention

References

Boden M. The creative mind: myths and mechanisms. Reading: Cardinal; 1992.

Boden M. What is creativity? In: Boden M, editor. Dimensions of creativity. Cambridge, MA: The MIT Press; 1994. p. 75–118.

Carroll N. Art, creativity, and tradition. In: Gaut B, Livingstone P, editors. The creation of art. New essays in philosophical aesthetics. Cambridge: Cambridge University Press; 2003. p. 208–34.

Feyerabend P. Creativity – a dangerous myth. Crit Inq. 1987;13:700–11.

Gaut B. Creativity and imagination. In: Gaut B, Livingstone P, editors. The creation of art. New essays in philosophical aesthetics. Cambridge: Cambridge University Press; 2003. p. 148–73.

Jarvie IC. The rationality of creativity. In: Dutton D, Krausz M, editors. The concept of creativity in science and art. Dordrecht: Martinus Nijhoff; 1981. p. 109–28.

Koestler A. The act of creation. London: Picador; 1975.

Musil R. The man without qualities (trans. Eithne Wilkins and Ernst Kaiser). London: Picador; 1930/1979.

Nanay B. An experiential account of creativity. In: Paul E, Kaufman SB, editors. The philosophy of creativity. Oxford: Oxford University Press; 2012.

Novitz D. Creativity and constraint. Aust J Philos. 1999;77:67–82.

Weisberg R. Creativity: beyond the myth of genius. New York: Freeman; 1993.

Creativity, Intelligence, and Culture

James C. Kaufman[1] and Winter Meyer[2]
[1]Department of Psychology, Learning Research Institute, California State University at San Bernardino, San Bernardino, CA, USA
[2]Learning Research Institute, California State University at San Bernardino, San Bernardino, CA, USA

Before discussing how creativity and intelligence are impacted by culture, the basic question of how the two constructs are related must be addressed. Sternberg and O'Hara (1999) argued for five possible relationships: Creativity could be a subset of intelligence; intelligence could be a subset of creativity; or the constructs of creativity and intelligence could be overlapping, coincident, or simply disjointed.

Creativity and Intelligence

Most work, however, assumes a connection; as Plucker and Renzulli (1999) concluded, the key question is not *whether* but *how* the two are related. Although creativity and intelligence are clearly related, the exact nature of this relationship is still being explored by research. Scholars have generally found that paper-and-pencil measures of creativity (such as divergent thinking tests) are significantly associated with psychometric measures of intelligence. Traditional wisdom has argued for a "threshold effect," in which creative potential and psychometric intelligence are positively correlated at low levels of IQ and continue to be positively correlated through IQs of approximately 120. Across many of these studies (conducted on both children and adults), in people with higher IQs, the two constructs have been reputed to show little relationship.

More recently, however, this theory has come under fire. Kim (2005) conducted an extensive meta-analysis of 21 studies containing 45,000 participants and using multiple measures of IQ and creativity. She found virtually no support for the threshold theory, showing very small positive correlations (mean correlation of .174) between measures of cognitive ability (designed to measure *g*) and measures of creativity and divergent thinking.

Most of these studies use intelligence measures that primarily have been designed to measure *g*, or a general factor of intelligence. Most theories of intelligence, however, are more complex than simply *g*. One example is crystallized and fluid intelligence, as proposed by Raymond Cattell and John Horn. Fluid intelligence (*Gf*) is the ability to apply a variety of mental operations to solve novel problems, ones that do not benefit from past learning or experience. Crystallized intelligence (*Gc*) is the breadth and depth of a person's accumulated knowledge of a culture and the ability to use that knowledge to solve problems. One study that examined crystallized versus fluid intelligence and creativity, conducted by Sligh, Conners, and Roskos-Ewoldsen (2005), used an individually administered IQ test and a creative invention task (in which people would use shapes to create a possible object, and then name and describe their invention). Sligh et al. found that *Gc* showed the same moderate and positive relationship to creativity as in past studies. In contrast, *Gf* was more related to creativity in people with higher IQs. This finding implies that those who receive high Gf scores may be more likely to be creative than those who receive high Gc scores.

Intelligence and Culture

One notable area where creativity and intelligence diverge is how they are associated with culture. As it is measured, intelligence tends to show significant discrepancies by culture. Within American culture, African Americans and Hispanic Americans tend to receive lower scores of measures of intelligence than do Caucasians and Asian Americans; standardized tests such as the SATs, ACT, Graduate Record Exams (GREs), and Advanced Placement (AP) exams have shown similar patterns of discrepancy among ethnic groups. Although some researchers argue that these measures reflect actual differences, this view is not a commonly accepted one. Some scholars, for example, point to the discrepancy between socioeconomic status and opportunities across ethnicities, whereas others argue that differences are a result of implicit biases in the measures of intelligence that are used. Another perspective is that current ability measures do not incorporate enough aspects of intelligence to truly reflect a person's "global" ability (Kaufman 2010).

Across cultures, Asians and Europeans tend to receive higher scores, whereas Africans receive lower scores; more notable, however, are the different values and implicit beliefs about intelligence. Asians often see effort as a component of intellectual ability, for example, and Africans tend to emphasize practical abilities. It is difficult to draw larger conclusions about intelligence across cultures given that the vast majority of tests used are translated Western tests. Many scholars argue that any differences that emerge are due to test bias (Sternberg and Kaufman 2011).

Creativity, Culture, and Ethnicity

Within creativity, however, such differences by ethnicities and culture are typically slight or nonexistent. As reviewed by Kaufman (2010), most studies of ethnic differences in creativity have used divergent thinking tests; others have used actual creative performance as rated by experts or self-assessments. There tend to be very few differences between African-Americans and Caucasians. Those that have been found favor African-Americans. Hispanic Americans are outperformed by Caucasians on verbal divergent thinking measures (likely because of language discrepancies), but there are no differences on nonverbal measures (or, curiously, verbal measures of creative performance). Some studies have indicated that the bilingual students may have an advantage in creative abilities. Bilinguals have been proposed to be more cognitively flexible, allowing them to see problems from multiple perspectives.

An example of a study that looked at multiple ethnicities and gender is Price-Williams and Ramirez (1977). They found an interesting ethnicity by gender interaction. African-American males and Hispanic American males outperformed Caucasian males on a divergent thinking test. However, the results were reversed for females. Caucasians outperformed African Americans and Hispanic Americans on fluency. There have been few other studies that have found this type of interaction; the vast majority of the studies that examine gender differences either find no significant differences or mixed results.

There are many studies on differences in Asians and Europeans or Asians and Americans. Generally, Asians or Asian Americans outperform Europeans or Caucasians on measures of analytic ability but score lower on measures of divergent thinking. Studies that look at actual creative performance find either no differences or slight differences favoring Americans/Caucasians. In one such study, Rostan, Pariser, and Gruber (2002) studied Chinese American and Caucasian students' artwork, with two groups in each culture: students with additional art training and classes, and students with no such classes. Each group's artwork (one drawing from life and one drawing from imagination) was judged by both Chinese and American judges. There were no significant differences between cultures from either set of judges. The only differences found were that art students (regardless of ethnicity) received higher ratings for their artwork than did non-art students.

Practical Applications

Kaufman (2010) argued that the discrepancy between ethnic differences on creativity measures versus intelligence/achievement tests could offer an opportunity for more equitable admissions criteria. There are two ways that standardized tests are criticized for being potentially biased. A common layperson's approach to criticizing tests as biased is to point to significant differences that occur between males and females and among ethnic groups on various tests of aptitude or ability.

Researchers who advocate psychometric approaches to bias in testing take a more sophisticated view of the problem and do not accept the notion that just because two groups perform differently on a mental test, therefore, the test itself must be in error or biased. Current approaches evaluate content statistically to identify specific items that are inappropriate because they unfairly favor one group over another. Methods are commonly applied as well to determine whether different constructs are measured across nominal groups by the same test; a test may measure verbal ability in Caucasians, for example, but may be measuring something quite different (such as exposure to American culture) in a Hispanic American population. These are only a few of the recent, more sophisticated, methods of considering bias assessment (Reynolds 2000). When a test measures something different from what it was intended to measure for specific groups, then it may be considered a biased instrument against those groups. A measure is fair to the extent that the score only includes (a) variables associated with the construct being measured, and (b) random variance from error. In other words, a measure is fair to the extent that it minimizes systematic error in true score estimation as a function of group membership. If a test systematically assigns certain groups lower scores than their "true" score, then the test should be considered biased.

Creativity assessment can reduce bias from both the layperson and psychometric approaches. If creativity is used to create a fuller picture of an applicant, and if creativity is an unmeasured component of ability, then these measures might also help minimize errors in decision-making regarding such students (many conceptions of intelligence, as mentioned earlier, include creativity as a core component). This possibility for reduction in error can be conceptualized in two very different and complementary ways. Assume one is trying to understand a person's overall cognitive abilities, but only a narrow range of relevant abilities (e.g., those measured by traditional IQ tests) are being assessed. Even if these abilities are being assessed fairly, the ability of the examiner to understand the person's cognitive functioning may be limited. This limitation may be different for different groups. If, for example, some abilities are more relevant in some cultural settings than others, then the unmeasured abilities may have a differential impact on understanding people's abilities based on their culture. Such a discrepancy would create bias in the assessment process. To use a cross-discipline example, imagine a test of visual artistic ability that only looked at sketching. The artistry test would miss many other core components (such as watercoloring or drawing), and would over-reward people who were especially good at sketching. In doing so the test would have an implicit bias against people who were color-blind.

In addition, consider a college admissions program (or a clinical test examiner) trying to assess a limited range of a person's cognitive abilities (e.g., IQ). If the available tests are believed to be biased, it may be possible to correct some of the systematic error present if other cognitive abilities are tested, as long as these abilities are believed to influence scores adversely on other tests in the examination. If, for example, scores on a valid and reliable test of creativity could be shown to correlate with some systematic ethnic bias of IQ tests, then perhaps the creativity test scores could be used to attenuate any systematic error on the IQ tests.

Conclusions and Future Directions

Although there are differences in scores on ability and achievement measures across cultures and ethnicities, these differences are reduced, eliminated, or reversed on most creativity measures. Indeed, including creativity tests as part of a global ability or achievement measure would also likely reduce ethnic differences. Although the psychometric definition of biased assessment is the most relevant for an academic audience, creativity tests can also increase people's perceptions of bias in admission assessments.

Cross-References

▶ Cognition of Creativity
▶ Creativity Across Cultures
▶ Techno-Globalization and Innovation

References

Kaufman JC. Using creativity to reduce ethnic bias in college admissions. Rev Gen Psychol. 2010;14:189–203.

Kim KH. Can only intelligent people be creative? J Secondary Gifted Edu. 2005;16:57–66.

Plucker JA, Renzulli JS. Psychometric approaches to the study of human creativity. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 35–60.

Price-Williams DR, Ramirez III M. Divergent thinking, cultural differences, and bilingualism. J Soc Psychol. 1977;103:3–11.

Reynolds CR. Methods for detecting and evaluating cultural bias in neuropsychological tests. In: Fletcher-Janzen E, Strickland TL, Reynolds CR, editors. Handbook of cross-cultural neuropsychology. New York: Plenum; 2000. p. 249–85.

Rostan SM, Pariser D, Gruber HE. A cross-cultural study of the development of artistic talent, creativity, and giftedness. High Abil Stud. 2002;13:125–56.

Sligh AC, Conners FA, Roskos-Ewoldsen B. Relation of creativity to fluid and crystallized intelligence. J Creative Behav. 2005;39:123–36.

Sternberg RJ, Kaufman SB, editors. Cambridge handbook of intelligence. New York: Cambridge University Press; 2011.

Sternberg RJ, O'Hara LA. Creativity and intelligence. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 251–72.

Creativity, Invention, Innovation and Entrepreneurship, Discourse

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Creativity: Cultural Capital in Mathematics

Rae Ann Hirsh
Early Childhood, Carlow University, Pittsburgh, PA, USA
Indiana University of Pennsylvania,

Synonyms

Inventiveness; Originality; Problem solving; Resourcefulness; Social capital

In the realm of education, creativity is not usually associated with mathematics. The average mathematics classroom is dominated with step-by-step directions, algorithms, and logical formulas for problem solving. In the past, this may have been sufficient for problem solving due to the tools available to students. However, access to cultural goods, tools, resources, and technologies has changed dramatically in the past few decades and has radically changed the tools available to students. With this change, creativity has emerged as the new cultural capital of the mathematics classroom. Creativity is needed to address current and future problem-solving challenges of the twenty-first century and beyond.

Key Concepts

Creativity

Emerging technology and innovative access has radically changed the career and lifestyle options of the human race and will continue to change them. The tools and roles of the future are unknown, but preparation for that future occurs daily in classrooms around the globe. Survival in this type of elusive future will require a very fluid/adaptable type of thinking that is closely associated with creativity (Gardner 2009). This type of thinking can be referred to as divergent thinking or "originality, flexibility, and elaboration; and fluency in thinking" and is often thought to be at the core of creativity (Sak and Maker 2006, p. 279). Creativity itself has been defined in hundreds of ways throughout decades. An analysis of 42 definitions of creativity by Kampylis and Valtanen (2010, p. 198) reveals four key components commonly referred to as the four Ps of creativity (person, process, press, and product):

1. Creativity is a key ability of *individual(s).*
2. Creativity presumes an *intentional activity* (process).
3. The creative process occurs *in a specific context* (environment).
4. The creative process entails the generation of *product(s)* (tangible or intangible). Creative product(s) must be novel (original, un*conventional*) and *appropriate* (valuable, useful) to some extent, *at least* for the creative individual(s).

Mathematics

Mathematics can be defined as using number sense, geometry, estimation, measurement, statistics, probability, fractions, decimals, patterns, spatial sense, and relationships to solve problems. Problem solving is defined by the National Council for Teachers of Mathematics (NCTM) as "engaging in a task for which the solution method is not known in advance" (NCTM 2000, p. 52). A critical piece of the NCTM's definition is that the solution method is *not known* in advance. In the past, math has been looked at as a process of solving problems with *known* algorithms. Knowing an algorithm in advance negates a student's mathematical thinking and hinders the development of place value and number sense (Kamii 1988).

Mathematics Education

Contemporary mathematics education relies heavily on the common core state standards initiative.

The common core state standards initiative in the United States recognizes eight main foci:

- Making sense of problems and persevere in solving them
- Reason abstractly and quantitatively
- Construct viable arguments and critique the reasoning of others

- Model with mathematics
- Use tools strategically
- Attend to precision
- Look for and make use of structure
- Look for and express regularity in repeated reasoning

These core foci of the USA are similar to many other countries, with the exception of how and what is required of students at various grade levels (Kilpatrick 2010). The common theme in these eight foci is problem solving; therefore, "it should be a well-integrated part of the curriculum that supports the development of mathematical understanding" (NCTM 2000, p. 52). Mathematics education relies on centuries of *cultural capital*. "A math textbook, without always acknowledging it, contains wisdom from ancient cultures and the accumulated history of human thinking" (Lonergan 2007, p. 1).

Cultural and Social Capital

The term cultural capital is credited to Pierre Bourdieu in the 1960s. Bourdieu was interested in the noneconomic/material reasons why educational disparity existed between students of lower socioeconomic backgrounds and students of other social classes. He proposed that students bring specific competencies, aesthetic preferences, and dispositions to the classroom that have been instilled and reinforced from a strong cultural perspective and access. Contemporary sociologists view these competencies and dispositions as a "form of currency in the social realm" (Winkle-Wagner 2010, p. 7). A student's cultural capital can have advantages in some settings and disadvantages in others. Cultural capital can be acquired through social origin and education and presents itself within a space where capital is produced and assessed, like a classroom. Social capital manifests itself in relationships. Relationships with family, peers, teachers, and materials have tremendous influence on the learning environment and contribute to cultural capital wealth (Pishgahadam and Zabihi 2011).

Creativity as Cultural Capital

Cultural capital takes into account the dispositions, values, traditions, preferences, arts, skills, advantages, and intergenerational equity of specific groups of people. Cultural capital can be used as leverage to elevate or lower social status which influences all other aspects of life. When creativity is infused into the definition of cultural capital, the uniqueness and skills of different cultures are valued and respected. This leads to an appreciation of divergent thinking and an encouragement of creative problem solving. In the mathematics classroom, creativity has been traditionally devalued and narrowly focused on specific skills and strategies. Creativity was not seen as valuable cultural capital, but as playful distraction, nonsense, and/or inattentiveness. This ultimately leads to standardized thinking and reserved reactions. Embracing creativity as cultural capital in the mathematics classroom revitalizes the problem-solving process, expands the boundaries of the math field, and invites competitiveness and innovation into the classroom and ultimately into the global workplace.

Current Trends in Mathematics Education and Their Link to Global Competitiveness

The National Center for Education Statistics (NCES) monitors and reports how US students perform in specific subject areas, such as mathematics. The NCES gathers its data from state standardized test scores and international standardized mathematics assessments. Mathematics achievement is typically assessed and compared internationally through the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). Results from the TIMSS and PISA are frequently cited as reasons for improving mathematics education and are motivators for international competition. Despite the heavy reliance on the results of these standardized assessments, questions regarding the fallout of high test scores have emerged. A comprehensive 40-year study of countries' TIMSS scores demonstrates unexpected findings (Baker 2007). The higher a country's TIMSS scores were 40 years ago, the lower the country's economic health and national wealth today. Economic growth in countries improved as test scores dropped. Quality of life, as measured on the quality-of-life index, improved as test scores decreased. The Economist Intelligence Unit's Index of Democracy showed that countries with the highest test scores had lower levels of democracy. The number of creative patents was much higher in countries with lower test scores. Yong Zhao highlights Baker's work in his PowerPoint presentation to the Pennsylvania Association for Supervision and Curriculum Development and be accessed at the following website:

http://zhaolearning.com/wp-content/uploads/2011/11/PASCD.pdf

The trend to rely on standardized assessment results has resulted in a one-size-fits-all math education classroom that replaces creativity and problem solving with skills, drills, and memorization. This may raise international test scores, but lower international market competitiveness by negating creativity, innovativeness, and originality in careers rooted in mathematics, engineering, and technology. Creativity is valuable cultural capital, unique to cultures that value independence, creative thought, and divergent thinking. The social and educational origins of cultural capital provide a unique opportunity for creativity in the mathematics classroom. Creativity allows one to value the social capital contributions of individuals and add the importance and value of creativity to the cultural capital repertoire. In the mathematics classroom, it is pertinent to specifically focus on the cultural capital acquired through interaction and create social acceptance and importance of creativity in problem solving.

Sir Ken Robinson, a proponent of creativity in the classroom, eloquently explains the evolutionary need for creativity in schools and highlights the current trends and disvalue of creativity as cultural capital in the following TED Talk.

http://www.youtube.com/watch?v=hkPvSCq5ZXk&feature=related

Policy and Practice

Science, technology, engineering, and math (STEM) initiatives are specifically designed to increase science and math skills in children and build awareness for science, math, technology, and engineering careers. Judith Ramaley, the former director of the National Science Foundation's education and human resources division, began the STEM initiative in 2001. Her idea was to abandon the isolated teacher-directed content areas of the sciences and mathematics and teach them as interdisciplinary, collaborative inquiry-based explorations and problem-solving experiences that transcended gender and class boundaries. STEM has recognized that valued skill sets have changed from solitary isolated skill sets to collaborative innovative application. As the STEM initiative grew momentum in schools, the exclusion of a very necessary component was glaringly apparent. The foundational skills for math and science are there, but the ingenuity to create, solve problems, and invent is lacking. Creativity is missing. In 2011, STEM responded to the creativity crisis in the STEM program through the introduction of an A for arts. STEM is now STEAM – science, technology, engineering, arts, and mathematics. STEAM recognizes that:

- Arts education is a key to creativity.
- Creativity is an essential component of, and spurs, innovation.
- Innovation is agreed to be necessary to create new industries in the future.
- New industries, with their jobs, are the basis of our future economic well-being.

The trend in STEM corroborating Albert Einstien's thinking of "We can't solve problems with the same kind of thinking we used when we created them."

Core math initiatives of the USA and other countries need to be grounded in an understanding of the cultural capital contemporary students possess and be cognizant of the elusive tools and roles of the future. Math standards, math practices, and math classrooms need to recognize the importance of divergent thinking, encourage creative problem solving, and nurture and respect creativity.

Conclusion and Future Directions

As educators prepare students for the twenty-first century and beyond, a renewed emphasis in divergent thinking is taking place and is necessary for the future global society. To keep creativity alive in the classroom, educators need to keep in mind the four Cs – content, connection, choices, and coauthorship (Longergan 2007). The fluidity of creative thought has distinct implications for the role content knowledge plays in the development of creativity. “Knowledge can provide the foundation for creative work: however, too much knowledge may preclude the thinker from going beyond stereotyped responding or bring about negative transfer to new problem situations” (Sak and Maker 2006, p. 281). The content presented to students should be integrated into interdisciplinary projects that require contextual math to complete the project. Creativity also involves connection to *real-world* disciplines. The connection can happen through the arts, technology, engineering, or science and is reinforced through the STEAM initiatives. Choice is something seldom seen in education, but extremely important not only to creativity but to initiative, industry, and problem solving. Too often, education is presented in a linear fashion with one right answer. Students need questions that invite a multitude of answers and pathways. This is critical as students face a future where the roles and tools of the society will look quite different from present day. Coauthorship refers to the student’s role in problem identification and formulation. Involving them in the task of identifying a problem increases motivation, encourages them to look at the world more critically, and helps them to identify the need to solve the problem. This process encourages creativity as students began posing their own problems to solve.

Cross-References

▶ Convergent Versus Divergent Thinking
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity Definitions, Approaches
▶ Divergent Thinking

References

Baker K. Are international tests worth anything? Phi Delta Kappan. 2007;89(2):101–4. http://www.pdkintl.org/kappan/kappan.htm

Gardner H. Five minds for the future. Boston: Harvard Business School Press; 2009.

Kampylis PG, Valtanen J. Redefining creativity: analyzing definitions, collocations, and consequences. J Creat Behav. 2010;44(3):191–214.

Kilpatrick J. A comparison of proposed US common core math standards to standards of selected Asian countries. Education News. 2010 July 9. http://www.educationnews.org/ed_reports/94979.html

Longergan M. The case for creativity in math education. Horace. 2007;23(2). http://www.essentialschools.org/resources/386

National Council of Teachers of Mathematics. Principles and standards for school mathematics. Reston: National Council of Teachers of Mathematics; 2000.

Pishgahadam R, Zabihi R. Social and cultural capital in creativity. Can Social Sci. 2011;7(2):32–8. www.cscanada.org

Sak U, Maker CJ. Developmental variation in children’s creative mathematical thinking as a function of schooling, age, and knowledge. Creat Res J. 2006;18(3):279–91.

Winkle-Wagner R. Cultural capital: the promises and pitfalls in education research. ASHE High Educ Rep. 2010;36(1):1–144. doi:10.1002/aehe.3601.

Creatology

▶ Science of Creativity

Cross-Cultural Creativity

▶ Creativity Across Cultures

Cross-Cultural Entrepreneurship and Business

▶ Entrepreneurship and National Culture (According to Hofstede’s Model)

Cross-Disciplinarity

► Interdisciplinary Research (Interdisciplinarity)

Cross-Employment

David F. J. Campbell
Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
University of Applied Arts, Vienna, Austria

Synonyms

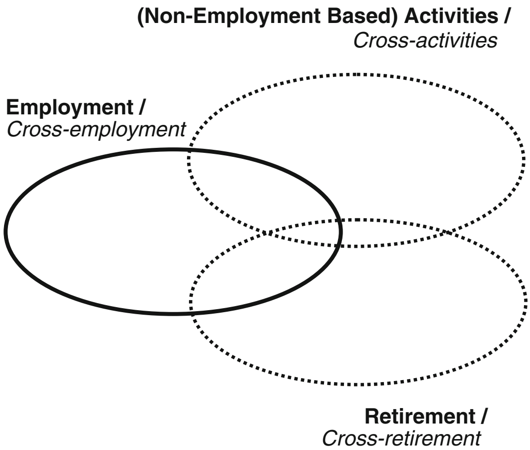
Cross-employment and cross-retirement; Multi-employment; Network-based arrangement of work; Organizational arrangement of nonlinear research (knowledge production) and nonlinear innovation (knowledge application); Tenure track and cross-employment

Concept of Cross-Employment

Cross-employment represents a type of multi-employment, where a person is being employed simultaneously by more than one organization (institution). The emphasis here is placed on employment by at least two organizations, and it must be simultaneous (and not a sequential first-then) form of employment. The opposite concept to cross-employment would be the single employment by only one organization (or institution) at a time. Employment implies that the person is involved in social and tacit learning of the different organizations that also behave as organizational environments. When employment is in reference to knowledge production and knowledge application, then cross-employment should also be understood as an expression of and as a form for organizing, optimizing, and excelling research and innovation. Cross-employment already exists as an empirical phenomenon. How common or uncommon currently cross-employment is, is difficult to assess. This topic has not been sufficiently researched, so far. Beyond the empirical aspects of cross-employment, also the question could be raised, whether cross-employment has also the qualities of a normative and ideal-typical category: Should work, also in association with knowledge production, research, and innovation, be organized in a way of allowing for more (or even encouraging) arrangements that follow the logic of cross-employment?

Cross-employment as a specific term and concept was first introduced by Campbell (2011). In Carayannis and Campbell (2012, p. 24), the following comprehensive description for cross-employment is being presented: "*Cross-employment* (multi-employment) may be regarded as one (organizational) strategy for realizing creative knowledge environments. Cross-employment (multi-employment) refers to a knowledge worker, employee, who is being simultaneously employed by more than one organization, possibly being located in different sectors (e.g., a higher education and a non-higher education institution, e.g., a university and a firm). *This supports the direct network-style coupling of very different organizations in knowledge production and innovation application*, expressing, therefore, what nonlinear innovation could mean in practical terms ... Cross-employment makes possible 'parallel careers' for individuals (knowledge workers) across a diversity of organizations and sectors, thus also a simultaneous operating in parallel in organizations with different rationales and innovation cultures." The creative knowledge environments (CKEs), as a concept and term, were introduced by Hemlin et al. (2004).

Cross-employment (employment) has a hybrid overlapping or can be combined with other forms of activities that are nonemployment based (such as self-employment) or also with partial (part-time) retirement, then being called cross-retirement in connection with employment



Cross-Employment, Fig. 1 The hybrid overlapping of employment and cross-employment with activities and retirement [Source: Author's own conceptualization]

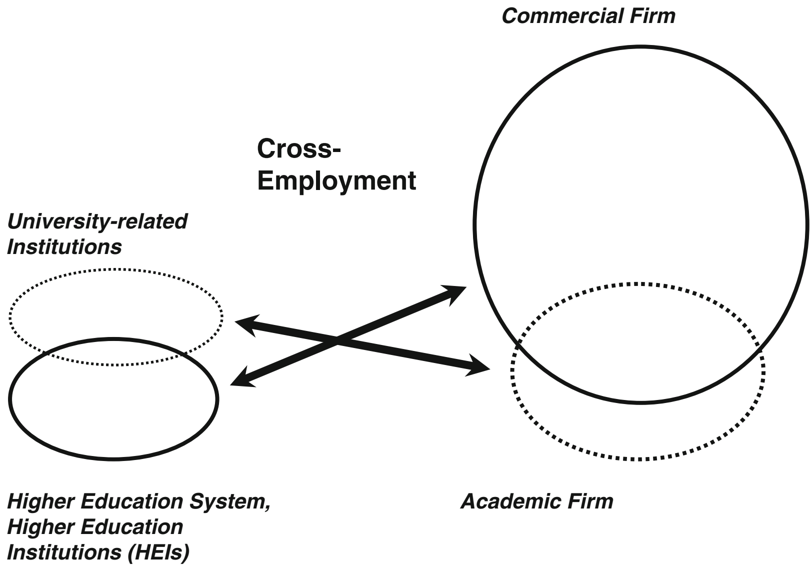
or cross-employment (Fig. 1). Ramifications of cross-employment, therefore, are not only limited to types of employment.

Characteristics and Opportunities of the Concept of Cross-Employment

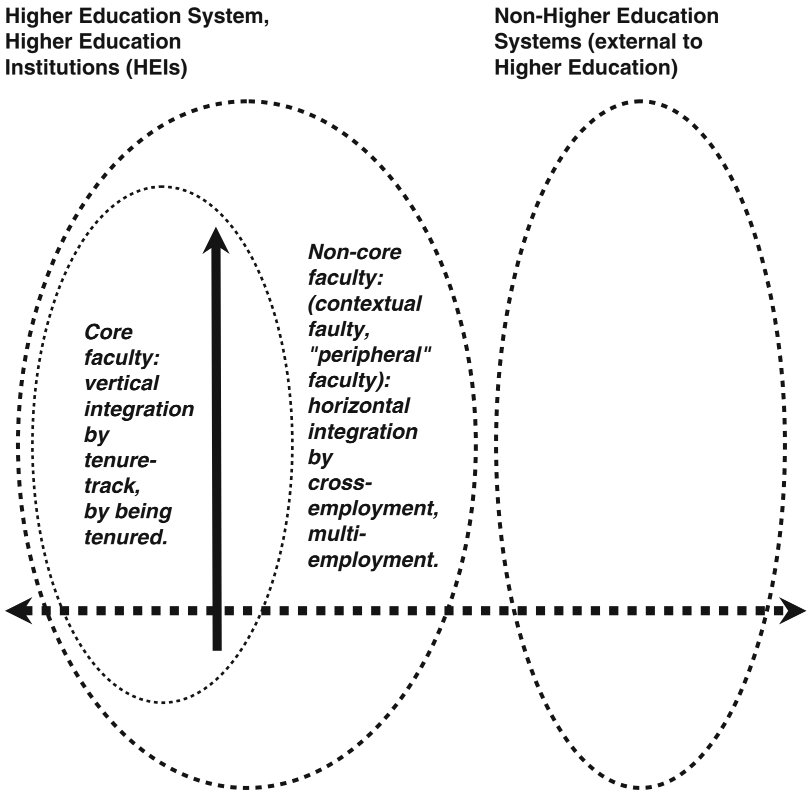
Cross-employment does not only have advantages, when compared with single employment. However, in the following, those characteristics of cross-employment should be elaborated in more detail, which offer opportunities and potentially also benefits to (individual) persons as well as the organization. The context for cross-employment to be discussed here is an organization (institution) that is engaged in knowledge production and knowledge application, or research and innovation:

1. *Creative development of complementary competences, diversification, and pluralization of the competence base of organizations:* Persons that can base their activities of knowledge production and knowledge application on working relations of cross-employment are in a position of creatively (and innovatively) developing further complementary competences that also refer to practical experiences and tacit knowledge. For the organization, this has the potential benefit that the spectrum of competences of their employees is being diversified and pluralized to a crucial extent. This supplies evidence how cross-employment represents one approach for helping to develop "creative knowledge environments" within organizations. The combination of complementary competences also nurtures the creation of new competences. Organizations (institutions), therefore, should regard cross-employment also as an organizational opportunity for themselves.
2. *Network-style formation of linkages (and bridges) across organizations and sectors:* Cross-employment supports the formation and advancement of networks and network linkages between organizations (institutions). In fact, cross-employment represents a crucial form of organizational manifestation for the development and promotion of networks. For example, there can be cross-employment between two or more universities (higher education institutions), where in one case the employee may focus on academic research, and in the other case on organizational quality enhancement. In such a scenario, the cross-employment would unfold still within one sector, the higher education system. Cross-employment, however, can also create network-style connections between organizations in different sectors, for example, the higher education sector and the economy (the business enterprise sector): In such a scenario, the cross-employment would act and behave trans-sectorally and would perform a trans-sectoral building of linkages and bridges. Multiple forms, networks, and combinations of trans-sectoral cross-employment between universities (higher education institutions), university-related institutions, firms (commercial firms, academic firms), and other organizations (e.g., of the civil society) are possible, feasible, and even recommendable (see Fig. 2). Cross-employed persons, across different organization and sectors, create (or at least have the potential of creating) a multitude or heterogeneity of cross-organizational and cross-sectoral networks.

Cross-Employment, Fig. 2 Possible network linkages of cross-employment between higher education and other organizations (sectors) [Source: Author's own conceptualization based on Campbell and Carayannis (2013), p. 29]



3. *Cross-employment as one organizational expression for nonlinear innovation:* The model of linear innovation is often being referred to Vannevar Bush (1945). One core understanding of that model is that first there is basic research in a university context, which later develops further to an innovation application in context of a firm. This linear framing of innovation is being challenged by the notions of an evolving nonlinear innovation. In practice, there often will be a hybrid overlapping of forms and processes of linear and nonlinear innovation. This may mean that an organization (firm) engages simultaneously in different technology life cycles at different degrees (levels) of technology maturity (closer to basic research, or closer to application and market commercialization). Cross-employment represents another crucial manifestation and organizational representation of and for nonlinear innovation. For example, a cross-employed person (knowledge worker) can participate in basic research at a university, and, at the same time, may be involved in innovation application and knowledge practice in a firm or another organization outside of university. Such a person works simultaneously at both ends of the whole spectrum of knowledge production and knowledge application.
4. *The balancing of tenure track and cross-employment within universities and other higher education institutions (academic institutions):* The traditional understanding of an academic career at a university follows the tenure track logic. Tenure track implies: At the beginning there is a competitive entry, and the performance of the tenure-track-based academic (junior) faculty member is being regularly evaluated. If being positively evaluated, the faculty member finally will be tenured, otherwise is being dismissed by the institution. Tenured academic faculty certainly enjoys substantial privileges, for example, allowing (and being encouraged) to focus more independently on basic research. However, the one main problem of this tenure-track-based model of careers is that it runs the risk of developing into a "minority model" for academic faculty. Numbers of tertiary-education-graduates increasingly exceed the available positions in higher education institutions. So what should happen to the rest (the "silent majority") of academic faculty or potential academic faculty? There are serious concerns of a diffusion and a



Cross-Employment, Fig. 3 Vertical integration by tenure-track and horizontal integration by cross-employment (multi-employment): only within higher education or within and outside of higher education [Source: Author's own conceptualization based on Campbell and Carayannis (2013), p. 68]

spreading of depriving working and living conditions of numerous faculty members at higher education institutions. Cross-employment may offer here one solution for the non-core academic faculty, allowing to balance risk of academic careers, employment statuses, competence development, and a more stable and enduring pooling of different financial resources and funding schemes for academic faculty members that are either not tenured or also not on a tenure track. Here, the tenure track logic would provide a "vertical integration" of the core faculty, and cross-employment a "horizontal integration" of the non-core or peripheral academic faculty either within the higher education system or across higher education and non-higher education (Campbell and Carayannis, 2013, pp. 67–68). This, furthermore, would offer the option and opportunity of "parallel careers" to individuals. Cross-employment, however, should not only be regarded as an option of balancing risk for those who did not make it to enter and to complete successfully a tenure track, but has also the distinct characteristics of a career scheme of itself (see Fig. 3). Cross-employed academic faculty demonstrates also qualities of a new, a novel, and of an innovative and creative academic entrepreneurship.

Conclusion and Future Directions

Of course, there are problems and risks associated also with cross-employment. For the individual person, this may be the stress of becoming overburdened by heavy loads of multi-tasking. For the individual person (e.g., being engaged in knowledge production and knowledge application), this defines a need to search for potential synergies and knowledge and competence surpluses that again pay off positively. Organizations, network connected by cross-employed, also should learn, how to translate this into mutual benefits and opportunities for all of the involved institutions. For organizations (e.g., firms), who are mutual competitors, cross-employment-based connections may not be feasible. Speaking more generally, this, of course, refers to the following challenge: How to balance and to organize cross-employment, networks, and competition? The concept of "Co-Opetition" (Brandenburger and Nalebuff, 1997) tries to capture these complex patterns of interaction or of potential interaction. In other cases and scenarios, however, organizations may benefit from mutually connecting networks of cross-employment. In contemporary context, there is (perhaps) not too much, but (probably) not enough cross-employment. *Cross-employment has all the potentials and capabilities of adding to the creative transformation of how knowledge production (research) and knowledge application (innovation) are being processed and performed. Cross-employment represents one form of organizational expression and manifestation, what networks and nonlinear innovation can mean in organizational terms.* Cross-employment, however, creates also a need for adapting and improving regulations of governance (network governance) and legal regulations, so that the potential dynamics can also unfold in reality, to the advantage of the knowledge economy, knowledge society, and knowledge democracy. Further empirical investigation and research on the topic of cross-employment and the involved ramifications appears furthermore to be necessary. Virtualization (Pfeffer 2012) and the use of advanced technological means could also imply of exploring ways of integrating or linking the global with the local through and by cross-employment.

In the analysis, being presented here, no distinction was drawn between cross-employment and multi-employment, they were treated as interchangeable terms and concepts. Should there be an interest in finding and emphasizing nuances of a different meaning, then an analogy could be drawn (or at least suggested) to the concept of "academic disciplines." Multi-employment would be closer to multi-disciplinary, where competences (disciplines) continue to be independent. Cross-employment, however, would have more similarity with interdisciplinary and transdisciplinary: On the one hand, those different network-connected competences should also help forming new competences (perhaps at a meta-level); on the other hand, new (creative) opportunities are being created for combining and linking basic research with application and innovation application (or exploration and exploitation in firm context).

In conclusion, the following quote of Campbell and Carayannis (2013, p. 36) summarizes crucial key aspects of the whole complex of cross-employment: "Several forms and variations of cross-employment are thinkable and reasonable. Cross-employment can stretch (in network-style arrangements) across different higher education institutions or can link universities with non-universities, i.e. organizations outside of higher education (for example, firms or organizations of the civil society). Cross-employment should foster the creativity of and in knowledge production and knowledge creation. The cross-employed academic profession or cross-employed academic faculty involves itself and engages in a much broader spectrum of knowledge production."

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Academic Firm
- ▶ Ambidexterity
- ▶ Creative Knowledge Environments
- ▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation
- ▶ Global University System in World Society
- ▶ Higher Education and Innovation
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
- ▶ Nonlinear Innovations
- ▶ Palliative Care and Hospice - Innovation at End of Life

▶ Transdisciplinary Research (Transdisciplinarity)
▶ University Research and Innovation

References

Brandenburger AM, Nalebuff BJ. Co-opetition. New York: Doubleday; 1997.
Bush V. Science: the endless frontier. Washington: United States Government Printing Office; 1945. http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm#transmittal.
Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als Chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE (February 2, 2011). 2011. (http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500).
Campbell DFJ, Carayannis EG. Epistemic governance in higher education. Quality enhancement of universities for development. New York: SpringerBriefs in Business, Springer; 2013. http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6.
Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development. New York: SpringerBriefs in Business, Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3.
Hemlin S, Allwood CA, Martin BR. Creative knowledge environments. The influences on creativity in research and innovation. Cheltenham: Edward Elgar; 2004.
Pfeffer T. Virtualization of universities. Digital media and the organization of higher education institutions. New York: Springer; 2012. http://www.springer.com/business+%26+management/media+management/book/978-1-4614-2064-4.

Cross-Employment and Cross-Retirement

▶ Cross-Employment

Cross-Employment and Multi-Employment

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Cross-Retirement (Cross-Employed Cross-Retired) and Innovation

Gerhard W. E. Blasche[1] and David F. J. Campbell[2,3]
[1]Center for Public Health, Medical University of Vienna, Vienna, Austria
[2]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[3]University of Applied Arts, Vienna, Austria

Synonyms

Cross-employment; Flexible retirement; Partial retirement; Phased retirement; Semi-retirement

The Concept of Cross-Retirement

Phased or partial retirement describes retirement schemes allowing employees approaching retirement age to gradually reduce the number of working hours. Reasons may be a greater need for recovery from work, health problems, or a desire for more leisure time to gradually adapt to full-scale retirement. Thus, phased retirement enables older employees to remain in the labor market, but with less work pressure and more time for recreation. In these schemes, the potential loss of income may or may not be compensated by social transfer benefits. Cross-retirement (i.e., cross-employed and cross-retired) likewise aims at allowing the individual to combine the benefits of retirement and those of work in a similar way, but with some important distinctions. Cross-retirement (a) does not constitute a transition period but rather an additional phase of life without any predetermined endpoint, and (b) the ratio of work and free time should be self-determined and flexibly adjustable to the individual's needs. Cross-retirement thus should enable the individual to continue to contribute to society while limiting the restraints of regular employment. Cross-retirement represents a status where a person is retired and works at the same time. More precisely defined, this means that a person works (full-time, but probably more likely part-time), however also earns retirement payments, to which he or she is eligible and entitled. Cross-employment, as a complementary term and concept (Campbell 2011; Campbell and Carayannis 2013; Carayannis and Campbell 2012), refers to a person with two or more simultaneous employment statuses. In practice, several (creative and innovation-inspiring) combinations, arrangements, and network configurations between cross-retirement and cross-employment appear possible, plausible, and feasible.

Financial Considerations

In several of the advanced economies and OECD (Organization for Economic Co-Operation and Development) countries, raising the (legal and/or de facto) age (minimum age) for retirement represents a hot topic that is being intensively, and politically controversially, discussed. Arguments in favor of a continuous increase of the retirement age assert that otherwise the pensions systems cannot be financed by public means adequately, because there is also a general tendency of an increased life expectancy. Not raising the retirement age may have the consequence that retirement payments are not sufficient anymore for covering the costs of a good life in higher age in the long run. Cross-retirement may bring in here a perspective additionally important for the public debates, and should therefore be treated as a serious political issue to be considered. Retirement, in the context of cross-retirement, may shift some of the underlying financial fundamentals in support of a betterment of the long-term financing (public financing) of pension systems.

Theoretical and Empirical Background

Life Expectance, Socio-Demographic Factors, and Retirement Age

Life expectancy has been increasing especially in industrialized counties at a rate of roughly 2.5 years per decade for the last one and a half centuries, and so far, there is no indication that this trend will change in the near future, despite new potential health threats such as obesity (Oeppen and Vaupel 2002). In 1840, life expectancy for Swedish women was 45 years; currently, in 2011, life expectancy for an Austrian woman is 83.3 years. Irrespective of this trend, the labor force participation of older individuals has considerably declined in the past 60 years (Guillemard and Rein 1993). In the first half of the twentieth century, approximately 70 % of the men over the age of 65 were actively working. By 1970, the rate of employment in men over 65 had declined sharply to barely 20 % in most industrialized countries. Similarly, the employments rates, e.g., of men aged 55–64 in the Netherlands declined from 80 % in 1970 to 45 % in 1990. Several factors can be held responsible for this trend, such as the policy of companies and governments to encourage older employees to enter retirement, a change in work status with less self-employed individuals in the work force, a decrease in the satisfaction with and the quality of work conditions, and a change in the individuals' perception regarding life and work. However, these changes have created an ever-growing number of individuals claiming retirement benefits and thus a substantial financial burden for industrialized countries. In several European countries, governments are striving to change this development with a mix of policies (Cooke 2006). These include outlawing mandatory retirement at a certain age as well as age discrimination, increasing pension eligibility ages, closing other paths of early retirement, and introducing flexible and part-time retirement policies. So far, e.g., the Netherlands has been successful in increasing labor participation in those over 55 from an all-time low in 1996 of 20 % to above 30 % in 2006. In Austria, efforts are underway to increase retirement age by e.g., investing in medical rehabilitation and by discouraging individuals from entering early retirement due to health problems. Recently, the European Commission has suggested increasing retirement age to 70 years in the next decades to meet the increases of life expectancy.

Benefits and Costs of Work on Psychosocial Well-Being and Health

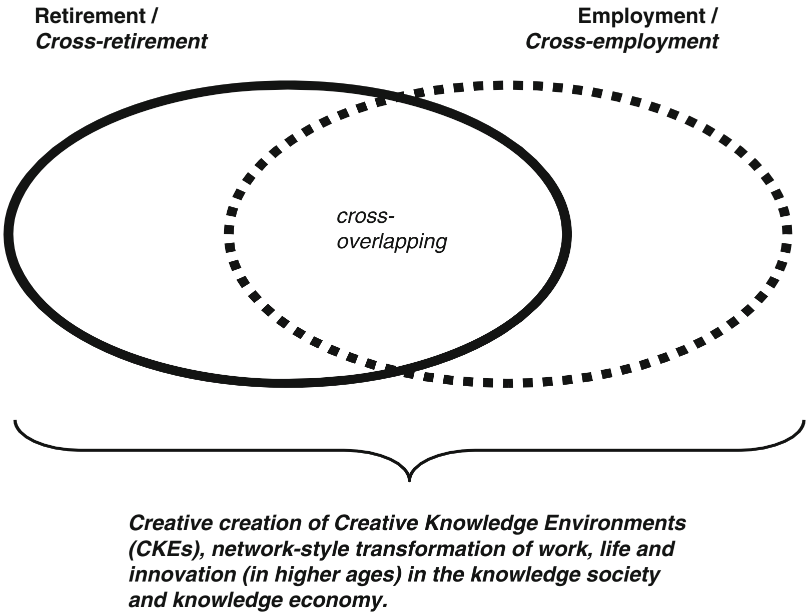
Next to the obvious benefit of employment in gaining an income, work also has several psychosocial benefits for the individual that are of importance for the well-being and health of the individual. This fact becomes obvious when considering the dramatic negative impact of unemployment on health, even when those unemployed receive social security benefits. Of all psychosocial factors, unemployment is generally found to be the leading cause of ill health. In her seminal book, Marie Jahoda, the pioneer in research on unemployment, named five pathways through which employment positively affects health and well-being (Jahoda 1982). Work provides a meaningful daily and weekly time structure, provides supportive and challenging social contact, fosters meaningful individual activity, enables the feeling of having a collective purpose or common goal, and provides a work-related identity and a societally relevant status. Though studies on the positive effects of work on health and well-being are scarce, recent studies show, e.g., that volunteering improves mental health, especially in those beyond the age of 65 (Musick and Wilson 2003). However, whether work is good for the individuals' health and well-being depends strongly on the psychosocial quality of work. Though employment generally is associated with better mental health, work associated with high job demands, low job control, job insecurity, and unfair pay tends to be associated with *worse* well-being than unemployment (Butterworth et al. 2011). Thus, in some instances, it is better not to work.

Health and Productivity of Elderly Employees

As individuals age, relevant physical and cognitive faculties decline. Typically, these are seeing and hearing, processing complex stimuli, holding multiple items in working memory, reaction time, muscular strength, coordination of movement, and overall physical capacity. However, in most jobs, these changes are more than compensated by experience and a resulting greater efficiency, thus leading to stable productivity. Exceptions are jobs where cognitive or physical requirements exceed capacities and experience provides little advantage, such as unskilled manual work, fast data processing, or generally high levels of work demands (Silverstein 2008). Cognitive and physical capacities, in addition, decline at different speeds for each individual, resulting in greater differences between older individuals than between younger individuals. Indeed, it can be observed that older cohorts of employees, typically beyond the age of 60, show stable or even improved rates of productivity and fitness when those less able have left the workforce (and thus the cohort) due to retirement. Another feature of elderly employees is their greater physical disability in terms of higher rates of chronic disease and chronic pain disorders as well as a slower recovery from illness or injury. Elderly working individuals also show higher levels of work-related fatigue and need more time to recover from work and thus more leisure time (Mohren et al. 2010). Flexible work arrangements and more time for restoration can compensate for these needs.

Benefits and Costs of Retirement on Health and Well-Being

Retirement undoubtedly has positive effects on several psychosocial variables. Retirement is characterized by an increase in the availability of free leisure time, a removal of potentially adverse working conditions such as insufficient appreciation, time pressure, and social conflict and usually with a removal of financial insecurity. Among the most prominent effects of retirement is a reduction of prolonged fatigue, a reduction in depressiveness, and an improvement of general well-being. However, the prevalence of, e.g., cardiovascular or respiratory diseases does not change, nor does the number of musculoskeletal problems (Westerlund et al. 2010). Thus, despite its positive effects on mental health and well-being, retirement does not improve physical health. On the contrary, evidence is accumulating showing that earlier compared to later retirement may even be associated with a slightly greater mortality and thus earlier



Cross-Retirement (Cross-Employed Cross-Retired) and Innovation, Fig. 1 Heterogeneity and diversity in cross-retirement for knowledge production and innovation

death (Quaade et al. 2002). Though conclusions are premature, those retired may lack the positive psychosocial factors associated with work described above such as a feeling of purpose and a meaningful daily time structure. Thus, retirement improves mental health possibly by increasing opportunities for leisure time and by removing adverse psychosocial factors potentially associated with the previous job. However, retirement does not improve physical health.

Benefits of Flexibility and Freedom of Choice

Controllability is the major factor defining stress. The individual who has no control over an adverse situation will show a large and enduring stress response. In the occupational realm, low job discretion, together with high work demands, constitutes high strain jobs and is associated with a wide array of health problems (Theorell 1997). It is obvious that jobs which do not allow the employee to decide how to approach a task, how to solve a problem, what tools to use, when to take a break, when to start and end work, when to take a vacation, and so forth will be associated with more strain and discomfort. On the other hand, recent reviews point to the fact that flexible working conditions which provide workers with control and choice (such as self-scheduling or gradual/partial retirement) have a positive effect on health and well-being (Joyce et al. 2010). Thus, the more elderly employees are able to decide when and how and how much to work, the greater are the chances that work will not only not be disabling, but on the contrary have a positive impact on health and well-being. However, obviously and regretfully, not all jobs will qualify and allow this flexibility.

Conclusion and Future Directions

Implications for Theory, Policy, and Practice

The concept of cross-retirement opens up a whole new spectrum of perspectives, so far undervalued in the public debates and political issue discourses. As cross-retirement a status is being defined, where a person receives retirement payments on the one hand, but still is benefiting from a paid employment (self-employment) status on the other hand. Cross-retirement can be combined with full-time employment, but also with various forms of part-time employment. Particularly combinations and network-style arrangements of and between cross-retirement and cross-employment offer opportunities and promise potentials for work, life, and innovation capabilities of persons in higher ages and their contributions to the knowledge society and knowledge economy (see Fig. 1). Cross-retirement, in combination with cross-employment (or without cross-employment), has the potential of transforming work, life, and the knowledge production, as they are being currently still understood in a conventional setting. Persons, benefiting from cross-retirement payments, can engage more freely and independently, and with more freely available time, in processes of knowledge production and innovation in society and economy. This extra free time could have an effect on pushing and encouraging creativity and innovation that is based on unconventional thinking or on practices parallel (outside) to the established working life. Cross-retirement, also (but not only) when linked to networks of cross-employment, adds to diversity and heterogeneity in organizations; therefore it supports the formation and development of "creative knowledge environments" (Hemlin et al. 2004). The current research and literature suggests that creative knowledge environments, within organizations, promote organizations in their efforts of knowledge production and innovation application (see again Hemlin et al. 2004). Employers, organizations, and institutions should realize more openly that cross-retirement represents one approach for expanding and complementing a diverse and heterogeneous knowledge and competence base that underlies organizations and that adds to the capabilities of organizations in their creative knowledge production and innovation application ambitions and strategies. Cross-retirement may also imply the need for "social innovations" within organizations, so that organizations (also economic organizations) benefit from cross-retirement.

One further implication of cross-retirement is that the hard line ("deadline" of beginning) of retirement is being switched into a gradual process of an interesting transformation with a positive prospect and perspective. Cross-retirement is being carried by the effort to integrate (to keep integrated) the elderly persons (those who want and can) into processes of knowledge production and innovation in the knowledge society and economy. Cross-retirement certainly will not solve all issues and problems in association with aging. But it is important that the potentials and opportunities of cross-retirement (also when combined with cross-employment) should enter the public discourses and political debates more straightforward. Cross-retirement would have to be coupled with a redesigning of society and the economy, at least to some extent.

Cross-References

▶ Citizen Science in Health Domain
▶ Creative Knowledge Environments
▶ Cross-Employment
▶ Healthcare and Innovation
▶ Palliative Care and Hospice - Innovation at End of Life

References

Butterworth P, Leach LS, Strazdins L, Olesen SC, Rodgers B, Broom DH. The psychosocial quality of work determines whether employment has benefits for mental health: results from a longitudinal national household panel survey. Occup Environ Med. 2011;68:806–12.

Campbell DFJ, Caryannis EG. Epistemic governance in higher education. Quality enhancement of universities for development. New York: Springer; 2013. http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6

Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als Chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE. 2011. http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500. 2 Feb 2011.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3

Cooke M. Policy changes and the labour force participation of older workers: evidence from six countries. Can J Aging. 2006;25:387–400.
Guillemard AM, Rein M. Comparative patterns of retirement: recent trends in developed societies. Ann Rev Sociol. 1993;19:469–503.
Hemlin S, Allwood CM, Martin BR. Creative knowledge environments. The influences on creativity in research and innovation. Cheltenham: Edward Elgar; 2004.
Jahoda M. Employment and unemployment: a social-psychological analysis. Cambridge Cambridgeshire/New York: Cambridge University Press; 1982.
Joyce K, Pabayo R, Critchley JA, Bambra C. Flexible working conditions and their effects on employee health and wellbeing. Cochrane Database of Syst Rev. 2010;2: CD008009.
Mohren DC, Jansen NW, Kant I. Need for recovery from work in relation to age: a prospective cohort study. Int Arch Occup Environ Health. 2010;83:553–61.
Musick MA, Wilson J. Volunteering and depression: the role of psychological and social resources in different age groups. Soc Sci Med. 2003;56:259–69.
Oeppen J, Vaupel JW. Demography. Broken limits to life expectancy. Science. 2002;296:1029–31.
Quaade T, Engholm G, Johansen AMT, Moller H. Mortality in relation to early retirement in Denmark: a population-based study. Scand J Public Health. 2002;30:216–22.
Silverstein M. Meeting the challenges of an aging workforce. Am J Ind Med. 2008;51:269–80.
Theorell T. Fighting for and losing or gaining control in life. Acta Physiol Scand Suppl. 1997;640:107–11.
Westerlund H, Vahtera J, Ferrie JE, Singh-Manoux A, Pentti J, Melchior M, Leineweber C, Jokela M, Siegrist J, Goldberg M, Zins M, Kivimaki M. Effect of retirement on major chronic conditions and fatigue: French GAZEL occupational cohort study. BMJ. 2010;341:c6149.

CSR

▶ Small Businesses and Sustainable Development

Cultural Cities

▶ Entrepreneurship in Creative Economy

Cultural Dimensions

▶ Entrepreneurship and National Culture (According to Hofstede's Model)

Cultural Diversity

▶ Diversity and Entrepreneurship

Cultural Entrepreneurship

▶ Entrepreneurship in Creative Economy

Cultural Policy

▶ Entrepreneurship in Creative Economy

Culture

▶ Creativity and Confucianism

Cumulative Advantage

▶ Networks and Scientific Innovation

Cyber Entrepreneurship

▶ Microfirms

Cyberentrepreneurship and Proximity Relationships

Serge Le Roux
Research Unit on Industry and Innovation, University of Littoral, Dunkerque, France
Research Network on Innovation, Paris, France

Synonyms

Corporate management; Digital economy; Regional economy; Technologies; Territorial management

Notions of Cyberentrepreneurship and Proximity Relationships

Context and Presentation of the Subject

For over half century, information technologies have deeply impacted economy landscape and company ecosystem: data, production, management, work organization, entrepreneurship. We identify a new profile emerging: "the cyberentrepreneur." These transformations driven by IT technologies have also finally affected regional environments, contents, authorities. Immaterialization overcomes some of the historical constraints of production, such as "distance-time, distance-cost, access speed . . . . . . the ease of travel" (Cattan 2011; Duranton 2008). These changes, already significant, appear to be only the beginning of a much longer cycle, where the intangible and conceptual elements will take a stronger and stronger dominant position.

Definitions

Electronics Physical science for formatting and management of electrical signals to, among other things, allow high-speed transmission and the mass storage of information.

Computers Techniques for the automatic processing of information through electronic machines, mobile phones, and others, equipped with specific programs, software.

Cyberentrepreneur Kind of entrepreneurship using information and communication technologies in different business functions: management, marketing, recruitment, finances, relations with the innovative environments, local resources etc.

Internet Multi-connection system of computer networks for horizontal exchange of information between individuals.

Social Networks Free association of individuals and organizations can exchange information directly with each other through information and communication technologies.

Ubiquity Computer system embedded in hardware and miscellaneous items and linked.

Teleworking Pattern of organization of the production function where the work activities of certain employees are periodically physically separated.

Collaborative Organization of the work activity of a group of people connected by functional links and making an indivisible product.

Cyberentrepreneurship and Proximity Relationships: Close and Necessary Links

The Cyberentrepreneur, À New Entrepreneur Profile

The cyberentrepreneur generates the following new dimensions of capitalism:

Social capital: a shift from personal and family environment to social networks (see Jeremy Rifkin 2011, of the strategic importance of the ability to access relevant information/persons)

Financial capital: a shift from local venture capitalists to global financial markets

Cultural capital: a shift from silo framework to knowledge management (Bouwman and Hulsink 2002; Carrier et al. 2004)

Elevation of quality level of intervention of entrepreneur may strengthen, in the territorial environment of the firm, exclusion effects, such as digital illiteracy, unemployability, networks access shadow zones, constrained immobility, etc. The expansion of social, financial, and cultural functions of the cyberentrepreneur, compared to its predecessor, not "cyber," transforms its relations to the territories:

Management of production becomes ubiquitous (in synchronous or asynchronous modes); it can act on several areas simultaneously.

Research skills are expanded (by the use of teleworking, for example); they bring together geographically dispersed knowledge in a unified process.

The assembly is the product of agile and collaborative methods, raising levels of quality and quantity of human and technical interventions (on the place of production, for marketing).

Cyberentrepreneur and Management of the Firm

Since the emergence of computers, in the decades post-second world war, it was soon realized that innovation is great and generic. Of course, the inertia of traditional Taylorist patterns of work organization has been strong (strong enough to last until now) but managerial innovations (e.g., quality circles) reached to enter, to seek to renew the relations within the firm. New waves of innovations (microcomputer, Internet, and social networks) will make obsolete these first attempts to renovate.

More than half a century after the emergence of what some call "the scientific and technological revolution," the social innovation path traveled is still quite insignificant, evidenced by the following:

- The small progress of participative management in companies
- The strong resistance to implementing remote working solutions
- The difficulty of integrating young people into existing organizations
- The light interactions between firms and territories
- The limited distribution of collaborative work tools
- The gap between the cultural level and practices of organizations
- Under-use of creative potential of employees, etc.

The cyberentrepreneur still remains, essentially, a mythical concept, who does experience only partially new ways of working and organizing production. These psychological, cultural, and behavioral delays are disadvantageous for involved firms, individuals, territories; they generate unnecessary costs and are the source of waste of resources. If the new models of both economic and territorial management are strengthened in the theoretical research, they are not widely present in actual practice.

Cyberentrepreneur and Homogenization of the Territories

Among the current developments in the territories, academics (Aubert et al. 2011) report the existence of the integration process, "The constitution of homogeneous environments on micro-spaces. From a social point of view, the search for the inter-se prevails; from an economic point of view, specialization prevails; from a political point of view, the club effects are predominant" (Aubert 2011).

In social terms, the action of cyberentrepreneur can accentuate the effects of connection between individuals, for example, by stimulating the need to develop social networks, but the action of this new form of firm can also worsen the isolation of people who are outside the ways of accessing these networks, by quartering the society and causing discharges, ghettoization, and social relegation.

On the economic front, the trend identified by experts on territorial dynamics (the fragmentation of settlements and erratic aspects that contain many strategies of location) the cyberentrepreneur can oppose another form of structuring of space, based on cross-linking the organization of production, itself made possible by the use of teleworking (distanciation of internalities, marginalization of physical moves) and subcontracting (outsourcing, globalized research skills).

On the political front, the rise of clubbing behaviors may be overcome or circumvented, thanks to the effects of the economic work of cyberentrepreneur, with the wide use of practices of e-learning, strengthening specialized networks, etc.

The Cyberentrepreneur, Dynamisor of the Residential Economy

In terms of the economy of a territory, the distinction between economics called "production" ("Turned to external markets, this model spreads competitive positions in order to catch the revenue streams necessary for regional growth" – Aubert 2011) and the so-called residential ("Centered on the local market, this model can satisfy the needs of residents" – Aubert 2011) is important in terms of development potential in all the meanings related to local area (more or less prosperous, the number and quality of services to the population, value of the equipment, treatment of disparities, etc.).

Cyberentrepreneur action may contribute to change in relationship between these two forms of economic activity, in that it consumes or produces or sells goods and intangible services (in fact, today, every "good" or "service" comes in the form of an arrangement of various material elements, in decreasing proportion, and especially and increasingly intangible elements). It allows the creation of gateways between the two types of economies:

- Cyberentrepreneur may provide local activities access to foreign markets, and enable local staff to have additional income ("production") as a form of endogenous local economy.
- Cyberentrepreneur may also pull into territory services related to production economy at very low costs that previously would have severely strained the budgets of local staff.
- Cyberentrepreneur may finally through teleworking enable local officials to have a job in a firm located in the economic system of the territory (see Appendix).

Teleworking, Coproduction of the Firm and the Territory

The network logic implemented by the cyberentrepreneur should lead to the emergence of a new type of space, cross-fertilizing product of the firm and the territory.

This new system will be economic and territorial:

- No rural, in the meaning "very survivals artificially maintained" (Lussault 2011) that is to say beyond the traditional model of self-sufficiency and developing a new vision based on self-productive and reticulate autonomy and an emerging right to sedentarity.
- Neither urban in the meaning of submission to the working environment and living imposed by the firm, that is to say based on finding a balanced framework, consistent with the desired lifestyle, connected to the company but with a loose connection, not tense.
- Not quite neo-rural or suburban, in the meaning of "space formerly rural, escheated, (which) urbanizing with the introduction of spatial forms, practices, values and references that come from urbanization" (Lussault 2011) that is to say to a sustainable and distanced position, initiating a new model for economic and territorial:
  - Reconstructed with elements of the urban and rural;
  - Co-produced by the firm and the territory;

  and constituting an early clarification in the chaotic environment of proliferating, moving, uncontrollable space-time between individuals (see also Aurigi 2005).

The territory of usual reference for decision makers is defined by the limits of the administrative district (this one of the local elections, the definition of budgetary resources, the map of public facilities, etc.). In terms of economic activity, public policies aim to traditionally attract production units, brick and mortar, in the territory.

With digital technology, teleworking is possible. It implies a redefinition of local and regional strategies: The goal is less filling preinstalled industrial estates as the attraction of jobs in the territory of reference, that is to say people coming to live and telework on this territory, their employers may be located in places far removed from that territory, creating a "connectivity between remote locations . . . a growing interweaving of the positions of centrality and situations peripherals, blurring some of the notions of inside and outside, of dominant and dependent" (Cattan and Frétigny 2011; Malecki and Moriset 2008).

Explanation: Travel time between home and workplace does not assume much importance, this shift takes place once or twice a week and can be achieved outside the peak hours.

Benefit to the employee: In addition to the gain resulting from the removal of daily commuting, he built a "right to physical sedentarity" can keep his home even if he changes jobs.

Advantage for the firm: In addition to gains in productivity and lower management costs, the company can expand its recruitment area and retain employees, even when changing their place of residence.

Conclusions and Future Directions

Two possible directions of developments, in the case where labor practices geographically separated from the place of assembly productions would be populated: either to strengthen the trend toward metropolization (as was demonstrated by Jacques Levy as "diffusion phenomenon of urban, growing indistinctness between two socio-spatial orders that, until recently, all opposed" – Pinson and Rousseau 2011), either to introduce a new model of territorial organization, "re-personalization" of space (and the role of cyberentrepreneur to find a research field to develop its potential and give strength to the adage, "without the digital immateriality, no possible") (Lussault 2011).

Cross-References

- ▶ Digital Economy and Business Creation
- ▶ New Forms of Entrepreneurship in a Sustainable Knowledge-based Service Economy
- ▶ Proximity Relationships and Entrepreneurship
- ▶ Territory and Entrepreneurship

References

Aubert F, Georges-Marcepoil E, Larmagnac C. Les satellites interconnectés. Territoires. 2011;2040, n° 4, pp. 121–127

Aurigi A. Making the digital city: the early shaping of urban internet space. Aldershot: Ashgate; 2005.

Bouwman H, Hulsink W. A dynamic model of cyber-entrepreneurship and cluster formation: applications in the United States and in the low countries. Telemat Inform. 2002;19:291–313.

Carrier C, Raymond L, Eltaief A. Cyberentrepreneurship: a multiple case study. Int J Entrep Behav Res. 2004;10:349–63.

Cattan N, Frétigny JB. Les portes d'entrée de la France et les systèmes territoriaux des flux, Territoires. 2011;2040, n° 3, pp. 61–77.

Duranton G. Distance, land and proximity: economics analysis and the evolution of the cities. Environ Plan A. 2008;31:2169–88.

Lussault M. L'ultra-urbain mobilisé dans la mondialisation, Territoires. 2011;2040, n° 3, pp. 11–26.

Malecki EJ, Moriset B. The digital economy: business organization, production processes and regional development. London: Routledge; 2008.

Pinson G, Rousseau M. Les systèmes métropolitains intégrés. Territoires. 2011;2040, n° 3, pp. 29–58.

Rifkin J. The third industrial revolution: how lateral power is transforming energy, the economy, and the world. London: Palgrave Macmillan; 2011.

D

Data Mining

► State Space Paradox of Computational Research in Creativity

Daydreaming

► Imagination

Decision

► Social Capital of the Entrepreneur

Decision Making and Judgment

► Method for Creating Wisdom from Knowledge

Decrease in Creativity

Kyung Hee Kim[1] and Robert A. Pierce[2]
[1]The College of William and Mary, Williamsburg, VA, USA
[2]Christopher Newport University, Newport News, VA, USA

Synonyms

Creativity crisis; Creativity slump; Decrease in creativity scores

One issue relevant to the issue of creativity is whether it can be measured objectively. In the absence of such a measure, the question of whether creativity is increasing or decreasing is merely speculation and based upon anecdotal evidence. One measure, however, provides better guidance: Torrance Tests of Creative Thinking (TTCT). Torrance developed the TTCT in 1950s, and the test has been updated five times, in 1974, 1984, 1990, 1998, and 2008. The TTCT appears in almost 40 different languages. Educators and corporate entities use and reference the TTCT more than any other creativity tests in the world. Research shows that the TTCT scores are an excellent predictor of creative achievement in later adulthood. The TTCT predicts creative achievement better than any other creativity tests or divergent-thinking tests, and based on extensive analyses, it can be concluded that the TTCT is more than just a divergent-thinking test: it is the best creativity test currently available.

Kim's (2011) study called "The Creativity Crisis" on changes in creativity over time included almost 300,000 scores on the Torrance Tests of Creative Thinking (TTCT). These are from kindergarten through 12th-grade American students as well as adults from 1966 to 2008. TTCT scores are different than IQ. The TTCT is designed to measure creative potential, and IQ is designed to measure intelligence. Creativity can elevate giftedness into eminence. Further, *creative* is not synonymous with *artistic*, and the TTCT measures creativity on many other levels

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than artistic ability. The TTCT gives a *profile* of test results on several subscales, different than test like the IQ, which give a single measure of intelligence. The TTCT measures (1) fluency, (2) originality, (3) creative strengths, (4) elaboration, (5) abstractness of titles, and (6) resistance to premature closure.

Kim's study (2011) detected a decline in the creativity of young Americans, which has persisted over the past two decades. Research needs to be done to establish the causes for the decrease in each of the six subscales (fluency, originality, creative strengths, elaboration, abstractness of titles, and resistance to premature closure) and to understand the implications. The United States has, since its inception, excelled by harboring and nurturing creativity and creative thinkers, and the trend could have significant, long-lasting, and global repercussions.

Findings

The results of Kim's 2011 study indicate that:

Decrease in Fluency Scores Since 1990

In creativity testing, fluency refers to the ability of the test takers to produce ideas based upon visual cues. It measures the number of the ideas produced. Between 1990 and 2008, individuals' ability to produce many ideas significantly decreased. The biggest decrease in fluency scores was for children between kindergarten and grade 3, and the second biggest decrease was for children between grades 4 and 6, which suggests that younger children's ability to produce many ideas significantly decreased since 1990. Contrary to popular wisdom, this result might suggest that young people, although they have access to many varieties of visual media, are less competent than earlier generations with generating many ideas.

Decrease in Originality Scores Since 1990

Individuals' ability to produce unique and unusual ideas significantly increased until 1990, but significantly decreased from 1990 to 1998, and remained static from 1998 to 2008. Originality is the only TTCT subscale that is reflective of different cultures and time. Thus, Torrance required developing and updating originality lists culture- and time-specifically. The credibility of originality scores of the TTCT based on the originality lists that Torrance developed in 1984 is problematic. The continued use of 1984 originality lists leads to an expectation that the originality scores go up artificially as time goes on until the originality lists are updated. The results showed that the originality scores decreased from 1990 to 1998 and remained static from 1998 to 2008. However, the decrease may have been underrated through the use of outdated scoring lists, and thus, originality scores may have actually significantly decreased. Examining each age group separately showed that the biggest decrease in originality scores from 1990 to 2008 was for children between kindergarten and grade 3. It can be concluded that younger children's ability to produce infrequent, unique, and unusual ideas has significantly decreased since 1990.

Determining the cause of the decrease is complicated, as the causes may be multiple. Nevertheless, the decrease runs in close parallel to the rise of the standards movement in education. The standards movement itself was a reaction to a perceived decrease in the effectiveness of American education (as reported, e.g., in *A Nation at Risk*, 1983). It is arguable that the standards movement has increased focus in American public schools with respect to identifiable targets of learning (the standards and their supporting objectives). However, the standards movement and its companion, the accountability movement (NCLB and various state-level tests), have probably decreased teacher creativity in the classroom and decreased frequency of more creative assessments. Today in school, many students are assessed only using multiple-choice testing and other objective assessments, which give students virtually no room for creativity. Over time, these assessments are likely to condition students to avoid original and unexpected responses and instead to strive for the one correct answer.

Decrease in Creative Strengths Scores Since 1990

Creative strengths scores significantly decreased from 1990 to 2008. The decrease of creative strengths scores since 1990 might indicate that, over the last 20 years, children are becoming verbally expressive, less emotionally expressive, less lively or passionate, less perceptive, less humorous, less imaginative, less unconventional, less connecting of seemingly irrelevant things, less synthesizing, or less able to see things from a different perspective. Creative strengths capture a person's disposition toward creative outcomes and are an overall predictor of creative potential. A decline in creative strengths is a special concern as it augurs a lower future disposition. Other subscales measure attributes, such as fluency, that have some commonalities with a trainable skill. A low creative strengths score may indicate a lack of receptivity to training for creative attributes.

Isolating the cause of the trend may be difficult. Nevertheless, students' constant access to media may be partially to blame for the decrease on this subscale. Before students had handheld electronic devices, they often had to come up with their own means to pass free time. Today, students can quickly turn to videos, video games, music, and other forms of electronic entertainment. Though many benefits can perhaps emerge from this sort of use of modern electronic technologies, students may be losing creative potential: some of them no longer create forms of entertainment.

Decrease in Elaboration Scores Since 1984

Individuals' ability to think in a detailed and reflective manner as well as their motivation to be creative significantly decreased from 1984 to 2008. The decrease in elaboration scores since 1984 might indicate that people of all ages are losing their ability to elaborate upon ideas and for detailed and reflective thinking over the last 30 years. They are becoming less motivated to be creative, and the home, school, and society overall encourage creativity less. The ability to elaborate is a skill, and it can be taught, provided that teachers and parents make a commitment to do so. As the skill weakens, so will the disposition to see merit in it, or for students to engage in it. Thus, the more elaboration decreases, the more difficult it will be to reduce this trend.

Decrease in Abstractness of Titles Scores Since 1998

Individuals' ability for abstract thinking, synthesis and organization thinking processes, and capturing the essence of the information involved significantly decreased from 1998 to 2008, a little later than the decreases of other TTCT subscales, which started in 1984 (elaboration) or in 1990 (fluency, originality, and creative strengths). Abstractness of titles scores are expected to increase because they are positively associated with verbal intelligence scores, and intelligence scores have increased over time, as the so-called Flynn effect indicated. Thus, the decrease suggests that the scores may have actually decreased earlier than 1998. This result indicates that younger children are becoming less capable of the critical thinking processes of synthesis and organization and also less capable of capturing the essence of the information to know what is important.

The ability to think abstractly, to synthesize, and to organize rests on education and assessments that value these qualities. Modern technologies have, however, inadvertently worked against these skills. Endless amounts of information are easily available on every subject, and rather than engaging in deep thought and analysis, students can effortlessly search, find, and rephrase others' work product. Students can thus avoid practicing and developing the type of abstract thinking, synthesis, and organization that is necessary to perform creatively.

Decrease in Resistance to Premature Closure Scores Since 1998

Children's ability to be intellectually curious and to be open-minded significantly decreased from 1998 to 2008. Just like the abstractness of titles scores below, resistance to premature closure scores are expected to increase because they have a strong positive relationship with intelligence scores, and also intelligence scores have increased. Thus, the decrease suggests that the scores may have actually decreased earlier than 1998. This result indicates that younger children are becoming less intellectually curious and also less open to new experiences.

Conclusion and Future Directions

The results of Kim's creativity crisis study (2011) showed that creativity scores in the United States significantly decreased since 1990: elaboration by 17.39 %, abstractness of titles by 7.41 %, fluency by 7.00 %, creative strengths by 5.75 %, originality by 3.74 %, and resistance to premature closure by 1.84 %. This means that American people of all ages are becoming less creative. Creativity scores for children between kindergarten and grade 3 decreased the most, and those from children between grades 4 and 6 decreased by the next largest amount.

As noted above, the causes for the decreasing trends in creativity measures are not yet determined. Nevertheless, all of the subscales measure different aptitudes of students' desire, ability, and incentive to think deeply. Modern technologies, changing values, and changes in approaches to education have all discouraged deep thinking and pushed students to quick responses and to *objective* singular right answers to questions. As thinking skills and disposition for creativity atrophy, the skills are used less often and the condition grows worse. Overall, these changes could signal a major turning point in American society.

Though the effect on American society of these decreases could be substantial and devastating, the biggest concern is the effect that these decreases may have on children themselves, on children as individuals: the decrease in creativity may reflect specific changes in how children are reared by parents and taught by their teachers. In turn, today's children and tomorrow's future adults may have fewer internal resources with which to confront the world. This condition could well impact them materially, as they could well have fewer creative resources when facing a rapidly changing economic environment (in which they have to make a living). More worrisome is that tomorrow's adults may have fewer internal resources to face the difficulties of human existence: personal crises, life transitions, and emotional conflicts. Collectively, people with fewer creative skills have less ability to produce constructive change in response to a changing environment.

Almost everyone says, "I love creativity." Parents and teachers, television advertisements, and corporate mission statements herald "creativity." People claim to want creative students and creative solutions. Most of these people really mean they enjoy some of the celebrated end results of creativity, like Picasso's paintings and iPhones. However, when a creative idea is first presented, most people are quick to reject the idea. Most people are idea killers. They tend to explain why new ideas will fail, instead of thinking about how to make them work. Most people are uncomfortable with new ideas, challenges, changes, the unknown, and uncertainty. The decrease in creativity reflects a shift in social values, to which for developmental reasons children are especially receptive. Our society in fact values creative people and creative ideas progressively less, and children inclined toward creativity will be progressively less valued and less tolerated. Creative children, for example, are often diagnosed as having attention deficit disorders; the standard response is to medicate them. With legislation like the No Child Left Behind Act and its predecessors, we are institutionalizing the unimaginative, rewarding mediocrity by students and teachers, and rejecting creative expressions from our children. Creative children are bored and encouraged to be underachievers. The longer this continues, the more pronounced the effects will be, and the effects on any particular individual could be life threatening in the long term, as these children grow up to find solace in alcohol, drugs, and other distractions. Regardless, these children are not reaching their potentials, which is the biggest concern.

In broader point of view, creative thought has been the most important ingredient for the economy of the past and of the present, so it is expected to remain so in the future. America is a child among nations, and she has always relied on her vast reserves of creative thinkers to take her to the next level and to best every challenge. The heart of the American spirit is American ingenuity, the ability to create novel solutions. The United States used to provide creative climate that fostered creativity, provide opportunities for creative individuals, and reward creative achievements. Americans used to celebrate individuality, difference, and independent thinking. The creative soul is part of what enabled the United States to ascend to world leader, with such an unhistoried population. Creativity used to be central to the American identity and the American spirit, and these associations explain part of the public's fascination with the study of creativity. The United States has served as a beacon for creative hearts and adventurous spirits, calling out to those in search of freedom of expression and freedom of thought. Until recently, the freedoms we enjoy here have provided fertile ground for creative people to grow their ideas and to explore. As a result, the United States has attracted more creative people from other parts of the world. Albert Einstein, Nikola Tesla, and Mikhail Baryshnikov come immediately to mind as examples. Will they still come here as the beacon of creative freedom begins to fade and as other countries are more receptive even than America in welcoming their contributions? As the United States is less and less a climate that encourages creativity, will it still continue to attract those seeking creative expression, and will it still be a wellspring of invention, innovation, and entrepreneurship? As a society, are we going to prepare young people both for ever-changing professional lives and for the emotional challenges of adult life?

Cross-References

▶ Creativity and Emotion
▶ Creativity Tests

References

Cox H. "The market as god: living in the new dispensation." The Atlantic. 1999. http://www.theatlantic.com/magazine/archive/1999/03/the-market-as-god/6397/

Hanson V. In defense of the liberal arts: the therapeutic left and the utilitarian right both do disservice to the humanities. National Review Online. 2010. http://www.nationalreview.com/articles/255390/defense-liberal-arts-victor-davis-hanson

Kim KH. The creativity crisis: the decrease in creative thinking scores on the Torrance Tests of Creative Thinking. Creativity Res J. 2011;23:285–95.

Zammuto RF. Are the liberal arts an endangered species. J High Educ. 1984;55(2):184–211.

Decrease in Creativity Scores

▶ Decrease in Creativity

Defense Technology

▶ Innovation in Defense Technologies

Democracy

▶ Quality of Democracy and Innovation

Democracy of Knowledge

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Democracy, Theory

▶ Quality of Democracy and Innovation

Democratic Innovation

▶ Quality of Democracy and Innovation

Democratic Reforms

▶ Innovation and Democracy

Democratization

▶ Innovation and Democracy

Democratizing Innovation

▶ Quality of Democracy and Innovation

Denotational Mathematics

▶ In Search of Cognitive Foundations of Creativity

Departure

▶ Product Innovation, Process Innovation

Design

▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Design Education

▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Creativity Training in Design Education

Design Thinking

▶ Innovation in Business: Six Honest Questions

Developing Countries

▶ Microfirms

Developing Radical Inventions

Wilfred Schoenmakers[1] and Geert Duysters[2]
[1]Management Studies Group, Wageningen University and Research Centre, Wageningen, The Netherlands
[2]Brabant Center of Entrepreneurship, Eindhoven University of Technology and Tilburg University, Eindhoven, The Netherlands

Introduction

Inventions lie at the heart of technological progress of companies and of economic development in general. The word "invention" is however a very broad concept covering an extensive spectrum ranging from simple, incremental inventions to pathbreaking radical inventions. Incremental inventions are mere adjustments to existing products or technology. They typically have limited impact on the technological paradigm. Radical inventions on the other hand are in general seen as being a clear deviation away from the current technological paradigm (Hage 1980; Nelson and Winter 1982), making their impact on technological progress and economic development more prominent. This results in radical inventions often being responsible for the creation of new technological systems and sometimes even new industries. Radical inventions can thus be considered a vital basis for a sequence of subsequent developments around this original invention (Mokyr 1990).

In the past, many theoretical discussions have focused on the effect of radical inventions (e.g., Ahuja and Lampert 2001; Rosenkopf and Nerkar 2001; Dahlin and Behrens 2005; Tellis et al. 2009). Unfortunately, only very few studies have so far been undertaken to uncover the nature of radical inventions. Large-scale empirical investigations into the technological origin of radical inventions are meager if not absent. The few studies that can be found concentrate on the Schumpeterian role of company size in the creation of radical inventions and innovations. The concluding empirical results of the different studies remain however divers (Scherer 1991). Others studies have looked at the influence of organizational aspects on the development of radical inventions (for an overview see Chandy and Tellis 1998). A study by Schoenmakers and Duysters (2010) argues that it is crucial to understand the specific technological features that influence the development of radical inventions. This thus means that this study is not focusing on the market success of an invention, as is commonly the case in many existing studies. Instead, it centers its attention on the technological origins of radical inventions. They thus do not focus on the regularly used concept of innovation but instead focus on the invention itself. They particularly focus on the classical discussion whether radical inventions are seen as following from a recombination of existing knowledge (Schumpeter 1939; Fleming 2001; Nerkar 2003) or whether they are based on totally new knowledge (Poel 2003). For organizations, it is important to better understand the building blocks of radical inventions, for this can help them in making sound decisions for the creation of new knowledge in either concentrating their efforts on internal development for the development of an original piece of new knowledge or to focus on external knowledge in their search for "neue kombinationen" (Schumpeter 1939) via strategic alliances or partnerships based on "open innovation." From the perspective of society as a whole, the importance of understanding the origins of radical inventions is in the prospective influence of radical inventions on the creation of new technological paradigms or even new industries.

How Radical Inventions Are Built

Different publications up till now have stressed the importance of radical inventions (e.g., Ahuja and Lampert 2001; Rosenkopf and Nerkar 2001; Dahlin and Behrens 2005). Among scholars and practitioners alike, there is clear agreement on the positive influence of radical inventions on technological, industrial, and societal change. The influence of these inventions on the economy as a whole or on company performance has been extensively investigated in different studies. Research into the nature of radical inventions themselves is on the other hand rather sparse. Except for a few distinguished exceptions (e.g., Ahuja and Lampert 2001) few studies have been directed toward the technical content of radical inventions. Most studies focus on the concept of innovation, rather than invention. For a definition of a radical invention, the paper by Schoenmakers and Duysters (2010) turns to the article of Ahuja and Lampert (2001) where they define radical or breakthrough inventions as "those foundational inventions that serve as the basis for many subsequent technical developments" (Ahuja and Lampert 2001, p. 523). Ahuja and Lampert thus clearly focus on the technical content of an invention. Inventions are thus not considered radical from a user or market point of view but rather from their technological importance. Furthermore, they also postulate that radical inventions are inventions that function as a basis of knowledge for many successive inventions. According to their definition, the technological content of radical inventions thus serves as input for many succeeding inventions (see also Trajtenberg 1990a, b). In the research by Dahlin and Behrens (2005), they deem technologies as radical when they are novel, unique, and have an impact on future technology. They also consider inventions as radical if they are constructed of already existing but beforehand-unconnected knowledge (Hargadon 2003). It is thus not only the individual component of knowledge that can be novel in their definition but also the new combination of existing components. Dahlin and Behrens (2005) also, just as Ahuja and Lampert (2001), focus on the impact of radical inventions on future technology. Also in the definition of Dahlin and Behrens (2005), radical inventions are those inventions with a relatively large impact on future inventions. Inventions are thus seen as being radical if comparatively many succeeding inventions use its knowledge. This means that the impact of an invention on succeeding inventions can be considered a proxy for radicalness. All inventions that serve as an important precursor for later inventions are said to be considered as radical inventions. Schoenmakers and Duysters (2010) therefore use the impact of inventions on successive inventions as an estimate for the radicalness of that invention. They focus their attention solely on technological inventions.

When thinking of radical inventions, many people still believe that they come about by the single genius of some lone inventor who, after many years of solitary research, finally has his/her moment of glory. Even though this lone inventor still exists up till now (Dahlin et al. 2004), in today's fast changing and complex technological field, the lone inventor is rather the exception than the rule (Hargadon 2003). Nowadays inventions, and especially radical inventions, come about mostly from the joint effort of a team of experts with expertise on different technological fields. Also many practitioners and researchers alike think that radical inventions are always based on completely new knowledge (Poel 2003). There is however a vast range of literature which proposes that in fact it is the recombination of already existing knowledge which is the ultimate source of novelty (Fleming 2001; Nerkar 2003). In the late 1930s, even Schumpeter (1939) considered invention as coming from new combinations or "neue kombinationen" (Schumpeter 1934, pp. 65–66). Nelson and Winter (1982, p. 130) stress "...that invention in the economic system...consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence." Even a simple realignment of already existing components can, according to Henderson and Clark (1990), be a main cause of destabilization in key industries. Also Hargadon and Sutton (1997) have shown how firms can create novelty by simply being a technology broker and in that way bringing together already existing components. In Fleming's words: "...an invention can be defined as either a new combination of components or a new relationship between previously combined components" (Fleming 2001). Furthermore, according to Hargadon (2003) radical inventions are only seldom based on totally new knowledge. Radical inventions quite often are developed from a recombination of already existing knowledge. "When ... connections are made, existing ideas often appear new and creative" (Hargadon and Sutton 1997, p. 716). Very important in this respect is the recombination of beforehand-unconnected knowledge or unconnected knowledge domains (Hargadon 2003). All these researchers have in common that they believe that radical inventions are brought about by predominantly a recombination of existing knowledge or the discovery of a new context for already existing knowledge (Poel 2003).

On the other hand, a number of researchers still would argue that a radical invention is predominantly based on truly novel knowledge and thus goes beyond simple recombination, irrespective of a few examples of inventions based on the recombination of existing knowledge or a new context for existing knowledge.

So is it completely new knowledge, or a recombination of existing knowledge, that is the main cause of radical inventions? Up till now, this has largely remained a theoretical discussion. Large-scale empirical evidence was up till now not available. Even though both views are possible, and also observable, radical inventions originating from two basic sources, the recombination of existing knowledge as well as from the creation of truly novel knowledge, recent research found that recombination is more important for radical inventions than truly novel knowledge (Schoenmakers and Duysters 2010).

If, as follows from the research by Schoenmakers and Duysters (2010), radical inventions are for a substantial part based on already existing but beforehand-unconnected knowledge, then the question becomes: What specific recombination of what kind of existing knowledge will usually lead to the development of radical inventions? For example, existing knowledge typically comes about in, broadly speaking, two different forms: mature knowledge and emergent knowledge. The recombination of existing knowledge can thus be based on the one hand on mature knowledge, or on emerging knowledge, or on a combination of mature and emerging knowledge. Currently, there is a discussion among researchers about the significance of both forms of technologies (Ahuja and Lampert 2001; Nerkar 2003). Emerging technologies are technologies that are relatively new and which are considered to be cutting-edge technology (Ahuja and Lampert 2001). Therefore, emerging technologies offer numerous possibilities for developing new technologies via recombination. Emerging technologies have the possibility to offer firms important new knowledge components that also aid them in the advancement of radical inventions (Ahuja and Lampert 2001). A problem with emerging technologies however is that firms often do not yet have the complete comprehension of the technology. This deeper understanding is however vital for the development of radical inventions. Therefore, firms that are used to relying too much on emerging technologies will very often have problems with seeing the full potential of this new knowledge for the development of future technologies (Nerkar 2003). On the other hand, mature technologies "are usually well understood and offer greater reliability relative to more recently developed and less tested" technologies (Ahuja and Lampert 2001, p. 527); they were usually also tested and used in many diverse situations. Especially incumbent firms will favor mature technologies to emerging technologies since they are usually more familiar with these technologies. They also have more knowledge of the possibilities and the limitations of these technologies. The results of emerging technologies are thus much more uncertain. Via R&D, firms devote effort into building up absorptive capacity in their organization. Absorptive capacity is quite often path dependent and is also corresponding to a firm's earlier research. For this reason, firms will thus have more difficulty with absorbing emerging technologies. Firms can speed up their innovation process by using their absorptive capacity through focusing on existing technologies. Using emerging technologies is often difficult because of experimentation costs and in the beginning a limited output. Firms will have to go through an extensive learning curve to get a full understanding of the new technology, without having the guarantee that this new technology will eventually deliver anything valuable. Firms might also have to train their employees in how to work with this new technology or they might even have to change company routines or company practices, something which is not easily accomplished and will certainly involve considerable costs for the company (Nelson and Winter 1982). So while emerging technologies offer many possibilities, they might also create many significant difficulties. In spite of these difficulties of the use of emerging technologies, research by Schoenmakers and Duysters (2010) shows that firms also need emergent knowledge for the production of radical inventions. Mature technologies are vital, but there is an increasing agreement that emergent technologies are also very important, especially for radical inventions. Radical inventions are thus, as compared to nonradical inventions, to a higher degree based on emergent technologies.

Notwithstanding this expected positive correlation between emergent technologies and radical inventions, emergent technologies have their drawback too for the development of radical inventions. If firms, with their research, only focus on emergent technologies, then this will lead to new knowledge but only to knowledge with a limited impact on coming technologies. If firms however focus too much on mature knowledge, then this might lead to only incremental inventions (Nerkar 2003). The possibilities for mature technologies to deliver radical inventions are limited. The full potential of mature knowledge might however on the other hand not be fully used because this knowledge might not be publicly known or it was not useable at the time of its development due to lack of the development of complementary knowledge, institutions, or standards that are required to use this piece of knowledge to its full potential (Nerkar 2003). When this complementary knowledge is eventually developed and combined with the mature knowledge from the firm, this can make the development of new inventions possible. Since mature technologies, as compared to emerging technologies, are usually well comprehended, the combination of mature and emerging technologies could offer ample possibilities for the development of radical inventions. This would also make the full use of mature knowledge possible. This combination of mature and emerging knowledge was also found in the research of Schoenmakers and Duysters (2010) to be very important for the development of radical inventions. So not only is emergent knowledge important for the development of radical inventions, so is also the combination of mature and emerging knowledge. Radical inventions are thus, more than nonradical inventions, based on a combination of mature and emergent technologies.

However valuable the combining of mature and emerging knowledge might be, many firms have a tendency to look for new knowledge locally, not only within their current technological field of expertise (Stuart and Podolny 1996) but also within the similar geographical area as where they are operating (Verspagen and Schoenmakers 2004). Different reasons are found to explain this phenomenon, like for instance: overreliance on existing company routines; employee experience lock-in effects or rigid company structures. Furthermore, firms tend to value the convenience of technological and geographic proximity in their search process. Because of this restrictive search process, companies often experience bounded rationality and build their new knowledge on a limited subset of the total available knowledge set. Granstrand et al. (1997) found that the technological competencies of large firms are heavily depending upon their past competencies and that these competencies are fairly stable over the years (Granstrand et al. 1997, p. 13). Knowledge is thus "imperfectly shared over time and across people, organizations, and industries" (Hargadon and Sutton 1997, p. 716). This could very well produce the development of "core rigidities" (Leonard-Barton 1995) and the appearance of "competency traps" (Levitt and March 1988). Firms experiencing these kinds of traps will have difficulty developing radical inventions. Firms that rely for instance more on their past knowledge produce more inventions, but these inventions will be less relevant (Sorensen and Stuart 2000).

Research by Granstrand et al. (1997), Patel and Pavitt (1997), and Brusoni et al. (2001) shows that a firm's product portfolio is usually smaller than its technological portfolio. An explanation for this observed trend might be that firms need to look for valuable technologies being developed outside of their core technological field of expertise in order to be able to make use of new technological possibilities that this new knowledge eventually might deliver (Granstrand et al. 1997). Innovating firms thus need to focus on a broader technological field, which would imply that also for the development of radical inventions a broader technological scope is necessary. This then also implies that a radical invention is not only the basis of many subsequent inventions (Trajtenberg 1990b) but also itself based upon more knowledge bases compared to incremental inventions (Rosenkopf and Nerkar 2001). This does not refer to the number of individual pieces of knowledge but refers instead to the diversity in the knowledge bases or knowledge domains where an invention is based upon. Therefore, it can be expected that radical inventions make use of knowledge coming from a larger pool of knowledge than nonradical inventions, something that also follows from the research of Schoenmakers and Duysters (2010).

Conclusion and Future Directions

Radical inventions are thus not only based more on the recombination of before unconnected knowledge, on emerging knowledge, and a combination of mature and emerging knowledge but also on a larger variety of knowledge domains.

For firms willing to develop radical inventions, besides a certain degree of absorptive capacity and flexibility, it is thus necessary to cooperate with other firms in alliances or via "open innovation." Firms increasingly need knowledge from other knowledge domains outside of their own companies. Collaboration therefore seems to be vital for the development of radical inventions. Further research into the development of radical inventions and collaboration in the form of alliances or open innovation networks will hopefully shed more light on this relationship.

Cross-References

▶ Ambidexterity
▶ Creative Management
▶ Creativity in Invention, Theories

▶ Innovation and Entrepreneurship
▶ Innovations of and in Organizations
▶ Intellectual Property Rights
▶ Interdisciplinarity and Innovation
▶ Invention Versus Discovery
▶ Inventive Resources
▶ Knowledge Capital and Small Businesses
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Nature of Creativity
▶ Open Innovation and Entrepreneurship
▶ Organizational Creativity

References

Ahuja G, Lampert CM. Entrepreneurship in large corporations: a longitudinal study of how established firms create breakthrough inventions. Strat Manag J. 2001;22:521–43.

Brusoni S, Prencipe A, Pavitt K. Knowledge specialization, organizational coupling, and the boundaries of the firm: why do firms know more than they make? Adm Sci Q. 2001;46(4):597–621.

Chandy RK, Tellis G. Organizing for radical product innovation: the overlooked role of willingness to cannibalize. J Marketing Res. 1998;35(4):474–87.

Dahlin KB, Behrens DM. When is an invention really radical? Defining and measuring technological radicalness. Res Policy. 2005;34(5):717–37.

Dahlin K, Taylor M, Fichman M. Today's Edisons or weekend hobbyists: technical merit and success of inventions by independent inventors. Res Policy. 2004;33(8):1167–83.

Fleming L. Recombinant uncertainty in technological search. Manag Sci. 2001;47(1):117–32.

Granstrand O, Patel P, Pavitt K. Multi-technology corporations: why they have "distributed" rather than "distinctive" core competencies. Calif Manage Rev. 1997;39(4):8–25.

Hage J. Theories of organization. New York: Wiley Interscience; 1980.

Hargadon A. How breakthroughs happen. The surprising truth about how companies innovate. Boston: Harvard Business School Press; 2003.

Hargadon A, Sutton RI. Technology brokering and innovation in a product development firm. Adm Sci Q. 1997;42:716–49.

Henderson RM, Clark KB. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. Adm Sci Q. 1990;35(1):9–30.

Leonard-Barton D. Wellsprings of knowledge. Boston: Harvard Business School Press; 1995.

Levitt B, March JR. Organizational learning. Ann Rev Sociol. 1988;14:319–40.

Mokyr J. Punctuated equilibria and technological progress. Am Econ Rev. 1990;80(2):350–4.

Nelson R, Winter S. An evolutionary theory of economic change. Cambridge: Harvard University Press; 1982.

Nerkar A. Old is gold? The value of temporal exploration in the creation of new knowledge. Manag Sci. 2003;49(2):211–29.

Patel P, Pavitt K. The technological competencies of the world's largest firms: complex and path-dependent, but not much variety. Res Policy. 1997;26(2):141–56.

Rosenkopf L, Nerkar A. Beyond local search: boundary-spanning, exploration, and impact in the optical disk industry. Strat Manag J. 2001;22(4):287–306.

Scherer FM. Changing perspectives on the firm size problem. In: Acs ZJ, Audretsch DB, editors. Innovation and technological change: an international comparison. New York: Harvester Wheatsheaf; 1991.

Schoenmakers W, Duysters GM. The technological origins of radical inventions. Res Policy. 2010;39(8):1051–9.

Schumpeter JA. The theory of economic development. Cambridge: Harvard University Press; 1934.

Schumpeter J. Business cycles: a theoretical, historical and statistical analysis of the capitalist process. New York: McGraw-Hill; 1939.

Sorensen JB, Stuart TE. Aging, obsolescence, and organizational invention. Adm Sci Q. 2000;45(1):81–112.

Stuart TE, Podolny JM. Local search and the evolution of technological capabilities. Strat Manag J. 1996;17:21–38 (Summer special issue).

Tellis GJ, Prabhu JC, Chandy RK. Radical innovation across nations: the preeminence of corporate culture. J Marketing. 2009;73(1):3–23.

Trajtenberg M. A penny for your quotes: patent citations and the value of inventions. Rand J Econ. 1990a;21(1):172–87.

Trajtenberg M. Economic analysis of product innovation: the case of CT scanners. Cambridge, MA: Harvard Business School Press; 1990b.

Van de Poel I. The transformation of technological regimes. Res Policy. 2003;32(1):49–68.

Verspagen B, Schoenmakers W. The spatial dimension of patenting by multinational firms in Europe. J Econ Geogr. 2004;4(1):23–42.

Development

▶ Quality of Democracy and Innovation

Development Economics

▶ From Personal to Impersonal Exchange in Ideas

Development Policy

► Entrepreneurship Policy

Devise

► Invention Versus Discovery

Dialectical Inquiry

► Model of Dialectical Learning

Dialogical Critical Thinking in Children, Developmental Process

Marie-France Daniel[1] and Mathieu Gagnon[2]
[1]Département de kinésiologie, Université de Montréal, Montréal, Québec, Canada
[2]Université de Sherbrooke, Sherbrooke, Québec, Canada

Synonyms

Complex thinking; Evaluative thinking; Higher-order thinking; Reflexive thinking

Origins of the Concept of Critical Thinking

Critical thinking is strongly related to formal logic. Since Aristotle, the rules of formal logic have been considered as the most refined instrument for developing human thinking. It is only at the end of the nineteenth century, with the pragmatists and especially with Charles Sanders Peirce, that logic lost some of its formality to become applied logic. With John Dewey, logic became "reflexive thinking." Logical thinking therefore became a social instrument to help individuals solve scientific, social, or personal problems. Starting in the mid-twentieth century, following along the lines laid out in the ideas of American pragmatists, the concept of critical thinking was put forth, in particular by philosopher Robert Ennis. Since then, the concept has exerted influence on Education Sciences, Medical Sciences, Engineering, Psychology, etc. Philosophers have something of a tendency to emphasize the reasoning component in critical thinking, while recent works in psychology and psychopedagogy tend to emphasize the problem-solving component or its inquiry process. There is no consensual definition of critical thinking, but it is generally recognized as a type of thinking that "doubts methodically" (Foulquié 1982), as it is the "examination of a principle or a fact, for the purpose of making an appreciative judgment of this principle or fact" (Lalande 1991).

If Ennis' definition of critical thinking outlined the path for further development of the concept, Lipman's definition offers complementary aspects. Also, Lipman is the originator of the Philosophy for Children (P4C) approach, and P4C is the context in which the model of the developmental process of dialogical critical thinking emerged.

Critical Thinking According to Robert Ennis

In 1962, Ennis defined critical thinking as logical thinking characterized by complex cognitive skills. Then he adjusted his definition to include the influence of creative thinking and predispositions (1991, 1993). Creativity presupposes skills such as inventing, associating, suggesting alternatives, making analogies, formulating hypotheses, etc. And, by predispositions, Ennis refers to attitudes such as being curious, strategic, rigorous, etc. To Ennis, thinking in a critical manner implies the ability to judge the credibility of sources; to identify conclusions, reasons, and hypotheses; to appreciate the quality of an argument; to develop and defend a point of view; to ask relevant clarifying questions; to search for reasons; to draw conclusions that are credible and viable, etc. In sum, critical thinking is reflective thinking focused on what is to be believed or accomplished. In this definition, the term “reflective thinking” refers to the awareness that is manifested in the search for, or the use of, valid reasons; the term “focused” implies a nonaccidental intellectual activity, in other words, an activity based on reasons and consciously focused on a goal; and the phrase “regarding what is to be believed or accomplished” indicates that critical thinking can evaluate statements and beliefs as well as actions (Norris and Ennis 1989). To assess learning of critical thinking, Ennis designed tests centered on learning formal and informal logic. These tests are essentially intended for college and university students.

Critical Thinking According to Matthew Lipman

According to Lipman, critical thinking represents a tool to counter nonreflective thinking and actions. Individuals need critical thinking to help them think well and evaluate, among all the information received, the most relevant in accordance with the objectives they pursue. In contrast to current definitions of critical thinking, which limit critical thinking to its products, Lipman looks into the components that structure the processes as well as the results, in particular into the notions of “research” and “good judgment” that is, judgment that can take into account all the elements of a problem as well as the inquiry steps to which it leads. In this sense, critical thinking aims at judgment, is governed by criteria, is self-correcting, and is sensitive to context (Lipman 1988, 1991, 2003).

Although Lipman considers that there is continuity between critical and creative thinking, as they permeate each other in the formation of judgments, he also points out the discontinuity between these two forms of cognitive processing. Critical thinking involves reasoning and critical judgment and it looks for truth, while creative thinking involves artistry, craft, and creative judgment and it looks for meaning. Creative judgments are not logical inferences, they are personal and unique responses to situations. Following Peirce, Lipman considers creative thinking as “ampliative reasoning” in that it goes beyond the given and extends the thinking process. Generalizations, hypotheses, analogical and metaphorical reasoning, and so on, are instances of ampliative reasoning or creative thinking. Lipman defines creative thinking as thinking that is sensitive to criteria, is self-transcending, and is governed by context.

This discontinuity between critical and creative thinking leads Lipman to emphasize the concept of higher-order thinking. Higher-order thinking presupposes complex thinking – which is more complex than critical thinking alone; it involves both critical and creative thinking. Later on, Lipman also added caring thinking, which means valuing, appreciating, and focusing on what is respectable, valuable, and meaningful. Complex thinking is concerned with both procedural and substantive considerations, aims at resolution of problematic situations, is metacognitive (thinking that is aware of its assumptions, methodology, procedures, perspectives, as well as being conscious of the implications, the reasons and evidence that support the conclusions), and is sensitive to context and to others.

How can complex thinking be fostered in pupils? His Deweyan and Vygotskyan influences lead Lipman to maintain that complex thinking increases in sophistication in the context of peer interactions and, more precisely, in the context of philosophical dialogue within a community of inquiry – elements that constitute the essence of the educational approach he conceived, the P4C.

Philosophy for Children

In the P4C approach, philosophy does not refer to a transmission of intellectual knowledge to individuals who are mature and already capable of complex thinking. Instead, philosophy is defined as a means toward sensitizing children to instances of ambiguity and vagueness, while strengthening their questioning, reasoning, and dialogical skills so as to enable them to cope with the perplexing aspects of daily situations.

P4C is an approach put forward by Lipman in the 1970s; it is now implemented in about 50 countries and its curriculum has been translated into at least 20 languages. The curriculum includes novels for pupils aged 6–15 years old, and manuals to help teachers facilitating the philosophical exchanges among pupils. To facilitate philosophical sessions, Lipman and his colleagues propose the following three steps: reading, collecting pupils' questions, and dialogue within a community of inquiry (Lipman et al. 1980).

Reading. Pupils read a chapter from a philosophical novel out loud, taking turns. This activity is important as marker of cooperation among peers and active participation in the P4C sessions. The novels are said to be philosophical because they are based on concepts issuing from different areas of philosophy (logic, ethics, aesthetics, politics, etc.). Yet the philosophical concepts are meaningful to pupils, as they are presented in narrative form, in the first person (the voice from within vs. the voice of authority) and in ordinary language; they are associated with real-life experiences (adventures and romance). Furthermore, the novels, due to the progression of logical concepts as a spiral, are likely to contribute to creating a schema in pupils' mind. A schema pertaining to a concept corresponds to the meanings of that concept.

Collecting pupils' questions. After reading the chapter, the pupils are invited to formulate questions that intrigue them and which they would like to discuss. This second step presupposes that they put sufficient effort into comprehending the text to question the situations described. Comprehension requires not only a knowledge of words, but also a global understanding of the text and of the context. This step encourages pupils to embark on a process of inquiry. Fostering pupils' questioning is a pedagogical objective that is not always valued in traditional pedagogy, in which the power and the right to ask questions usually belong to teachers. However, learning to question is fundamental, in that it stimulates critical and creative thinking in pupils.

Engaging in dialogue within a community of peers. The third step in the Lipmanian approach is intended to provide youngsters with elements of answers to the questions they formulated during the previous step. To facilitate the inquiry, the teacher, using the manuals, asks follow-up questions such as: *Why do you say so: can you justify your point of view? Who has a counter-example? What are the resemblances and distinctions between x and y?* and so on.

A philosophical dialogue is more than a mere conversation. Its apprenticeship is a complex process, moving from simple to more complex exchanges – from anecdotal exchanges to monological, noncritical dialogical, semicritical dialogical, and critical dialogical exchanges (Daniel et al. 2002, 2005). **Anecdotal** exchange refers principally to an account of specific and personal experiences with little or no consideration for the common question being addressed by the group. **Monological** exchange refers to a reflexive discussion related to the common question addressed by the group, but which follows its own course without being influenced by the divergent points of view expressed by peers. **Noncritical dialogical** exchange refers to an intersubjective type of exchange that is constructed in pyramid form based on peer interventions, where each point of view contributes, in varying degrees, to enriching the group's perspective. A noncritical dialogue remains simple as there is no evaluation of viewpoints. **Semicritical dialogical** exchange refers to an exchange that contains certain criticisms directed at peers, but these criticisms do not influence the pupils that receive them. Therefore, at the end of the exchange, the initial perspective is enriched but not modified. Finally, a **critical dialogical** exchange is a type of exchange that is intersubjective and evaluative; therefore it is constantly being transformed. The third step of P4C strives toward this last type of exchange.

The development of philosophical reflection presupposes not only the development of critical dialogue involving complex thinking skills and attitudes, but also an increasing sophistication of pupils' representations.

A Model of the Developmental Process of Dialogical Critical Thinking

The model of the developmental process of dialogical critical thinking arose within the context of P4C. It first "emerged" (see Charmaz 2005; Glaser and Strauss 1967) from analyses of philosophical exchanges among pupils aged 9–12 years who were members of classes from Quebec, Mexico, and Australia (Daniel et al. 2005). The model was recently revisited in an experiment conducted with children aged 4–12 years in classes from Quebec, Ontario, and France (Daniel and Gagnon 2011, 2012). The above studies were subsidized by the Social Sciences and Humanities Research Council of Canada.

In this model, critical thinking is said to be "dialogical" because, within the context of P4C, dialogue is the main stimulus for this type of thinking. The components of dialogical critical thinking (DCT) differ from traditional definitions of critical thinking (rooted in formal logic and universal standards of rationality) in that DCT is defined by four thinking modes: logical, creative, responsible, and metacognitive.

Unlike other models of cognitive development, the developmental process of DCT is not linear nor hierarchical, but is recursive and manifests as a "scaffolding" process, that is, the thinking gradually appropriates more complex representations while keeping its anchoring in simpler representations. DCT development is rendered operational by means of epistemological perspectives, that is, it is transformed according to the sophistication of the pupils' meanings and representations of the world, which can either focus on the self (egocentricity), take into account others' points of view (relativism), be oriented toward the improvement of the common good (inter-subjectivity), and so on. The sophistication of pupils' meanings and representations underlies two processes related to decentering (from the self to others and then to the common good) and to abstraction (from concrete/particular to generalization and then to abstraction/conceptualization) (Daniel et al. 2011). The term "epistemological *perspective*" refers to the manner in which meanings and representations are constructed, no matter what object is in question. Furthermore, epistemological perspective refers to the idea of "relational epistemology" (Thayer-Bacon 2003). Finally, DCT is understood as a social research process (vs. an individual outcome).

Table 1 presents the operational components of the model of the developmental process of DCT, these being the four thinking modes and six epistemological perspectives.

The four thinking modes are defined as follows (Daniel and Gagnon 2012).

Logical: Logical thinking refers principally to informal logic in which the main characteristic is a search for coherence. Coherence is observed in the articulation of language and the convergence of ideas. The logical mode is fundamental to the developmental process of DCT because it allows congruity between the question posed and the answer provided, between the statement and its justification, etc.; in its more complex manifestation, it implies rigorous argumentation, that is, premises are justified, analyzed, and evaluated in cooperation with peers. The main manifestations of thinking skills relating to logical thinking that emerged from the transcripts – from the simplest to the most complex – are: statements, descriptions, explanations, definitions, justifications, and argumentation.

Creative: Creative thinking refers to a search for meaning, a contextualization of points of view and a transformation of perspectives. In its complex manifestations, this mode of thinking, because of the divergent relationships it creates, is fundamental to the development of DCT. Indeed, creative thinking presupposes the formulation of questions that stimulate doubts regarding the certainty of participants' representations and, in so doing, it provides access to more complex resolutions of the problem and/or explorations of the question. The main manifestations that emerged from the transcripts – from the simplest to the most complex – are: examples, analogies, comparisons, counter-examples, nuances, divergent relationships, and critical questions.

Responsible: Responsible thinking is more in line with the Deweyan perspective of "moral thinking" in that it combines cognition (explanation, evaluation, etc.) and emotion (empathy, sensitivity to others, etc.) in an interdependent relationship. The responsible thinking mode is related to reflections on social/moral beliefs, rules, actions, values, etc. From the perspective of the development of DCT, the responsible mode appears fundamental because it eventually represents the balance between the right to express oneself and the

Dialogical Critical Thinking in Children, Developmental Process, Table 1 Model of the developmental process of dialogical critical thinking (Daniel and Gagnon 2011)

Modes/epistemology	Logical	Creative	Responsible	Metacognitive
EGOCENTRICITY	Statement based on the perceptual experience of a specific and personal fact	Statement that gives meaning to a personal point of view	Statement that is related to a personal and specific behavior linked to a social or moral belief	Retrospective statement about a personal and specific task, point of view, feeling, etc.
POST-EGOCENTRICITY	Statement based on experience (personal or of someone close) + reasoning	Statement that gives meaning to a personal point of view (but distanced from self)	Particular/concrete statement linked to a moral or social rule (learned) Not contextualized.	Retrospective statement about a personal task, point of view, feeling, etc. (distanced from self)
PRE-RELATIVISM	Somewhat generalized statement that is not justified or with an implicit, circular or false justification	Statement that is new, divergent, or that presents different situations/solutions/ hypotheses (units) in relation to a personal idea or to someone else's idea	Statement linked to a somewhat generalized action in a moral or social perspective	Descriptive retrospective of a personal task, point of view, feeling, etc. (distanced from self)
RELATIVISM	Statement based on a generalization that stems from reasoning and experience Incomplete/concrete justifications	Relationship that gives meaning to a peer's point of view (by completing it or adding a nuance or a new relationship/ perspective)	Statement that expresses a will to understand/include others (from the immediate environment) with or without appealing to an integrated moral/ social rule	Descriptive retrospective of another person's task, thought, etc. (from the immediate environment)
POST-RELATIVISM/ PRE-INTERSUBJECTIVITY	Justification based on "good reasons" that stem from simple reasoning	Relationship that presents a different context that takes into account the group's perspective	Statement that justifies a desire to understand/ include others (distant environment) with or without the use of an integrated moral/ social rule	Descriptive retrospective of another person's task, thought, etc. (distant environment)
INTERSUBJECTIVITY	Justification based on criteria. Conceptualization based on simple reasoning	Evaluative relationship that provides a different meaning and transforms the perspective	Doubt that underlies the evaluation of categories (rules, principles, social/ moral values)	Evaluative statement that expresses a change in perspective following the integration of criticism
	Conceptualization	*Transformation*	*Categorization*	*Correction*

responsibility to do so with sensitivity; it anchors evaluation of facts, of points of view, and so on, in concern for others and eventually in concern for the common good. The main manifestations of thinking skills of the responsible mode that emerged from the transcripts – from the simplest to the most complex – are: statements, descriptions, explanations, and evaluations relating to a personal behavior, to group rules, or to social/ ethical values.

Metacognitive: The metacognitive thinking mode refers to awareness of a thought ("thinking about thinking") but also, in its simplest expression, to awareness of a task completed, emotion experienced, point of view expressed, etc. The metacognitive mode is fundamental to the increasing sophistication of DCT because it is the only mode that allows for retrospection that eventually leads to self-correction. The main manifestations – from the simplest to the most complex – are: recalling (expressed in the form of a statement) a behavior, task, emotion, point of view, etc.; descriptions related to a task completed, emotion experienced, point of view expressed, etc.; evaluations of a perspective, a thought, etc., that lead to correction.

Each of the above thinking modes is dynamic, and is likely to reflect an epistemology that is more or less complex. For example, creative thinking can be centered on particular and personal examples, or it can develop relationships with peers' viewpoints, or transform the group's perspective by posing new questions or proposing divergent relationships. The epistemological perspectives, as they emerged from the analyses, are defined as follows (Daniel and Gagnon 2012):

Egocentricity: This is the perspective that underlies the most simple meanings and representations. It implies certainty as well as dualistic and concrete representations of the world, which are not influenced by divergent points of view. In this perspective, statements refer to the pupil's specific personal experience, are centered on simple units (vs. relationships), are without nuance, and are formulated in "I" form. Below is an example of egocentricity as manifested in creative thinking, as a personal example serves to justify a point of view and give it meaning.

> (Pupil of 9–10 years): *(. . .) it's true because once I did something nice and then there was a lottery at the day-care and I won a prize (. . .).*

Post-egocentricity: This is also a perspective characterized by concreteness and centering, but it underlies a slight increase in sophistication of representations and meanings. Pupils' statements are somewhat decentered, referring to the specific experience of a pupil's immediate environment (e.g., family), centered on simple units, not justified and generally formulated in "we" form (including self and others) or possessive "he/she" form. Here are examples of post-egocentricity as manifested in creative thinking.

> (Pupil of 5–6 years): *Me too my dad he does the same.*
> (Pupil of 10–11 years): *(. . .) for example my grandfather he died, for sure my friend he will understand me.*

Pre-relativism: In this perspective, representations and meanings starts to become more sophisticated. Pupils describe their point of view to peers. These points of view underlie the beginnings of generalization, but remain grounded in familiar surroundings or contexts. Statements are centered on units and generally formulated with a general "we" or with a generalized "they." Below are examples of pre-relativism as manifested in creative thinking, as pupils add a different viewpoint to the group's perspective or present more than one side of a problem.

> (Pupil of 5–6 years): *I don't agree because babies they have brains like humans (. . .) because babies can think because they know they're in their mother's belly.*
> (Pupil of 7–8 years): *Sometimes there are people on boats who play at shoving each other and sometimes someone gives a big shove and the other person can fall into the water.*

Relativism: This is an epistemological perspective that presupposes a rupture in the groups' representations. Pupils seem to become aware that the world is not so simple (good/bad, right/wrong). They seem to be aware that others have different beliefs, points of view, etc., as they listen to others more actively. On the other hand, they want others to understand the meanings of their ideas, hence their statements are more elaborate than in the previous perspectives and they include a justification explicitly articulated (e.g., *because*. . .). Justifications are stated in the form of concrete and/or incomplete explanations with underlying simple relationships between points of view or contexts (vs. units that are independent from each other); justifications are still grounded in experience, but with the beginnings of generalization; they are generally formulated in "you," "we," or generalized "they" form. Below is an example of relativism as manifested in creative thinking, as pupils agree with their peer's viewpoint but add an element that complements the peers' viewpoint in order to further develop it.

> (Pupil of 9–10 years): *I agree with F. I find it's true you have to take your responsibilities. Often parents will want the child to have responsibilities to help out in the house because when you're a large family you have a bigger house so everyone has to help out and all that.*

Post-relativism/pre-intersubjectivity: This perspective illustrates the continuation of the process of decentering and abstraction that began in the previous perspectives. It implies that statements are generalized and show the beginnings of conceptualization; they include a justification that is explicitly articulated, presented in the form of a "good reason" (supposing an underlying inference rather than linked to a practical experience), related to peers' points of view. Statements imply the beginnings of a constructive evaluation. Below is an example of post-relativism/pre-intersubjectivity as manifested in creative thinking, as the pupil brings in a different perspective which he justifies with a good reason that was not previously developed in the group.

> (Pupil of 11–12 years): *Well I don't really agree with M (that adults are more intelligent than children) because it's not just adults who are intelligent (there are) also children who are intelligent and these children become adults.*

Intersubjectivity: In this perspective, representations and meanings are complex, as statements are conceptualized, are presented in the form of questioning or as a constructive evaluation of points of view, premises, etc., underlying a search for different meanings (vs. for a single truth) that include argumentation expressed in negotiation form. Statements include justifications that are explicitly articulated, are presented in the form of criteria (subjective or objective), are well developed although not comprehensively, and are linked to peers' points of view. Statements are centered on social or ethical concerns, and sometimes explicitly include self-correction. Below is an example of intersubjectivity as manifested in creative thinking, as pupils present evaluative relationships that contribute to increasing the sophistication of, or even to transforming, the group's perspective.

> (Pupils of 11–12 years): Pupil 1: - *If it's about intelligence, I think humans are at the top of the list. I think humans are the only ones that can do mathematics. Humans invented English and mathematics. Math is like another language we invented. We use it to understand things, to do the things we have to do well, to understand the reasons behind things. Like why the sky is blue and why can't we float or fly. So we invented mathematics to explain these things. But animals, they just think "sky" and they don't really think, they don't really think about the sky. Because they have, if for us eating and mating are an instinct, for them it's their principal instinct. (...)* Pupil 2: - *I do not quite agree with what Pupil 1 said. Well, it does depend, because we invented maths and you can't blame them (animals) for not doing it (...) And people just think they're dumb because they don't know our ways, but they probably think we're dumb, if they do think. So I kind of, I don't know. (...) And look at us, we have massive holocausts over land and we kill thousands of people but they'll just have one old fight and then it'll be over. I kind of think animals are smarter in their own way and we're smarter than them in our own way.*

Conclusions and Future Directions

Dialogical critical thinking is a process of evaluating an object of thought (whether concrete or abstract) in cooperation with a community of peers in an attempt to reach meaningful representations of that object that are more complex and valid than representations used at the beginning of the inquiry. Dialogical critical thinking is a developmental process that manifests itself through cognitive skills and attitudes that focus on conceptualization, transformation, categorization, and (self-)correction. DCT therefore presupposes the development of four thinking modes: logical, creative, responsible, and metacognitive. These thinking modes increase in complexity through the operation of six epistemological perspectives: egocentricity, post-egocentricity, pre-relativism, relativism, post-relativism/pre-intersubjectivity, and intersubjectivity. As this definition emerged within the P4C context, further contributions could be to explore its components with pupils who have no experience with P4C, that is, in other school disciplines or in the context of informal exchanges.

References

Charmaz K. Grounded theory in the 21st century: applications for advancing social justice studies. In: Denzin N, Lincoln Y, editors. The Sage handbook of qualitative research. 3rd ed. Thousand Oaks: SAGE; 2005. p. 507–37.
Daniel M-F, Gagnon M. A developmental model of dialogical critical thinking in groups of pupils aged 4 to 12 years. Creative Educ. 2011;2(5):418–28.
Daniel M-F, Gagnon M. Pupils' age and philosophical *praxis*: two factors that influence the development of critical thinking in children. Childhood Philos. 2012; 8(15). Online.
Daniel M-F, Lafortune L, Pallascio R, Splitter L, Slade C, De la Garza T. Modeling the development process of dialogical critical thinking in pupils aged 10 to 12 years. Commun Educ. 2005;54:334–54.
Daniel M-F, Pettier J-C, Auriac E. The incidence of philosophy on the discursive and language competencies of pupils aged four years. Creative Educ. 2011;2:296–304.
Daniel M-F, Splitter L, Slade C, Lafortune L, Pallascio R, Mongeau P. Are the philosophical exchanges of pupils aged 10 to 12 relativist or inter-subjective? Crit Creative Thinking. 2002;10:1–19.
Ennis R. Critical thinking: a streamlined conception. Teach Philos. 1991;14(1):5–25.
Ennis R. Critical thinking assessment. Theor Pract. 1993;32(3):179–86.
Foulquié P. Dictionnaire de la langue philosophique. Paris: Presses Universitaires de France; 1982.
Glaser BG, Strauss AL. The discovery of grounded theory. Strategies for qualitative research. Chicago: Aldine; 1967.
Lalande A. Vocabulaire technique et critique de la philosophie. Paris: Presses Universitaires de France; 1991.
Lipman M. Critical thinking—What can it be? Educ Leadersh. 1988;46:38–43.
Lipman M, Sharp AM, Oscanyan FS. Philosophy in the Classroom. Philadelphia: Temple University Press; 1980.
Lipman M. Thinking in education. Cambridge: Cambridge University Press; 1991.
Lipman M. Thinking in education. Cambridge: Cambridge University Press; 2003.
Norris SP, Ennis RH. Evaluation of critical thinking. Pacific Grove: Midwest Publications; 1989.
Thayer-Bacon B. Relational "(e)pistemologies". New York: Peter Lang; 2003.

Digital Economy

► Cyberentrepreneurship and Proximity relationships

Digital Economy and Business Creation

Alain Philippe Batsale
University of Paris 12, Paris, France

Synonyms

Digitization; Information technology (IT)

Digital economy is the convergence of computing, communications, and contents. The two main components are computer industry and information treatment. It might be said that hardware is too physical to be discussed on a topic about digital, but the software cannot be considered without the hardware, and the hardware is of no use without its software. As far as business creation is concerned, the computer industry has led to the emergence of a huge industrial sector which continues to innovate. But, taking the example of France, if 1.2 million jobs have been created by the Internet, the estimated number of jobs destructed by this innovation is around 500,000 in this country. And regarding the information technology, the consequences may still be more equivocal: in matter of businesses, the process of creative destruction is engaged and is supposed to last long before a new equilibrium is reached.

A Case of Creative Destruction

The computer industry has gone through several revolutions (mainframes, minicomputers, personal computers, cloud computing) that led each time to new businesses. This industry is very emblematic of that process. Just include Microsoft, Apple, Google, and Facebook to illustrate the outstanding capabilities of the computer industry to generate start-ups that quickly become major global companies. New products, new devices, and new software, since the times of mainframes to the days of the Internet, have naturally involved the creation of new businesses.

Schumpeter (1942) separates several types of innovations that lead to business creation. The innovations set up by the computer industry consist mainly in the occurrence of new products. Mainframes, minicomputers, microcomputers, and smartphones have appeared over time, and the list is not supposed to be closed. In the computer industry, even software, which is also a kind of digital hardware, does not usually replace an existing product and frequently establishes a new kind of good. On the contrary, regarding the information treatment, it is rather a matter of new process of production or more precisely of reproduction. So the information treatment has driven a history more disturbed. The underlying process of digitizing leads to products of replacement more than real novelty. For instance, files of data instead of books, records, or films. So the information treatment has generated a new way of reading books or the press, a new kind of films and unknown types of musical records, and, in general, a new way of transmitting information. The materiality of these products has changed drastically: no more atoms, now, just bits. And this transformation involves definite economical consequences.

So besides the problems of creative destruction yielded by the emergence of new types of products in the computer industry, the proper nature of the information technology files of bits gives place to new economics: the digital economy. The economical pattern of a file of bits as a digital product is constant fixed costs and zero marginal costs (Varian 2004), so it is difficult to apply the neoclassical principle of a price equal to the marginal cost of production. This particular cost structure is the "baseline case" (Varian 2004) for information goods, particularly for digitized ones, while it is rather unusual for physical products with capacity constraint in the production process. So, in digital economy, good compliance with the laws of economics may lead to sale prices close to zero or to free. The confrontation between the new digital products and the old physical ones is therefore a very conflictual meeting, and the development of piracy is a big concern for firms implied in these markets.

New Businesses: Downsized Hardware and Digitalized Contents

The computer industry and the telecoms sector, on the hardware side, have known rather a traditional evolution; based on hardware downsizing on size and price, thanks to major innovations: transistor, integrated circuits, and microprocessor. A train of disruptive innovations (Christensen 1997) has generated a large number of new businesses. The first computer firms used to be large companies from the mechanographical (IBM) or the electric/electronic sectors. The personal computer revolution and the emergence of the Internet enabled lots of start-ups to emerge, some of them eventually becoming major companies. This was done mainly through new products downsizing traditional ones. On this hardware side of the industry, the traditional laws of industrial economics still apply generally, and the evolution of the sector has been rather similar to the one of other sectors.

The computer industry, on the software side, has known a slightly different trend which is also the logic of information technology. In the real sense, this is the digital economy which is based on the very nature of digitizing. While the hardware side leads to new products and new businesses by downsizing, there is a large freedom in the price level for digital products which sharpens the competition with traditional products, as it is the case for digital information goods. Since a digital product (generally a non-tangible public good) lacks of physical constraints in reproduction, its structure of costs (high fixed cost and low marginal cost) enables three specific pricing discrimination strategies: market for one, with highly personalized products; versioning, with different prices for different market segments; and selling at different prices to different groups of consumers. These strategies give to digital products a big competitive advantage over the (traditional) physical ones, strengthen the process of creative destruction, and threaten seriously the old firms.

In the beginning, the competitive advantage or the innovative product enables the creation of numerous firms. A lot of businesses are created, as we have seen, for instance, about digital music or social networks (information technology) or around new devices as smartphones or tablets (computer industry) by the emergence of small firms whose usual pattern is the start-up. This moment is followed by a standardization process which organizes the industry. In the meantime, firms of the previous periods are mostly weakened.

A Specific Process of Standardization

So another important feature of the digital economy, inherited from the computer industry, is the specificity of its standardization process. It is proper to the information technology sector and influences deeply the market structure, the number and the nature of the firms, and the way businesses are created all along the life cycle of products. This process was developed by IBM with the 360 machine, and it combines openness and modularity. This kind of routine, as the evolutionary economists might say, was verified for several products.

The digital economy is a network economy regulated by what is called increasing returns of adoption (Arthur 1989), which means the greater the number of costumers, the greater the utility of the product. The first period of the process of standardization is a time of trial and error during which many businesses are created around products following different protocols not compatible with one another. There is a second period when one of these products is able to reach the status of standard, be it for quality reasons, market power reasons, agreement between firms, or whatever. If a business wants to survive, it has to join the standard, when it is possible, or perish. A big amount of the young firms that have been created during the period of trial and error are supposed to disappear with the emergence of the standard. Then a third period begins, and the standard product may develop a kind of ecosystem and give birth to a new set of businesses connected with that standard. The standardization process was experienced for the IBM 360, the operating systems by Microsoft, the microprocessors by Intel, but also for the search engine by Google or (presumably) the social network by Facebook. Meanwhile, the firm that has set up the standard becomes usually a global major company.

We can detect several economical leverages behind the standardization process (Varian 2004), for instance, the switching costs that affect a customer who tries to change after having adopted a product. Moving from one operating system to another, from one social network to another, and from one Internet Access Provider (IAP) to another is not that easy and generates significant costs. The switching costs and the increasing returns of adoption may cause a virtuous circle in favor of a standard. There is also an economical concept which is called "lock-in" to describe strategies used by firms to prevent customers to escape. These forces help a successful product, a dominant design, to supplant the other ones and stay almost alone on a market. Moreover, the victory of a winner product is still strengthened by the network externalities yielded by the complementary products that other firms may find it profitable to produce in order to make use of the ecosystem created. The network externalities are also a way to set up new businesses.

In the Search of a New Model: The Protection of Contents

The total balance sheet between new firms and businesses destructed by the development of the digital economy is still difficult to set precisely, especially concerning the digitization of contents. Even if we can anticipate that the final figures will be positive, there is a deep concern about the classic media. The regulation may be made using the law, for instance, through property rights.

The cost structure of digital products was first an issue with the development of the software industry. Large firms in the computer industry were converted experts in the management and use of property rights to cope with the ease of copying software. This is even more accurate with the growing digitization of contents over the Internet. If Facebook creates a new kind of ecosystem, pieces of music downloaded eliminate the use of a CD-ROM. Until a viable economic model is found, new businesses will be set up for the lawyers as well.

Conclusion and Future Directions

The digital economy may create many businesses, but many companies are threatened by the digitization of the economy. This is the consequence of two processes. Firstly, inside the computing sector itself, on the hardware side, by the creation of new products, mainly by downsizing and secondly, as a threat against the firms of other sectors, on the software side and with the information treatment, by digitizing processes and contents.

Regarding the hardware aspect, the traditional laws in economics still apply. For instance, Apple succeed in managing several lines of products with an astonishing marketing, a very efficient brand policy, and reduced costs of production made possible by overseas units of production. The processes engaged for this achievement are described by traditional industrial economics.

On the software side, when the information is effectively digitized, this is the very domain of digital economy. There, the marginal cost is frequently close to zero, the selling price is difficult to determine, and the virtuality of the digit seems to have attacked the economical reality. Even the price of firms seems to be affected, a young company which has not made any profit may value billions of dollars; the rise of Apple's market capitalization seems to have no ending. But, with Hal Varian, we can consider that in the economics of information technology, the old principles still work remarkably well. Only, effects that were not quite usual in the industrial economy, network effects, switching costs, or differentiated prices are the common law in digital economy. So we need to focus on these peculiarities more than to change for a new economy.

What political and economical authorities must cope with is a traditional process of creative destruction, while this process is sharpened by the extraordinary power of digitizing. The organization of a new industrial paradigm has to be set up. In the past, this process has always established the grounds of a new era of prosperity. Why would it be different this time?

Moreover, we can see a kind of new innovation ecosystem around the Internet which can be compared with the mechanical one during the nineteenth century and what happened around the combustion engine in the beginning of the twentieth century and the integrated circuit in the 1960s. These are examples of combinatorial innovation which boosted the all economy and as it is now question of bits and not atoms, at the speed of light all around the world, the development of this new paradigm may be very much faster than the former ones.

Cross-References

▶ Business Creation
▶ Creative Destruction

References

Arthur WB. Competing technologies, increasing returns, and lock-in by historical events. The Economic Journal. 1989;99(394):116–31.

Christensen CM. The innovator's dilemma. Boston: Harvard Business School Press; 1997.

Schumpeter JA. Capitalism, socialism and democracy. New York: Harper Collins; 1942/2008.

Varian HR. Competition and market power. In: Varian HR, Farrell J, Shapiro C, editors. The economics of information technology. Cambridge: Cambridge University Press; 2004. p. 1–47.

Digitization

▶ Digital Economy and Business Creation

Direct Legislation

▶ Innovations of Direct Democracy

Direct Say

▶ Innovations of Direct Democracy

Directed Evolution® Technology

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Synonyms

Guided evolution; TRIZ forecasting

Definition

Directed Evolution® is a technology involving systematic processes for building a sustained competitive advantage through the effective management of the evolution of various artificial (man-made) systems by utilizing evolutionary patterns for technologies, markets, business, social systems, etc.

Directed Evolution is a result of integration and further development of *technological forecasting* and the *Theory of Inventive Problem Solving*.

Technological forecasting was introduced in the mid-1950s as a collection of non-related techniques based on probabilistic modeling of future characteristics of various systems. While proven being useful for short-term predictions, the method failed to deliver reliable long-term results, primarily due to the tools that were utilized to develop the forecasts.

The Theory of Inventive Problem Solving originated in the mid-1940s by Genrich Altshuller is based on the assumption that inventions in technological systems appear not randomly but rather in compliance with certain statistically recurrent *patterns of technological evolution* that could be revealed and utilized for organized and structured innovation. Typically, each pattern of evolution includes multiple *lines of evolution* – more detailed descriptions of how this pattern could be realized step-by-step.

By the mid-1970s, the discovery of patterns of evolution has enabled the introduction of *TRIZ forecasting*. Unlike traditional technological forecasting, it is based on utilization of predetermined patterns offering new directions together with proven ways how they could be realized. However, while providing valuable insight on the nature of the next generations of the given systems, TRIZ forecasting could not provide reliable answers when these new generations would come to existence.

The Directed Evolution (DE) technology was introduced in the early 1990s by Ideation International's research group as a proactive approach to the evolution of technology. Instead of making a prediction and waiting for it to be confirmed, the DE process uses numerous patterns and lines of evolution for the purpose of identifying possible scenarios, selecting the most promising ones, then building a road map and planning the process of implementation. In other words, DE is a method to predict future generation of a system by inventing it. To date, DE can be applied to various aspects of human life, including product and process development, evolution of technologies, markets, organizational development, and more. Later, significant progress has been made with the introduction of Directed Evolution® software, which incorporated powerful analytical tools and substantial knowledge base for predicting and solving various problems and more.

Typical results of a DE project include:

1. A comprehensive diagnostic analysis of the DE subject, including identifying problems hindering the evolution of the given system, revealing the system's evolutionary potential and evaluation of the applicable intellectual property
2. Solving selected problems, generating new ideas, and building futuristic concepts for the short-, mid- and long-term
3. Predicting possible mistakes and undesired events associated with further evolving the system and developing recommendations for their timely detection and prevention and possibly capitalization on them
4. Providing recommendations for the effective growth of intellectual property, structuring an IP portfolio, and increasing the company's creative potential

To date, over 100 of DE projects have been completed. The list of selected DE projects includes automotive, petrochemical, oil, medical instrumentation, electronic and other industries, consumer products, and business organizations.

Note. Directed Evolution is a registered trademark of Ideation International Inc. The name was suggested by Dr. Gafur Zainiev.

Cross-References

▶ Inventive Problem Solving (TRIZ), Theory
▶ Patterns of Technological Evolution
▶ TRIZ Software for Creativity and Innovation Support

Discover

▶ Invention Versus Discovery

Discovery

▶ Technological Invention of Disease

Displacement of Metaphors

▶ Knowledge Society, Knowledge-Based Economy, and Innovation

Disruptive Innovation in Higher Education

▶ Higher Education and Innovation

Distressed Finance

▶ Small Businesses - Value, Transmission, and Recovery

Distributed Innovation Process

▶ Collaborative Innovation and Open Innovation

Distributed Metacognition and Creative Ideas

▶ Social Metacognition and Micro-creativity

District

▶ Clusters, Networks, and Entrepreneurship

Divergent Thinking

Mark A. Runco
University of Georgia, Athens, GA, USA

Synonyms

Creative potential; Flexibility; Fluency; Ideation; Originality

Introduction

The theory of divergent thinking is among the most useful in all of creativity studies. Many people equate divergent thinking with creativity tests, which is not an accurate view since (a) divergent thinking is useful outside of assessment and testing and (b) divergent thinking is not synonymous with creativity. That being said, tests of divergent thinking are the most commonly used estimates of the potential for creative thinking. But divergent thinking tasks are also useful as exercises, even when there is no need or interest in measurement, and the theory of divergent thinking is useful when attempting to understand creative thought, even when there is no need for application, data, or assessment. It is a good theory. It stands up when the criteria for what makes a good theory (e.g., broad coverage, testable hypotheses, parsimony) are used to evaluate it. This entry starts with a summary of the theory of divergent thinking and then moves to how that theory led to measurement and assessment.

Theories of Divergent Thinking

The theory of divergent thinking was developed almost entirely by two people, J. P. Guilford (1968) and E. Paul Torrance (1995). Guilford was interested in creativity and in fact pushed the entire field of creativity studies into the scientific realm when presented his 1949 Presidential Address to the American Psychological Association. It was titled "Creativity" and contained a compelling argument for why creativity could and should be examined empirically. Guilford saw that creativity is "a natural resource," an idea that is being renewed today. Of more immediate influence was his Structure of Intellect model which attempted to delineate cognitive ability. It started with approximately 80 distinct skills and capacities but after years of empirical work grew such that it included 120 of them. Right before his death, Guilford proposed that there were in fact 180 identifiable and distinct skills and capacities.

There were questions about Guilford's statistical preferences, and these brought the orthogonality of the distinct skills into question. But the distinction Guilford offered between convergent and divergent thinking proved to be enormously useful. It fit well into theories of creativity and allowed the construction of reliable tests of creative potential. Guilford himself developed dozens of tests of divergent thinking, as did E. Paul Torrance. In fact, Torrance's (1995) battery of assessments, *The Torrance Tests of Creative Thinking*, remains the most commonly used measure in creativity studies.

Note, however, in the first paragraph the idea that tests of divergent thinking should be viewed only as estimates of potential. This point must be underscored since it allows us to avoid the mistake that tests of divergent thinking measure creativity. What they do is *estimate* creative *potential*. They are estimates because there is measurement error. Of course, that is true of any test or measure (thus characterizes all research in the behavioral sciences). As a matter of fact, the reliability and validity of divergent thinking tests, when they are administered and scored in accordance with the latest procedures, are as high or higher than many other behavioral tests. They are at least as reliable and valid as IQ tests, for example, and more reliable and valid than most tests of personality. Still, they are not perfectly accurate. There is no such thing as a perfectly accurate test. Tests are predictions. They sample behavior and then predict future behavior. Tests of divergent thinking do offer reasonable predictions of future creative performances – at least certain creative performances.

Some of the original tests did not offer very good predictions. Indeed, many people rejected divergent thinking tests in the 1970s because the predictive validity studies at that time were less than impressive. But the tests have improved. In fact, both the predictors (i.e., the tests of divergent thinking) and the criteria have improved. The older studies showing poor predictions used criteria that were available at that time, but these either focused on personality traits or on socially recognized creative accomplishment. They did not focus on what tests of divergent thinking actually assess, which is ideation. Tests of divergent thinking provide information about *ideational fluency* (the number of ideas a person gives when asked an open-ended question), *ideational originality* (the tendency to give unusual or novel ideas), and *ideational flexibility* (the variety of ideas given or the number of conceptual categories in the ideational output). Sometimes *elaboration* is used (the tendency to exploit one conceptual category) but not often. The only appropriate criteria when checking the predictive validity of tests of divergent thinking must also focus on idea. One measure was designed for exactly that (the *Runco Ideational Behavior Scale*, or RIBS) and studies using it are the ones that give reliability and validity in excess of what is found for IQ tests or personality inventories.

Additional Indices and Tests of Divergent Thinking

Tests of divergent thinking have been scored for *appropriateness* of ideas, as well as fluency and so on. This is notable because of the claim that tests of divergent thinking only estimate creative *potential*. They do not guarantee actual creative *performance*. Of course, if you want to measure actual creative performance, it is easy to administer an inventory of creative accomplishment. These are self-reports and as such are open to certain biases, but they do reliably index how many specific creative performances (e.g., "How many times have you had something published?" "How many patents have you been awarded?" "How many public recitals or concerts have you given") and accomplishments. The distinction between potential and actual performance is a critical one, especially for educators or anyone choosing a measure of creativity. It is discussed in detail in this same volume ("► Four Ps in Organizational Creativity").

The appropriateness index was developed for tests of divergent thinking because although they offer good information about originality, creativity is more than originality. Creativity requires some sort of appropriateness, effectiveness, or fit. It an idea is just original, it is not creative. In fact, highly original ideas that lack effectiveness may be crazy and not at all creative. Originality is necessary but not sufficient for creativity. Other newer indices and scores for divergent thinking tests focus on the metaphorical impact or degree of transformation, but none of these has been studied extensively. Most research uses only fluency since it is highly correlated with originality and flexibility, but this is a mistake. There is reliable variance to originality and flexibility scores, even when fluency scores have been statistically controlled, and even more importantly, originality is more critical for creativity than is productivity. If only one score was to be used, it should be originality and not fluency. The best technique is to look to a profile, with fluency, originality, and flexibility.

It is not just the scores from tests of divergent thinking that determine the reliability and validity. The tasks themselves are also important. In fact, some tests insure that creativity is especially well and realistically sampled. Consider in this regard tasks that assess *problem generation* as well as problem solving. All tests of divergent thinking are open-ended. Unlike tests of convergent thinking, which require that the individual find the one correct or conventional answer, divergent thinking tasks allow multiple answers and ideas. Most of them present a problem, such as "name all of the strong things you can think of" or "list as many uses as you can for a toothbrush." Others are realistic (e.g., "you forgot a hat and the sun just appeared from behind the clouds.... what can you do to avoid sunburn?"). Yet others go beyond problem solving and tap problem generation. This is tied to the problem-finding abilities that are so critical for actual creativity. Often there is more creativity to identifying and defining a problem than there is to solving it! For that reason, some tests of divergent thinking ask the individual to list as many problems as they can (e.g., "list problems faced by a typical student at your school."). Thus, the examiner gets an estimate of both problem-finding and problem-solving originality.

Problem generation tasks were used in one study that had especially impressive predictive validity. This investigation used realistic (presented) divergent thinking problems as well as realistic problem generation tasks in a study of the relationship of each with suicide ideation. The rationale relied on the large literature on psychopathology and creativity (e.g., the "mad genius controversy"); there is a long-standing interest in the relationship of creativity with clinical and subclinical tendencies. Suicide ideation is thought to precede actual suicide attempts. It is especially troubling when it is paired with depression. If that occurs, there is a high likelihood of an actual suicide attempt. The impressive part of this research was that a combination of the divergent thinking tests actually predicted suicide ideation better than depression! In fact, the association between depression and suicide ideation was determined and then statistically controlled, and still the divergent thinking tests were significantly related to (and predictive of) suicide ideation. Very importantly, it was a statistical interaction that was the accurate predictor of suicide ideation. In particular, suicide ideation was likely among individuals who had both (a) fluency with problem generation (they saw many problems) and (b) low flexibility (a kind of rigidity of thought) when solving problems.

A Technology of Ideation

One attraction of divergent thinking is that it applies to so much of our behavior. Think for a minute how often ideas are involved in our actions! Ideas are involved for all of our mindful behavior (we have an idea, think about it, and perhaps act on it), and depending on how an idea is defined (see this volume, the entry on "▶ Ideas and Ideation"), they may be involved in everything except reflex. One conclusion of the recent volume, *Divergent Thinking and Creative Ideation* (Runco 2012) was that the divergent thinking research has given us a "technology of ideation." The idea here (pun intended) was that ideation is an important and broadly applicable process and divergent thinking methods provide us with a reliable method for studying ideas. Note that this again implies a separation between ideation and creativity. Creativity sometimes depends on original ideation, but ideation is important outside of creativity.

The breadth of applicability is reinforced by a quick look at all of the populations who have been involved in the divergent thinking research. Virtually all age groups have been studied, for example. Preschool children who cannot yet write can still be assessed by giving them 3D objects and having them talk about what the object could be. They will talk freely and their discourse can be scored for all of the typical indicators, including originality. Older adults have been studied, and interestingly, they have an idiosyncrasy: They seem to suffer, with age, specifically in their flexibility. They rely more and more on routine and habit and their ideas become less and less varied and diverse. One last example of a population which has been studied was that of entrepreneurs. The divergent thinking tests designed for them asked for ideas concerning the strengths, weaknesses, opportunities, and threats to their businesses. This SWOT model is often used in studies of entrepreneurs and was adopted for the divergent thinking tasks in an attempt to insure that the participants in the research – highly successful entrepreneurs – would be engaged in the tasks.

That is an important point and reinforced the argument that tests of divergent thinking are merely estimates of potential. Just because someone does well at one point, on any test or sample of behavior, does not guarantee that they will do the same in the future. Insuring that individuals are engaged in the tasks does help in this regard because those individuals are much more likely to perform at their highest level when motivated. This is actually a benefit of all realistic tests of divergent thinking. There is a drawback, however, in that realistic tests seem to allow individuals to look back on their experience and find ideas by searching long-term memory. As a result, originality scores are often low in realistic tests.

Another way to engage individuals when assessing divergent thinking is to insure that they do not treat the tasks as typical tests. If divergent thinking tasks are presented such that they appear to be tests, examinees focus on convention and correctness. They are not nearly as original as they are if the tasks are called games instead. Originality is much more likely if the tasks have directions which de-emphasize spelling, grades, points, correct answers, or evaluations of any sort. Originality is likely if the tasks are called games and examinees are told to have fun. If divergent thinking tests are not administered in this game-like fashion, the same individuals who do well on traditional tests, like those in school, will be the only ones who do much. Other students may have creative talents, but their originality will not be clear unless they are assured that divergent thinking tasks are not convergent nor academic tests. If divergent thinking tasks are administered in a game-like fashion, students who do not receive high grades may very well stand out and excel in their ideation.

Conclusions and Future Directions

Additional research is needed to insure that tests of divergent thinking are used most effectively. Research in progress is testing new indices, to go along with originality, flexibility, and fluency, for example. Other work is manipulating the instructions given with these tests, the idea being that results are only valid if respondents and examinees are interested in generating ideas. Of most importance for future research may be techniques that will allow tests of divergent thinking to be used but used such that the information obtained is indicative of creative performances that occur in the natural environment. Too often, tests are only indicative of behavior that can be elicited in controlled settings. What is most important, however, is behavior as it occurs in the natural environment. Headway is being made (e.g., with realistic tests of divergent thinking) toward testing that will predict behavior in the natural environment with great accuracy.

There are other ways, besides divergent thinking tests, to estimate creative potential. Note, however, that tests of divergent thinking capture the most important part of creativity – originality – and do so in a reliable fashion. There is a sizable literature on divergent thinking, which means that plenty of data and results can be found to aid and support interpretations. They are theoretically justified, by the Structure of Intellect model as well as various associative theories. Tests of divergent thinking can be used with a broad range of populations. And they allow the individual to produce something – to create. The creation or product is an idea, but ideas are of enormous value, for world-changing inventions and everyday coping. Divergent thinking tests must be viewed as *estimates* of the *potential* for creative thinking, but they are good estimates, and there are few things that should be invested in as heavily as creative potential.

Cross-References

▶ Brainstorming
▶ Cognition of Creativity
▶ Convergent Versus Divergent Thinking
▶ Ideas and Ideation

References

Guilford JP. Creativity, intelligence, and their educational implications. San Diego: EDITS; 1968.
Runco MA, editor. Divergent thinking. Norwood: Ablex Publications; 1991.
Runco MA, editor. Divergent thinking and creative ideation. Cresskill: Hampton Press; 2012.
Torrance EP. Why fly? Norwood: Hampton Press; 1995.

Divergent Thinking Tests

▶ Creativity Tests

Divergent Versus Convergent Thinking

Olga M. Razumnikova
Cognitive Physiology Laboratory, State Research Institute of Physiology SB RAMS, Novosibirsk State Technical University, Novosibirsk, Russia

Synonyms

Creativity versus intelligence; Innovation versus critical thinking; Intuitive thinking versus logic thinking; Irrational versus rational thinking

Key Concepts and Definition of Terms

The concept of divergent and convergent thinking was created by J.P. Guilford to term different types of psychological operations while problem solving. **Divergent thinking** is defined as producing a diverse assortment of appropriate responses to an open-ended question or task in which the product is not completely determined by the information. So, divergent thinking concentrates on generating a large number of alternative responses including original, unexpected, or unusual ideas. Thus, divergent thinking is associated with *creativity*.

Convergent thinking involves finding only the single correct answer, conventional to a well-defined problem. Many facts or ideas are examined while convergent thinking for their logical validity or in which a set of rules is followed. Convergent thinking focuses on reaching a problem solution through the recognition and expression of preestablished criteria. Standard *intelligence* tests are similarly believed to measure convergent thinking.

Divergent Versus Convergent Thinking, Table 1 Differences in characteristics associated with convergent and divergent thinking

Characteristics	Convergent	Divergent
Problem type	Well-defined	Poorly defined
Responses	Single	Multiple
Psychometric index	Intelligence	Creativity
Attention	Focused and local	Defocused and global
Mood	Negative	Positive
Predominating thinking strategy	Analytical and rational	Intuitive and irrational
Specific strategy of response selection	Deductive retrieval	Insight
Brain activation	High-level and localized	Low-level and widespread
Hemisphere dominance	Left	Right
Domain of specific giftedness	Science	Art
Adaptation to constant environment	Mental health	Mental diseases

Theoretical Background and Open-Ended Issues

The differences between convergent and divergent thinking in information processes, psychological operations, and brain activity are presented in Table 1 and in Figs. 1, 2.

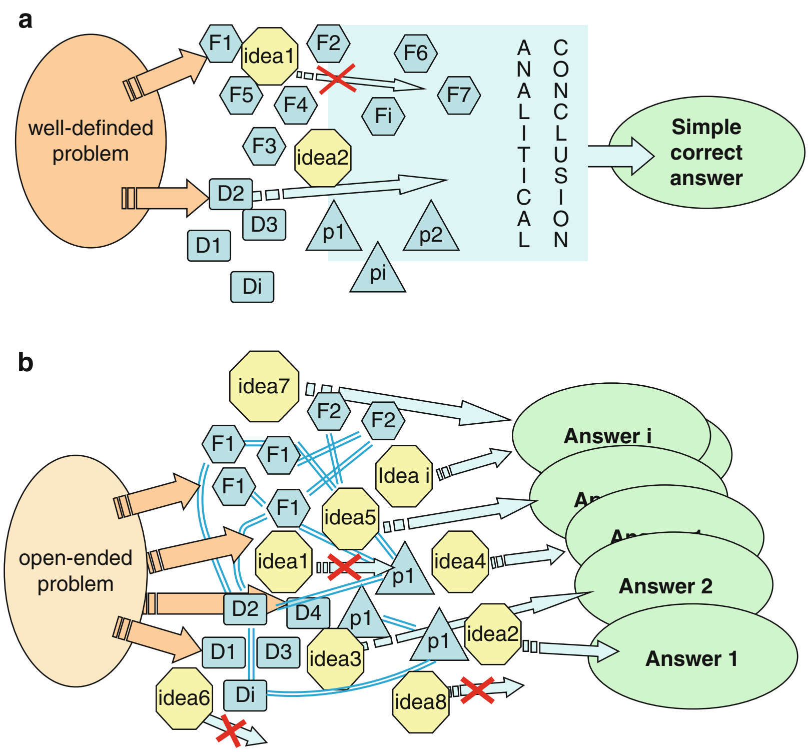
Three basic indices of divergent thinking have been offered of Guilford:

- *Fluency* (total number of the generated ideas)
- *Flexibility* (the number of categories in the ideas)
- *Originality* (the number of unique or unusual ideas)

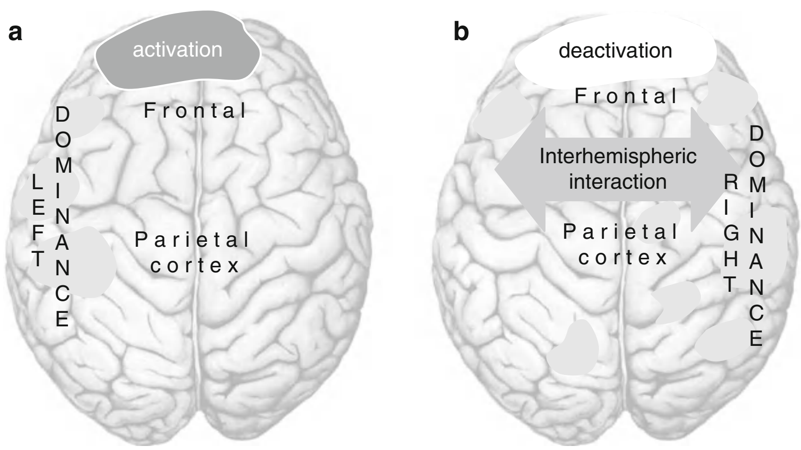
Effectiveness of divergent thinking suggests a combination of knowledge, good memory, and fluency in associations between sensory and semantic information, as well as richness of ideas, imagination, and fantasy.

The basic index of successful convergent thinking is high speed of the right answer finding. The same condition is due to measurement of mental abilities or well-known *intelligence quotient* (IQ). Intelligence, as measured on many commonly used tests, is often separated into verbal, figural, and numerical, which can be combined to produce a full-scale intelligence score. Also social, emotional, motor, and other components of intelligence are differentiated. Successful convergent thinking required a perceptual exactness in observation, great volume of general and domain-specific knowledge, good memory, analytic-abstract reasoning, and finally fast acceptance of the logical decision.

So, main contrary characteristics of convergent and divergent thinking are a quantity of task solution (simple vs. multiple, respectively), time of answer finding (short vs. long), and concept mapping of idea search (specific vs. widespread associations). However, convergent and divergent thinking have also some **similarity characteristic** in psychological processes while difficult problem solving as it presented in Table 2. These different types of thinking are important components of creative process including the formulation of a problem (dominance of convergent thinking), widespread search of variable ideas of a problem solution (function of divergent thinking), and choice of the final decision based on critical comparison of generated ideas (again convergent thinking phase). So, convergent thinking dominates while domain-relevant knowledge and data are identified and analyzed but divergent thinking – during



Divergent Versus Convergent Thinking, Fig. 1 Scheme of organization of convergent (**a**) versus divergent (**b**) thinking. F1. . .I, D1. . .I, and p1. . .i sign different semantic categories in multiple knowledge structures



Divergent Versus Convergent Thinking, Fig. 2 Model of hemispheric organization of convergent (**a**) versus divergent (**b**) thinking

information transformation and generation of both ideas collection and many possible criteria for reviewing these ideas.

Organization of Divergent Versus Convergent Thinking

Semantic transformations of information and ideas exploring as well as one important source of wit and humor are evidence of divergent thinking. Associational knowledge reflects regularities in experience based on probabilistic linkages among stimuli. Traditionally, *associational knowledge* has been held to give rise to new original thought through variable interconnections of remote concepts (see Fig. 1b). Extensive knowledge provides an information basis for flexible search of different

Divergent Versus Convergent Thinking, Table 2 Similarities in characteristics associated with convergent and divergent thinking

Sensory processes	Careful observation of their environments to gather information through the senses
Memory	Large working memory capacity
	Implicit and explicit memory resources
Knowledge	Effective application of requisite processing operations to relevant domain-specific and general knowledge
Task types	Verbal, figural, numerical, and social
Cognitive structures and abstraction	Using different concept maps and abstract models to understand the world
Emotional regulation	Negative emotions induce increased motivation to task performance, but positive emotion facilitates associative and semantic priming and supports the processing of global perceptual information
Brain activity	Interaction of specific and associative brain areas in line with individual strategies of problem solving
Adaptation to variable environment	Integration of intellectual and creative abilities to introduce change, innovation, or improvement over what exists

and similar features of objects and processes from various semantic categories that contributed to the generation of many new concepts and creative problem solutions. A *heuristic* or *insight* is a strategy that ignores part of the information, with the goal of making creative decisions after incubation period.

On the contrary, convergent thinking is defined as creating of completely determined product. *Linear logic*, schematic knowledge, and mapping operations are contributed to arrive at a firm conclusion based on relevant information. The theory of mental models is widely accepted as the explaining theory in relational reasoning (e.g., Goodwin and Johnson-Laird 2005). In line with this theory, humans construct internal representation of objects and relations in working memory, matching the state of affairs given in the premises. Convergent thinking narrows the available responses with the goal of selecting the single correct response (Fig. 1a) and can inhibit creative though as stops on one most probable idea.

However, as the stage model predicts, sometimes, convergent thinking may be necessary for final selection of original and acceptable problem solution. Two complementary subsystems are required to reach the desirable results: (1) an idea generation subsystem that embeds semantic knowledge and whose dynamics generates ideas as conceptual combinations and (2) a critic, which receives the generated ideas and produces evaluative feedback based on its domain knowledge about the given context.

Involvement of multiple knowledge structures, the capability to memorize which answers and categories have been produced, as well as the accessibility of memory traces in general should be helpful in acquiring both high creativity and intelligence test scores. The large variety of data resulting in an average correlation between divergent thinking and intelligence tests has been found using a meta-analysis of 21 studies and 45,880 participants (Kim 2005). This relationship was moderated by age, gender, specific abilities, personality, and other factors. However, patterns of relationships between these factors and the convergent and divergent thinking organization still should be studied.

So, paradoxical complementary combinations of contrary kind of thinking occur in different phases of novelty production: convergent thinking might dominate in the phases of preparation and verification, but divergent thinking in that of illumination.

Neuronal Mechanisms of Divergent and Convergent Thinking

Understanding of neuronal mechanisms of divergent and convergent thinking may not only improve a performance of different cognitive tasks but also provide new insights into regulation of innovation activity. Possible brain correlates underlying divergent and convergent thinking are found in neuroscientific studies. As example of convergent thinking, mathematics operations can be tested.

Neuropsychological as well as brain imaging studies converge on the view that *arithmetic processing* is subserved by frontoparietal areas and the basal ganglia (Dehaene et al. 1996). The left angular gyrus, perisylvian language areas, and the basal ganglia are assumed to mediate the retrieval of overlearned arithmetic facts, such as the multiplication tables, from long-term memory. The stronger activation within frontal areas in calculation tasks (Fig. 2a) has been interpreted as reflecting working memory demands, as well as error monitoring and strategic organization. There are evidences that numerical information is represented and processed by regions of the prefrontal and posterior parietal lobes, with the intraparietal sulcus as a key node for the representation of the semantic aspect of numerical quantity. The intraparietal region seems to be associated with an abstract, amodal representation of numbers in as much as it can be activated by numbers presented in various culturally learned symbolic notations. Exact arithmetic depends more on left lateralized, possibly language-related structures, while approximate arithmetic is tied to a quantity representation in bilateral intraparietal areas.

Deductive reasoning as variant of convergent thinking is the attempt to reach secure conclusion from prior beliefs, observations, or suppositions. Some reports have characterized deduction as predominantly left hemispheric, variously recruiting regions in inferior frontal, frontotemporal, and occipito-fronto-temporo-parietal cortices (Goel and Dolan 2004). Core deduction area is the left rostro-lateral prefrontal cortex, a region implicated in tasks involving goals/subgoals.

It can be concluded that the *specific network* involved in skilled arithmetic performance (i.e., convergent thinking) has been established. The inferior parietal sulcus and prefrontal cortex are assumed to mediate a common representation of quantity, and both arithmetic and sentence processing activated large sets of areas strongly lateralized to the *left hemisphere* (Fig. 2a).

On the contrary, divergent thinking and creativity are associated with widespread interconnections between *multiple brain regions* and relative dominance of the *right hemisphere* (Razumnikova 2005; Arden et al. 2010) (see Fig. 2a). A meta-analytic review of the literature to establish how creative thinking relates to hemispheric dominance revealed no difference in predominant right-hemispheric activation for verbal versus figural tasks, holistic versus analytical tasks, and context-dependent versus context-independent tasks (Mihov et al. 2010).

Right-hemisphere dominance in divergent thinking is caused to the facts that the right temporal and parietal cortices may provide a crucial nonlinguistic component needed for the intuitive generation of novel ideas using semantic knowledge in terms of features, concepts, and categories as well as verbal operations, such as the metaphor and humor creation or semantic operations that require a wide net of associations.

Semantic information in the brain is represented at several levels, ranging from combinations of sensorimotor features, through amodal concepts, to semantic categories. Considerable evidence now supports the idea that semantic processing involves several cortical functional networks including the left temporal lobe, the prefrontal cortex, the anterior cingulate cortex, the orbitofrontal cortex, and parts of the occipital cortex. Thus, if great volume of knowledge is necessary for difficult task performance, integration of functions of both hemispheres is required often for a finding of the best decision.

Many investigators have proposed that the ability to generate novel ideas or divergent thinking is associated with increased hemispheric cooperation. In line with this, hypothesis studies of patients with callosal resection have revealed a decrement in complex cognitive ability and EEG coherence studies suggest an association between effectivity of divergent thinking and interhemispheric coupling (Bogen 2000; Razumnikova 2005). Decreased callosal connectivity enhances hemispheric specialization, which benefits the incubation of ideas that are critical phase of creativity, and it is the momentary inhibition of this hemispheric independence that accounts for the illumination (Moore et al. 2009). Alternatively, decreased size of corpus callosum may reflect more specific localization of selective hemispheric processes, thereby facilitating efficient intrahemispheric functional connectivity. So, the corpus callosum is necessary for transferring earlier integrative aspects of divergent thinking from the right hemisphere to the left one, which would be essential for creative output, that is, verbal and motor answer.

The lateralized processing of the different forms and types of knowledge stored in the right and left hemispheres may be particularly important during different types of divergent thinking (verbal, figural, or social). The right hemisphere is dominated at exploring for new possibilities while the left hemisphere is more likely to result in the application of a previously learnt concept or pattern to a new problem.

An important aspect of cognitive fluency and flexibility is inhibitory control, the ability to dynamically modify or cancel planned actions in response to changes in the sensory environment, or task demands. The control and planed functions are performed in the prefrontal cortex which is deactivated during divergent thinking according to divergent task-induced alpha rhythm synchronization (Fig. 2b). This effect can be interpreted as congruent with idea that *defocused attention* and *inhibitory control decrease* is associated with effective search of original ideas.

Implication for Theory, Policy, and Practice

Successfulness in both divergent and convergent thinking can be considered within the more comprehensive concept of cognitive competence. This concerns the complex achievement forms of problem perception, information processing through learning transfer, and divergent/convergent thought processes in various situations and in different field of activity. There are findings that generally supported the view of convergent scientists and divergent artists. Scientific eminence requires high level not only intellectual but creative abilities and manifests itself in development of solution-relevant hypotheses regarding scientifically unsolved problems, the development of new theories and methods, and original problem solutions. Creativity is generally expressed, for example, in technical areas through original processes, new methods, useful inventions, and valuable products. Analysis of creativity and intelligence scores with regard to extracurricular activities shown that highly creative versus highly intelligent students dominated in art, literature, technology, and social skills whereas in science these scores were equivalent (Perleth and Sierwald 2001).

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According to a neural plasticity model, it is expected that environmental interventions in the different form of training in divergent and convergent thinking would improve both creative and intellectual abilities. Schooling and specific intervention programs do affect relative intellectual or creative performance. A well-known tool to enhance divergent thinking in groups is brainstorming. There are many techniques for individual development of ability to generation of original ideas: challenge facts, analogies, random word and picture, and others.

It should also be noted that the magnitude of the thinking score increase would be a function of the underlying differences in neural plasticity. If there are large individual differences in neural plasticity, then even relatively large interventions would not be sufficient to overcome differences in this factor.

Conclusion and Future Directions

So, divergent thinking concentrates on producing a large number of appropriate and adequate alternative responses and often is associated with creativity which involves the generation of varied, original, or unusual ideas in response to an open-ended task. On the contrary, convergent thinking involves finding the single correct answer, and standard intelligence tests are similarly believed to measure convergent thinking.

A major question for further research is a studying individual variability in complex neuronal mechanism of divergent versus convergent thinking depending on sex, age, personality, intelligence, handedness, etc. It is necessary to unify neuroimaging methods and psychometrical testing of different components of thinking designed to provide greater spatial localization of function in brain. The future of primary creativity research would perhaps be focusing not only on the specialization of the hemispheres but on particular brain areas that are in constant interplay and communication. There is also open-end question on a role of interhemispheric or anterior and posterior cortex interaction in information selection during creative activity. Further research using techniques that can provide information about the nature of white matter connections, such as diffusion tensor imaging, will help to explain the mechanism by which effectivity of divergent thinking relates to size of corpus callosum.

Recently, more and more attention is given to the use of psychological knowledge in the politician and ordinary life. In this connection, studying of functional mechanisms of social creativity or implications of divergent and convergent thinking concepts on work, at home, or in complete adaptation to the world represents a great interest.

Cross-References

▶ Cognition of Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Brain
▶ Creativity and Systems Thinking
▶ Divergent Thinking
▶ Nature of Creativity
▶ Scientific Creativity as Combinatorial Process

References

Arden R, Chavez RS, Grazioplene R, Jung RE. Neuroimaging creativity: a psychometric view. Behav Brain Res. 2010;214(2):143–56.

Bogen JE. Split-brain basics: relevance for the concept of one's other mind. J Am Acad Psychoanal. 2000;28: 341–69.

Dehaene S, Tzourio N, Frak V, Raynaud L, et al. Cerebral activations during number multiplication and comparison: a PET study. Neuropsychologia. 1996; 34:1097–106.

Goel V, Dolan RJ. Differential involvement of left prefrontal cortex in inductive and deductive reasoning. Cognition. 2004;93(3):B109–21.

Goodwin GP, Johnson-Laird PN. Reasoning about relations. Psychol Rev. 2005;112(2):468–93.

Kim KH. Can only intelligent people be creative? A meta-analysis. J Second Gift Educ. 2005;16:57–66.

Mihov KM, Denzler M, Forster J. Hemispheric specialization and creative thinking: a meta-analytic review of lateralization of creativity. Brain Cogn. 2010;72: 442–8.

Moore DW, Bhadelia RA, Billings RL, Fulwiler C, et al. Hemispheric connectivity and the visual–spatial divergent-thinking component of creativity. Brain Cogn. 2009;70:267–72.

Perleth Ch, Sierwald W. Entwicklungs- und Leistungsanalysen zur Hochbegabung. In: Heller KA, editor. Hochbegabung im Kindes- und Jugendalter. 2nd ed. Gottingen: Hogrefe; 2001. p. 171–355.

Razumnikova OM. Gender-dependent frequency–spatial organization of the brain cortex activity during convergent and divergent thinking: II. Analysis of the EEG coherence. Hum Physiol. 2005;31(3):275–84.

Diversity and Entrepreneurship

Laurice Alexandre-Leclair
Research Network on Innovation, CEDAG Paris Descartes University, Paris, France

Synonyms

Clusters; Cultural diversity; Environment; Ethnic entrepreneurship; Gender; Immigrants; Minority

Every society is composed of social and cultural groups. For researchers, diversity has become increasingly important. Diversity means variety. This variety can be evaluated along the dimensions of race, ethnicity, gender, sexual orientation, socio-economic status, age, physical abilities, religious beliefs, political beliefs, or other ideologies (Baycan-Levent et al. 2003). Disabilities are sometimes also included among these variables.

According to Hampden-Turner and Chih (2010), diversity includes visible characteristics such as nationality, ethnicity, gender, and age, and also invisible characteristics such as creativity, beliefs, and tastes. These authors state that there is an important connection between fixed diversity and voluntary diversity. In this discussion, the focus is on *fixed diversity*, such as ethnicity and culture, because these variables are directly linked to entrepreneurship. *Voluntary diversity* is more a strategy of human resources recruitment, adopted by firms in order to improve their image and their reputation amongst their stakeholders and demonstrate that they practice corporate social responsibility.

Diversity is considered by some authors as a factor of competitiveness. Amin and Graham (1997) (in Eraydin et al. 2010) state that cities have never been homogeneous entities; social, cultural, and ethnic forms of diversity have always been key items on the urban research agenda. As a result of processes of globalization, neoliberalization, and economic restructuring, most urban centers in advanced economies have faced significant increases in migration (Eraydin et al. 2010). From an economic perspective, debates about diversity have entered the competitiveness literature (Thrift and Olds 1996; Storper 1997; Florida 2005). Eraydin et al. 2010 cite Fainstein (2005), who argues that "the competitive advantage of cities and thus the most promising approach to attaining economic success, lies in enhancing diversity within the society, economic base, and built environment." Zachary (2000), Florida (2001), and Boodar and Rath (2005) also highlight the positive role of diversity in achieving a competitive economy.

Diversity is a core factor that leads to entrepreneurship. Hampden-Turner and Chih (2010) quote Saxenian (1999), who declares that "immigrants have created a very large proportion of the world's wealth. Moreover, Vecania (1999), quoted by Baykan-Levent (2003), raised the point that for individuals who are unable to adapt to a social system, such as those in ethnic and migrant minority groups, their marginal social position is a driving force to become self-employed. Self-employment in this case is not only a means to earn a living, but it is also a way of obtaining recognition and social acceptance.

Many studies have demonstrated that, despite their investments in human capital, minority workers (including immigrants) are systematically excluded from employment that offers high salaries, job security, and promotion opportunities (Yoon 1997) (in Bogan and Darity 2008). A number of other authors claim the positive relationship between diversity and entrepreneurship. Thuse, the aim of this discussion is to explore diversity and entrepreneurship. As mentioned before, diversity encompasses a wide variety of characteristics. This discussion focuses on ethnicity and culture because these characteristics directly affect entrepreneurship. Culture and entrepreneurship will be discussed first, followed by ethnic entrepreneurship.

Culture and Entrepreneurship

Sowell (1981) has claimed that different economic outcomes across different ethnic groups are due to culture rather than market or institutional discrimination. For instance, the relative success of black West Indians, compared with other black Americans, is attributed to their distinctive cultural values.

In their work, Sobel et al. (2010) present the definition of Lavoie (1991) of culture and entrepreneurship: "It pointed that entrepreneurship necessarily takes place within culture, it is utterly shaped by culture, and it fundamental consists in interpreting and influencing culture. Consequently, the social scientist can understand it only if he is willing to immerse himself in the cultural context in which the entrepreneurial process occurs."

Hofstede (1980, 1993) declares that national cultural values influence the conduct of business in particular countries. Sobel et al. (2010) tried to measure the relation between cultural diversity and entrepreneurial activity using five different measures of entrepreneurship (average business start-up rate, net business creation rate, venture capital per capita, patents per capita, and measure of productive entrepreneurship) in a cross-state analysis. They found that the states with the most diversity in their cultural makeup have higher rates of entrepreneurial activity.

Moreover, Sobel et al. (2010) discuss cultural capital. They state that different geographic areas across the globe are characterized by their own unique cultures. When people migrate from one country to another, they bring some of their unique cultural capital with them. Because entrepreneurship is about coming up with new and unique combinations of resources, this interchange of ideas may lead to more innovations, new products, and generally a higher rate of entrepreneurial initiatives.

Along the same lines, according to the cultural hypothesis, the inclination of some immigrant and ethnic groups toward entrepreneurship can be explained by their ethno-national attributes (Yoon 1997) (in Bogan and Darity 2008), however, Bogan and Darity (2008) argue that one must take into consideration other factors contributing to the entrepreneurial role of minorities, such as class resources, urban racial segregation patterns, and immigrant disadvantages. The experience of Chinese and Japanese immigrants in the American labor market prior to World War II is a good example of return migration. The immigrants initially were welcomed when they came to fill the labor shortages on sugar plantations, in the mines, and in railroad construction camps on the West Coast. But when labor competition developed during economic depressions, they became the targets of anti-Asian campaigns and institutional discrimination (Yoon 1997) (in Bogan and Darity 2008).

In order to validate these characteristics, Bogan and Darity (2008) took the example of Korean immigrants. For example, Korean immigrants' class resources for their business activities not only include financial capital but also human capital. Korean immigrants with middle class backgrounds possess the knowledge and motives that are required for successful entrepreneurship. College-educated Korean immigrants have advantages in terms of management skills and attitudes over native-born, non-Korean small business owners, who usually have less education (Min 1988b) (quoted by Bogan and Darity 2008).

Korean entrepreneurs have benefitted from discrimination against blacks. The reluctance of corporations to invest in inner-city, minority areas and the retirement of white business owners from these areas created a small business void that was happily filled by Korean immigrants (Min 1988b; Light and Rosenstein 1995) (in Bogan and Darity 2008); a void that black entrepreneurs were unable to fill due to lack of resources, capital, and so on.

Bogan and Darity (2008) note that, for Korean immigrants, their situation as disadvantaged immigrants may be a more significant influence on their business behavior patterns than the cultural influence of their Korean background.

Other factors should be taken into consideration in order to better understand the role of culture in entrepreneurship. For instance, Ibrahim and Galt (2011) highlight the importance of human capital determinants such as schooling, education, and other features that determine productivity (Chiswick 1983). Knocke (2000) (in Ibrahim and Galt 2011) challenged the argument that intrinsic cultural factors are obstacles to labor market integration by showing that integration, segregation, or discrimination against ethnic minorities results from economic needs and structural labor market characteristics.

Ethnic Entrepreneurship

Ethnic entrepreneurialism can only be understood as a multi-dimensional organism existing in an external context that needs to be properly specified.

According to Baycan-Levent et al. (2003), ethnic minorities are gradually becoming a majority in some European cities. The influx of foreign migrants has brought about economic advantages, but it has also caused a multiplicity of social and economic tensions. With a few exceptions, ethnic groups belong, in general, to the lower socio-economic segment of European cities, mainly as a result of their lack of education and skills, which led them toward self-employment. On the other hand, some authors (Bates 1997; Borjas 1999) (in Pecoud 2010) maintain that immigrant entrepreneurship is related to class resources, because entrepreneurship requires financial and human capital and, consequently, self-employment would not modify immigrants' socio-economic conditions.

Ram et al. (2010) note two problems in comparative research about ethnicity and entrepreneurship. The first is the tendency to focus on a single ethnic group in isolation from the wider small business population, which can accentuate perceived differences (this idea is also proposed by Jones et al. 1992; and Mulholland 1997). They also cite Zimmer and Aldrich (1987, p. 422), who declares that "the comparative study of immigrants and native groups shifts the focus from group differences to group similarities. Studies examining only immigrants may find apparently distinctive characteristics, but in fact many traits are common to all small business owners."

The second problem argued by Ram et al. (2000) is the ignorance of influence of sector on business activity in the frame of ethnic entrepreneurship. When cross-section comparisons are taken into account, inter-communal differences are often less acute than imagined. They give the example of Jones et al. (1994), who confirm that South Asian owners work significantly longer than others; this was found to be largely due to the overwhelming concentration of South Asian firms in labor-intensive sectors like food retailing and confectionery, tobacco, and newsagents.

Consequently, Ram et al. (2000) conducted research on ethnic minority business in the catering sector in the UK, because this sector is one of the niches traditionally occupied by ethnic minorities when they are offering their own unique national foods. According to their findings, the family plays a role in the formation and management of the enterprise across *all* ethnic groups, although it can take different forms. Even though the South Asian business owners, the same as white and African-Caribbean owners, declared that they would not want their children to enter the family business, the researchers noticed that South Asian children found their employment in the family business. This is an example of the importance of family among South Asian groups, but it emerged from economic necessity rather than notions of solidarity (Metcalf et al. 1996).

Pecoud (2010) provides a definition from Zhou (2004, p. 1040): "Ethnic entrepreneurs are often referred to as simultaneously owners and managers of their own businesses whose group membership is tied to a common cultural heritage or origin and is known to out-group members as having such traits; more importantly, they are intrinsically intertwined in particular social structures in which individual behavior, social relations, and economic transactions are constrained."

Ethnicity-based explanations of entrepreneurship coexist with two arguments (Pecoud 2010). The first, mostly developed by British scholars, sees self-employment as the product of the context in which migrants live and work: blocked opportunities, unemployment, and discrimination leave no choice to migrants but business (Barrett et al. 1996) (in Pecoud 2010). Migrants also invest in sectors whose unattractive conditions (long working hours, low return on investments, etc.) put off their previous owners.

Baycan-Levent et al. (2003) present different factors leading ethnic people to self-employment and entrepreneurship: motivations and orientation, labor and capital conditions, customer relationships, and gender and generational differences. We add to this list racial background and contingency factors, which play a role in differentiating and encouraging or discouraging entrepreneurship.

Motivation and Orientation

In addition to the classical motives that push minorities towards entrepreneurship, the existence of ethnic and social networks also plays a major role in motivating immigrants towards entrepreneurship (Delft et al. 2000; Johnson 2000; Kloosterman et al. 1998; Masurel et al. 2002; Ram 1994a, 1994b; Wilson and Portes 1980) (in Baycan-Levent et al. 2003).

Normally, ethnic companies start with a focus on clients from their own ethnic group, with traditional products, services, and communication channels. This internal orientation and the mutual trust within the ethnic network provides a protected market and a ready labor force (Baycan-Levent et al. 2003) and creates a loyalty between the ethnic firm and its clients (Dyer and Ross 2000).

Labor and Capital Conditions

Through their networks of relatives, co-nationals, or co-ethnics, new firms have a privileged and flexible access to information, capital, and labor (Basu 1998; Kloosterman et al. 1998) (in Baycan-Levent et al. 2003)

Customer Relationship

According to Baycan-Levent et al. (2003), several studies refer to an intra-cluster ethnic loyalty, while highly intensive communication behavior within the ethnic community offers potential competitive advantages for ethnic firms (Donthu and Cherian 1994; Dyer and Ross 2000).

Gender and Generational Differences

Baycan-Levent et al. (2003) emphasize that age and generation can affect the kind of entrepreneurship. The first generations involve more pull factors, whereas the second generation may exhibit more pull factors. First-generation ethnic entrepreneurs are more motivated by discrimination, problems with the transferability of their diplomas, and obtaining status, compared with their second-generation counterparts. In other words, while first-generation immigrants may be more frequently "forced entrepreneurs," second-generation immigrants may act more frequently as "voluntary entrepreneurs" (Baycan-Levent et al. 2003), which supposes that the second generation is free to invest in new markets outside the internal market.

Baycan-Levent et al. (2003) note that this difference also exists for gender difference. Female ethnic entrepreneurs involve more pull factors, their motivation stemming from their education level and work experience and skills, business goals, and management styles and personal value system. Most female ethnic entrepreneurship belongs to services sector; the businesses are small and the owners are relatively young. The social network plays a role also in entrepreneurship. In their study of South Asian people, Ram et al. (2000) noticed that women's work was often not acknowledged, despite its importance to the business.

Racial Background and Entrepreneurship

Researchers examining the success or failure of ethnic entrepreneurs who share the same racial and national backgrounds found that they perform differently in different countries (Ibrahim and Galt 2011). Indeed, some authors make the difference between immigrant entrepreneurship and Black American entrepreneurship. According to Butler (2005) (in Bogan and Darity 2008) and others, the primary difference between black and immigrant entrepreneurs was that black business owners were forced to develop separate enterprises and sell in a restricted marketplace while immigrants were allowed to operate in the economic mainstream. Bogan and Darity (2008) quote the survey of Bearse (1984), who found that foreign-born blacks are more likely to be engaged in entrepreneurship than U.S.-born blacks. The same study's fundamental finding is that the likelihood of black being entrepreneurs is significantly lower than for other groups. Nevertheless, Boyed (1991b) reinforced the view that black immigrants and native blacks share race-related disadvantages.

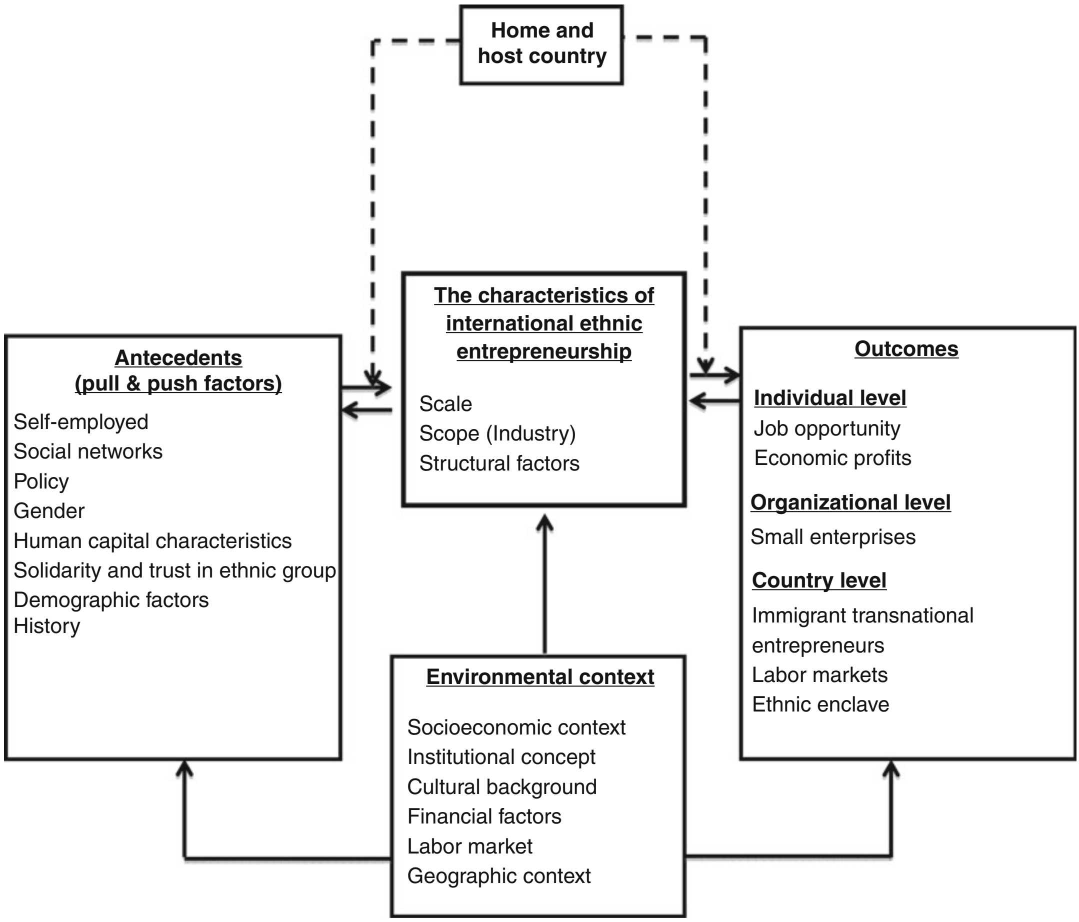
Eraydin et al. 2010 highlight the role of diversity in stimulating innovation. They quote Fainstein (2005), who declares that "forms of social, cultural, ethnic and spatial diversity attract multiple forms of human capital, and undoubtedly encourage cultural and artistic creativity, and technological and scientific innovation."

Contingency Factors

Ibrahim and Galt (2011) quote Evans and Jovannic (1989), who note that there is a link between the financial situation and entrepreneurship for some groups where initial endowments are restricted or where access to funds is difficult and there is likely to be a lower level of entrepreneurial activity and vice versa.

On the other hand, Ibrahim and Galt (2011) highlight the role of institutional arrangements proposed by the institutional economists (North 1990; Williamson 1975, 1985) in reducing transactions costs. These costs may be classified under three headings: search and information costs, bargaining and decision costs, and policing and enforcement costs (Dahlman 1979).

Concerning the relationship between the culture and entrepreneurship, it has been argued that some ethnic groups are endowed with social institutions and cultural norms that foster entrepreneurial talent



Diversity and Entrepreneurship, Fig. 1 Characteristics of international ethnic entrepreneurship (Ilhan et al. 2011)

(Davidsson 1995; Wilson and Portes 1980) (in Ibrahim and Galt 2011). Tight social networks provide flexible and efficient possibilities for the recruitment of personnel, acquisition of capital, and exchange of information based on mutual trust among the members of the network (Werbner 1990).

Furthermore, Eraydin et al. (2005) distinguish between types of social capital. The first, called *bonding capital*, is created via the strong social ties that exist between individuals, family members, close friends, and members of certain ethnic groups. The second is *bridging capital*, which exists between heterogeneous individuals such as friends of friends. A third type is *linking capital*, characterized by connections between individuals, established professional and administrative structures, and local communities (Foord and Ginsburg 2004).

According to Davidson and Honig (2003) (in Ibrahim and Galt 2011), factors in the exogenous environment in which business is conducted, such as the fiscal environment, labor market regulations, administrative complexities, intellectual property rights, and bankruptcy law, will also determine the specific response of ethnic entrepreneurial to establishing a business. Another factor that influences ethnic entrepreneurial decisions in a host country is the propensity for entrepreneurship in the country from which they or their families emanate. The historic differences between countries in the rate of entrepreneurship will influence the likelihood of individuals becoming entrepreneurs (Sternberg and Wennekers 2005; Wennekers, Uhlaner, and Thurik 2002) (in Ibrahim and Galt 2011).

Conclusion and Future Directions

Diversity is discussed in different literature: economy, management, sociology, anthropology, and so forth. Most authors focus their research on the relationship between culture and/or ethnicity and entrepreneurship, even though diversity involves other factors such as gender, age, and disability. This discussion highlights the fact that the culture of immigrants as much their ethnicity can affect, positively or negatively, self-employment. Many factors lead ethnic people to entrepreneurship: the existence of ethnic and social networks, labor and capital conditions, gender and age, racial background, and contingency factors such as institutional environment, geographic context, and so on. The model of Ilhan et al. (2011) (Fig. 1) summarizes the characteristics of entrepreneurship, taking into account all contingency factors. In this figure, the authors suggest that the environmental context, such as socioeconomic context, institutional concept, cultural background, financial factors, labor market, and geographic context, influence the outcomes on an individual level, organizational level, and country level. The environmental context elements are directly linked to the pull and push factors, such as social network, gender, and demographic factors. On the other hand, pull and push factors may influence the characteristics of international ethnic entrepreneurship, while the scale, the scope of the industry, and the structural factors may influence the outcomes and the pull and push factors.

Gender studies deserve further study because, in certain cultures or ethnic groups, women turn to entrepreneurship in order to be independent and/or to make a living for their family. Furthermore, exploring diversity from the perspective of economic competitiveness could be an interesting complement to studies of immigration and entrepreneurship.

Cross-References

▶ Entrepreneurship and Social Inclusion
▶ Entrepreneurship in International Context
▶ Environmental Determinants of Entrepreneurship
▶ Female Entrepreneurship
▶ Microfirms
▶ National Culture
▶ Network and Entrepreneurship
▶ Small Business
▶ Social Networks and Entrepreneurship

References

Baycan-Levent T, et al. Diversity and ethnic entrepreneurship: dialogue through exchanges in the economic arena. Sustainable Development in a Diverse World (susdiv.org). 2003.

Bogan V, Darity W. Culture and entrepreneurship? African American and immigrant self-employment in the United States. J Socio Econ. 2008;37:1999–2019.

Eraydin A, et al. Diversity matters: immigrant entrepreneurship and contribution of different forms of social integration in economic performance of cities. Eur Plan Stud. 2010;18(4).

Hampden-Turner C, Chih G. Dilemmas of diversity: a new paradigm of integrating diversity. World Future. 2010;66:192–218.

Ibrahim G, Galt V. Explaining ethnic entrepreneurship: an evolutionary economics approach. Int Bus Rev. 2011;20:607–13.

Ilhan-Nas T, et al. International ethnic entrepreneurship: antecedents, outcomes and environmental context. Int Bus Rev. 2011;20:614–26.

Pecoud A. What is ethnic in an ethnic economy? Int Rev Sociol. 2010;20(1):59–76.

Ram M, et al. Ethnic minority business in comparative perspective: the case of the independent restaurant sector. J Ethn Migr Stud. 2000;26(3):495–510.

Sobel R, et al. Does cultural diversity increase the rate of entrepreneurship? Rev Austrian Econ. 2010;23:269–86.

Diversity Entrepreneurship

▶ Female Entrepreneurship

Divestment Spin-Off

► Extrapreneurship

Dreaming

► Imagination

Dotcoms

► Startup

Dynamic Generation

► Imagination

E

Ecclesia

► Creativity and Church

Eco-Innovation

► Technology Push and Market Pull Entrepreneurship

Economic Development

► From Personal to Impersonal Exchange in Ideas
► Innovation and Entrepreneurship

Economic Dynamics

► Creative Destruction

Economic Evolution

► Entrepreneur and Economists

Economic Model

► Business Model

Economic Theory

► Entrepreneur and Economists

Ecosystem

► Academic Firm

Ecosystems

► Systems Theory and Innovation

Education

► Promoting Student Creativity and Inventiveness in Science and Engineering

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Education, Discourses

▶ Creativity, Discourses

Effects of Intuition, Positive Affect, and Training on Creative Problem Solving

Joshua Fairchild[1], Dawn Eubanks[2] and Samuel T. Hunter[1]
[1]The Pennsylvania State University, State College, PA, USA
[2]Behavioural Science and Strategy, Warwick Business School, The University of Warwick, Coventry, UK

Synonyms

Creative performance; Innovation; Instinct; Learning; Mood; Unconscious awareness

Intuition and Creative Problem Solving

The ability to solve problems creatively is an essential element of success for individuals and organizations (Scott et al. 2004). As such, a thorough understanding of this process would be immensely beneficial, and is of paramount importance for enhancing performance on creative tasks. However, creative problem solving is a complex phenomenon that is influenced by numerous contextual factors and individual differences. Thus, deciphering the key influences on this process remains a core concern of creativity researchers, who have identified many factors that exert such an impact. Among these myriad elements, intuition appears to be especially important (Bowers 1987).

Scholars have defined intuition in numerous ways. However, there are several common elements across these definitions. In examination of these similarities, Eubanks, Murphy, and Mumford (2010) define intuition as a process that involves the development of an unconscious pattern that guides performance, problem solving, and decision making on complex tasks. In accord with this definition, there are three key characteristics of intuition:

1. Intuition involves the use of minimal information to identify patterns.
2. Intuition may occur through unconscious processes.
3. Intuition can influence performance on complex tasks.

In sum, intuition involves the unconscious manipulation of information as part of the problem-solving process. In order to understand how this may impact creative performance in particular, it is vital to examine the theoretical background of this and related constructs, as well as empirical research on this topic.

Overview and Theoretical Background

Baylor (2001) notes that definitions of intuition involving subconscious pattern formation and recognition must at some level involve implicit or tacit knowledge. Such knowledge is typically acquired unconsciously as a result of experience, and can be beneficial in complex problem-solving tasks, in part by giving rise to intuition (Reber 1989). Such an approach to problem solving is essential in the realm of creative performance, where problems are often ill defined, and connections between various elements may be ambiguous (Mumford and Gustafson 1988).

A related principle that is similarly valuable for creative problem solving is expertise. Indeed, intuition may in part be developed as a function of expertise (Baylor 2001). Similar to the way that intuition allows subconscious patterns to influence performance, expert performance is largely driven by unconscious recognition of patterns rather than conscious decision making (Shanteau 1992). Indeed, expert performance often relies on making quick judgments without time for reflection (Simon 1990; Shanteau 1992). Such performance develops over a long period of continued practice, through which an individual becomes increasingly familiar with his or her focal domain (Ericsson and Charness 1994). Cognitive theory on working memory suggests that as individuals gain expertise in a domain, they develop schema that enhance their ability to hold multiple elements of a problem in working memory (Baddeley 2007). Since the ability to make connections and determine patterns among information is reliant on what a person can maintain in working memory (Baddeley 2007), expertise may serve to facilitate intuition by directly enhancing this resource.

Furthermore, as an individual develops expertise, he or she forms a mental model of the domain, which serves to drive future decision making (Hill and Levenhagen 1995). In line with research on intuition, expert performance often relies on proceduralization, through which unconscious connections among prior experiences and ideas drive work-related behavior (Shanteau 1992). Thus, expertise often leads to increased subconscious processing of information and, therefore, more decisions that are driven by intuitive judgments.

Examining the influence of expertise can provide some possible explanations for the development of intuition. However, it must be remembered that while expertise and intuition are related constructs, they are not synonymous; intuition is capable of influencing performance beyond the effect exerted by expertise alone (Eubanks et al. 2010). Therefore, in order to more fully understand how intuition can impact creativity, it is necessary to examine some specific mechanisms by which intuitive judgments may occur.

In a synthesis of the extant literature, Eubanks and colleagues (2010) identify three competing interpretations of mechanisms by which intuition may impact creative problem solving. First, intuition may influence problem solving by triggering unconscious associations between contextual cues and salient affective experiences (Simonton 1980). According to this view, intuition results when aspects of the problem at hand trigger networks of associations related to affectively laden prior experiences. This is thought to induce the emergence of unconscious patterns, which in turn inform decisions.

In contrast, Johnson-Laird (1983) suggests that mental models form the basis for intuitive judgments. Such an approach posits that when an established mental model is activated and applied to a situation, it can lead to the individual making decisions about elements of the present situation that are consistent with the established mental model. This effect mirrors cognitive literature on satisficing, in which the activation of established heuristics can lead individuals to make snap decisions, based on the manner in which previously synthesized patterns of information can be applied to a current problem (Simon 1990).

Finally, Gresov (1989) suggests a fit appraisal-based approach to intuition. According to this perspective, when an individual's established mental model fits the current situation well, he or she subconsciously identifies similarities between the model and elements of the situation. These similarities then give rise to the patterns of associations involved in intuitive problem solving. It is worth noting that these theoretical approaches have not been thoroughly evaluated with regard to their influence on intuition and problem solving. However, these approaches may serve as jumping-off points for interventions to enhance intuition and improve problem solving, such as training programs. Such programs are discussed in more detail in a subsequent section. Before discussing such interventions to enhance intuitive problem solving, it is necessary to understand how intuition can be assessed at the individual level.

Measurement of Intuition

Research on intuition has demonstrated that it exists in part as a function of individual differences. That is, the ability and desire to act on intuition as a mechanism for problem solving varies among individuals. Although training and expertise within a domain may influence how intuitive a given individual may be (e.g., Baylor 2001), people do in fact have a baseline level of intuition that impacts performance. For instance, research by Bowers and colleagues (e.g., Bowers 1987) found that individuals were able to develop solutions to problems for which insufficient information was available. Specifically, participants were able to identify connections among elements within the problem and develop valid predictions about the solution before being presented with sufficient information to identify the correct solution. Furthermore, individuals differed not only in their ability to make intuitive judgments, but also in their willingness to propose solutions that were based on such intuitions. Additionally, Eubanks and colleagues (2010) note that such judgments can be useful tools in the process of creative problem solving.

In light of such individual differences, the measurement of intuition at the individual level becomes an important issue. Westcott (e.g., Westcott 1961; Westcott 1966) developed such an instrument to assess individual intuition. This instrument involved presenting individuals with 20 analogical problems to solve and allowing them the opportunity to request additional clues if they felt it necessary. Participants were found to differ both in the number of problems they solved correctly and also in the number of clues requested and their confidence in their proposed solutions. Westcott and colleagues identified intuitive individuals as those who correctly solved the greatest number of problems with the fewest clues.

This measure has demonstrated reasonable test-retest reliability, as well as construct validity (in terms of relationship with cognitive ability measures). However, this instrument is not without criticism, particularly with regard to its domain relevance. That is, critics suggest that the use of analogical problems has limited real-world applicability, and that there is a lack of evidence that this test is predictive of creative problem-solving performance (for further discussion, see Eubanks et al. 2010). More recently, Eubanks and colleagues (2010) devised a problem-solving task that assessed intuition in a creative domain. In their study, individual intuition was found to be a positive predictor of creative performance, particularly in terms of the quality and elegance of participants' solutions. It was suggested that solution elegance in particular may benefit from intuitive problem solving; elegance is an assessment of how well the components of a solution fit together and flow (Besemer and O'Quin 1999), and thus, highly intuitive people are more likely to produce such solutions due to their predisposition to unconsciously attend to patterns and themes.

Influences on Intuitive Performance

Numerous factors may influence the impact of intuition on creative problem-solving performance. In particular, individuals' level of positive affect is thought to be a key predictor of problem-solving success, and a major potential influence on intuitive performance. Research has demonstrated that positive affect predicts creative performance in particular, and that such effects are due to changes in thought processes, and not simply an increase in individuals' motivation (e.g., Isen 1993; Estrada et al. 1994). For example, a study of doctors found that inducing positive affect led to earlier correct judgments about patients' diseases (Estrada et al. 1994). Furthermore, relative to doctors who did not receive this affect manipulation, those who did integrated a larger number of sources and were less prone to making errors in their diagnoses.

Particularly relevant to the present discussion, research suggests that positive affect can influence problem-solving performance by inducing intuitive behavior (Eubanks et al. 2010). When positive affect is high, people are better able to generate patterns in information, incorporate a greater variety of information into such patterns, and identify similarities and differences within such patterns (Isen and Daubman 1984; Kahn and Isen 1993). Recent research has supported the role of positive affect as a moderator of the intuition-creative performance relationship. Specifically, Eubanks and colleagues (2010) found that inducing positive affect was associated with higher quality solutions for individuals low on intuition. However, inducing positive affect was also associated with a decrease in the quality of solutions proposed by highly intuitive individuals. It is possible that such a decrease is a result of decreased critical assessment due to participants' increased positive affect (Eubanks et al. 2010). A similar trend was observed for the originality of solutions proposed by these individuals. These findings suggest that while positive affect may enhance creative performance when individuals are not inherently intuitive, affect manipulations also have the potential to impair creative performance in certain circumstances. As such, it is important to consider additional factors that may influence the relationship of intuition with creative performance. In particular, training individuals to successfully cultivate and harness intuitive judgments may be especially beneficial.

Although intuition exists in part as a relatively stable individual characteristic, research on the relationship between expertise and intuition suggests that training may serve to enhance intuitive performance (Ericsson and Charness 1994; Baylor 2001). Cognitive theory suggests that the development of expertise (such as through a training regimen) results in the proceduralization of declarative knowledge (e.g., Berry and Broadbent 1984). Such a process is associated with the development of tacit knowledge, which was previously stated to be associated with the development and activation of intuition (Reber 1989).

It is thought that individuals trained to both recognize and apply intuitive judgments to the problem-solving process will perform better on creative problem-solving tasks. In particular, training may influence the relationship between intuitive understanding of a problem and subsequent creative performance. For instance, providing training on relaxation strategies is thought to enhance the effects of intuition of creative performance (e.g. Markley 1988).

Although it can be argued that training can influence the relationship between intuition and creative performance, it is noteworthy that approaches to intuition-based training programs may vary, depending on the perspective on intuition that one takes. That is, each of the three perspectives on intuition discussed previously likely would point to very different training programs. For instance, the associational approach to intuition (Simonton 1980) would recommend training programs that emphasize strategies to build and strengthen the associational networks that are thought to provide the underpinnings of intuition. Such an approach would likely promote exploration of one's environment and salient experiences, in order to develop more material to drive future intuitive judgments. In contrast, a mental model–based approach (Johnson-Laird 1983) would likely focus on exercises to enhance the recognition and activation of patterns of information. Such a recommendation is consistent with literature in the field of expert performance (e.g., Shiffrin and Schneider 1977), which suggests that highly trained experts rely heavily on automatized processes and previously synthesized information to make judgments. Finally, the fit appraisal approach to intuition (Gresov 1989) would likely involve providing trainees with opportunities to practice appraising situations in order to identify elements that are congruent with or dissimilar to established mental models. Further review and commentary on the characteristics of successful creative performance training programs may be found in Scott, Leritz, and Mumford (2004).

In order to further examine the effects of training on intuition and creative problem solving, Eubanks and colleagues (2010) developed a self-paced training program that provided training based on one of the three approaches to intuitive problem solving described previously. A fourth experimental condition received no such training and served as a control group. Findings in this study demonstrate the interconnectedness of intuition, training, and positive affect. For three dimensions of creative performance (quality, originality, and elegance; see Besemer and O'Quin 1999), training resulted in greater performance for individuals with neutral affect, relative to untrained individuals. However, individuals who experienced induced positive affect and did not receive training outperformed individuals who received both a training program and the affect induction. It is suggested that training programs may require individuals to switch from their typical preferred problem-solving strategies, whereas positive affect can enhance the efficacy of existing strategies, resulting in greater performance increases (Eubanks et al. 2010).

It is further noteworthy that, although all three training approaches demonstrated increased creative performance for individuals with neutral affect, an approach centered on strengthening individuals' mental models of the design space demonstrated reduced gains in terms of solution originality, relative to other training programs. It may be the case that reliance on existing connections among constructs and ideas (in the form of established mental models) may result in the development of solutions that are less novel than those developed from approaches emphasizing the development and evaluation of new patterns and associations.

Conclusion and Future Directions

Current findings demonstrate that intuition can be measured as an individual difference (e.g., Westcott 1966), and that individual variability in intuition can predict creative performance (Eubanks et al. 2010). Furthermore, also at the individual level, positive affect has been found to impact the effects of intuition on creative problem solving, particularly with regard to the quality of solutions devised (Eubanks et al. 2010).

Such empirical studies are a relatively recent addition to the body of literature on intuition and creative problem solving, and continued scholarly pursuits in this field will likely yield further gains. Specifically, recent work suggests the need to further examine the contexts in which affect most strongly impacts the intuition-creative performance relationship. Such research demonstrates that positive affect may in effect substitute for intuition in the creative problem-solving process. This also points to the importance of developing interventions to capitalize on this relationship. For instance, it would be fruitful for studies to examine when it may be most effective to provide affect-enhancing cues, and when it may be more valuable to provide potentially drier, but perhaps more informative directions.

Researchers also need to further investigate the conditions under which training may best enhance the effect of intuition on creative performance. Recent empirical research has provided preliminary evidence for such effects, but the conditions under which potential gains are maximized needs to be studied in more detail. Furthermore, additional moderators of this relationship (such as positive affect) should be tested more fully.

From a theoretical perspective, scholars in this area need to further advance their understanding of the factors that give rise to intuitive behavior in the realm of creative problem solving. Among the perspectives described in the extant literature, those that have been examined empirically seem to be similarly effective in many circumstances. This points to the likelihood that these apparently varied approaches may operate on similar theoretical underpinnings. Further studies to identify what these commonalities may be, and how they operate, could provide a better understanding of the phenomenon of intuition.

Finally, this body of literature has implications for the broader study of creative problem solving. In particular, research on intuition in problem solving (Eubanks et al. 2010) shows that intuition likely does not have a uniform, positive impact on all aspects of creative solutions. That is, highly intuitive individuals who draw heavily on prior experiences may not produce more original solutions than less intuitive people. Instead, solutions devised by these individuals are likely to excel on other dimensions of creative performance, specifically solution quality and elegance. This differential impact not only implies that outcomes of intuitive problem solving must be examined in terms of multiple constructs, but also underscores the importance of evaluating creative performance as a multifaceted construct (Besemer and O'Quin 1999). Thus, further study of intuition in creative problem solving has the potential to enhance our understanding of both intuition as a construct, and also of creative performance as a complex outcome.

Cross-References

- ▶ Cognition of Creativity
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Mental Models and Creative Invention

References

Baddeley AD. Working memory, thought and action. Oxford: Oxford University Press; 2007.

Baylor AL. A U-shaped model for the development of intuition by level of expertise. New Ideas Psychol. 2001;19:237–44.

Berry DC, Broadbent DE. On the relationship between task performance and associated verbalisable knowledge. Q J Exp Psychol. 1984;36A:209–23.

Besemer SP, O'Quin K. Confirming the three-factor creative product analysis matrix model in an American sample. Creativ Res J. 1999;12:287–96.

Bowers KS. Intuition and discovery. In: Stern R, editor. Theories of the unconscious and theories of the self. Hillsdale: The Analytic Press; 1987. p. 71–90.

Ericsson KA, Charness N. Expert performance: its structure and acquisition. Am Psychol. 1994;49(8):725–47.

Estrada CA, Isen AM, Young MJ. Positive affect improves creative problem solving and influences reported source of practice satisfaction in physicians. Motiv Emot. 1994;18:285–99.

Eubanks DL, Murphy ST, Mumford MD. Intuition as an influence on creative problem-solving: the effects of intuition, positive affect, and training. Creativ Res J. 2010;22(2):170–84.

Gresov C. Exploring fit and misfit with multiple contingencies. Adm Sci Q. 1989;34:431–53.

Hill RC, Levenhagen M. Metaphors and mental models: sensemaking and sensegiving in innovative and entrepreneurial activities. J Manage. 1995;21(6):1057–74.

Isen AM. Positive affect and decision making. In: Lewis M, Haviland JM, editors. Handbook of emotions. New York: Guilford; 1993. p. 261–77.

Isen AM, Daubman KA. The influence of affect on categorization. J Pers Soc Psychol. 1984;47:1206–17.

Johnson-Laird PN. A computational analysis of consciousness. Cogn Brain Theory. 1983;6:499–508.

Kahn BE, Isen AM. The influence of positive affect on variety seeking among safe, enjoyable products. J Consum Res. 1993;20:257–70.

Markley OW. Using depth intuition in creative problem solving and strategic innovation. J Creativ Behav. 1988;22:85–100.

Mumford MD, Gustafson SB. Creativity syndrome: integration, application, and innovation. Psychol Bull. 1988;103:27–43.

Reber AS. Implicit learning and tacit knowledge. J Exp Psychol: General. 1989;118(3): 219–35.

Scott GM, Leritz LE, Mumford MD. The effectiveness of creativity training: a meta-analysis. Creativ Res J. 2004;16:361–88.

Shanteau J. Competence in experts: the role of task characteristics. Organ Behav Hum Decis Process. 1992;53: 252–66.

Shiffrin RM, Schneider W. Controlled and automatic human information processing: II. Perceptual learning, automatic attending, and a general theory. Psychol Rev. 1977;84(2):127–190.

Simon HA. Invariants of human behavior. Annu Rev Psychol. 1990;41:1–19.

Simonton DK. Intuition and analysis: a predictive and explanatory model. Genet Psychol Monogr. 1980;102:3–60.

Westcott MR. On the measurement of intuitive leaps. Psychol Rep. 1961;9:267–74.

Westcott MR. A note on the stability of intuitive thinking. Psychol Rep. 1966;19:194.

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Effectuation

▶ Business Emergence

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▶ Institutional Entrepreneurship

Embeddedness

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► Self-made Man
► Social Capital of the Entrepreneur
► Social Entrepreneurship

Entrepreneur – Change Agent, Promoter, Broker

► Institutional Entrepreneurship, Innovation Systems, and Innovation Policy

Entrepreneur and Economists

Sophie Boutillier
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Creation of activities; Economic evolution; Economic theory; Individual initiative; Innovation

Introduction

The objective of this text is not to present an exhaustive analysis of the economic theories of the entrepreneur but by revisiting the works of a few key economists, to develop a reflection on the evolution of the role of the entrepreneur in today's capitalist society. We should underline an apparent contradiction between two phenomena: the growing number of scholars of entrepreneurship (especially from the beginning of the 1980s) (Landström and Lohrke 2010; Boutillier and Uzunidis 1995) and the greater importance of large enterprises in today's capitalism, despite numerous new business start-ups (Microsoft, Apple, Google, Facebook, etc.). Even if it appears to be the result of the "destructive creation" of Schumpeter (1942; Boutillier and Uzunidis 1995), which is the process of the continuous technological and organizational change of capitalism, the recent progress in new technologies of information and communications offers new opportunities of profit and investment for entrepreneurs. However, from the beginning of the 1980s, economists' interest in entrepreneurship can be explained by the development of self-employment and the increase in the number of small businesses. Indeed, governments have sought an answer to employment problems by promoting the creation of new businesses. Conversely to this, subsequent to the period of economic growth from 1945 to 1975 in industrialized countries, since the end of the 1970s, the increase in salaried employment has slowed down.

We highlight that this economic evolution is taking place in a new historical context characterized by the rise of financial markets. Entrepreneurship has emerged as a specific field of research in economics since the beginning of the 1980s. This period was characterized by two linked phenomena: (1) the end of the economic growth period (1945–1975) and (2) the failure of Keynesian policy. This new economic evolution would be based on a radical economic and political change. Thus, the challenge was to find a new economics dynamic based on a new institutional structure, in other words, a new institutional structure to promote free markets and entrepreneurship (private initiative).

Between the end of the 1950s and the end the 1970s, the entrepreneur, as an economic instrument of change, disappeared from economic theory. Entrepreneur has been replaced by the firm. Baumol (1968) pointed out this weakness of economic theory: "the theoretical firm is entrepreneurless – the Prince of Denmark has been expunged from the discussion of Hamlet" (Audretsch et al. 2011, p. 166). The entrepreneur does not exist in the neoclassical model, even if he is a central figure of capitalism. How can you explain this situation? Can it be explained by the development of managerial capitalism? Certainly, but the answer can be found not only in economic facts but also in economic theory. Two main elements can be suggested: (1) since the mid-twentieth century, economics as a science has become increasingly formalized and mathematically oriented. "An approach that made it difficult to include the entrepreneur in the models of economics" (Landström and Lohrke 2010, p. 25). (2) The neoclassical theory with Walras' model has reduced the entrepreneur to a decision-maker. Three economists founded the theory of the entrepreneur: Richard Cantillon, Jean-Baptiste Say, and Joseph A. Schumpeter. They brought to bear three basic elements: uncertainty, risk, and innovation. Paradoxically, profit does not take a lot of place in the economic theory of the entrepreneur. To be an entrepreneur seems to be a game or in other words a challenge to change economic routines.

Entrepreneurs and Key Economists

Historical Contexts

Nevertheless, the entrepreneur, as an economic concept, appeared at the beginning of the eighteenth century with Richard Cantillon. For economists, the entrepreneur plays an important role in capitalism because he (or she) is a source of innovation (technical or social). Three historical economists founded the theory of entrepreneurship: Richard Cantillon (approx 1680–1734) in the eighteenth century, Jean-Baptiste Say (1767–1832) in the nineteenth century, and Joseph A. Schumpeter (1883–1950) in the twentieth century. All three brought the same determining elements: uncertainty, risk, and innovation. To summarize, the entrepreneur, as an economic function, embodied the continuous economic evolution of capitalism.

The Classical Age: Beginning of the Industrial Revolution

Since the early contributions in the eighteenth century, the entrepreneur has personified the uncertainty of the free market. Cantillon created his theory during the first industrial revolution, at the beginning of the eighteenth century, during a period when governments had an important economic influence. The objective of mercantilist policy was to promote the creation of big public enterprises and to limit economic dependence on other countries. War was a tool for governments to collect new wealth that they could not get though international trade or by their own economic development. According to R. Cantillon, the fundamental role of the entrepreneur is to make decisions in an uncertain economic context. In the *Essay on the Nature of Commerce in General* (published in 1755), the entrepreneur is described as a risk-taker who bears uncertainty. The entrepreneur takes risks because he buys a product with a definite price, but he sells the same product for another price which can be lower or higher. Cantillon does not offer in this text a precise definition of uncertainty. Cantillon, basically defines uncertainty as the inability to predict a future state or condition.

The Maturity of the First Industrial Revolution

J.-B. Say is, like Cantillon, a liberal economist. In his *Traité d'Economie Politique* ("Handbook of Political Economy" published in 1803), Say presents a theoretical model which is based on the free market, the basic engine of the economic process. The well-known Say's law illustrates this conception of the economic process. In this framework, the fundamental role of the entrepreneur is to innovate. The entrepreneur is a middleman between the scientist who produces knowledge and the worker who uses it to develop new industrial activities. Thus, Say emphasizes that the role or the entrepreneur consists of combining the factors of production into an organization. The entrepreneur has a coordinating role in production and distribution. But J.-B. Say does not show the links between his economic law and the place and the role of the entrepreneur in this economic context. Thus, if the goal of Say was to personify the invisible hand of Adam Smith, the result was very disappointing.

The Beginning of the Managerial Capitalism

J. A. Schumpeter, in *The Theory of Economic Development* (published in 1911), underlines that the entrepreneur is the economic individual who realizes new "productive combinations." Schumpeter provides an exhaustive list of typical opportunities for entrepreneurs who recognize and exploit them (Bonnet et al. 2010, p. 56):

1. The introduction of a new good – that is one with which consumers are not yet familiar – or of a new quality of good.
2. The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially.
3. The opening of a new market, that is, a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market existed before.
4. The conquest of a new source of supply of raw material or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created.
5. The carrying out of the new organization of any industry, like the creation of a monopoly position (for example though trustification, or the breaking up of a monopoly position.

To summarize, Schumpeter provides five sources of change and profit. Schumpeter underlines that the entrepreneur is embedded in society. He is not atomistic, isolated, and immersed in a process quite different from the other social phenomena. Schumpeter develops his theory of the entrepreneur on the critical analysis of Walras. The Walras' model is static (competitive equilibrium context). However, two Walras' hypotheses have determining implications for the behavior of entrepreneurs, the hypothesis of market atomicity and the hypothesis of perfect information:

1. Entrepreneurs have equal access to the same risky ideas or technology and receive all the profit from risk-taking.

2. Entrepreneurs have access to the same information. They do not have a specific strategy in the competitive process. Entrepreneurs are always and everywhere maximizers.

The Scientific Project of Schumpeter

The scientific project of Schumpeter is to create a new economic theory because the Walras' model cannot explain the movement of capitalism (crisis, recession, growth, and technological change). In Schumpeter's theory, the entrepreneur plays an important role as an engine of change. The Schumpeterian entrepreneur is not rational (according Walras). If entrepreneur's objective is profit, it is also to call into question the organizational and productive routines.

But Schumpeter has been influenced by another famous neoclassical economist, Carl Menger (1840–1921). Menger's theory is fundamentally different from that of Walras' theory as a means of understanding entrepreneurial behavior. For Menger, individuals are heterogeneous, and they do not make decisions consequent on behavior of absolute maximization, but relatively. In other words, two economic individuals equipped with the same resources may behave in very different ways (contrary to Walras' theory). In Menger's model, uncertainty plays an important role, in contrast to Walras. The influence of Menger on Schumpeter's thinking was very important, even if this subject is not often developed by economists. Menger was a marginalist economist like Walras, but he drafted a theory which is the opposite of the economic rationality of Walras. According to Walras, economic rationality is based on a strict calculation between resources (capital or work) and a gain (profit or salary). Each economic group is homogeneous (capitalists, entrepreneurs, workers, or consumers). Menger's approach emphasizes the subjectivity of economic values. Menger's entrepreneur does not exist in a context of certainty (as Walras says). In an uncertain context, the entrepreneur has to find information and knowledge to build his own strategy. Focusing on the uncertainty angle, Menger picks up a theme introduced by Cantillon, who is often considered as the forerunner of Austrian thought. In Menger's model, uncertainty plays an important role, the opposite of Walras'.

The Schumpeterian concept of "creative destruction" summarizes the three elements which founded the economic theory of entrepreneurship: "capitalism (. . .) is by nature a form or method of economic change and not only never is, but never can be, stationary" (Boutillier and Uzunidis 1995, pp. 34–37). Schumpeter says that "creative destruction" is the "essence of capitalism." Thus, if the entrepreneur is the engine of change, then Cantillon, Say, and Schumpeter were themselves an engine of change of economic theory: Cantillon's theory criticized the Mercantilist theory and the high power of the state. Say's theory questioned the Smithian economic model and the theory of the "invisible hand." Schumpeter debates the Walrasian theory based on perfect competitive market structures. In addition, Cantillon, Say, and Schumpeter shaped a new economic paradigm. Beyond this proposition, another common characteristic links these three theories: the entrepreneur does not represent a person but a process or a function, not an employment category nor a start-up enterprise. In this sense, the entrepreneur is a kind of ideal type (according to Max Weber's definition). The entrepreneur personifies the evolution of capitalism at three different stages of its history: at the beginning of the eighteenth century with Cantillon (i.e., at the beginning of the first industrial revolution), at the beginning of the nineteenth century for Say (i.e., at a mature stage of industrial capitalism), and Schumpeter during the emergency of managerial capitalism. In other words, the historical context underlies economic theory.

Schumpeter Between Marx and Walras

Schumpeter created the concept of the entrepreneur to improve Walrasian theory, but in so doing, he follows Marx on the subject of the end of capitalism. According to Marx, capitalism would collapse because the system was programmed to fail. On the other hand, Schumpeter also feels that capitalism should collapse despite its outstanding and sustained success. But, they think in common that small enterprises will disappear. In the future, the economic system will be only composed of large firms that will plan the world economy. According to Schumpeter, the entrepreneur will disappear in this new scheme because the mechanism of innovation will be based not on an individual economic actor (the entrepreneur) but on an organization (the big enterprise): "Economic progress tends to become depersonalized and automatized. Bureau and committee work tend to replace individual action" (Schumpeter 1942, p. 133). Like Marx at the middle of the nineteenth century, Schumpeter was not the only economist who developed this idea. Alfred Marshall did so too, and a few years later, in the 1930s, Ronald Coase explained in a well-known article "The Nature of the Firm" (1937) the evolution of the market between large and small enterprises. He describes a dialectical process where large and small firms play a defined role according to the economic context (growth or recession) and the intensity of the uncertainty.

The End of the Entrepreneur: The End of the Capitalism?

Does the Entrepreneur Exist in Managerial Capitalism?

The main eccentric aspect of Schumpeter's analysis was the link between the extinction of the entrepreneur and the end of capitalism. It seems that he was influenced by the analysis of Karl Marx about the end of capitalism and the transition toward socialism and afterwards toward communism. The entrepreneur who was the central figure of capitalism disappears. For Schumpeter, like Marx, it is not a proletarian revolution which will kill capitalism. Capitalism will be destroyed by its own forces: the free market and competition. The managerial enterprise takes the place of the entrepreneur as an economic performer. Nonetheless, the "enterprise" takes the place of the "entrepreneur." Thus, after the Second World War, economists forgot completely the entrepreneur and focused their attention on the firm. But, according to E. Penrose (1959), the term "entrepreneur" can be used to refer to individuals or groups. So the concept of "entrepreneurial services" which are "those contributions to the operations of a firm which relate to the introduction and acceptance on behalf of the firm of new ideas, particularly with respect to products, location, and significant changes in technology, to the acquisition of new managerial personnel, to fundamental changes in administrative organization of the firm, to the raising of capital, and to making of plans for expansion, including the choice of method of expansion" (Penrose 1959, p. 31 ref). Before Kirzner, Penrose links the entrepreneur to the decision process based on the discovery of opportunities: "the decision to search for opportunities is an enterprising decision requiring entrepreneurial intuition and imagination and must precede the 'economic' decision to go ahead with the examination of opportunities for expansion" (Penrose 1959, p. 34, ref). In this way, the entrepreneur exists in a managerial economy. So in fact, the fundamental question is not the end of the entrepreneur and capitalism but the evolution of capitalism (accumulation and concentration of capital) along with the evolution of the role of the entrepreneur.

Uncertainty, Market, and Entrepreneur

Nevertheless, two contemporary economists, Franck Knight (1885–1972) and Israel Kirzner (1930–) have developed a theory of the entrepreneur exclusively based on uncertainty. So they take their place in the analytical field opened by Cantillon 200 years earlier. Frank Knight, in *Uncertainty and risk* (published in 1921), underlined the existence of a direct relation between the entrepreneur, uncertainty, profit, and risk. Knight defines uncertainty is terms of the entrepreneur's inability to accurately predict a future situation. Knight makes a key distinction between risk and uncertainty. According to Knight, the term risk properly used refers to situations in which the possibility of these outcomes can be expressed in terms of mathematical probabilities before a decision is made. Thus, under conditions of risk, the decision-maker is able to insure against possible negative outcomes. Within Knight's context, uncertainty represents "defects of managerial knowledge," and it is these defects that account for profit and loss.

Under conditions of uncertainty, decision-makers are not able to insure against possible negative outcomes because not only are they unable to predict the probability that any specific outcome will occur, but they are unable to meaningfully foresee the true range of possible outcomes. But like Schumpeter, according to Knight, the entrepreneur represents an economic function, not a person. Knight things in the context of managerial capitalism based on a collective management between shareholders and managers.

According to Israel Kirzner, the entrepreneur is not a hero, or in other words, anybody can be an entrepreneur, because the capitalist economy gives a large range of opportunities of profit. In *Discovery, Capitalism, and Distributive Justice* (published in 1969), Kirzner develops the analysis of the entrepreneur in two ways. The first follows Menger's theory. Even if the entrepreneurial theory has been influenced the other economists, mainly F. von Hayek, according to Kirzner, the role of the entrepreneur is to coordinate information as part of the process of division of knowledge. Like Menger, Kirzner does not consider the entrepreneur as a rational economic player who makes decisions in a certain context. The Menger entrepreneur exists in an uncertainty context. But, the main teaching of Menger's theory is the analysis of the "entrepreneurial alertness." In Kirzner's theory, profit opportunities result from prices, quantities, and qualities that diverge from their equilibrium value. Some individuals tend to notice, or be alert to, these opportunities, and their actions bring about changes in prices, quantities, and qualities. The entrepreneur is alert to a new product or a superior production process and steps into this market gap before others (Foss and Klein 2010, p. 105). The entrepreneur of Kirzner is a discoverer, not an innovator. Entrepreneur discovers new resources uses, new products, new markets, and new possibilities for profitable trade.

As stated above, the Kirznerian entrepreneur exists in an uncertainty context. One of the main functions of Kirznerian entrepreneur is to discover new knowledge about which products, processes, new organizational forms, etc. are needed. Thus, Kirzner builds a theoretical link between Cantillon's, Knight's, and Schumpeter's approach. This statement is confirmed by the role played by Kirzner's entrepreneur in the process of innovation. Even if Kirzner talks about "discovery" and not "innovation" like Schumpeter, his entrepreneur consists not of a category of employment or an enterprise but a "pure entrepreneur." In other words, the Kirznerian entrepreneur is an economic function or a kind of metaphor. He embodies the economic evolution of capitalism. For example, Kirzner argues that the entrepreneur is a "nonowner." As Schumpeter underlines, nobody can be an entrepreneur for all his life. The entrepreneur is an entrepreneur only when he creates innovation, so usually only for a short period of time.

The Entrepreneurial Society

According to David B. Audretsch (2007), "the entrepreneurial society had replaced the managed economy" (2007, p. 19). The "managed economy" was based on large firms, or in other words: conformity, monotony, rigidity, and homogeneity. The entrepreneurial society is based on entirely different values: nonconformity, autonomy, creativity, and self-reliance. The entrepreneurial society offers a large range of new opportunities. Workers can rapidly change jobs. Audretsch illustrates his book, *The Entrepreneurial Society*, with different cultural references from the 1960s: Bob Dylan, Janis Joplin, or Jack Kerouac who represented during this decade young people who wanted to change the world. These artists lived in the managed economy, an economy based on mass production and Taylorism, with no opportunity to create. The crisis of the managed economy gives new opportunities in the entrepreneurial field. A new division of labor will develop between small and large firms, reinforcing the notion that mass scale production is not the only criterion of the production organization.

Today, in spite of the development of managerial capitalism, the entrepreneur always embodies capitalism. Entrepreneur personifies his dynamic of change. In this intellectual context, the entrepreneur is not an individual but an economic function.

Entrepreneur and Economists, Table 1 The theory of the entrepreneur (synthesis)

Authors	The entrepreneur is	Theoretical criticism	Historical context
Richard Cantillon 1680–1734	A nonfixed income earner	Against mercantilism and the economic role of the state	Beginning of the first industrial revolution
Jean-Baptiste Say 1767–1832	The matchmaker between the scientist who produces knowledge and the worker who uses this knowledge in an industrial process	To personify the "invisible hand" of Smith	Maturity of the first industrial revolution
Karl Marx 1818–1883	The behavior of the entrepreneur (or capitalist) takes place in a particular economic system – capitalism	To criticize classical theory	
	The contradiction of capitalism		
Léon Walras 1834–1910	The role of the entrepreneur is to maximize his profit in a context of pure competition	To develop a new theory based on classical theory	Beginning of managerial capitalism
	Economic rationality of the entrepreneur		
Carl Menger 1840–1921	The entrepreneur has no place in a context of certainty. He (or she) has to find information and knowledge to build his (or her) strategy.		
Joseph A. Schumpeter 1883–1950	Is an economic function which realizes new combinations of factors of production	To develop Walras' theory of the entrepreneur and Marx's theory about capitalism	
Franck Knight 1885–1972	The entrepreneur faces the market uncertainty that cannot be probabilized	To develop the neoclassical theory of the firm	Maturity of managerial capitalism (fordist firm)
Ronald Coase 1910–	What are the opportunities for creation of enterprises according a dialectical relation between the enterprise and the market?		Maturity of managerial capitalism (network firm)
Edith Penrose 1914–1996	Entrepreneurial services. The entrepreneur can exist in a big enterprise.		
William Baumol 1922	Entrepreneurial activity is crucial for radical innovations and growth		
Mark Casson 1945	Entrepreneurs specialize in taking judgmental decisions about the coordination of scarce resources		
David Audretsch 1954	Creativity of the Entrepreneurial Society		

Conclusion and Future Directions

In economic reality, it is easy to identify entrepreneurs: Rockefeller, Carnegie, Renault, Tata, Gates, or Zuckerberg. But for economists, it is not an easy task. If they are certain that the entrepreneur is the engine of capitalism, they have, in contrast, great difficulty in finding entrepreneurs in economic reality. Since Cantillon, the pioneer of the theory of the entrepreneur, the entrepreneur is a metaphor to explain the capitalist evolution. If the entrepreneur can be identified as an individual, on the other hand, he takes his place in a social context which defines economic and social functions. So, the entrepreneurial function introduces economic and technical change, but it also contributes to the reproduction of a socioeconomic system based on competition and individual property.

So, in this context, we can understand why the entrepreneur exists in managerial capitalism. Entrepreneur, exists under different aspects in large and small enterprises. The entrepreneurial function explains the introduction of technical change in preindustrial society but also the development of new activities at the end of the twentieth century. However, in preindustrial economics, just as in managerial capitalism, the entrepreneur has an important task: to create jobs and first of all his (or her) own job. In an economy based on market mechanism that is the fundamental survival condition (Table 1).

Cross-References

- ▶ Entrepreneur
- ▶ Entrepreneur in Utopian Thinking
- ▶ Entrepreneur: Etymological Bases
- ▶ Heroic Entrepreneur, Theories
- ▶ Schumpeterian Entrepreneur
- ▶ Social Entrepreneurship

References

Audretsch DB. The entrepreneurial society. Oxford: Oxford University Press; 2007.

Audretsch DB, Falck O, Heblich S, Ledrer A, editors. Handbook of research on innovation and entrepreneurship. Cheltenham: Edward Elgar; 2011.

Baumol WJ. Entrepreneurship in economic theory. The American Economic Review. 1968;58(2):64–71.

Bonnet J, Pérez G, de Lema D, Van Auken H, editors. The entrepreneurial society. How to fill the gap between knowledge and innovation. Cheltenham: Edward Elgar; 2010.

Boutillier S, Uzunidis D. L'entrepreneur. Une analyse socio-économique. Paris: Economica; 1995.

Foss NJ, Klein PJ. Entrepreneurial alertness and opportunity discovery: origins, attributes, critique. In The Historical Foundations of Entrepreneurship Research, Hans Landström and Franz Lohrke, eds. Aldershot, U.K.: Edward Elgar; 2010.

Landström H, Lohrke F, editors. Historical foundations of entrepreneurship research. Cheltenham: Edward Elgar; 2010.

Penrose ET. *The Theory of the Growth of the Firm*. Oxford University Press: New York; 1959.

Schumpeter JA. Capitalism, Socialism and Democracy. London: Routledge, 1942.

Entrepreneur in Utopian Thinking

Ferreira Nathalie
Research Network of Innovation, Paris, France

Synonyms

Associationism worker; New social organization; Utopian socialism

Summary

At the end of the nineteenth century, the social question became paramount for many thinkers (Saint-Simon, Fourier, Owen, Buchez, Godin, and Proudhon) who advocated a new society in which fairness and social justice are the pillars. They imagined a society based on small entities of production and consumption using the principle of cooperation between the parties on an equal basis. Some of them, such as Fourier, Owen, and Godin, seek to put their ideas into practice. While none of these thinkers had a defined theory of the entrepreneur (the latter being associated with the capitalist owner), all took the company as a privileged social exchange.

Economic Concepts and Entrepreneurial Utopia

Entrepreneur

According to the dictionary "Petit Robert," the definition of the entrepreneur is "one who undertakes something," "a person who is responsible for the performance of work," or "any person who sets up various factors of production (natural agents, labor, capital) to sell products and services," or "anyone who runs a business on his own behalf and that organizes the various factors of production (natural agents, labor, capital) to sell products or services."

According to the Universal Dictionary of Trade published in 1723, "the contractor" is one who undertakes a work, while during the Middle Ages, "to be an entrepreneur" simply means one who undertakes a task. The definition of entrepreneur has changed its meaning by the sixteenth and seventeenth centuries leading to the definition of Diderot and Alembert, which defines the entrepreneur as "Whoever is in charge of a book"; that definition has changed a little from the one cited above.

It was not until the early eighteenth century that the concept of entrepreneur became a theoretical concept, when the economy became a field of independent thinking and a scientific discipline in its own right.

The first theory of the entrepreneur was developed by Cantillon (1680–1734) who in 1755 published an *Essai sur la nature du commerce en général*. If the word entrepreneur was already used in everyday language, Cantillon gives a rigorous economic meaning. The entrepreneurship is an active process of coordination of production and exchange, channeling goods from production to the final consumers through the exchange markets.

Cantillon defined the entrepreneur as the person buying the factors of production and/or goods at a certain price to sell at an uncertain price. The entrepreneur is seen as a risk taker. Other scholars also place the entrepreneur at the heart of the economic debate.

J-B. Say (1767–1832) follows the work of Cantillon by defining the "business of the entrepreneur." He carefully defines the different levels of intervention in the business and the qualities that must be provided as follows: First, the entrepreneur is the main agent of production. His work is productive as well as that of the worker or the scientist. Second, the entrepreneur must have an "ability to judge," that is to say, the entrepreneur must determine the needs and especially the means of satisfying them. Finally, the entrepreneur shall not rely on the routine and constantly innovate. The entrepreneur is thus placed by J-B. Say in an intermediary place between the scientist, who produced the knowledge, and the worker, who applies that science to industry.

Schumpeter (1883–1950) defines, in turn, a heroic entrepreneur who places his approach at the heart of innovation. He creates a new product not known to the consumer and introduces a new method of production.

The nineteenth century was marked by economic turmoil, social and technological disasters: development of industry and wage labor on a large scale. The working conditions were extremely hard for workers. In these conditions, the social question becomes paramount. A number of thinkers, such as Saint-Simon, Fourier, Owen, Buchez, Godin, and Proudhon, advocated a new society based on small entities of production and consumption under the principles of cooperation between the parties on an equal basis.

While these thinkers are not carefully defined so the economic concept of entrepreneur, all seek to apply their ideas then qualified of "dream economy" or "utopias," the company is, therefore, their instrument of choice.

Utopia

The word utopia, which originates from the title of the famous book by Sir Thomas More's *Utopia* (1516), refers to both a literary genre, a kind of political fiction that attempts, often in a cumbersome and sometimes brutal way, to achieve a form of social organization which is supposed to embody an ideal deemed absolutely good. Since 1516, the term has been used to refer to an ideal or impossible society.

The number of recognized utopias is considerable. However, some recurring themes and structures characterized utopia. Most utopias were born in the heart of the nineteenth century. They were based on egalitarianism and refuted private property. The repeated plea for collective ownership constituted a criticism of societies where private ownership of land or capital was the dominant social institution, and appeared as the primary cause of the ills of these societies. The perception of injustice and human misery lead the authors to imagine a form of organization that could eliminate the causes of these evils.

Many considered that social problems were the product of bad institutions, which distort or thwart the natural tendencies of men. The remedy most often suggested was the brainchild of more liberal and humane institutions capable of encouraging the development and improvement of the individual and the establishment of an education system that could foster the development of the individual. The Utopians preferred to experiment with the economic and social development of a complex economic theory. They generally started with a local action as an example.

The main interest of utopian thinking was to embrace not only the political but also social and economic private life (marriage, education of children, etc.). The formal presentation of a utopia involved the detailed description of an ideal or dreamed world. Utopianism is a way of thinking about the best or happier form of society without concession or compromise with existing institutions.

The Concept of the Entrepreneur in Nineteenth Century Utopians

Claude Henri de Rouvroy, Count of Saint-Simon (1760–1825)

Against the aristocracy, Saint-Simon opposed the new owners who were the purchasers of national property. In the review *L'Industrie (1816–1818)*, the author outlines the main principles of the philosophy on which it is based. Industry is work of any kind, guided by human intelligence, whether manual or intellectual, agricultural, industrial, or commercial. For him, the term "industry" has the same meaning as the term "producer." The farmer is a producer who works to be protected against the owner of private means. It is on the basis of these producers that Saint-Simon wants to rebuild a new society, against those who have no work, either the owners or operators of nonliving shareholders a dividend. Producers are, therefore, opposed to idleness.

In his text *Parabole (1819)*, the author emphasizes the uselessness to the nation, of all those who do (the "Hornets") not produce: of the Court and Princes of the Church, the officers, and the judges. However, he considers the most modest workers, in field or workshop as essential to the nation. Among the industrious, the share of the proletariat is important. Saint-Simon, therefore, wants to increase the number of proletarians capable of managing the business through education. At the top of the industry are the bankers who organize the economy through the issuance of credit. Thus, the author advocates a socialist, technocratic, and planned economy.

Charles Fourier (1772–1837)

Fourier (1829) criticizes industrial anarchy due to the fragmentation of ownership and commercial parasitism – sources of all the disorders of civilization. The first evil of the capitalist production system is poverty which "seems proportional to progress," and whose cause is the waste that involves the absurdity of mass circuits of production and consumption.

Fourier criticizes agriculture in its civilized form, based, according to him, on the two contradictory vices of fragmentation and concentration. If work in the fields in this form is disgusting, then the division of tasks and long hours of hard work make working in factories even more repugnant. The competition in this sector has the corollary that piecemeal work, compounded by the machinery, degrades the workers physically and mentally. The central question Fourier intends to answer, then, is – How to make work fun? For Fourier the only way to do this is to ensure that work becomes for man the fruit of his own passion and his own desire.

The whole theory of Fourier is based on the premise that the key to the problem of the social question comes down to knowing the ordering willed by God. This key is then nothing other than the "attraction," which, in the same way, enables the world and social order. For all human societies, the engine more than anything is *the passion* – "the passionate attraction." By analogy with the global world organized according to Newton's law, Fourier proposes an "industry association" based on "passionate attraction." It is no longer about creating, as in military, hierarchical organizations and authoritarian discipline, but to develop mechanisms that encourage individuals to work for the collective interest. Fourier escapes the liberal impasse which prohibited the development of businesses beyond the capabilities of monitoring bosses. He also avoids the paternalism of the philanthropists. In a logic that is hierarchical and vertical, Fourier proposes a new model of social relations based on careful management of the passions. Fourier's thought rests on two assumptions: attraction and association. The free play of passions must allow "universal harmony." To achieve this, he imagines a unique model of social organization: the phalanx. In "harmony," property is merely the participation in the entire property of the phalanx, without the absolute power of management. Far from being the mere fantasy of a utopian, the phalanstery influenced the thought of many manufacturers throughout the nineteenth century.

Jean-Baptiste Godin (1817–1888)

Locksmith's apprentice at the age of 11, Godin had an early awareness of the alienated character of the working class, through meetings and lectures. In 1837, he developed the idea of replacing the sheet metal by melting in the manufacture of stoves and furnaces, which earned him an immediate success. In 1881, his workforce totaled 1,337 employees and manufactures and the famous stoves has become a world leader in its field. To improve the working conditions and lives of his workers, in 1859 Godin built a social housing complex near the factory, the Familistery of Guise in France in 1859. Godin quickly took into account the aspirations of workers and immediate benefits of the work involved to better distribute wealth and ensure social protection. Pursuing the goal of gradually increasing the property of the company in the hands of its staff, he created in 1881, "the working capital association" that resulted in common ownership and profit sharing, as well as easier access to higher responsibilities and the distribution of wealth. It was put in place alongside pension and welfare, a welfare system managed by Mutual employees (health insurance made compulsory from 1861). It provided free medication and visits (1870). In addition, he invented the Republican promotion of Merit. While Godin was generous, he was by no means egalitarian. Participation went even further: It was not only aimed at limited results but also extended to the management of the company. In 1880, the company took the statutes of a working cooperative and kept its production going until 1968.

Robert Owen (1771–1858)

In 1800, Owen became the owner of the Scottish shadowing in England that tried to transform the factory model. Its design was the result of a moral protest against the damage caused on the social fabric by industrial progress and greed. He maintained that man is the product of its socio-economic and cultural environment. It is, therefore, sufficient to control education, production, and trade to restore collective solidarity. By acting on what he calls "external circumstances" (standard of living, morality, place of residence) that can transform the most radically human behavior. Owen's first practical social change at the microeconomic level involved experimenting with a new work environment based on education. Inside the factory, to respect the dignity of workers, he established a plan for economic and social reorganization based in particular on a reduction of working time (10 h instead of 15), the establishment of kindergartens (which would not be exploited in factories), the opening of evening classes for workers, etc. Owen implemented a program of modernization of machines and a system of preventive maintenance to reduce the costs of their dysfunction. He advocated a policy of high wages. On this point, his vision prefigures that of Henry Ford. Anticipating the socialists of the nineteenth century, Owen (1847) believed that "the natural standard of value is, in principle, human labor, or a combination of manual and mental energies of man when they come into action." But he does not ignore the importance of profitability for the company and the significant benefits that it could gain from the well-being of its workers. It is in this sense that this Scottish entrepreneur can be called modern.

Philippe Buchez (1796–1865)

Buchez is often considered one of the first theorist's worker associations. Thinker wants to practice Christianity and spread democracy in all spheres of economic life. He wants to "establish a republic in the workshop." Religious inspiration is also clear in the preamble to the statutes of the cooperative, the Association of Christian jewelry in gold, which he founded in 1834 and which he defines as "a simple application of moral principles taught by Christianity." To propagate his ideas to the working class, he published small workers' newspapers, such as *L'Européen* and *L'Atelier*. Founded in 1840, the workshop aimed to prepare the complete emancipation of the working classes. The reciprocity of his teaching is the way in which he approached this goal. Buchez not only dreamed of an ideal society but wanted to develop local initiatives for elite workers. His profession as a hygienist led him to combine theory with practice, but he first started listening to the workers.

His approach is essentially based on two dimensions: the condemnation of competition and a critical analysis of society. The criterion of private property, Buchez divided society into two classes: the entrepreneurs whom he sees as parasites, unnecessary intermediaries and workers, victims of the capitalist sampling. To help workers regain some dignity in work, Buchez calls for the elimination of the first class. To achieve this, he offers the solution of the labor organization of production. Based on the sharing of work tools, the association must avoid the hoarding of profits or surplus by the contractor, and allow for sharing between the workers. A fifth of those profits must, however, be set aside to build social and inalienable capital in order to avoid the situation whereby those who are established exploit the newcomers. Buchez defines in detail the status and functioning of workers' associations. He attempts, in particular, to determine the conditions of the supply of capital that prevent ownership of decision-making power by a minority. The cooperative principles defined by Buchez strongly inspired the International Cooperative Alliance (1895) and were reflected in the 1947 Act "on the status of cooperation."

Pierre-Joseph Proudhon (1809–1865)

Not believing in the power of a violent revolution, Proudhon recommended social reform within the capitalist system. This anti-society must apply the principles of association, mutually. The revolution of 1848 created an explosion of workers' associations. For Proudhon, the revolutionary act is in the will of workers to organize on their own. He deplored interference by the state and its authority in the management of these associations. The authoritarian state was incompatible with free management. Proudhon rejected all social organization imposed from the summit.

The position taken by Proudhon in respect of the property is another key element of his thought. This seems to be finalized after his first paper on the property, entitled *Qu'est-ce que la propriété?* (1840), in which he replied: "Property is theft." Yet the intention is not to deny property but to restore it on new foundations. Thus, Proudhon condemns private property. Private property to a certain extent is contrary to justice; it is the property that "receives different names according to the things that happen: rent, interest, profit, gain" and is based on "the amount of abuse," as he stated in 1841 in his letter to Blanqui. This "right to bargain" in a way is on the activities of workers and effortlessly from the owner. While acknowledging that the property is not reprehensible in itself, as a result of the work and savings and as an expression of freedom, Proudhon, nevertheless, holds that it steals the fruits of labor, the only productive element. Therefore, capitalist must give workers what is theirs: the key to the social problem, then, is to return to the worker the full product of his labor.

Proudhon is well in line with those who only work, defined as the intelligent action of man over matter, as the sole producer of wealth.

Rebuilding society from the bottom-up, that is to say, productive activities, Proudhon wants to work to be the source of personal autonomy. The worker, becoming once again master of his actions and decisions must recognize himself in a job that, in turn, has found its full meaning. Against the fragmentation of tasks, Proudhon proposes to go the worker with an entire series. The frustration of workers formerly confined to a single action disappears with job enrichment. Once the work is reinstated, the de-alienation of workers is accomplished in the work itself.

As far as the "right to bargain" is concerned, he draws constructive solution. Of course, the capitalist entrepreneur returns the worker a counterpart for his labor, but he keeps for himself the value of the extra work done in a collective manner. Proudhon, like Smith, thinks that the division of labor leads to increased productivity and denounces the capitalist ownership of the collective force. For Proudhon, the capitalist entrepreneurs "steal" the extra value engendered by the collective strength from the individual strength. The only solution that allows the worker to recover what the capitalist owner charged is through the formation of workers' associations. But the association is not a virtue in itself and must be dominated by law and justice, based on reciprocity, "the social contract, both political and economic, which embraces the individual, family, and the city."

The reciprocity is a justice formula that members of society, regardless of which rank they are, guarantee service for service, credit for credit, and property for property. Proudhon does not want to replace all private property with collective property, because this also contradicts the law. The social system that must succeed private property is possession. Opposed to the right to use and abuse that characterizes property, Proudhon highlights the benefits of a property under the control of the society. If for Proudhon's thought property is theft, the possession is, however, considered a prerequisite for the maintenance and development of a free and creative labor. For the same reasons, Proudhon wants to maintain a market economy: competition has an incentive; it is "the expression of social spontaneity," the guarantee of "freedom" associations.

Proudhon anticipates the slogan of the First International, which states that emancipation "will be the work of the workers themselves," which was proposed by subsequent Marxists. He is also the first to lay the foundation for the utopia of workers as self-producers.

Conclusion and Future Directions

A review of several utopias written or practiced in the field of entrepreneurship carries many lessons. For the utopian thinkers, their obvious interest is the fact that they were not only intellectual adventures and imaginary experiments, sometimes sustainable and economically efficient (in the case of Godin's company). They were not conducted systematically to overthrow the established order, but rather to transform it. These thinkers did not write the theory of the entrepreneur. However, the company has the appropriate level for them to transform society. Reform or modernization of its social relations calls for changes to all other levels of society, because it is an essential place of socialization. The social importance and richness of utopias studied here matter less for their achievements as multiple effects they were the crucible. Is it not in this sense that we should recognize them for being an inspiration and energy in the invention of other more equitable and humane business models?

Cross-References

▶ Entrepreneur
▶ Entrepreneurial Organizations
▶ Social Entrepreneurship
▶ Social Innovation
▶ Social Responsibility

References

Cantillon R. Essai sur la nature du commerce en général. London: Macmillan; 1755.

Fourier C. Le nouveau monde industriel et sociétaire. Paris: Bossange père; 1829.

Proudhon P-J. Qu'est-ce que la propriété? Premier mémoire. 1840

Owen R. Le Livre du nouveau monde moral. Paris: Paulin; 1847.

de Saint-Simon CH. Œuvres complètes. Paris: Anthropos; 1819–1820.

Schumpeter J. Théorie de l'évolution économique. Recherches sur le profit, le crédit, l'intérêt et le cycle de la conjoncture. Paris: Dalloz; 1935.

Entrepreneur, Theory

▶ Entrepreneur: Etymological Bases

Entrepreneur: Etymological Bases

Sophie Boutillier[1,2] and Dimitri Uzunidis[1,3]
[1]Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France
[3]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Business; Entrepreneur; Entrepreneur, Theory

The study of the etymology of words is a fruitful way to understand the history of social practices, as a reflection of social behavior. Words stem from social practices that change in dynamic interactive processes. Our objective is to present some examples of the etymology of the word "entrepreneur" in French and English. Since a long time ago, French and English people use the same word: "entrepreneur." The historical roots of the word "entrepreneur" as well as of the verb *entreprendre* go back to the war vocabulary.

Surrounding a town is indeed compared to an entrepreneurial activity since it is an act that combines strategy, organization, and risk. More recently, the words "entrepreneur" and *entreprendre* have worn an economic meaning. Thus, the entrepreneur is a person who concludes a contract with a government or a public authority as a goods supplier or to undertake – for its account – infrastructural investments (such as building roads or buildings). This illustrates a contractual relationship between the entrepreneur and the State or with another entrepreneur, and which supposes a kind of "trust" between the different parts of the contract. In such kind of contracts, the entrepreneur takes (economic or financial) risks, though. This explains that in the economic as well as in the war vocabulary, the entrepreneur is apprehended in the sense if "risk taker." According to the famous definition of Jeremy Bentham, the "entrepreneur" is also apprehended in the sense of a "project maker" in both economic and war vocabulary. In a different way of thinking, being an entrepreneur is also a mean to be at a higher level of the social ladder or hierarchy.

First, we will present the etymology of the word "entrepreneur" in both French and English languages. The aim from this presentation is to emphasize the complex relationship between risk and social dynamics related to this concept. Second, we will extend our etymological analysis of the word "entrepreneur" in other different languages, for instance, Arabic, Chinese, Japanese, and Russian. Through these examples, we confirm that the meaning of the word "entrepreneur" around the world is always related to the diptych "risk" and "trust."

The European Roots of the Word "Entrepreneur"

French and English people use the same word to name the "entrepreneur." In French, the word "entrepreneur" stems from the Latin word *inter prehendere*, which corresponds to the verb *entreprendre* in French and means "to grab" or "to take control." During the Middle Age, the verb *entreprendre* in France used to mean "to cover" while the word "entrepreneur" means "to attack." The entrepreneur used to mean an attacker in popular French language. However, at the beginning of the fifteenth century, the verb *entreprendre* means "to come to grips with" and later "to take risk" or "to challenge."

The primary sense of the word "enterprise" in French comes from war language, though. In fact, since military people need to handle complex technologies and equipment (Vérin 1982), an organization –thus a strategic process – to "make war" is required: that used to be called "enterprise." The economist and military engineer, Vauban (1633–1707), describes besieging a town as an enterprise. It is based on a complex organization, the objective of which is to conquest a town all by minimizing the loss of human lives (Vauban, 1707). Besides, during the siege of the town, there was the important concern of supplying the army with food.

Since the sixteenth century, the word entrepreneur in the French language has attributed a different meaning, that is, of a person who constructs a building or supplies goods for the account of a public authority, for instance, the government (Vérin 1982; Explorations in Entrepreneurial History 1960). This transaction is translated by a contract between the two parts (the entrepreneur and the public authority). According to this procedure, the entrepreneur earns a fixed sum predefined in the contract; taking thus a financial risk. The French economist Richard Cantillon defines the entrepreneur as a person who buys goods at a certain price and sells them at an unknown price. Hence, we reach a basic and universal definition of the word entrepreneur which corresponds indeed to the definitions given by other languages. In the

Dictionnaire Universel du Commerce (Savary des Bruslons 1723), the entrepreneur is simply defined as a person who undertakes a work. In the *Encyclopédie* of Diderot and d'Alembert (1751–1772), the entrepreneur is also defined as a person who undertakes a work. But this encyclopedia gives more detailed definitions by separating the fields of the work, such as the "manufacturing entrepreneur" (*entrepreneur de manufactures* in French) or "building entrepreneur" (*entrepreneur de bâtiments* in French).

In the English language, the word "entrepreneur" is frequently used as well as the words "undertaker" and "adventurer" or "merchant adventurers." In the *Johnson's Dictionary* (1755), the word "adventurer" is defined as a person who hazards, who takes any chance, or who wants to control his destiny. In the English language, the word "entrepreneur" (*The Oxford English Dictionary*, Weiner E.S.C., Simpson J.A., 1991) was also used during the fifteenth century according to the simple definition: "a person who undertakes." During the nineteenth century, the word "entrepreneur" is used as "one who undertakes an enterprise" or "one who owns and manages a business," or "a person who takes risk of profit or loss." The word "undertaker" is not used as a maker of business, but like a manager. For example, Adam Smith talks about an "undertaker of a great enterprise" in his famous book: *The Wealth of Nations* (1776).

To summarize, the entrepreneur, in French and in English languages, is a person who wants to control his life and to get rich. The entrepreneur is usually a bourgeois, rarely a noble. So, through doing business, a bourgeois can become an influent person, as we notice the social phenomenon in Shakespeare's (*The Merchant of Venice*) or Molière's (*Le Bourgeois gentilhomme*) works. This same phenomenon is partially noticed in the Arabian literature where the merchant could also be positively appreciated.

So, to become an entrepreneur is a way of social rise. For example, during the Roman Empire, slaves could manage a property (or a trade enterprise) for their master. If the slave-manager gets very rich, he can have his emancipation. But he could not forward his fortune to his children by inheritance (Andreau 1999).

Entrepreneur, Profit, Trust, Chance, and Risk: A Universal Way of Thinking?

In Greek modern language, for example, the meaning is similar as in French or English languages. The word *epixeimatias* in modern Greek language comes from *epixeiro* which means "to come to grips with." Thus, the entrepreneur is a person who has got an active behavior, who acts, but all by insinuating a notion of "trust."

In Arabic language, the etymology of the word "entrepreneur" is the same as in French. In literary Arabic, the entrepreneur is a *moukawel*. In other words, he is a creator of an enterprise or a maker of projects. The verb *kawala, youkawilou, moukawalatan* means to negotiate, to discuss a business, but also to give a work to someone (e.g., via subcontracting) (Vérin 1982). In the Arabian literature, the merchant has a good image as long as he does not intend to steal other people. This aspect of the Arabian literature is very important. Since the seventh century, Arabian economists (Averroès 1126–1198, Ibn Khaldoom 1332–1406) (Verrier 2009) have built an important economic work based on Aristotle's principles (the chrematistic). If most of these economists are liberal, they think that the free market is not only a mean to buy goods, but a mean for speculation, though. Thus, in this context, the entrepreneur plays an important role. We can also underline that the prophet Mahomet was a businessman, before to be declared as a prophet. He worked in the enterprise of his wife... In the Arabian literature, both Sinbad the sailor and Aladdin were also merchants...

In Chinese language (Chan 2010), the word "entrepreneur" is composed by three ideograms: the first one is *qi* which means in ancient Chinese "hope." The second is *ye*, which means "business" or "career." Together, *qi* and *ye* mean "enterprise." The third ideogram is *jia* which means "house" in ancient Chinese. Later, *jia* has been used as "master." So, in China, as in Europe, becoming an entrepreneur can be an opportunity to become a rich and influent man. The emergence of this expression dates to eighteenth to nineteenth century, with the development of trade exchanges with European merchants (and also during the Opium Wars).

In Japanese language, we have a static definition of the entrepreneur. The word "entrepreneur" is a *kigyou ka* in the Japanese language. *Kigyou* is an "enterprise." *Ka* means "house." But, *kigyou ka* in Japanese language has got two different meanings: "business" and "enterprise."

In Russian language, the "enterprise" is a *predpriatie*. The "entrepreneur is a *predprenimalted*. The verb is *predprinimat* (Барышников, 1994). The word *predpriat/predprinimat* is a translation form German language which means to begin to do something including the idea of responsibility. In Russia, during the seventeenth to eighteenth century, we can distinguish three types of "entrepreneurs" according to their sector of activity (Галаган, 1997). In the agricultural sector, the word employed is *koulak*, which could be translated to "punch." The *koulak* are the richest farmers of Russian villages. For trade activities, there is a large range of words: *kupets*, *torgovets*, *kommersant*, *spekuliant*, and *kantar*. *Kupets* comes from the verb *kupat/pokupat* which means to buy. *Torgovets* comes from Latin language *tirgus* or *turgus* which means "place" and "market." *Kommersant* comes from the French word *commerçant*. *Spekuliant* comes from the verb to speculate. *Kantor* comes from *comptoir* in French language or *kontor* in German language. For the industrial sector are used the words *predprenimatel*, *fabrikant*, and *manufakturshik*. The word *predprinimatel* means "entrepreneur." *Fabrikant* comes from the French word *fabrique* (in English "factory"). *Manufakturshik* comes from "manufacture." These three words include the fact to employ workers for a job and also the notion of property. From the eighteenth century (with Peter the Great and Catherine II), the entrepreneurial activity becomes easier (see for example, Барышников, 1994 and Кузьмичев, Шапкин, 1995). During the socialist period, the word "*predprenimaltelstvo* is mentioned as a forbidden activity. The only word that Lenin kept is "cooperative." Today, *preprenimatel*, *kommersant*, and *kantor* are used, but *kantor* has got now a popular meaning. The entrepreneur as a *predprenimatel* defines a legal statute. The English words "businessman" and "business" are widely used, especially for successful enterprises. Today, these words are universal in every language.

Conclusion and Future Directions

The etymology of the word "entrepreneur" is very rewarding. This brief etymological study shows that the entrepreneur is a social actor who has got an important role to play. By his capacity to invent, he has got the power to change his economic environment. But, the etymological study shows also the rise of an individualist behavior. To become an entrepreneur is a way of self-enrichment.

In France or in England, the entrepreneur as a social actor appears within the sixteenth to seventeenth century, with the emergence of individualism and the economic and geographical expansion of Europe, which became the first economic power at that time. Thus, European economic models have speeded toward other countries. Yet, a deeper research is needed in order to study more in detail the etymology of the word entrepreneur and its influence on our today's vocabulary.

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Cross-References

- ▶ Entrepreneur
- ▶ Entrepreneurship Education
- ▶ Heroic Entrepreneur, Theories
- ▶ Individual Determinants of Entrepreneurship

References

Andreau J. Banques et affaires dans le monde romain. Paris: Seuil; 1999.

Chan WKK. Chinese entrepreneurship since its late imperial period. In: Landes DS, Mokyr J, Baumol W, editors. The invention of entreprise: entrepreneurship

from ancient mesopotamia to modern times. Princeton University Press: Princeton; 2010.
Diderot D, d'Alembert J. Encyclopédie, ouDictionnaire raisonné des sciences, des arts et des métiers. Paris; 1751–1772.
Explorations in entrepreneurial history (1960) Cambridge, MA.
Johnson S. A Dictionary of the English Language. London: Jack Lynch; 1755.
Savary des Bruslons J. Dictionnaire universel de Commerce. Paris: Jacques Estienne; 1723.
Smith A. The Wealth of Nations. London: Methuen & Co., Ltd; 1776.
Vauban S. Projet d'une Dixme royale. Paris; 1707.
Vérin H. Entrepreneurs, Entreprise. Histoire d'une idée. Paris: Presses Universitaires de France; 1982.
Verrier R. Introduction à la pensée économique de l'Islam du VIII[e] au XV[e] siècle. Paris: L'Harmattan; 2009.
Weiner ESC, Simpson JA. The Compact Oxford English Dictionary. Oxford University Press; 1991.

References in Russian Language

Барышников МН. Исмория делового мира России. Пособие для студентов вузов. – М., 1994.
Галаган АА. История российского предпринимательства. От купца до банкира. Пособие для вузов. – М., 1997.
Кузьмичев АД, Шапкин ИН. Отечественное предпринимательство: очерки истории: Учебное пособие. – М., 1995.

Entrepreneur's "Resource Potential," Innovation and Networks

Dimitri Uzunidis[1,2], Sophie Boutillier[1,3] and Blandine Laperche[1,3]
[1]Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France
[3]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Innovative entrepreneur; Innovative entrepreneurship; Innovator

Introduction

In the current so-called knowledge economy, innovation is considered as the engine of economic growth (Romer 1990; Aghion and Howitt 1998; Audretsch 2006). During the second part of the twentieth century, the big firm was considered as being at the origin of innovation (thanks to its ability to gather large amounts of resources). However, since the 1980s, the entrepreneur has made his/her comeback on the forefront on the economic and political scene. What is the exact role of the entrepreneur, and how does he/she succeed in the innovation process, which still – and perhaps, because of its rapid pace, more than ever – requires the gathering of large amounts of money, competencies, and information? To answer this question, the work of several economists is studied, mainly J. A. Schumpeter is one (1883–1950), who can be considered as a precursor in the analysis of entrepreneurship linked to the innovation process.

The entrepreneur is the one who disturbs the neoclassical equilibrium by executing new combinations in the means of production (Schumpeter 1911/2006), who puts the economy on the path of motion and development (Schumpeter 1939), but he/she is also the one who, by his/her extinction, accounts for the self-destruction of capitalism (Schumpeter 1942/1976). The entrepreneur, the first hero of economists according to Schumpeter, is incontestably Schumpeter's own hero. But the hero is an elusive one: being an entrepreneur is not a profession but a function according to Schumpeter, and thus entrepreneurs have a butterfly-like existence.

What is the origin of the entrepreneur's function? Is entrepreneurship a natural gift, as J. A. Schumpeter seems to believe? Why does the entrepreneur's function disappear and is not a long-lasting one? It is important to develop an approach combining economics and sociology in order to go deeper into the analysis of the social origin of the entrepreneur's function, studying the construction of his/her "resource potential," that is, the set of knowledge, relations, and financial resources gathered together by the entrepreneur in his/her environment. This resource potential is not stable and may be increased or reduced in different economic, political, and social contexts. However, this entry does not try to define the exact ingredients of a "good" public policy for entrepreneurship. As a matter of fact, since J.M. Keynes on the one hand and also the work of the economists of the public choice school, economists have learnt that the impacts of public policies are not always the expected results (Keynes 1933; Buchanan and Tullock 1962). This entry aims to insist on the entrepreneur's socioeconomic background. Notwithstanding his/her own qualities (smartness, ability to judge), the entrepreneur is here considered as a social actor, influenced by the social, economic, and political context. The analysis in terms of "resource potential" aims at going deeper in the explanation of what turns the potential entrepreneur into the real one.

The first part of this entry comes back to socioeconomic and historical analysis of the entrepreneur's function, showing that this character is concurrently the driving force of capitalism, as well as the reason for the evolutionist character and the questionable self-destruction of this economic system. The second part points out the origins of the entrepreneur's function and develops an analysis of the resource potential in relation to a network approach, which is fed but also differentiated from current – or more ancient – approaches in terms of social capital. The proposed formalization in terms of "organic square of entrepreneurship" is thus an attempt to explain the temporary character of the entrepreneur's function. It also supports the thesis according to which today's entrepreneur can be sketched as a socialized entrepreneur (a network-based entrepreneur) at the interplay between the strategies of states and big firms.

Business Creation and the Dynamics of Capitalism

J. A. Schumpeter (1883–1950) is not the first economist to draw attention to the entrepreneur. Richard Cantillon (1680–1733), Jean-Baptiste Say (1767–1832), Karl Marx (1818–1883), or Alfred Marshall (1842–1924) made important contributions to the economic analysis of this character (Boutillier and Uzunidis 1995, 1999, 2006). However, J. A. Schumpeter's approach is original in that he/she formalized the entrepreneur's function in relation to the dynamics of capitalism (Uzunidis 2004, 2006a).

The Entrepreneur: The Driving Force of Capitalism?

First of all, the entrepreneur, as viewed by J. A. Schumpeter (1911/2006), is the one who questions the economic *status quo* prevailing in the neoclassical vision. As a matter of fact, for neoclassical economists, and especially their leader Léon Walras (1834–1910), the basic model is the one of pure and perfect competition. Competition is the only way the market can operate. In this context, there exist neither big firms nor small firms, but only firms of similar size (assumption of market atomicity). Firms are and will remain firms of similar size, which accounts for the absence of technical progress. The economy duplicates itself indefinitely. For L. Walras, the industrial entrepreneur "buys textiles and raw materials, rents factories, workshops, machinery and tools, hires spinners, blacksmiths and mechanics" (Walras 1874/1988, p. 287). The Walrasian entrepreneur does not innovate. He buys or rents services or raw materials or other input required by production. He selects according to the price of production factors (interest rate for capital, wage rate for labor).

The Schumpeterian entrepreneur questions the economic status quo because he/she is the economic agent that makes new combinations of production factors, corresponding to as many investment opportunities. He is the driving force of the capitalist economy. He embodies the dynamics of capitalist change as well as industrial and technological progress. There are five such combinations:

- The introduction of a new good – that is, one with which consumers are not yet familiar – or of a new quality of a good
- The introduction of a new method of production, that is, one not yet tested by experience in the branch of the manufacture concerned, which need by no means be founded upon

a discovery scientifically new, and can also exist in a new way of handling a commodity commercially

- The opening of a new market, that is, a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before
- The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created
- The carrying out of the new organization of any industry, like the creation of a monopoly position (e.g., through trustification) or the breaking up of a monopoly position (Schumpeter 1911/2006, p. 66)

According to Schumpeter, to be an entrepreneur is neither a profession nor a long-lasting state. On the contrary, to be an entrepreneur is a "function." This is the second characteristic of the Schumpeterian entrepreneur: "the entrepreneur's function is to combine the productive factors, to bring them together" (Schumpeter 1911/2006, p. 76). The entrepreneur is then very different from the common vision of the manager who manages the day-to-day production: "everyone is an entrepreneur only when he/she actually 'carries out new combinations', and loses that character as soon as he/she has built up his/her business, when he/she settles down to running it as other people run their businesses" (Schumpeter 1911/2006, p. 78). To be an entrepreneur does not mean automatically to have a long-lasting relation with an individual concern, as stressed by J.-B. Say or A. Marshall in their own words.

For J.-B. Say, (Say 1828/1996), the entrepreneur stands between the executing work of the worker and the research work of the scientist ("L'entrepreneur met à profit les facultés les plus élevées et les plus humbles de l'humanité. Il reçoit les directions du savant et les transmet à l'ouvrier," J.-B. Say, *Cours*, Atenéo, 1843, Chap. VI, p.96). As a result, there is a distinction between three kinds of industrial operations: the research by the scientist, the application by the entrepreneur, and the execution by the worker. However, according to Say, the entrepreneur may at the same time lead research, apply the results to industry, and by himself/herself manufacture what will be sold. In his/her *Principles of Political Economy*, Alfred Marshall (1842–1924) defines the entrepreneur as putting forward his/her managerial skills, his/her faculty to know how to organize the work of an important number of people. His function is to manage the production in a way that a given effort may have the most important effect to satisfy human needs (Marshall 1906).

The entrepreneur can then have various profiles: he/she can either be independent or an employee of a public company, or he/she can also have no durable relation with an individual business. As a result, J. A. Schumpeter has a particular view of the connection between entrepreneur, risk, and profit. One of the meanings of the verb "to risk" being "to attempt," to "undertake," entrepreneur and risk are directly linked, as shown by the history of the economic thought referring to the entrepreneur (Boutillier and Uzunidis 1995, 1999; Blaug 1998; Laperche 2003). The first main issues refer to the nature of the entrepreneur's remuneration. Then, as the dissociation between the entrepreneur and the capitalist becomes clearer, economists will be interested in the entrepreneur's function and the associated risks.

In the classical economic thinking, and particularly in Adam Smith's works (1723–1790), the economic agents that are the entrepreneur and the capitalist are often confused, as well as the financial risk and the undertaking risk. Before Adam Smith, Richard Cantillon, (see Cantillon 1997) who is, according to Schumpeter (1954/1983, t. II, p.242), the first economist to use the term "entrepreneur," the entrepreneur's remuneration is a fair remuneration of the incurred risk. According to him, entrepreneurs (the term is used, taking account of the period, to qualify merchants) are "people with uncertain revenues" because their revenues depend on the risk they take in a context of uncertainty. Their function consists in acquiring means of production at certain prices with the purpose to sell at uncertain prices. For Schumpeter, the entrepreneur's role does not only consist in taking economic risks. The terms "entrepreneur" and "capitalist" are not synonymous. The ordinary shareholder is not always an entrepreneur. The capitalist is only an owner of money, debts, or goods.

J.-B. Say, in the context of industrialization, and Schumpeter, when the movement of capital concentration gains ground, give substance to the notion of risk as they particularly focus on the entrepreneur's function. For these two authors, even if they express it differently, the undertaking risk is the risk linked to innovation. This point of view was also the one of Ricardo and Marx, who considered that industrial gains were composed, for a part, of the remuneration they receive, for a time, from the first introduction, in the economic process, of an original improvement, for example, a new machine. They have thus discovered, according to Schumpeter, a special case of the most typical gain of the entrepreneur, Schumpeter (1954/1983, t.II, pp. 361–362). However, while J.-B. Say and A. Marshall – who also draw attention to the organizational and productive function of the entrepreneur – tried to justify the profits of the entrepreneur, Schumpeter asserts that profit is not the entrepreneur's first motivation. His behavior is similar to the one of a gambler. The entrepreneur is prompted by a desire for power. The joy to win and to create prevails in the intrinsic lure of gain. Profit crowns the success of the "new combinations." This is the expression of the value of the entrepreneur's contribution to production in the same way as the wage is the reflection of the worker's production.

Finally, apart from these psychological characteristics of the entrepreneur, Schumpeter insists a lot on the capacity of this entrepreneur to overcome the banker's resistance, the latter feeling an aversion for risk linked to innovation. According to Schumpeter, the existence of the entrepreneur is not sufficient to put the economy on the path of evolution. The potential entrepreneur needs access to money, that is, the admission ticket to participate in the game: "The requisite funds – his/her admission ticket to the social store of means of production – he/she borrows from a bank" (Schumpeter 1939, Vol.1, p.131; see also Ulgen 1996). In *Capitalism, Socialism and Democracy*, Schumpeter will explain that credit is at the origin of development, saying that it is the source from which one can draw to finance the execution of new combinations.

Entrepreneur, Innovation, and Progress

In *Business Cycles* (1939), J. A. Schumpeter analyzes the cyclical process of evolution of the economy. This one stems from the business spirit, the entrepreneur's activity, and the introduction of radical innovations.

Innovation, in the broad sense of the word, is, for Schumpeter, the only origin of competitiveness, the determining element of accumulation. It is also at the origin of disequilibrium and imperfections. Schumpeter extends the marginalist theory (but then questions it) and cleverly explains, thanks to the concept of innovation, the emergence of profit differentials at a given time in a given economy driven by pure and perfect competition as well as the evolution of the economic activity.

Consequently, the role of innovation – and thus of the extraordinary person, the entrepreneur – is essential to the explanation of economic cycles (Uzunidis 1996, 2006b). According to Schumpeter, since only the most enterprising and venturesome people act, innovation appears in "swarms." These innovations induce a rise in the demand for capital goods, a decrease in production costs, and an increase in the number of goods supplied. The increased capacity on the supply side is associated to a boom in demand, stemming from the new consumption needs, the positive anticipations of economic agents, and the development of bank loans. The ensuing rise in profits puts the economy on an ascending trajectory. This stage of prosperity, after the stimulating effect of radical innovation, is prolonged by minor innovations. The boom, however, limits itself, as, paradoxically, innovation contributes to downsizing. Investment and excessive optimism during the years of strong growth may explain the cycle shift: losses, bankruptcies, and job-cuts, etc. The crisis will last as long as there exist production capacities in excess. When adjustment to the innovations is complete, deflation ends and the Walrasian equilibrium is restored. This thorough cleanup of the economy releases the business spirit so that a new innovation wave may occur. This refers to J. A. Schumpeter's "creative destruction" process which "is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in" (Schumpeter 1942/1976, p. 83).

According to Schumpeter, but also to Marx, (see for ex. Marx (1976)) technical progress results in the increase in the production scale, the development of the limited company: the limited company supplies capitalism with the necessary capital for the development of the big industry. The entrepreneur disappears when the big firm emerges (resting on the partition of organizational work and production work, which is basic to automation), managed by a double-headed team, the managers, and the shareholders (partition between management and ownership of capital): "Technological progress is increasingly becoming the business of teams of trained specialists who turn out what is required and make it work in predictable ways" (Schumpeter 1942/1976, p. 132).

The entrepreneur, who was the driving force of capitalism in the heroic age, has been replaced by a team of specialists whose essential task is innovation. So, capitalism becomes impersonal, and the organization has replaced the individual. J. A. Schumpeter thus shares with K. Marx the concept of self-destruction of capitalism. In *Capitalism, Socialism and Democracy*, J. A. Schumpeter explains that capitalism has made technical progress its *raison d'être*: "capitalism, then, is by nature a form or method of economic change and not only never is but never can by stationary" (1942/1976, p. 82). Is not the entrepreneur the driving force of capitalism just because he/she innovates, thus continuously creating new investment opportunities?

K. Marx writes: "the actual barrier to capitalist production is capital itself" (p. 244, book III). "Capitalist production generates its own negation which conditions the transformations of nature. It is the negation of the negation" (p. 557, book I). J. A. Schumpeter writes: "that those factors make not only for the destruction of the capitalist but for the emergence of a socialist civilization. They all point in that direction. The capitalist process not only destroys its own institutional framework but it also creates the conditions for another" (Schumpeter 1942/1976, p. 162). K. Marx and J. A. Schumpeter share the idea of self-destruction of capitalism, that self-destruction being paradoxically caused by its success. For the latter, the development of shareholders will have destabilizing effects on the future of capitalism, thus joining A. Smith (Smith 1776/2002), for whom the development of joint-stock companies is incompatible with the development of business, as the private appropriation feeling is absent. It is dissolved in the multiple ownership of capital. For J. A. Schumpeter, the occurrence of collective private property destroys initiative and the will to enrich oneself which are the cornerstones of capitalism. The spirit of enterprise vanishes, and the firm is no longer a place of economic opportunities, nor a place of professional and personal fulfillment, all that being replaced by a bureaucratic organization. "The capitalist process, by substituting a mere parcel of shares for the walls of and the machines in a factory, takes the life out of the idea of property. It loosens the grip that once was so strong – the grip in the sense of the legal right and the actual ability to do as one pleases with one's own; the grip also in the sense that the holder of the title loses the will to fight, economically, physically, politically, for 'his/her' factory and his/her control over it, to die if necessary on its steps" (Schumpeter 1942/1976, p. 142).

Networks and the Socialized Entrepreneur

However, in this early twenty-first century, not only capitalism has not disappeared, but its power on the global society is reinforced. Big multinational firms, TNCs, dominate the world economy, while myriads of small firms are born, grow, and die on a regular basis, thus composing a kind of stock from which capitalism finds its means of development. "The age of the Entrepreneur is like Camelot: it is only here for a brief, shining moment each (roughly) half century," says in this vein, Ray Canterbury (2001, p. 423).

Therefore, the domination of big firms is not incompatible with the maintenance of large numbers of small firms. Quite the opposite! The strong economic growth that came after WWII had provided Western Europe and the United States with safe and stable markets. After the trauma of the 1929 crisis, which had paved the way for war and dictatorship, all-out state intervention had become necessary (support of supply and demand). The economic crisis starting in the 70s questions many certainties. The industries and activities on which economic growth was based have reached maturity. The information and communication technologies (ICTs) generated by military programs represent new investment opportunities. Therefore, it is necessary to release the capital which has been frozen by nationalizations. This is done by the financial revolution. The limited company has a free hand. It develops through venture capital and pension funds. This is the way "new capitalism" sees the light. The division of labor has become more complex within and between firms. Firms communicate in real time and all over the world on the Internet. Financial markets have expanded on a global scale. The gap between capital management and property has become wider. It matters little whether the ownership of capital is collective; what is important is the individual possession of the profits capital generates.

The economic history of the last 30 years confirms this observation: domination by big firms and survival of myriads of small companies. The theory of corporate governance (even if it reverses the balance of power between managers and shareholders) is based on that concept of bureaucracy and collective organization. However, how can one account for the economists' craze for the entrepreneur? Has the latter become the driving force of capitalism (again)? Is (entrepreneurial) capitalism the end result of human evolution, as F. Fukuyama says (1993)?

There are diverse reasons for the entrepreneur's comeback in the economic theory. Among the main ones (see Boutillier 2006):

1. *The slow-down in economic growth and the persistence of massive unemployment*. The formation of new firms is perceived as a way of creating wealth (and boosting technological innovation), but also of creating employment. The establishment of new firms is perceived by political leaders as a social integration facilitator.
2. *The decrease in government social spending, the privatization and deregulation of the economy*. Facilitating the formation of companies is less costly to public budget than granting unemployed people a substitute income.
3. *The occurrence of ICTs, all being new investment opportunities*. Small firms (often affiliated with big firms through financial relations) test those new fields.
4. *The development of financial flows (following the liberalization of the economic forces and markets)* offers new financial instruments which both feed and weaken the economic growth due to their high instability.

The big firms, which control global markets, are led by organizations, and not by one individual who can easily be identified: the entrepreneur and founder. The firm is led by managers on behalf of its shareholders (the owners of the firm), as John Kenneth Galbraith already explained in the late 1960s (Galbraith 1967). Apparently, the development of financial markets since the early 1980s has restored part of their lost power to the shareholders, as these now get rid of unsatisfactory managers. However, despite the questioning of the vertical integration of big firms in favor of a network structure (made possible by the development of ICTs), big firms are still the global market organizing entities. "Corporate power lies with management – a bureaucracy in control of its task and its compensation," writes J. K. Galbraith in his/her last book published in 2004 (Galbraith 2004, p. 31; see also the analysis of this debate in Laperche 2005; Laperche et al. 2005, 2006). Since the 1960s, he/she has not departed by a hair's breadth from his/her position. The development of corporate bureaucracy has not resulted in the disappearance of capitalism, or the entrepreneur. The latter even receives assiduous care from the political leaders who have crowned him/her as a creator of innovation and employment, as well as the champion of social integration.

The following assumption may be proposed: the entrepreneur has not disappeared, but he/she is no longer a hero. Thus, he/she has become a socialized entrepreneur, an entrepreneur who is a player in the economy made up of (a) the planning decisions made by big firms which, even if networked, nevertheless are powerful bureaucracies, and (b) the states' policies which aim at reducing unemployment and boosting innovation in the developing knowledge economy. This is the new capitalism of the early twenty-first century!

Faced with the complexity of the today's economic activity, M. Castels (1996, 1997, 1998) went as far as to maintain, quite cleverly, that the fundamental unit of the economic system is no longer the entrepreneur itself, the family, the firm, or the state, but the network composed of different organizations. Regarding innovation, the division of labor and the very refined specialization of skills in the process of production remove any possibility of autarkical organization of the technological production. Partnerships between companies and between public and not-for-profit institutions, on the one hand, and companies on the other hand, and a whole panel of technical, financial, and commercial contributions, illustrate the theories of the classical economists (e.g., A. Smith and K. Marx). For them, as fast as the industry takes over the social production (and enlarges its market by appropriating the resources at the time), technical transformations can be witnessed, as well as core changes in the organization of the production and in the matter that the entrepreneur makes business. The entrepreneur is not a *deus ex machina* who puts the economy on the path of motion. The following part comes back to and explains the economic and social origins of the entrepreneur's function, thanks to a discussion of the profile of the entrepreneur considered as an economic player in the contemporary network-based economy.

The Entrepreneur's Resource Potential and Entrepreneurial Dynamics

The Resource Potential: The Origin of the Entrepreneur's Function

The concept of "resource potential" gives the possibility to assess the role played by the social origin, the educational background, the professional experience, and the financing sources of entrants (Boutillier and Uzunidis 2004; Boutillier et al. 2004).

Entrepreneur's "Resource Potential," Innovation and Networks, Table 1 The entrepreneur's resource potential: elements of definition

Resource potential	Main characteristics
Knowledge	Tacit knowledge obtained from the family
	Scientific and technical knowledge learned at school
	Knowledge obtained through relations
	Knowledge obtained through professional experience
Financial resources	Personal savings
	Love money: parents, friends, etc.
	Bank loan
	Financial aid from institutions (e.g., public aids)
	Seed money from another entrepreneur
Relations	Informal relations (family, friends, neighborhood, colleagues, etc.)
	Formal relations (State, banks, other enterprise, research institutes, etc.)

Source: Authors

Each individual owns a set of resources and uses his or her potential to improve their economic situation (to find a job with a good salary, to create an enterprise, to find another professional activity, etc.), and their choices also depend on their own resources. The resource potential is not a natural gift, but it is the product of a social process, of the opportunities and constraints implied by this process. What are the entrepreneurs' social origins? What did they study? Who were their parents? Were they entrepreneurs? Employees? Civil servants? What are their relations?

The resource potential can be analyzed in three parts: (1) knowledge (schooling, secondary education, higher education, further education, and professional experience, etc.); (2) financial resources (personal savings, bank loans, venture capital, and different forms of public support); (3) relations (family, personal, professional, institutional relations, etc.) (Table 1).

These three parts are interdependent. For example, the knowledge of an individual depends on his/her education and/or professional experience. And the family context (cf. Casson 1990) positively or negatively influences the educational choices. Many entrepreneurs were born to families of entrepreneurs. While studying, the individual meets new persons, who can become partners and bring knowledge, money, and relations. Making up a substantial address book is fundamental because it facilitates the search for money, markets and associates, etc.

Schumpeter considered that the entrepreneur's function was the result of a kind of not explained ability, and that his/her success was due to his/her competencies and also to a bit of luck: "in most cases the man who rises first *into* the business class and then *within* it is also an able businessman and he/she is likely to rise exactly as far as his/her ability goes – simply because in that schema rising to a position and doing well in it generally is not or was one and the same thing" (1942/1976, p. 74).

So, this approach goes deeper into the analysis of the origin of the entrepreneur's function, trying to add to the notion of "ability" a social dimension, notably when he/she spoke of the qualities of the entrepreneur and, first of all, his/her ability to convince the banker. Of course, according to him, the successful entrepreneur is the one who has the banker's support. This is perhaps part of his/her explanation of the entrepreneur's gift. Moreover, if Schumpeter focused in priority on the entrepreneur's ability to raise funds, this ability can be considered as part of a multidimensional ability in which knowledge and relations also have an important role to play. This approach of the resource potential is fed but also differentiated from the current (or more ancient) approaches in terms of social capital, as presented below.

The Theoretical Roots of the "Resource Potential": An Economic Approach to Social Capital

The concept of social capital officially appeared in human sciences at the beginning of the 1980s. P. Bourdieu (1980) is one of its main originators. His aim was to go deeper into the analysis of social relations. At the beginning of the 1960s, G. Becker (1975) defined the concept of "human capital," considering that all individuals own their knowledge and that they can take the decision to invest in their human capital to increase their merchant value on the labor market. With the concept of social capital, social relations become valuable resources (Boutillier 2005). The concept of social capital is the foundation of the concept of resource potential. However, in the economic and sociological literature, social capital is most often defined as a set of social relations. One may consider that social relations are only part of the resources that individuals can invest in to find a job, start a business, etc.

Capitalizing One's Own Knowledge

At the beginning of the 1960s, the concept of human capital became essential, in the theory as well as in economic facts. Enterprises and notably big ones needed more and more skilled employees due to the development of the service industry and the clearer separation between design and manufacturing, the affirmation of full employment, the development of the educational system, the continuous technical progress, and the resulting automation of industrial work.

This theoretical breakthrough was fundamentally initiated by G. Becker in the 1960s. A. Smith did precede him/her in this analysis, putting a lot of emphasis on the necessary development of education. But the true precursors of "human capital" are certainly T. W. Schulz (1959) and E. F. Denison (1962). The quality of human resources, the investment in education, the information of individuals, and knowledge are production factors. G. Becker's human capital is different from physical capital or financial capital because the knowledge and the know-how acquired by an individual during his/her training are embedded in him. The employer can take advantage of this knowledge if the employee keeps on working in his/her enterprise. Employers do not have a property right on their employees.

However, the human capital is a capital and, as such, the theory of capital can be applied to it, adapting it and putting forward some specific properties: human capital can be accumulated. All individuals may increase the number of years dedicated to its formation, normally through a quasi indefinite process. Marginal returns of investment in education are decreasing: along the life cycle, the accumulation of human capital follows a decreasing trend. As years go by, economic agents dedicate less time to training, all the more so as job perspectives become less numerous. The human capital return decreases with age: the integration of human capital in the individual limits his/her investment capacity. He is dependent on his/her physical and intellectual capacities. Moreover, an individual may accumulate human capital, without any positive result (added value on the labor market); human capital is both a private and a public good as an educated population is also more productive (cf. GDP growth, Lucas 1988).

The theory of human capital therefore presents similarities with the one of capital. The individual invests in himself, as the capitalist invests in his/her enterprise: the first one is incorporated in the individual, but the capital remains exterior to the entrepreneur who invests it. The law of decreasing marginal returns applies to human and physical capital alike.

Capitalizing One's Social Relations

Since the early 1990s, various works have been conducted by American sociologists (R. Putman, J. Coleman) in this direction. Social relations are considered a resource which can be capitalized by individuals. In order to improve their economic welfare, individuals use their social relations which are regarded as an individual and a collective good. According to those authors, the characteristics of social capital are similar to those of physical capital: decreasing returns, decreasing marginal productivity, etc.

P. Bourdieu (Bourdieu and Wacquant 1992) defined the concept of social capital in an analysis of social stratification. Differences in terms of revenues are not the only criterion of differentiation between social classes. For equal revenues, social behaviors and notably cultural ones can be very different. This social capital is a means to gain access to jobs, funding, etc., and the individuals belonging to dominant social classes are those who benefit from a wide network of social relations. P. Bourdieu defines social capital as the sum of actual or potential resources which are linked to the more or less institutionalized network of inter-acquaintance and inter-recognition relations possessed by an individual. Every individual is endowed with a social capital, but the latter is not a natural gift but the result of a strategy. Consciously or not, individuals invest to increase their social capital, this one depending on other forms of capital: economic capital, cultural, and symbolic one. A high economic or cultural capital facilitates the formation of a social capital. And a high social capital is also a means to increase the economic capital of individuals.

Long before P. Bourdieu, other sociologists drew attention to the potential wealth that constitutes a network of social relations. M. Weber (1905/1964) showed the link there was in the USA at the beginning of the twentieth century between the adherence to a religious community and success in business. In 1963, S. Macaulay (1963) published the result of a study conducted in the USA on transactions between firms, which are very often agreed without contracts or in inaccurate legal conditions. Entrepreneurs are often reluctant to formalities which may question trust. For American sociologists who studied the concept at the end of the 1980s, social capital can also be considered as a network of various relations, enabling the individual to improve his/her social insertion. Subtle links between social capital and human capital are also established.

The issue of social capital is only apparently simple (Gasse et al. 2004). It is, as a matter of fact, possible to find as many definitions as there are authors who draw attention to it. J. Coleman (1988, 1990) describes the social capital as a resource incorporated in interindividual relations. The resources drawn from social capital are privately appropriated and have certain similarities with externalities generated by the functioning of the market. Social capital is productive, just as human capital, and contributes to the increase of welfare. R. Putnam (2000) defines social capital as the network and reciprocal norms which are associated to it. Social capital has a given value for the individuals who are part of the network. R. Burt (1995) stressed the role of social networks in the evolution of carriers, studying the promotion of executives in a big technological firm.

International institutions, OECD and the World Bank, for example, were quickly convinced of the interest of social capital in order to improve public policies efficiency. OECD

(OCDE 2001) credits social capital with a major part in the increase of social welfare, considering three forms of capital linked by institutional arrangements: natural and product capital, human capital, and social capital. For the World Bank, social capital is also a means to fight against poverty in order to fill the gap created by the absence of institutions. Social capital is also a social support to informal economic relations, which depends on subtle relations of mutual trust and solidarity. In terms of public policies, the translation lies in the development of the associative sector (World Bank 2000).

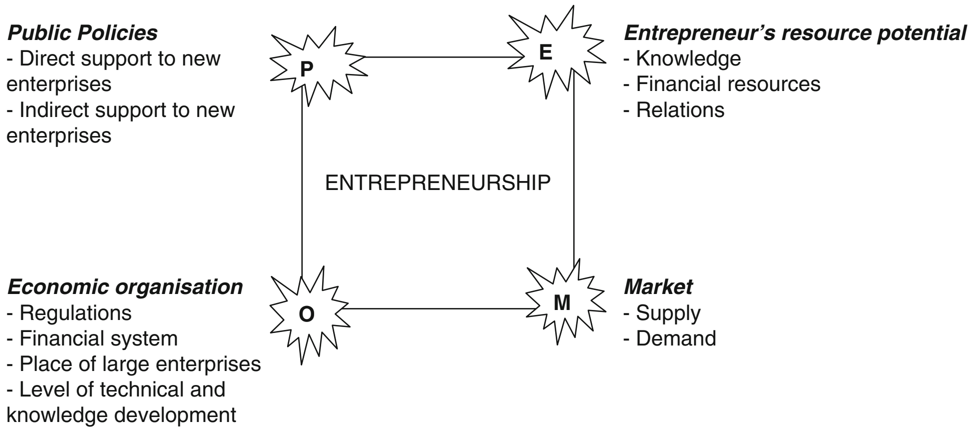
The concept of social capital also has certain similarities with the one of network, which was also introduced in social and human sciences in the 1990s. The image of the network as a sum of computer connections has lead many researchers to develop a metaphoric analysis (Castells 2001). Moreover, this kind of approach is interesting in that it takes account of the historical dimension. Merchant, political, and financial networks have always existed, but they have taken a new dimension with technical progress. This approach is not compatible with methodological individualism. The network is not seen as an appropriable good, capitalized by its members. The approach in terms of network is considered as a method to study the world's evolutions. The network is also used in different contexts, as, for example, the analysis of social cohesion, intermediary level between micro and macro. The accent is on the interpersonal links used to explain macro sociological phenomena (Granovetter 1973, 1985).

In a nutshell, those approaches in terms of human capital and social capital are interesting in that they question the pure rationality of individuals, putting them right in the middle of society (notably the role of family and state are clear) or in the "strategic group" (Porter 1982) they have chosen. In the management literature, the role of social relations and of networks is more and more used to explain the entrepreneurs' success (Sammut 1998; Davidsson and Honig 2003; Suire 2004; Marchesnay 2004; Chabaud and Ngijol 2005). But these approaches seem too simplistic because they remain largely focused on the individual, with very few references to the economic, social, and political context in which he/she acts. This analysis based on the "resource potential" can thus be considered as a further step in the social analysis of the requisites for an individual's success – more precisely the entrepreneur – or of the explanation of his/her failure.

The Organic Square of Entrepreneurship and the Network-Based Entrepreneur's Function

The resource potential is not a natural gift and is built by a conscious (or unconscious) strategy, linked to the economic, political, and social context in which the entrepreneur operates. Moreover, this potential is not stable. It can be increased, as explained by the above-mentioned American sociologist, but it can also decrease in some special cases or contexts. For example, a bankruptcy in Europe is very badly perceived and may be a case of drastic reduction in the resource potential; in another context, it may not change anything or even be regarded as an entrepreneurial attempt, which has to be followed by other attempts. In the same vein, public policies may help to increase an entrepreneur's resource potential or cause its decrease (support to business creation, taxes in connection with the creation of the enterprise, etc.). The economic network-based organization (regulations, financial system, locations of large enterprises, level of technical and knowledge development) and the market (supply and demand) may have the same positive and negative results on the resource potential of the entrepreneur and more globally on entrepreneurship. The formalization in the terms "organic square of entrepreneurship" is thus an attempt to explain why the entrepreneur's function is not a long-lasting and stable one. Being an entrepreneur is not a profession but a function which stops when the entrepreneur does not innovate anymore: the social, economic, and political context may cause the appearance or the disappearance of the entrepreneur.

First of all, the economic context is characterized by change. Change is created by the activity of entrepreneurs, and major change comes in a context of crisis. Change also creates new investment opportunities (creation of new needs thus causing an increase in demand, and so on).



Entrepreneur's "Resource Potential," Innovation and Networks, Fig. 1 The four extremities of the diagram represent the relationship between the Entrepreneur's resource potential (formed by its financial capital, cognitive and social), the market (inputs and outputs of the business), public policies to promote entrepreneurship and organization of the economic sector (regulation, barriers to entry, presence of large companies, etc.). These relationships define entrepreneurial capacity (entrepreneurship) in a given sector, a region or a country. (Source: Authors' own conceptualization)

The economic situation is thus fundamental to the emergence of the entrepreneurial function. Secondly, as mentioned earlier, even if the entrepreneur is a kind of *deus ex machina*, he/she also has some competencies, and notably the one to convince the banker and thus to raise funds. The financial resources are thus taken into account. More globally, the level of development of the financial system (and more precisely the banking system) is therefore very important to explain the entrepreneur's existence and success. Thirdly, institutional change (which characterizes the economic organization in the following scheme) is at the origin of the extinction or the revival of the entrepreneur's function. The aim here is to formalize the elements of the economic social and political context which may explain why the entrepreneur's function is not a stable one.

As a matter of fact, the entrepreneur's dynamism and qualities cannot explain per se the creation and success of small enterprises. This is the reason why a more systematic analysis of the key factors of entrepreneurship (or the network-based entrepreneur's function) – high tech or not – in today's economy may be proposed. Four major factors affect this: public policies, economic and social organization (the importance of large corporations, the nature of the financial system, and the level of development of knowledge), and the state of supply and demand which contribute to the building of the resource potential. The interdependence between these factors allows to analyze them through an "organic square of entrepreneurship" (Fig. 1).

The Organic Square of Entrepreneurship

What is the rationale of the "organic paradigm of entrepreneurship" and how to explain the choice of the incentive factors proposed here? To answer these questions, it is necessary to focus on the key factors of success of small businesses. S. Shane (2003), for example, makes a synthesis between the Schumpeterian entrepreneur (who is an innovator) and Kirzner's entrepreneur (who has to be well informed to catch the market opportunities) (Kirzner 1973, 1985). S. Shane defines the relevant environmental factors (institutional, political, and sociocultural) which may help the entrepreneur to innovate. However, he/she does not make reference to the entrepreneur's own resource potential. Many other studies conducted by specialists in management sciences have demonstrated that the creation and durability of small enterprises depend on the entrepreneur's ability to take into account the existing links between different internal factors (organization, financial resources, activity) and external ones (the different levels of the environment) (Sammut 1998; Marchesnay 2003). In this case, the approach is more centered on the individual. This analysis thus links the two approaches, focused on the entrepreneur and on the environmental factors.

This entrepreneurial "maturity" results firstly from the variety and abundance of the resource potential which they have built. The composition of this potential depends on external factors and on the entrant himself/herself. In particular, public support (direct or indirect) to the creation of new enterprises usually determines the financial resources entrepreneurs can have access to in order to set up or develop their business. The economic and social organization has several dimensions and different effects. The general level of development of knowledge influences the knowledge gathered by entrepreneurs (through their education and that of their staff through economic intelligence) and the technological level of their activity. The characteristics of the financial system (possibility or difficulty in being listed on the stock exchange, more or less "conservative" banks, and the access to venture capital) have an impact on the capacity of the individual to become an entrepreneur and on the development of new businesses. Market concentration and the place of large companies also influence the dynamism of entrepreneurial activities and the kind of activity they have. Finally, the overall economic situation determines the rhythm of new creations and also the types of activities conducted by such businesses (see Boutillier et al. 2004).

It is in this organic square of entrepreneurship that the entrepreneur's function lies. This is a temporary function because it stems from the gathering at one moment of some special conditions. According to the context, it is also possible to examine different types of entrepreneurs, which have different resource potentials – for example, high-tech entrepreneurs or low-tech ones for another part. This approach thus permits to go deeper into the analysis of the entrepreneur, no more as a disembodied agent but a social agent, in all its complexity.

Conclusion and Future Directions

To conclude, explaining the origin (resource potential) and the conditions of appearance of entrepreneurs (organic square of entrepreneurship or network-based entrepreneur's function) is all the more important as the entrepreneur has not disappeared, contrary to Schumpeter's prediction. He is on the contrary in the forefront of the economic scene. The entrepreneur is also in the heart of the political debate, his/her existence and durability (as an economic act and not as a function) being considered as the reason for economic growth. However, as explained above, the entrepreneur is no longer a hero. He has become a socialized entrepreneur, an entrepreneur who is a player in an economy made up of, on the one hand, the planning decisions made by big firms which, even if networked, nevertheless are powerful bureaucracies and, on the other hand, the state's policies to reduce unemployment and boost innovation and competitiveness.

The socialized entrepreneur in today's economy is an important force in the renewal of economic activity based on knowledge, information, finance, and industrial concentration. The innovative entrepreneur appears in innovation, knowledge, and finance-based networks built by large companies and specialized institutions. The debates on the networks focus as much on the flexibility, as on the increase in the firm's capacity to appropriate a large quantity of resources without investing in their formation. The large firm has turned into a center of formation and flexible coordination of partnerships but also of generating entrepreneurial opportunities. Coordination and innovation processes, both flexible and evolutionary, impose on the firm the pressing need to be provided with the different types of technological and intellectual means to acquire and combine uninterrupted flows of material and immaterial resources (see for ex. Howitt 1996). Complex networks associate large firms, start-ups, universities, public and private research, funding institutions, consultancy, and specialized business services, etc. dedicated to the innovation process. The importance taken by networks in economics reveals the necessity for collaboration, which is due to the complexity, the cost, and the risk of the innovation process. The growing burden on financial investment for the organization of productive activities implies cooperation between firms and institutions to facilitate continuous, "permanent" development of profitable new goods and services. It thus explains the renewal of the entrepreneur's function (notably spin-offs and outsourcing) as well as the invention of new organizational and interorganizational modes (alliances, partnerships, networks, clusters) (see Laperche et al. 2008).

The knowledge-based economy requires further research on the characteristics of the new entrepreneurs: the ability to adapt and the efficiency of the entrepreneur's capability depend on his/her cognitive categories, on the interpretation codes of the information itself, on the tacit skills and his/her procedures in solving the problems it encounters, and on his/her capacity to integrate innovation networks.

Schumpeter, focusing on the entrepreneur, considered as a *deus ex machina*, did not take enough account of the economic, political, and social context which may generate the entrepreneurial function. He did not see how far the entrepreneur was a social agent and even sometimes a political construction, sometimes aiming at repairing the system's failures and extending its life. Today, the approach developed here aims at better explaining it (when applied to the economic facts with socio-economic inquiries on entrepreneurial profiles), the innovative entrepreneur is replaced by a more pragmatic entrepreneur, whose main motivation lies in the acquisition of a revenue, which does not always mean his/her personal enrichment. Even if the conventional (in the sense of Galbraith) perception of the entrepreneur remains the one of a hero, the one who can easily, thanks to his/her natural gifts, become Rockefeller or Bill Gates, one may also consider how this myth is an "innocent fraud."

Cross-References

- ▶ Entrepreneur
- ▶ Entrepreneurship and Business Growth
- ▶ Environmental Determinants of Entrepreneurship
- ▶ Innovation Opportunities and Business Start-up
- ▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
- ▶ Network and Entrepreneurship
- ▶ Technology Push and Market Pull Entrepreneurship

References

Aghion P, Howitt P. Endogenous growth theory. Cambridge: MIT Press; 1998.

Audretsch DB, editor. Entrepreneurship, innovation and economic growth. Cheltenham: Edward Elgar; 2006.

Becker G. Human capital. Chicago: University of Chicago Press; 1975.

Blaug M. Histoire de la pensée Economique. Paris: Economica; 1998.

Bourdieu P. Le capital social. Actes de la Recherche en Sciences sociales. 1980;31:115–32.

Bourdieu P, Wacquant LJD. An invitation to reflexive sociology. Chicago: University of Chicago Press; 1992.

Boutillier S. Du capital social au potentiel de ressources : société entrepreneuriale, *Quid* de l'économie sociale, 5ème rencontres inter-universitaires d'économie sociale et solidaire, CEFI Université de Méditerranée, Marseille 11–12 mai 2005.

Boutillier S. The end of capitalism: J. K. Galbraith vs K. Marx and J. A. Schumpeter. In: Laperche B, Galbraith J, Uzunidis D, editors. Innovation, evolution and economic change. New ideas in the tradition of J. K. Galbraith. Cheltenham: Edward Elgar; 2006. p. 53–71.

Boutillier S, Uzunidis D. L'entrepreneur. Une analyse socio-économique. Paris: Economica; 1995.

Boutillier S, Uzunidis D. La légende de l'entrepreneur. Le capital social ou comment vient l'esprit d'entreprise. Paris: Syros; 1999.

Boutillier S, Uzunidis D. L'aventure des entrepreneurs. Paris: Studyrama; 2006.

Boutillier S, Uzunidis D. La création d'entreprises dans une région industrielle en reconversion. Essai de réflexion à partir du « Potentiel de Ressources », Quatrièmes Journées de la Proximité, Proximité, réseaux et coordination, IDEP GREQAMLEST et le groupe de recherche « Dynamiques de proximité », Marseille, 17–18 juin 2004.

Boutillier S, Laperche B, Uzunidis D. Le « Potentiel de ressources » de l'entrepreneur et le « carré organique de la création d'entreprises », Eléments de réflexion à partir du cas français, SASE, Juillet, Society for the Advancement of Socio-Economics, 2004.

Buchanan JM, Tullock G. The calculus of consent. Ann Arbor: University of Michigan Press; 1962.

Burt RS. Le capital social, les trous structuraux et l'entrepreneur. Revue française de sociologie. 1995; XXXVL:599–628.

Canterbury R. A brief history of economics, artful approaches to dismal science. Singapore: World Scientific; 2001.
Cantillon R. Essai sur la nature du commerce en général. Paris: Institut National d'Etudes Démographiques; 1997.
Casson M. Entrepreneurship. Cheltenham: Edward Elgar; 1990.
Castells M. La société en réseaux, L'ère de l'information. Paris: Fayard; 2001.
Chabaud D, Ngijol J. La contribution de la théorie des réseaux sociaux à la reconnaissance des opportunités de marché. Revue Internationale des PME. 2005;18:73–90.
Coleman JS. Social capital in the creation of human capital. Am J Sociol. 1988;94:95–120.
Coleman JS. Foundations of social theory. Cambridge: Harvard University Press; 1990.
Davidsson P, Honig B. The role of social and human capital among nascent entrepreneurs. J Bus Venturing. 2003;18:301–31.
Denison EF. The sources of growth in the US. New York: Committee for Economic Development; 1962.
Fukuyama M. The end of history and the last man. New York: Harper Perennial; 1993.
Galbraith JK. The new industrial state. Boston: Houghton Mifflin; 1967.
Galbraith JK. The economics of innocent fraud. Boston: Houghton Mifflin; 2004.
Gasse Y, Diochon M, Menzies T. Les entrepreneurs émergents dont l'entreprise est devenue opérationnelle et les autres: comparaisons lors de la conception du projet d'entreprise. J Small Bus Entrep. 2004;17:117–34.
Granovetter M. The strength of weak ties. Am J Sociol. 1973;78:1360–80.
Granovetter M. Economic action and social structure: the problem of embeddedness. Am J Sociol. 1985;91: 481–510.
Howitt P, editor. The implications of knowledge-based growth for micro-economic policies. Calgary: University of Calgary Press; 1996.
Keynes JM. The means to prosperity. London: Macmillan; 1933.
Kirzner I. Discovery and the capitalist process. Chicago: University of Chicago Press; 1973.
Kirzner I. Entrepreneurial discovery and the competitive market process: an Austrian approach. J Econ Lit. 1985;35:60–85.
Laperche B. Risque et innovation: repères. In: Laperche B, editor. L'innovation orchestrée. Risque et organisation. Paris: L'Harmattan; 2003. p. 7–17.
Laperche B, editor. L'entreprise innovante et le marché. Lire Galbraith. Paris: L'Harmattan; 2005.
Laperche B, Galbraith J, Uzunidis D, editors. John Kenneth Galbraith and the future of economics. London: Palgrave Macmillan; 2005.
Laperche B, Galbraith J, Uzunidis D, editors. Innovation, evolution and economic change. New ideas in the tradition of Galbraith. Cheltenham: Edward Elgar; 2006.
Laperche B, Uzunidis D, von Tunzelmann NG, editors. The genesis of innovation. Systemic linkages between knowledge and the market. Cheltenham: Edward Elgar; 2008.
Lucas R. On the mechanics of economic development. J Monet Econ. 1988;72:3–42.
Macaulay S. Non contractual relations in business: a preliminary study. Am Sociol Rev. 1963;28:55–67.
Marchesnay M. La petite entreprise: sortir de l'ignorance. Revue française de gestion. 2003;144:107–18.
Marchesnay M. 'L'hypofirme, fondement de l'hypermodernité ?', 7e Congrès International francophone en entrepreneuriat PME, Paris, 27–29 octobre 2004.
Marshall A. Principes d'économie politique. Paris: V. Giard et T Brière; 1906.
Marx K. Le Capital (1867), livre I, II, III. Paris: Editions sociales; 1976.
OCDE. Du bien-être des nations, le rôle du capital humain et social. Paris: OCDE; 2001.
Porter M. Choix stratégiques et concurrence. Paris: Economica; 1982.
Putnam R. Bowling alone: the collapse and revival of American Community. New York: Simon and Schuster; 2000.
Romer P. Endogenous technological change. J Political Econ. 1990;98:71–102.
Sammut S. Jeune entreprise. La phase cruciale du démarrage. Paris: L'Harmattan; 1998.
Say J-B. Cours d'économie politique. Paris: GF-Flammarion; 1828/1996.
Schulz TW. Investment in man: an economist's view. Soc Serv Rev. 1959;XXXVL:109–17.
Schumpeter JA. The theory of economic development. New Brunswick: Transaction Publishers; 1911/2006.
Schumpeter JA. Business cycles. New York: Macgraw Hill; 1939.
Schumpeter JA. Capitalism, socialism and democracy. New York: Harper Perennial; 1942/1976.
Schumpeter JA. Histoire de l'analyse économique. Paris: Gallimard; 1954/1983.
Shane S. A general theory of entrepreneurship. The individual-opportunity Nexus. Cheltenham: Edward Elgar; 2003.
Smith A. Recherche sur la nature et les causes de la richesse des nations. Paris: G-F Flammarion; 1776/2002.
Suire R. Des réseaux de l'entrepreneur au ressort créatif: quelles stratégies pour les territoires. Revue Internationale des PME. 2004;17:29–54.
Ulgen F. Economie monétaire et dynamique schumpétérienne d'évolution économique. Innovations, Cahiers d'économie de l'innovation. 1996;4:61–93.
Uzunidis D. Schumpeter et mouvements longs de l'économie. Aspects critiques de l'actualité économique. Innovations, Cahiers d'économie de l'Innovation. 1996;4:119–40.
Uzunidis D. L'innovation et l'économie contemporaine, Espaces cognitifs et territoriaux. Bruxelles: De Boeck; 2004.

Uzunidis D. Pépinière d'entrepreneurs: le capitalisme. Paris: L'Harmattan; 2006a.
Uzunidis D. Innovation, cycles et renouveau du capitalisme. In: Uzunidis D, editor. Pépinière d'entrepreneurs: le capitalisme. Paris: L'Harmattan; 2006b. p. 71–87.
Walras L. Eléments d'économie politique pure. Paris: Economica; 1874/1988.
Weber M. L'éthique protestante et l'esprit du capitalisme. Paris: Plon; 1905/1964.
World Bank Combattre la pauvreté. Rapport sur le développement dans le monde 2000–2001. Paris: 2000.

Entrepreneurial Behavior

► Psychological Aspects of Entrepreneurial Dynamics

Entrepreneurial Behavior and Eco-Innovation

Blandine Laperche
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

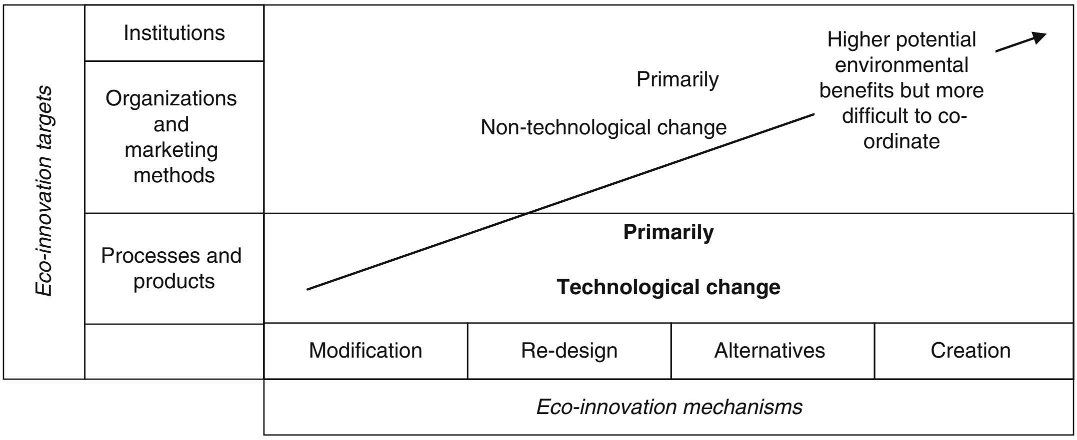
Capabilities to change firm's trajectory; Entrepreneurship and innovation; Innovation in green technology

The implementation of a sustainable mode of development has become a major aim of public policies in industrial countries, and the evolution of economic agents' behaviors (producers and consumers) is considered as the engine of this "new economy." Enterprises are thus induced to develop socially responsible behaviors, that is to say, to integrate social and environmental concerns into their business operations and in their interactions with their stakeholders on a voluntary basis. For firms, the entrepreneurial behavior that consists in the development of green innovation or eco-innovation resorts to this necessity to develop responsible behaviors. But the question for many firms (as well as for institutions and scholars) remains: how should the firm change its trajectory and thus develop an eco-innovation strategy?

Responsible Behavior and Entrepreneurial Behavior

If ethics was the first reason invoked by the tenants *of a social responsibility of enterprises*, the literatures on corporate social responsibility and on the objectives of the firm put forward two main reasons for developing responsible behaviors. The first one is related to the constraints that the external pressure from stakeholders such as employees, shareholders, customers, suppliers, the State, and the civil society puts on the firm. The second one is the opportunity for the firm adopting a responsible behavior to improve its economic results. Thus, developing a responsible behavior would be a "win-win" strategy first because it is more respectful toward the environment and the society and also because it is a profitable strategy. In order to improve its economic results in a global competition based on innovation as it is today, a firm needs to constantly develop and renew its products, processes, and organization. Innovation, whatever its forms, thus appears as the best solution to conciliate the idea of social responsibility with the necessity to make profits.

It is therefore possible to see a connection between responsible behavior and entrepreneurial behavior, for entrepreneurial behavior is also tightly linked to innovation, defined in the sense of Schumpeter. According to him, entrepreneurship is an economic function, which takes the form of a new product delivered through a new process, implementing a new organization, opening a new market... Entrepreneurial behavior, defined here by the innovation act, may be observed when an innovative firm is created as well as when an innovative project is implemented within an existing firm. From the enterprise point of view, the current equation of sustainable development therefore takes the following shape:



Entrepreneurial Behavior and Eco-Innovation, Fig. 1 Typology of eco-innovation (Source: OECD (2009))

"Corporate social responsibility + entrepreneurial behavior = eco-innovation."

But what does eco-innovation precisely mean?

A Definition of Eco-Innovation

"Green innovations," "eco-technologies," or "eco-innovations" have been so far mainly defined by political agendas; therefore, an economic definition that could be shared by scholars is still missing. In this entry, we retain the definition of eco-innovation provided by the OECD (2009), which adds two characteristics to the definition of innovation offered by the Oslo Manual: its explicit emphasis on the reduction of environmental impact and the fact that eco-innovation is not limited to products, processes, marketing, and organizational methods but also integrates innovation with social and institutional aspects.

This definition is therefore a broad one which includes products and processes forms of innovation. It also emphasizes the social and institutional changes involved in eco-innovation. The OECD (2009) offers a typology of eco-innovations based on targets, mechanisms, and impacts of eco-innovations (Fig. 1). Eco-innovation targets are products and processes, organizations and institutions. Four mechanisms – in other words the method by which change in the eco-innovation target takes place or is introduced – are identified: modification – small, progressive product and process adjustments; redesign – significant changes; alternatives – for example, introduction of goods and services that can fulfill the same functional needs and operate as substitutes for other products; and creation – design and introduction of entirely new products, processes, procedures, organizations, and institutions. The impacts define the effects of eco-innovation on the environment.

If social responsibility is not restricted to the development of technological innovation (new products and processes implemented on markets), it is one of the most visible ways to develop a responsible behavior. As a matter of fact, it is, for example, easier to communicate on a new ecological product or process than on, say, better working conditions which mostly concern the company's employees and not the consumers and potentially all the society. Green innovation or eco-innovation enhances the company image/reputation which may impact the profitability of the innovation process.

As also shown by the OECD (2009), firms thus largely focus on technological forms of eco-innovation, even if they also consider nontechnological changes, which may be organizational and institutional. The example of the automotive sector is interesting. While developing electric or hybrid cars, firms are more and more interested in offering a "service of travel," that is to say renting cars notably in urban areas. This is a good example as it implies to change the business model and thus the firm's organization as well as social norms and cultural values about using a car (which also resorts to institutional change).

Eco-innovation may be at the center of the new venture's business model, but it may be a new project in an existing firm. In the second case on which we focus here, the development of eco-innovation implies a change in the firm's trajectory. The issue of change at the firm level needs to be mobilized in order to understand the ability to change their technological trajectory in order to develop eco-innovation.

The Roles of Dynamic Capabilities in Trajectory Change

The evolutionary theory – particularly initiated by Nelson and Winter 1982 – tends to understand novelty and interpret change, by taking into account the environment and the history within which systems evolve. In those approaches, the evolution and objectives of firms are defined through the processes of learning and coordination, according to procedures of trial and error (search), which should lead to satisfactory results. The adoption of procedural rationality reflects the importance of uncertainty in which organizations operate and interact. According to the evolutionist approach, the evolution of the firm's trajectory depends on and results in a learning process that creates specific assets and new capabilities.

The learning process is a process by which repetition and experimentation lead to the fact that, over time, tasks are done in a better and faster manner and new opportunities in the procedures are constantly being tested. That process generates the production of cumulative knowledge materializing in organizational routines defined as models of interactions that are effective solutions to specific problems. They form an "organizational memory" embedded in the skills of workers and machinery. Those tacit routines are clusters of specific resources/assets and are not easily transferable. The firm operates along a path determined by the expertise accumulated through learning. Thus, specific assets determine the evolution or trajectory path of the firm. The path dependence precisely expresses that evolution of the firm, constrained by past investments. Even if accumulated skills can enhance the competitive advantage of the firm, they may also constitute a kind of trap, but the evolution of the firm is not necessarily gradual and does not exclude ruptures and bifurcations. The core or complementary assets present along the value chain can give the firm the possibility to change direction. The evolutionary theory of the firm can therefore help us comprehend the endogenous transformation of the firm over time.

The literature on innovation management (evolutionist theories and more globally resource-based theories) emphasizes the role of capabilities. The capabilities to develop and renew the specific resources and assets gathered into organizational routines are named "dynamic capabilities" by Teece et al. (1997). They refer to "the firm's ability to integrate, build and reconfigure internal and external competences to address rapidly changing environment" (Teece et al. (1997), p. 516). There are various kinds of dynamic as, for example, the dynamic capabilities to generate new ideas, to change the firm's projects, to develop new scientific and technical knowledge so as to change the knowledge base of the firm, to change the ways of launching new products, etc. All those dynamic capabilities are important in the trajectory change towards eco-innovation. However, the development of new scientific and technical knowledge aimed to change the knowledge base of the firm can be considered as a starting point.

According to us, the learning process and the building of immaterial specific assets gathering internal and external resources are achieved by and lead to the construction of what we call the firm's knowledge capital. "Knowledge capital" is defined as the set of information, knowledge, and know-how produced, acquired, combined, and systematized by the enterprise in order to create value. The building and the renewal of the knowledge capital appears as a tool to build new technological capabilities and thus to facilitate the change in the firm's trajectory. As a matter of fact, the knowledge capital of a firm refers to the way the enterprise acquires and collects information on markets, produces knowledge alone or/and in collaboration, transforms it into knowledge, routines, and know-how which are a source of specific advantages, and uses that knowledge and information in a process of value creation.

Technological capabilities and technological success are not considered today as the results of the firms' own resources but are the outcome of complex processes of collaboration and cooperation. Cooperation, collaboration, open innovation strategies, and scientific and technological networks are nowadays key words in the literature. The mutation of the firm's trajectory is expensive and risky. That is why, it reinforces the trend toward the collaborative creation of knowledge capital (or open innovation strategy), which is confirmed in the recent literature and involves various sectors, automotive to the pharmacy or even to chemistry, etc.

Firms collaborate with partners all along the supply chain: on basic research with universities and other research centers, on applied research and product development with other firms (suppliers, customers, start-ups, and sometimes competitors)... Collaboration is a way to reduce the cost (by sharing it) of development of new knowledge; it also gives the possibility to access to very specific knowledge. Collaboration has become a key word of innovation management and thus can be considered as a main feature of entrepreneurial behavior. And the role of collaboration is once more emphasized when one focuses on eco-innovation.

Collaboration as a Key Capability for Eco-Innovation

If we look more closely at the literature on eco-innovation, the role of capabilities and of collaboration is also put forward. To change the firm's trajectory toward eco-innovation, the creation of new dynamic capabilities is necessary. Lin et al. (2011) define green business innovation capabilities (GCICs) as "a green business innovation process wherein firms explicitly undertake capabilities to achieve higher green performance as well as commercial performance" (Lin et al. 2011, p. 1840). In their aim to evaluate GBICs at the firm level, they develop a framework made of 7 aspects – and 25 evaluation criteria – including the definition of a green technological innovation strategy, the attitudes of workers toward change in their work routines, the ability of the firm to formulate green innovative projects, the development and protection of green knowledge, the communication capability, the ability to work with external partners, and the management of business innovation. The development of new knowledge and the place of collaboration are clearly emphasized. Moreover, on the basis of a review of literature, Van Kleef and Roome (2007) compare the capabilities needed to develop innovation oriented toward competitiveness and those needed to develop innovation oriented toward sustainability. They show that these capabilities largely overlap, which is not surprising (as mentioned by the authors) as competitiveness is one part of the larger concept of sustainability. However, they put forward the importance given in the literature on green innovation to the communication and collaboration "with very diverse and culturally unfamiliar (and or local) networks of actors, on integrating their diverse perspective, criteria and information processing and decision styles" (Van Kleef and Roome 2007, p. 45).

From what precedes the development of collaboration reveals itself very important for different reasons:

- The sharing of knowledge and thus the risks and the cost of innovation in a context of economic uncertainty
- The necessity to comply with the different stakeholders' aims implied in eco-innovation strategies

To sum up, we can state that to be responsible, firms have to develop entrepreneurial behavior, that is to say, to innovate and more precisely to eco-innovate. Implementing eco-innovation often implies a change in the firm's trajectory, which can be achieved through the development of new dynamic capabilities. The constitution and renewal of the knowledge capital is the central tool for creating these capabilities. In this analysis, the ability to collaborate is emphasized for two reasons, one traditionally linked to the management of the innovation process (reduction of costs and risks, access to new knowledge) and one that is linked to the responsible behavior that characterizes eco-innovation (the various stakeholders implied in the eco-innovation process).

However, if we have here highlighted an important characteristic of entrepreneurial behavior in the context of eco-innovation, we should not forget that change is a difficult process. Can the eco-entrepreneur or the eco-enterprise succeed on its own?

The Costs of Change: How to Help Entrepreneurs to Eco-innovate?

Despite a growing awareness of the negative impacts of fossil fuel use and related technologies, attempts to shift toward cleaner substitutes are still proving difficult. On the one hand, that is because hydrocarbon technologies have benefited from advantages resulting from increasing returns to adoption and economies of scale that make them cheaper, performing, and user-friendly. On the other hand, green techs that fail to win early adoption success have been locked out from the market, unable to compete with the improved technology because of increasing returns. Moreover, in a context of crisis, the purchasing power of the population may decrease which do not stimulate the demand for new green products. Firms try by themselves through standards and marketing strategies to impose their products to "create" the demand and thus control the markets, but they do not make it all due to the cost, difficulties, and unproved profitability of eco-innovation (Laperche and Levratto 2012).

If we focus on the development of new scientific and technical resources and capabilities, the cost of change toward eco-innovation is also reinforced by the very important expenditures that are needed not only to develop product innovations but also to encompass new services and the activity's new organization. Despite the pooling of costs and risks and the acceleration of the innovation process enabled by collaborative research and development, the amounts of expenditures necessary to develop new products, processes, and services are still difficult to afford by the collaborating firms, especially in a context of economic recession.

Moreover, the shared costs implied by collaborative research do not exclude the existence of hidden costs that may increase the overall costs of change. Transaction costs (Williamson 1975) may be related to the finding to the appropriate partner (e.g., an academic laboratory working on the same subject), to the negotiation of the contract (sharing of knowledge and related intellectual property rights problems), and to the contract monitoring (risk of coopetition, intellectual property rights conflicts). These costs of change cannot be all overcome by the managerial capabilities of communication and diffusion of information. Institutional support is needed to reduce – if not overcome – this kind of costs. In France, for example, from the mid-2000s, in response to decisions made at European level in the Lisbon Strategy in 2000 and reaffirmed in 2008 to improve the competitiveness of enterprises, governments have become more involved in active support to the "technology transfer between public research and socioeconomic actors." Different devices, which are intended to support the constitution and promote the reorientation of knowledge capital in the future technologies have been introduced or improved: improvement of the Research Tax Credit (RTC), project financing via the ANR (National Research Agency), and European R&D programs as well as the French cluster policy named "Pôles de compétitivité" (2004).

Conclusion and Future Directions

Eco-innovation is now considered as a central element of industrial firms' strategies. To face the crisis and to position themselves on niches of the markets with high growth potential but also to satisfy the demand of various stakeholders, firms refocus their strategy and their organization toward the development of green products (goods and services) which imply organizational – but also many institutional – changes. At the firm's level and dealing with technological change, we have emphasized the role of the development of new dynamic capabilities. The capabilities to collaborate with various partners for the building and reorientation of the knowledge capital are central. As a matter of fact, in eco-innovation strategies, collaboration is a way to share the costs and risks of technological development and thus is a crucial vector of change of the firm's trajectory. It is also a way to comply with the aims and objectives of the various stakeholders implied in sustainable strategies of innovation. However, collaboration does not always reduce the cost of innovation since transaction costs may be the counterparts of the building of complex innovation networks. Institutional intervention (arrangements, laws, R&D and industrial programs, supply and demand incentives) is thus necessary to help firms overcome these hidden costs.

Cross-References

- ▶ Entrepreneur
- ▶ Entrepreneurial Capability and Leadership
- ▶ Green Business and Entrepreneurship
- ▶ Green Enterprising and Green Entrepreneurs
- ▶ Knowledge Capital and Small Businesses
- ▶ Small Businesses and Sustainable Development

References

Laperche B, Levratto N. Emergence of ecological opportunities and firms behavior. In: Laperche B, Levratto N, Uzunidis D, editors. Crisis, innovation and sustainable development. Cheltenham: Edward Elgar; 2012.

Lin Y, Tseng ML, Chen CC, Chiu ASF. Positioning strategic competitiveness of green business innovation capabilities using hybrid method. Expert Syst Appl. 2011;38(3):1839–49.

Nelson R, Winter S. An evolutionary theory of economic change. Cambridge: Harvard University Press; 1982.

OECD. Eco-innovation in industry, enabling green growth. Paris: OECD; 2009.

Teece DJ, Pisano G, Shuen A. Dynamic capabilities and strategic management. Strateg Manag J. 1997;18(7):509–33.

Van Kleef JAG, Roome NJ. Developing capabilities and competence for sustainable business management as innovation: a research agenda. J Clean Prod. 2007;15:38–51.

Williamson OE. Market and hierarchies: analysis and anti-trust implications. New York: The Free Press; 1975.

Entrepreneurial Capability and Leadership

Sharam Alijani
Department of Strategy and Entrepreneurship, Reims Management School, Reims, France

Synonyms

Entrepreneurial cognition; Entrepreneurial creativity; Entrepreneurial innovation; Organizational capability

The Field and Practice of Entrepreneurship

As a subject of scientific and social inquiry, entrepreneurship studies cut across numerous disciplines: economics, behavioral and cognitive sciences, sociology, law, management, and organization sciences. Placed within a multidisciplinary canvas, recent academic research focuses on a wide array of determinants and predictors of economic performance, technological innovation, and human and social capital growth. Among numerous research foci, the question of sources of entrepreneurial capability and leadership is of paramount importance to both scholars and policy makers. It is particularly important to distinguish between individual creativity that characterizes inspirational entrepreneurs and the capabilities that result from collective action and organizational competences and know-how. Consequently, entrepreneurial capability can be defined as a distinct set of individual and organizational capabilities and skills as well as actions, practices, and routines that aim to explore, integrate, and exploit untapped business opportunities within an instituted market context. Placed within a broader canvas, entrepreneurial capability represents the multiple facets of individual and collective initiatives that encompass different forms of social and economic innovation and renewal strategies. Different forms of entrepreneurship (e.g., individual, corporate, social, and institutional) respond to a wide array of strategic, organizational, and environmental contingencies. While entrepreneurial capability is a necessary condition for creating economic wealth, entrepreneurial leadership constitutes an essential characteristic of the individuals who build and sustain human and social capital.

Theories of Entrepreneurship and Entrepreneurial Activity

Entrepreneurship has often been associated with individual and organizational creativity and viewed as a distinct ability to engage in new activities. Consequently, the questions of "who," "when," "how," and "for what purpose" should one engage in entrepreneurial activities addresses the need to identify the sources of opportunities, value identification, and wealth creation (Hitt et al. 2011; Ireland et al. 2003; Shane and Venkataraman 2000; Bamford 2005; Miles 2005). Building on a more expansive definition by Hitt et al. (2011, p. 59) that describes entrepreneurship as a "*context-specific social process through which individuals and teams create wealth by bringing together unique packages of resources to exploit marketplace opportunities*," we set out to demonstrate that the "resource–capability" frontier portrays a multidimensional relationship between individual and organizational capabilities on the one hand and the institutional context and market stimuli on the other (see section "Entrepreneurs as Creators and Innovation Leaders"). As such, entrepreneurial capabilities and market instituted contexts play a pivotal role in creating economic value and developing social capital.

Classical economics referred to two categories of economic agents: wage-earner workers and capital-provider owners. Cantillon (1755), Smith (1776), and Say (2005) were among the first to provide a detailed description of entrepreneurial dynamics by analyzing the production and exchange mechanisms in conjunction with the theory of labor division and behavior. Ricardo (1817) made a clear distinction between farmers and laborers and the entrepreneur, whom he regarded as a rent-seeking capitalist. Ricardo defined rent as "*the portion of the produce of the earth, which is paid to the landlord for the use of the original and indestructible powers of the soil. It is often, however, confounded with the interest and profit of capital*" (Chap. II). Ricardo emphasized the source of value: "*value, then, essentially differs from riches, for value depends not on abundance, but on the difficulty or facility of production,. . .by the invention of machinery, by improvements in skill, by a better division of labour, or by the discovery of new markets, where more advantageous exchanges may be made, a million of men may produce double, or treble the amount of riches, ...; for everything rises or falls in value, in proportion to the facility or difficulty of producing it, or, in other words, in proportion to the quantity of labour employed on its production*" (1817, Chap. XX). Mill (1885) made a correlation between risk and return and opined that those who seek an indemnity for risk are to be considered as entrepreneurs rather than capitalists. Knight (1921) noted that a Walrassian perfectly competitive equilibrium could not hold if one had to assume that "entrepreneurs are not willing to take risks when facing market uncertainty unless they can expect a sufficient reward."

The Austrian economic school provided an alternative explication, in line with the general equilibrium postulate and the evolutionary market perspective. Hayek (1945) emphasized the importance of information and knowledge in individual and social decision-making processes and pointed to the causal links between individuals' microdecisions and the broader social choices. Despite information biases, markets provide considerable benefits to entrepreneurs as they seek to decipher complex price, investment, and trade options. Entrepreneurs are prepared and willing to optimize their risk-bearing choices as long as they can exert full control over their economic options. Schumpeter (1934, 1949) addressed the market equilibrium conundrum by stating that, under the assumptions of "general market equilibrium" there would be no room for any reward, rent, or profit for the risk-taking entrepreneurs. He went on to criticize the neoclassical economic theory on the ground that innovation required market knowledge and organizational capacities that go beyond simple managerial functions and skills. Von Mises (1949) referred to the dynamic essence of entrepreneurhsip in capitalist economies, while Kirzner (1973) pointed to the unique ability of entrepreneurial minds that can spot weak market signals, thrive in fields of uncertainty, and take bold leaps of faith to create the future.

Among many critiques of classical economists, Veblen (1904) offered a alternative perspective of the true motivations of profit-seeking industry barons of the early twentieth century. He extolled the American businessmen and capitalists, scorned financial titans, and seemed comforted by the idea that engineers and productive machines would ultimately replace unethical capitalists who sought to retain the lion share of profits.

Neoclassical analysis, on the other hand, postulated that economic agents act rationnall as they seek to maximize their utiliy and markets would ultimately tend toward wage and profit equilibrium. According to neoclassical economic theory, in perfectly competitive markets, firms enter the market as price-takers and their economic profits will be zero. Arrow (1951, 1962) and Alchian (1950) went into considerable length to explain how individuals used market information to make optimal social choices. In a similar vein, Baumol (1968, 1990), Baumol et al. (2007) sought to demystify the mediating role of entrepreneurs by offering an explanation for the market-induced mechanisms that lead to innovation. Landes et al. (2012) provide a detailed account of the evolution of the firm and the prevalence of entrepreneurship as a guiding principle of the economics of innovation and growth. The market economy spawns the seeds of competition by rewarding entrepreneurial audacity even though at times entrepreneurs' bold initiatives may sound foolish, experimental, and prototypical. According to Penrose (1959), there is ample evidence to indicate that the growth of innovative firms stem from a concerted effort of a particular group of individuals with superior capabilities. The endogenous growth model, conceptualized and elaborated by Solow (1956) and Romer (1990), has shed further light on how the utilization of certain variables such as human capital, investment in R&D, and knowledge-intensive inputs can place the firm on a higher innovation and growth trajectory.

Entrepreneurial capability testifies to individual and organizational creativity and is closely associated with the ability to lead in an increasingly knowledge-driven economy. Whereas motivation, creative thinking, and skills foster good entrepreneurship, efficacious managerial practices, good judgment and vision are required for sustaining entrepreneurial success (Amabile 1998). The exercise of good judgment in making decisions is a critical feature of entrepreneurial function in an increasingly informational economy (Casson 1982, 2001). Entrepreneurs have the capacity to calculate financial risks, allocate resources to new ventures, and create new-to-the-market value. Whereas individuals and small firms may show a high degree of resiliency in the face of changing markets, large firms may fail as their past successes can actually become obstacles to new market challenges (Christensen 1997). By seizing and pursuing opportunities, entrepreneurs engage the society on a path to economic prosperity and social progress (Fukuyama 1996).

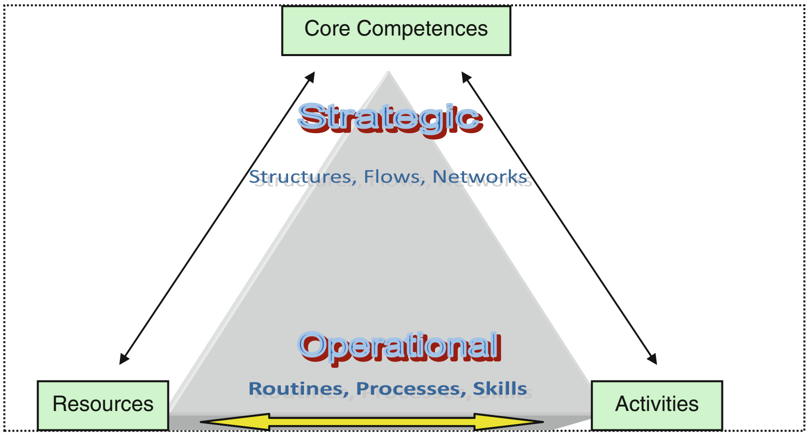
Opportunities, Resources, and Capabilities

Modern firms are characterized by a complex web of interactions among the various stakeholders whose decisions and actions shape the firm's innovation and renewal trajectory. Faced with unequal opportunities and steep competition costs, entrepreneurial firms seek to reconfigure their resources, reorchestrate their activities, and build new core competences throughout different growth stages. As complex organizations, modern firms seek to integrate and exploit new stocks of knowledge and acquire dynamic capacities in an effort to enhance their organizational and operational capabilities (Dooley and Van de Ven 1999). Dynamic capacity can be defined as an ability to integrate new competences and to reconfigure resources in response to changes in the business environment (Teece et al. 1997; Teece 2007; Helfat et al. 2007). Technological and organizational complements, such knowledge; individual and organizational skills; and the innovation structures, processes, and networks, constitute the main cornerstones of a firm's organizational capacities.

A significant research corpus has underscored the linkage between the firm's resource base, core competences and competitive advantage (Prahalad and Hammel 1990; Porter 1990; Barney 1991; Christensen 2001). The proponents of a resource-based perspective have brought to much scrutiny the nature of strategic resources that are used to create combinative and dynamic capabilities within an organization (Wernerfelt 1984; Kogut and Zander 1992; Teece and Pisano 1994; Augier and Teece 2006). The knowledge-based view of the firm (KBV) extends the resource-based view (RBV) by treating knowledge as a generic resource, and by emphasizing the importance of knowledge exploration, integration, and exploitation in building and sustaining organizational capacities. More specifically, the resource-based view treats knowledge as a generic resource (Brown and Duguid 1991; Grant 1996; Zack 2003). As such, knowledge may be categorized as "tacit," "explicit," "autonomous," and "systematic" (Teece 1998) or "core," "advanced," and "innovative" (Zack 1999). Whereas autonomous knowledge yields value without major modification of systems in which it has to be embedded, systematic knowledge requires modification to other subsystems (Teece 1998, p. 64). Unlike the codified form of knowledge, such as formulas and blueprints, tacit knowledge is difficult to articulate and transmit and may thus be subjected to errors of interpretation (Truch 2004; Greiner et al. 2007). By engaging in innovative ventures, entrepreneurs act as knowledge transformers and as agents of social innovation who instill creative thinking and disseminate knowledge skills. Corporations tend to use systematic knowledge and skills to acquire new market competences (Rogers 1983; von Hippel 1988). The competence-based view (CBV) of the firm places a particular emphasis on a broad array of individual and organizational skills as a foundation for knowledge creation and dissemination (Nonaka and Konno 1994; Nonaka and Takeuchi 1995).

Cohen and Levinthal (1990) have shed further light on the pivotal role of knowledge acquisition and assimilation as a mechanism for acquiring the capabilities that are needed to solve complex problems. In an effort to conceptualize the concept of absorptive capacity (ACAP), Zahra and George (2002) have identified two subsets by which firms acquire, assimilate, transform, and exploit knowledge. Knowledge "acquisition" refers to an externally generated knowledge, and knowledge "assimilation" points to the process of knowledge appropriation. Acquisition and assimilation activities enable a firm to achieve a potential capacity (PACAP), while transformation and exploitation tasks lead to a realized capacity (RACAP) (Zahra et George, pp. 190–91). The latter will improve a firm's feedback routines and augment organizational capabilities. Defined as a measure of organizational capability, absorptive capacity tends to increase with incremental use of information technology across the firm's boundary (Lane and Lubatkin 1998). It is noteworthy that changes in systematic knowledge imply technological discontinuities that lead to a different pattern of knowledge accumulation and utilization (Dosi et al. 2002). This is particularly the case of high-tech and information-driven industries such as biotechnologies (Mazzucato and Dosi 2006). According to Chandler (1977), roughly one half of the economic expansion during the 1840–1940 period resulted from improvements of organizational architecture rather than technological innovation.

Figure 1 illustrates the dynamic links between resources, activities, and core competences of the firm. Both strategic options and choices and operational architecture and activities need to be taken into account when assessing entrepreneurial capabilities. At the strategic level, structures, dynamic inter- and intra-firm flows, and network relationships need to assessed, designed, and



Entrepreneurial Capability and Leadership, Fig. 1 Building entrepreneurial capabilities (Source: S. Alijani)

implemented with a view on operational efficacy. Entrepreneurial capabilities have a direct bearing on the scale and scope of operations, the firm's organization, as well as its strategic positioning. Core competences can be sustained by reconfiguring the firm's resources and reorchestrating its activities.

In technologically advanced fields, firms carry out complex activities with a view on accelerating innovation and shifting their core activities toward knowledge-centric opportunities. Knowledge-intensive activities tend to focus primarily on building product and market innovation capabilities. The development of networks has spawned new knowledge-intensive collaborative modes and open innovation platforms among firms. By intensifying formal and informal relationships such as research partnerships and knowledge alliances and by setting up ambidextrous business units (Tushman and O'Reilly 1996), knowledge-intensive corporations tend to lower their transaction costs (Coase 1960, 1990; Williamson 1979). Williamson (1985) refers to the economic institutions of capitalism as increasingly complex organizations that must face comparative costs of planning, adapting, and monitoring task completion under alternative governance structures. Networks draw immense benefits from the pooling of research activities that facilitate cooperation across virtual business networks.

Central to the notion of entrepreneurial capability is the quintessential question of how institutional factors can affect entrepreneurial capabilities. North (1990) sheds further light on the formal and informal constraints and the impact of institutions on the firm's growth trajectory.

Entrepreneurs as Social Innovators

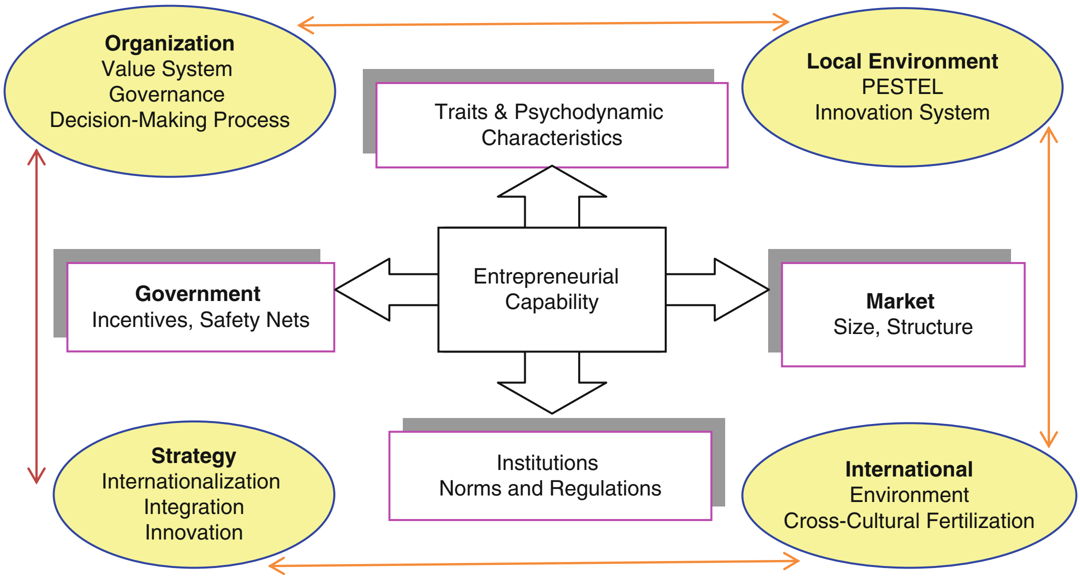
The entrepreneurial society is characterized by institutions, organizations, and individuals whose choices and collective action enable the society to effectively participate in creating and sharing value. The sheer generation of economic wealth may not be conducive to social justice. Yet, the absence of social and economic rights diminishes individual and social capacity to generate wealth. In Nicomachean Ethics Aristotle (2012) makes a clear reference to financial wealth where he avers "… wealth is evidently not the good we are seeking; for it is merely useful and for the sake of something else…" (1980, Book 1). The absence of political freedom leads to social and economic deprivations and shrinks the social space for free exchange of ideas and opportunities. While political deprivations bar citizens from making optimal social choices, justice and democracy provide the stimuli for cognizant and socially valuable initiatives. Sen (2009) endorses the idea of justice and considers that individual capability is directly linked to freedom "*…as it gives a central role to a person's actual ability to do the different things that she values doing*" (2009, p. 253). Consequently, the capability approach underscores the shift to opportunities and not the resources individuals and societies may possess. Sen's definition of capability and description of factors that lead to its deprivation are congruent with an entrepreneurial society that transforms economic wealth to social capability and blends individual capabilities to build social capital (Sen 2000, 2009).

Most studies point to key economic and social factors that affect such entrepreneurial and social capabilities. These studies emphasize the multiple links between capabilities and policies, in particular government support programs in favor of social justice, gender equality, education, and institutional building (OCED 2009). Good institutions instill the rule of law, institute and protect intellectual property rights, design effective social safety nets, and empower and engage a wide array of social and economic actors. While the local economy can provide a viable space for entrepreneurial initiatives, international markets can stimulate entrepreneurial momentum and spirit beyond national borders.

Cognitive Capabilities and Decision-Making Heuristics

Entrepreneurial capabilities may be viewed across different complementary dimensions that take into account a wide array of endogenous and exogenous factors such as entrepreneurial cognition, individual and social biases toward entrepreneurial and market initiatives. The cognitive dimension of entrepreneurial initiatives focuses on entrepreneurs' traits and value systems. Similarly, the decision-making heuristics demonstrates why an entrepreneur may feel confident and when he/she seeks new opportunities and goals for greater economic and social rewards (Shaver and Scott 1991; Bernardo and Welch 2001).

A significant research corpus has scrutinized the use of mental representations and shortcuts when making decisions (Simon 1957; Tversky and Khaneman 1974; Shanteau 1989; Gigerenzer and Todd 1999; Baron 1998). Individuals, communities, and societies show biases toward risk, success, failure, reward, status, sacrifice, tenacity, moral strength, discipline, and conflict. Cognitive biases may emanate from overconfidence and overoptimism (Cooper et al. 1988; Khaneman and Lovallo 1993; Bernardo and Welch 2001), control and planning fallacy (Keh et al. 2002), mood and affect infusion (Forgas 1995), overestimation (Russo and Schoemaker 1992; Busenitz and Barney 1997), and perceived self-efficacy (Chen et al. 1998; Shane 2003; Bandura 1997; Gist and Mitchell 1992). Overconfidence and overoptimism may be associated with the way entrepreneurs construe and interpret the temporal (when), social (for whom), and distal (where) dimensions of risk. Likewise, individual decisions may be associated with creative thinking and an intrinsic motivation to do something for its own sake because it is enjoyable (Deci and Ryan 1985), or a counterfactual thinking and assumption of how things may be done differently (Gaglio and Katz 2001), thus affecting the process of decision-making and decisions' outcomes. The perceived mismatch between optimal versus potential gains and losses are indicative of differences in individual traits and perceptions. Critics to the traits approach argue that time is a critical factor in evaluating risk and hence suggest a model that takes into account a wider risk horizon when measuring the outcomes (Das and Teng 1997). A near future approach to an expected outcome may be associated with new ventures with higher risks, whereas a distant approach may result in a lower-level risk perception (Dickson and Giglierano 1986). The proponents of intention-based theories focus on individuals' attitudes and behaviors in conjunction with the expected outcomes and goals. Tversky and Kahneman (1973) have categorized decision-making heuristics in terms of "availability," the ease with which an event can be imagined, "representativeness," how closely an object may resemble its parent population, and "anchoring" that suggests a comparison with some initial reference point. As an extension to their earlier "prospect theory," Tversky and Khaneman (1992) suggest using the cumulative prospect theory with a combinatory approach to low and high gains and/or losses. The critiques of such mathematical modeling argue that probability boundaries may be blurred by misperceptions, fallacies, and judgmental attitudes. Baron (2000) puts forward the idea



Entrepreneurial Capability and Leadership, Fig. 2 Multidirectional flows and effects of entrepreneurial capabilities (Source: S. Alijani)

according to which entrepreneurs frame decisions in terms of the gains they fail to make if they miss an opportunity rather than the losses incurred by seizing a new opportunity. The notion of framing refers to the way a decision's outcome is perceived by the entrepreneur and is closely associated with what can be viewed as a prospect for potential gains or losses. For instance, a risk-bearing entrepreneur is likely to think in terms of profits made or gains missed rather than losses incurred, whereas a risk-averse individual may think in terms of losses to be expected. Reasoned Action (Fishbein and Ajzen 1975) and Planned Behavior (Ajzen 1991) theories argue that personal beliefs are affected by other people's attitudes, especially by those whose views matter the most to the entrepreneur. Misperceptions and misinterpretations as well as social and economic fallacies lead to decision biases that affect entrepreneurs adversely. Krueger (2000) emphasizes the pivotal role of organizations in triggering entrepreneurial decisions and initiatives since organizations have the capacity to define norms and improve members' perceived self-efficacy.

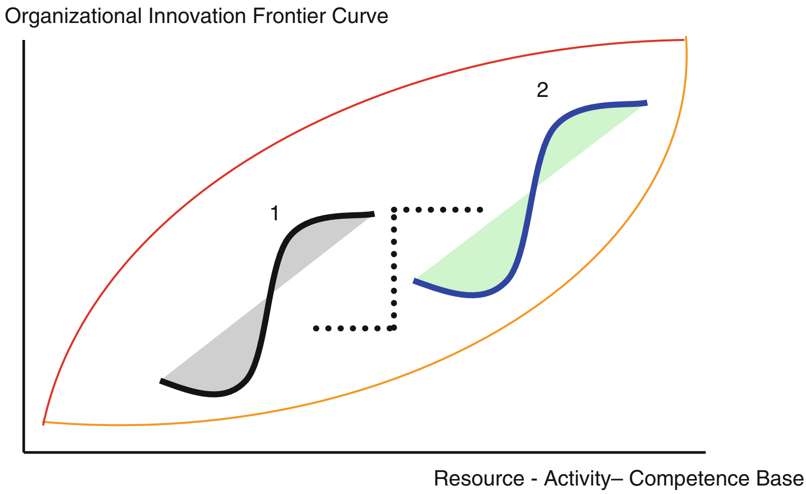
Faced with information asymmetry and uncertainty, entrepreneurs operate under conditions of bounded rationality every time they decide to create a new venture or move to a new market (Simon 1955, 1982). Since decisions can only be taken within the limits of one's cognitive capabilities – limitations of the human mind and the structure within which the mind operates – and since such decisions are subjected to a "time-space" constraint, entrepreneurs anticipate and respond to changes by considering different options, similar to what can be observed in efficient financial markets (McGrath 1999). In other words, entrepreneurs view new ventures as financial options whose success will depend on their distinct leadership qualities to face market contingencies. Figure 2 refers to a multidimensional model of entrepreneurial capability and points to four sets of determinants and factors that trigger entrepreneurial initiatives. Entrepreneurial capability may be observed to be associated with the psychodynamic characteristics of the individual, the firm's governance structure, market size and competitive structure as well as government support programs and institutional configurations, all of which determine strategic options and strategy-making modes (Mintzberg 1973, 1979). Factors such as exposure to international markets, integration and diversification intensity, government support programs (e.g., tax, investment, and export incentives), and property rights are among the factors that stimulate and bolster entrepreneurial initiatives and capabilities (Zahra and George 1991; Oviatt and McDougall 1999).

Entrepreneurs as Creators and Innovation Leaders

While creativity may be linked to one's emotions and psychodynamic characteristics, entrepreneurial capability is often associated with one's value system, leadership, and business ethics. Leardership measures the quality and extent of individual creativity as well as a distinct ability to engage in socially valuable and economically viable initiatives. The literature points to emotional intelligence as a criterion for leadership effectiveness (Antonakis et al. 2009; Goleman 1998; Mayer et al. 2008; Humphrey 2002; Walter et al. 2011). An emerging strand of research on neuroscience argues that leadership is shaped by one' coherence, a condition that can be attributed to coordinated brain activities measured by the degree of neural connectivity in the right frontal portions of the brain (Waldman et al. 2011; Camerer et al. 2005; Hines 1987).

Whatever the root causes of effective leadership – emotional intelligence, coherence, value systems, creativity, resilience, attention to minutiae, adaptation to change– effective leaders are likely to affect individual and collective perspectives by accelerating change and fostering innovation. This point can be further elucidated once placed within a historical perspective. For instance, the invention of the steam engine revolutionized the industry as it enabled entrepreneurs to use the new technology in their handcrafted activities and small fabrication industries. The second half of the nineteenth century heralded a heroic era of scientific entrepreneurship that was characterized by dazzling innovations in organizations and numerous industries. The transformation of the early steam engine and the emergence of a more robust combustion engine enabled engineers and entrepreneurs to turn their small-scale fabrication industries into mass production factories. The second half of the nineteenth and the early decades of the twentieth century were marked by a new breed of innovation-driven leaders who harvested the benefits of their investments in scientific and R&D activities. From early 1870s to late 1940s, a small number of local entrepreneurs succeeded in creating an impressive web of national and international ventures. The textile machine tool inventor, Eli Whitney, the pencil inventor and philosopher, Henry Thoreau, the prolific and multifaceted inventors of electricity and telephone, Thomas Edison and Graham Bell, the photography and computing machine visionaries, George Eastman, Herman Hollerith, and Thomas Watson are ranked among the most illustrious industry leaders and entrepreneurs who left an indelible imprint on the scientific and industrial foundation of their society. Thanks to their entrepreneurial initiatives and leadership qualities, market witnessed major technological breakthroughs and enjoyed numerous innovative products: photography (Kodak), computing and calculating machines (IBM), pharmacy and chemistry (DuPont), electricity and telephone (General Electric and Bell Laboratories), and automobile (General Motors and Ford corporation). Breakthrough embedded technologies gave birth to new ventures and entrepreneurial activities. The creation of Volta Laboratory by Alexander Graham Bell paved the way for a number of spin-offs in the telecommunication sector. Likewise, Henry Ford should be remembered as a visionary entrepreneur and industry leader who revolutionized the production organization by implementing new management practices and organizational innovation in the automobile industry. The advent of transformative technologies, such as semiconductors, microelectronics, and nanotechnologies in recent decades, has accelerated the pace of technological change. More importantly, knowledge-intensive firms have embraced the idea of acquiring new technologies and optimizing their value chains by sharing technical knowledge through open innovation platforms as a way to shorten the market-entry cycles (Chesbrough 2006, 2007).

Figure 3 illustrates the multiple linkages between a firm's "resource-activity" base and its "capability-competence" trajectory. The innovation-capability curve shows the incremental direction of growth resulting from the firm's continuous



Entrepreneurial Capability and Leadership, Fig. 3 Entrepreneurial capability trajectory (Source: S. Alijani)

effort to reconfigure its resources and reorchestrate its activities – in order to build new core competences. The "S"-shaped curve of innovation capability is indicative of the incremental nature of technology-competence diffusion dynamics, growing rapidly at initial stages and slowing down at later stages. The change can be measured through various organizational and financial indicators such as the revenues generated following the adoption of a new business model, the rate of return on assets resulting from new investments in R&D, or the productivity and profitability ratios resulting from new processes and implemented in the organization. Technical and organizational improvements will push the firm's innovation capability curve higher, thus creating feedback loops between individual and organizational capabilities.

The complementary nature of resources and the firms' dynamic capacities affects the pace and direction of the organizational innovation trajectory. Entrepreneurial creativity constitutes the cornerstone of organizational innovation and performance. Entrepreneurial efficacy requires leadership qualities, creativity, as well as a well-crafted global strategy.

Conclusion and Future Directions

Any attempt to assess entrepreneurial capabilities should begin by investigating the multidimensional flows and links resulting from individual, organizational, and market-constituted contexts. Such studies should provide a comparative framework for evaluating different forms of entrepreneurship. More importantly, future studies on entrepreneurial capabilities should encompass empirical and longitudinal research on market-instituted and organizational arrangements. The use of qualitative and quantitative data will allow to measure fully entrepreneurial performance and creativity across industries, cultures, and societies.

Cross-References

▶ Cognition of Creativity
▶ Corporate Entrepreneurship
▶ Creative Leadership
▶ Creativity and Innovation: What Is the Difference?
▶ Entrepreneur
▶ Entrepreneurial Opportunities
▶ Entrepreneurial Organizations
▶ Individual Determinants of Entrepreneurship
▶ Innovation and Entrepreneurship

References

Ajzen I. The theory of planned behavior. Organ Behav Hum Decis Process. 1991;50:179–211.

Alchian A. Uncertainty, evolution and economic theory. J Polit Econ. 1950;60:211–21.

Amabile TM. How to kill creativity. Harv Bus Rev. 1998;76(5):76–87.

Antonakis J, Ashkanasy NM, Dasborough DT. Does leadership need emotional intelligence? Leadersh Q. 2009;20:247–61.

Aristotle's Nicomachean Ethics. Translated by Bartlett R, Collins S, Chicago: University of Chicago Press, 2012.

Arrow KJ. Social choice and individual values. New York: Wiley; 1951.

Arrow KJ. The economic implication of learning by doing. Rev Econ Stud. 1962;29:155–73.

Augier M, Teece D. Understanding complex organization: the role of know-how, internal structure, and human behavior in the evolution of capabilities. Ind Corp Change. 2006;15(2):395–416.

Bamford CE. Creating value. In: Hitt MA, Ireland RD, editors. The Blackwell encyclopedia of management: entrepreneurship. Oxford, UK: Blackwell; 2005. p. 48–50.

Bandura A. Self-efficacy in changing societies. New York: Cambridge University Press; 1997.

Barney J. Firm resources and sustained competitive advantage. J. Manage. 1991;17(1):99–120.

Baron RA. Cognitive mechanisms in entrepreneurship: why and when entrepreneurs think differently than other people. J Bus Ventur. 1998;13(4):275–94.

Baron RA. Counterfactual thinking and venture formation: the potential effects of thinking about "what might have been. J Bus Ventur. 2000;15(1):79–91.

Baumol WJ. Entrepreneurship in economic theory. Am Econ Rev. 1968;58:64–71.

Baumol WJ. Entrepreneurship: productive, unproductive and destructive. J Polit Econ. 1990; 98(5):893–921.

Baumol W, Litan R, Schram C. Good capitalism, bad capitalism and the economics of growth and prosperity. New Haven: Yale University Press; 2007.

Bernardo AE, Welch I. On the evolution of overconfidence and entrepreneurs. J Econ Manage Strateg. 2001;10(3):301–30.

Brown J, Duguid P. Organizing knowledge. Calif Manage Rev. 1991;40(3):90–111.

Busenitz LW, Barney JB. Difference between entrepreneurs and managers in large organizations: biases and heuristics in strategic decision-making. J Bus Ventur. 1997;12(1):9–30.

Camerer C, Loewenstein G, Prelec D. Neuroeconomics: how neuroscience can inform economics. J Econ Lit. 2005;43:9–64.

Cantillon R. Essai sur la Nature du Commerce en Générale. London: Macmillan; 1755.

Casson M. The entrepreneur: an economic theory. Oxford: Martin Robertson; 1982.

Casson M. Information and organization: a new perspective on the theory of the firm. Oxford: Oxford University Press; 2001.

Chandler AD. The visible hand: the managerial revolution in American business. Cambridge, MA: Harvard University Press; 1977.

Chen C, Greene P, Crick A. Does entrepreneurial self-efficacy distinguish entrepreneurs from managers? J Bus Ventur. 1998;13(4):295–316.

Chesbrough H. Open business models: how to thrive in the new innovation landscape. Boston: Harvard Business School Press; 2006.

Chesbrough H. The market for innovation: implications for corporate strategy. Calif Manage Rev. 2007;49(3):45–66.

Christensen CM. The innovator's dilemma: when new technologies cause great firms to fail. Boston: Harvard Business School Press; 1997.

Christensen CM. The past and future of competitive advantage. MIT Sloan Manage Rev. 2001;42(2):105–9.

Coase R. The problem of social cost. J Law Econ. 1960;3(1):1–44.

Coase R. The firm, the market, and the law. Chicago: Chicago University Press; 1990.

Cohen W, Levinthal D. Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q. 1990;35:128–52.

Cooper AC, Woo CA, Dunkelberg W. Entrepreneurs perceived chances for success. J Bus Ventur. 1988;3:97–108.

Das TK, Teng B. Time and entrepreneurial risk behavior. Entrepreneurship Theory Pract. 1997;22(2):69–88.

Deci EI, Ryan ME. Intrinsic motivation and self-determination in human behavior. New York: Plenum Press; 1985.

Dickson PR, Giglierano JJ. Missing the boat and sinking the boat: a conceptual model of entrepreneurial risk. J Market. 1986;50:58–70.

Dooley KJ, Van de Ven AH. Explaining complex organizational dynamics. Org Sci. 1999;10(3):358–72.

Dosi G, Nelson R, Winter S, editors. Dynamics of organizational capabilities. New York: Oxford University Press; 2002.

Fishbein M, Ajzen I. Belief, attitude, intention, and behavior: an introduction to theory and research. Reading: Addison-Wesley; 1975.

Forgas JP. Mood and judgment: the affect infusion model (AIM). Psychol Bull. 1995;117:39–66.

Fukuyama F. The social virtues and the creation of prosperity. New York: Free Press; 1996.

Gaglio CM, Katz JA. The psychological basis of opportunity identification: entrepreneurial alertness. Small Bus Econ. 2001;16(2):95–111.

Gigerenzer G, Todd M. Simple heuristics that make us smart. New York: Oxford University Press; 1999.

Gist ME, Mitchell TR. Self-efficacy: a theoretical analysis of its determinants and malleability. Acad Manage Rev. 1992;17(2):183–211.

Goleman D. What makes a leader? Harv Bus Rev. 1998;76(6):93–102.

Grant RM. Toward a knowledge-based theory of the firm. Strateg Manage J. 1996;17(Winter):109–22.

Greiner M, Bohman T, Kremar H. A strategy for knowledge management. J Knowl Manage. 2007;11(6):3–15.
Hayek F. The use of knowledge in society. Am Econ Rev. 1945;35(4):519–30.
Helfat E, Finkelstein S, Mitchell W, Peteraf M, Singh H, Teece D, Winter S. Dynamic capabilities: understanding strategic change in organizations. New York: Wiley-Blackwell; 2007.
Hines T. Left brain/right brain mythology and implications for management and training. Acad Manage Rev. 1987;12:600–6.
Hitt MA, Ireland RD, Sirmon DG, Trahms CA. Strategic entrepreneurship: creating value for individuals, organizations, and society. Acad Manage Perspect. 2011;25(2):57–75.
Humphrey RH. The many faces of emotional leadership. Leadersh Q. 2002;13:493–504.
Ireland RD, Hitt MA, Sirmon DG. Strategic entrepreneurship: the construct and its dimensions. J Manage. 2003;29(6):963–89.
Keh HT, Foo MD, Lim BC. Opportunity evaluation under risky conditions: the cognitive processes of entrepreneurs. Entrepreneurship Theory Pract. 2002;27(2): 125–48.
Khaneman DJ, Lovallo D. Timid choices and bold forecasts: a cognitive perspective on risk-taking. Manage Sci. 1993;39(1):17–31.
Kirzner IM. Competition and entrepreneurship. Chicago: Chicago University Press; 1973.
Knight F. Risk, uncertainty and profit. Boston: Houghton Mifflin; 1921.
Kogut B, Zander U. Knowledge of the firm, combinative capabilities, and the replication of technology. Org Sci. 1992;3(3):383–97.
Krueger NF. The cognitive infrastructure of opportunity emergence. Entrepreneurship Theory Pract. 2000;24(3):5–23.
Landes DS, Mokyr J, Baumol W. The invention of enterprise: entrepreneurship from ancient Mesopotamia to modern times. Princeton: Princeton University Press; 2012.
Lane PJ, Lubatkin M. Relative absorptive capacity and interorganizational learning. Strateg Manage J. 1998;19:461–77.
Mayer JD, Salovey P, Caruso DR. Emotional intelligence: new ability or eclectic traits? Am Psychol. 2008;63:503–17.
Mazzucato M, Dosi G. Knowledge accumulation and industry evolution: the case of pharma-biotech. Cambridge: Cambridge University Press; 2006.
McGrath RG. Falling forward: real options reasoning and entrepreneurial failure. Acad Manage Rev. 1999;24(1):13–30.
Measuring Entrepreneurship. OECD entrepreneurship indicators program. Paris: OECD; 2009.
Miles MP. Competitive advantage. In: Hitt MA, Ireland RD, editors. The blackwell encyclopedia of management: entrepreneurship. Oxford, UK: Blackwell; 2005. p. 36–7.
Mill JS. Principles of political economy. New York: Gutenberg EBook; 1885.
Mintzberg H. Strategy-making in three modes. Calif Manage J. 1973;Winter:44–53.
Mintzberg H. The structuring of organizations. Englewood Cliffs: Prentice-Hall; 1979.
Nonaka I, Konno N. The concept of Ba: building a foundation for knowledge creation. Calif Manage Rev. 1994;40(3):40–54.
Nonaka I, Takeuchi H. The knowledge-creating company: how Japanese companies create the dynamics of innovation. New York: Oxford University Press; 1995.
North D. Institutions, institutional change and economic performance. Cambridge: Cambridge University Press; 1990.
Oviatt BM, McDougall PP. A framework for understanding accelerated international entrepreneurship. In: Rugman AM, Wright RW, editors. Research in global strategic management: international entrepreneurship. Stamford: JAI Press; 1999. p. 23–40.
Penrose ET. The theory of the growth of the firm. Oxford: Basil Blackwell; 1959.
Porter M. The competitive advantage of nations. New York: The Free Press; 1990.
Prahalad C, Hammel G. The core competence of the corporation. Harv Bus Rev. 1990;68(3):79–91.
Ricardo D. In: Sraffa P, editor. On the principles of political economy and taxation. Indianapolis: Liberty Fund; 1817. 1951.
Rogers EM. Diffusion of innovation. New York: Free Press; 1983.
Romer PM. Endogenous technological change. J Polit Econ. 1990;98:71–102.
Russo JE, Schoemaker PJ. Managing overconfidence. Sloan Manage Rev. 1992;Winter:7–17.
Say JB. Treatise on political economy (trans: Prinsep CR, 1821). Boston: Michigan Historical Reprint Series; 2005.
Schumpeter JA. The theory of economic development: an inquiry into profits, capital, credit, and the business cycle. Oxford: Oxford University Press; 1934.
Schumpeter JA. Capitalism, socialism and democracy. New York: Harper and Row; 1949.
Sen A. Development as freedom. New York: Anchor Books; 2000.
Sen A. The idea of justice. Cambridge, MA: Harvard University Press; 2009.
Shane SA. A general theory of entrepreneurship: the individual-opportunity nexus. Cheltenham: Edward Elgar; 2003.
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manage Rev. 2000;25(1):217–26.
Shanteau J. Cognitive heuristics and biases in behavioural auditing: review, comments, observations. Account Org Soc. 1989;14(1/2):165–77.
Shaver KG, Scott LR. Person, process, choice: the psychology of new venture creation. Entrepreneurship Theory Pract. 1991;16(2):23–45.

Simon H. A behavioral model of rational choice. Q J Econ. 1955;69:99–188.
Simon HA. Models of man. New York: Wiley; 1957.
Simon HA. Models of bounded rationality. Cambridge, MA: MIT Press; 1982.
Smith A. The wealth of nations. 4th ed. London: Methuen; 1776.
Solow R. A contribution to the theory of economic growth. Q J Econ. 1956;70:65–94.
Teece D. Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets. Calif Manage Rev. 1998;40(3):55–79.
Teece D. Explicating dynamic capabilities: the nature and microfoundations of sustainable enterprise performance. Strateg Manage J. 2007;28(13): 1319–50.
Teece D, Pisano G. The dynamic capabilities of firms: an introduction. Ind Corp Change. 1994; 12(3):537–56.
Teece D, Pisano G, Shuen A. Dynamic capabilities and strategic management. Strateg Manage J. 1997;18:509–33.
Truch E. Knowledge orientation in organizations. Aldershot: Ashgate; 2004.
Tushman M, O'Reilly C. Ambidextrous organizations: managing evolutionary and revolutionary change. Calif Manage Rev. 1996;38(4):8–30.
Tversky A, Khaneman D. Availability: a heuristic for judging frequency and probability. Cogn Psychol. 1973;5:207–32.
Tversky A, Khaneman D. Judgment under uncertainty: heuristics and biases. Science. 1974;185(4157):1124–31.
Tversky A, Khaneman D. Advances in prospect theory: cumulative representation of uncertainty. J Risk Uncertainty. 1992;5(4):297–323.
Veblen T. The theory of business enterprise. New York: Cosimo; 1904.
Von Hippel E. The sources of innovation. New York: Oxford University Press; 1988.
Von Mises L. Human action: a treatise on economics. San Francisco: Fox & Wilkers; 1949.
Waldman DA, Balthazard PA, Peterson SJ. Leadership and neuroscience: can we revolutionize the way that inspirational leaders are identified and developed? Acad Manage Perspect. 2011;25(1):60–74.
Walter F, Cole MS, Humphrey RH. Emotional intelligence: sine qua non of leadership or folderol? Acad Manage Perspect. 2011;25(1):45–59.
Wernerfelt B. The resource-based view of the firm. Strateg Manag J. 1984;5(2):171–80.
Williamson O. Transaction cost economics: the governance of contractual relations. J Law Econ. 1979;22 (October):233–61.
Williamson O. The economic institutions of capitalism. New York: Fress Press; 1985.
Zack M. Developing a knowledge strategy. Calif Manage Rev. 1999;41(3):125–45.
Zack M. Rethinking the knowledge-based organization. MIT Sloan Manage Rev. 2003;44(4):67–71.
Zahra S, George G. Predictors and financial outcomes of corporate entrepreneurship: an exploratory study. J Bus Ventur. 1991;6:259–85.
Zahra S, George G. Absorptive capacity: a review, reconceptualization, and extension. Acad Manage Rev. 2002;27(2):185–203.

Entrepreneurial Cognition

▶ Entrepreneurial Capability and Leadership

Entrepreneurial Creativity

▶ Entrepreneurial Capability and Leadership
▶ Planned Economy and Entrepreneurial Function

Entrepreneurial Development

▶ Psychological Aspects of Entrepreneurial Dynamics

Entrepreneurial Economy

▶ Creative Destruction

Entrepreneurial Finance

▶ Financing Innovation

Entrepreneurial Firm

▶ Start-Up and Small Business Life

Entrepreneurial Firms

▶ Entrepreneurial Organizations

Entrepreneurial Innovation

▶ Entrepreneurial Capability and Leadership

Entrepreneurial Knowledge

▶ Planned Economy and Entrepreneurial Function

Entrepreneurial Opportunities

▶ Business Climate and Entrepreneurialism

Entrepreneurial Opportunity

Fabienne Picard
University of Technology of
Belfort-Montbeliard, Belfort, France

Synonyms

Individual-opportunity nexus

Opportunities: The Driver of Entrepreneurship?

Entrepreneurship is nurtured by a diversity of streams of thought, with different origins, and the approach of entrepreneurial opportunity aims to build a new inclusive paradigm, sometimes called *a general theory of entrepreneurship.* The entrepreneurial opportunity concept originates from Austrian Economics tradition (particularly Hayek, Kirzner, Schumpeter). Entrepreneurship is fundamentally a human activity, and the entrepreneurial opportunity paradigm focuses on the intentionality of human action and of entrepreneurial decision. Opportunity plays a fundamental role in allowing individuals to advance their goal pursuits. Shane and Venkataraman (2000) seminal paper lays the foundation for this renewal paradigm around the central notion of entrepreneurial opportunity.

Economists, psychologists, sociologists, and a range of more applied fields including strategic management and entrepreneurship are interested in this concept of entrepreneurial opportunity. While opportunity is an interdisciplinary topic which arises naturally wherever choices have to be made, thinking entrepreneurship in terms of opportunities – their discovery or creation, their evaluation, and their exploitation – is a challenge for scholars. In fact, important debates are crossing the field of entrepreneurial opportunities such as why, when, and how entrepreneurial opportunities come into existence, subjective or objective nature of entrepreneurial opportunities, reasons why some people discover and exploit opportunities and not others, modes of exploitation of entrepreneurial opportunities, etc.

But the common issue of the research on entrepreneurial opportunity is to highlight the process of change in a capitalist society and the driving force of entrepreneurship – in line with the Schumpeterian works – to understand how markets function and come into being, and, last but not least, to explain or predict empirical phenomena of entrepreneurship.

Notion of Entrepreneurial Opportunity

Entrepreneurship as Entrepreneurial Process

According to the entrepreneurial opportunity paradigm, the field of entrepreneurship concerns the study of *how, by whom, and with what effects opportunities to create future goods and services are discovered, evaluated, and exploited* (Shane and Venkataraman 2000). Here, entrepreneurship involves the nexus of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals (Venkataraman 1997). However, the only existence of opportunity is a necessary but no sufficient condition of entrepreneurial process. The entrepreneurial process rises in both the existence of opportunities and the ability of individuals to detect and appropriate these opportunities.

Entrepreneurial Opportunity

The definition of entrepreneurial opportunity is not totally stabilized. Some scholars refer to "those situations in which new goods, services, raw materials, and organizing methods can be introduced and sold at greater than their cost of production" (Casson 1982). Entrepreneurial opportunity leads to the discovery of new means-ends relationships through which new goods, services, raw materials, and organizing methods can be introduced in order to create economic value and move the economic system toward or away from equilibrium. So the development of an industry or the emergence of new organizations naturally leads to the creation of new opportunities. Other scholars consider that *"entrepreneurial opportunity consists of a set of ideas, beliefs and actions that enable the creation of future goods and services in the absence of current market for them"* (Sarasvathy et al. 2003). Anyway, entrepreneurial opportunities are mostly created by activities of human agents. Individuals may deliberately create opportunities, but often opportunities are the unintended outcomes of activities motivated by other objectives.

Individual-Opportunity Nexus

This framework of entrepreneurship is based on the nexus of the presence of lucrative opportunities and the presence of enterprising individuals (Venkataraman 1997). According to the individual-opportunity nexus (ION) approach, entrepreneurial opportunities emerge from market disequilibrium or, more specifically, from the differences people have in their expectations, beliefs, awareness, and/or knowledge about the relative value of resources. This approach considers that people have different beliefs because of a lucky hunch, superior intuition, private information, etc. Consequently, people make different conjectures about the price at which markets should clear, or about what possible new markets could be created in the future (Shane and Venkataraman 2000).

Key Issues Across Entrepreneurial Opportunity Field

Considering the three steps of entrepreneurial process, discovery or creation, evaluation, and exploitation of entrepreneurial opportunity, many questions remain. If Shane (2003) considers that entrepreneurial opportunity follows a linear process from discovery to exploitation, other scholars emphasize the overlap between discovery and exploitation. Others believe that opportunity does not preexist but is created along the way by interactions between acting individuals and their environment. This question echoes to the nature of entrepreneurial opportunity. Some researchers argue that the subjective or socially constructed nature of opportunities makes it impossible to separate opportunity from individuals. Others contend that opportunity is as an objective construct, visible to or created by the knowledgeable or attuned entrepreneur. Consequently public policy issues may be very different.

Origins of Entrepreneurial Opportunities

Where did these entrepreneurial opportunities come from? The question posed by Shane (2003) is why these situations emerge in which it is possible for a person to come up with a new means-ends framework for recombining resources? The literature offers traditionally two main different explanations for these situations, the Kirznerian perspective and the Schumpeterian perspective.

Firstly, according to Schumpeter view (1934), the existence of entrepreneurial opportunity is contingent on the introduction of new information – technological, political, social, or economical information. Entrepreneurs can use this information to understand how to recombine resources into more valuable forms. Consequently, Schumpeterian entrepreneur discovers and pursues opportunities that exist outside the economic sphere and that are not yet reflected by the price system (Schumpeterian entrepreneur).

Secondly, in Kirzner approach (1973), people use the information that they possess to form beliefs about the efficient use of resources.

The existence of opportunity is linked to a differential access to existing information. What is in balance here is not the existence of the opportunity but the individual capacity to capture it and to access it. Moreover, people make errors or omissions – at any time or in any place – and their decision-making framework is not always accurate. These errors generate disequilibrium and opportunities for other people that are able to identify them. So, Kirznerian entrepreneur discovers and pursues opportunities that exist within the economic sphere and that are reflected by the price system. These two types of opportunities have different effects on economic activity: Kirznerian opportunities reinforce established ways of doing things, whereas Schumpeterian opportunities disrupt the existing system (information asymmetry and business creation). Differences between Schumpeterian and Kirznerian approach of entrepreneurial opportunities may be summarized in this table.

	Schumpeterian opportunities	Kirznerian opportunities
Origins of entrepreneurial opportunities	Disequilibrating	Equilibrating
Role of information	Requires new information	Does not require new information
Innovative impacts of entrepreneurial opportunities	Very innovative, break away from existing knowledge	Less innovative, replicate existing organizational forms
Innovative intensity of entrepreneurial opportunities	Involves creation	Limited to discovery
Characteristics of entrepreneurial opportunities	Rare	Common

Adapted from Shane 2003, p. 21

More recently, according to the knowledge spillover theory of entrepreneurship, the divergence between individuals and hierarchies may also generate entrepreneurial opportunities. Divergence appears when new knowledge and ideas are created in one context but left not commercialized by the source of the idea. Namely, entrepreneurial opportunities are generated not just by investments in new knowledge and ideas but in the propensity for only a distinct subset of those opportunities to be fully pursued by incumbent firms. Indeed, a divergence process between an individual and its hierarchy may appear. This gap in the valuation of new ideas across economic agents, or between economic agents and decision-making hierarchies of incumbent enterprises, creates the entrepreneurial opportunity.

Opportunity Identification and Entrepreneurial Alterness

There is an unresolved debate between scholars to determinate whether entrepreneurs discover or create entrepreneurial opportunities. Sometimes entrepreneur create themselves the entrepreneurial opportunity and sometimes entrepreneur are engaged in a discovery process from pre-existing trend. In fact, many opportunities exploited by entrepreneurs may be not new objectively, and any theory of opportunity should distinguish between those opportunities that are new and those that are not. Opportunities may emerge as by-products of market competition, and agents may deliberately or unwittingly create opportunities.

All opportunities must not be obvious to everyone all of the time because information is not widely distributed across the population. This is partly due to the specialization of information in the society (Hayek 1945). Two broad categories of factors influence the probability that particular people will discover particular opportunities: firstly, the possession of prior information necessary to identify an opportunity, so-called information corridors, and, secondly, the cognitive properties necessary to value it.

How are opportunities identified or constructed? This central question concerns the opportunity identification and the so-called *entrepreneurial alterness*. According to increasing number of researcher, opportunity identification represents the most distinctive and fundamental entrepreneurial behavior (Gaglio and Katz 2001). Alterness concept was introduced by Kirzner (1973, 1997) in order to explain market dynamics and the role of entrepreneurial function from an individual receptivity to available opportunities.

Which Modes of Action Are Mobilized to Exploit Entrepreneurial Opportunities?

There is a disconnection between the discovery or creation and the exploitation of entrepreneurial opportunities. Exploitation of entrepreneurial opportunities, that is, the transformation of knowledge in economic value, can take many organizational forms. Entrepreneurship which implies exploiting new opportunities does not always require the creation of new organizations. The creation of new organization is only one of the modes of exploitation of entrepreneurial opportunities. Entrepreneurship can also occur within an existing organization by the means of corporate venturing (Corporate entrepreneurship) or spin-off (Spin-off). Moreover, opportunities can be sold to other individual or to existing organizations, by licensing, for instance. The organizational forms taken by the entrepreneurial opportunity (including the decision to create a new entity to operate an idea) depend on the characteristics of technological opportunities attached to them.

From Technological Opportunity to Entrepreneurship

Technological opportunity is one of the central notions of economic evolutionist theory. Technological opportunity concerns the appearance and the creation of new technological solutions that create new economic value. Technological opportunities arise from the evolution of scientific and technological knowledge or a change in the level and structure of demand. The development of new technologies generates entrepreneurial opportunities, but according to Shane (2001), "The probability that an invention will be commercialized through the creation of a new firm varies with the nature of the technological opportunity discovered."

Conclusions and Future Directions

The notion of entrepreneurial opportunities is a very pertinent analytical framework of entrepreneurship which aims to recognize the complexity of entrepreneurial process. Consequently, public policy issues may be questioned to favor entrepreneurship (Entrepreneurship policy).

Could we foster individual capacities to identify opportunities and make easier the access of information, or could public policy stimulate the economical and technological environment capacity of opportunities creation? How could we make easier the commercial exploitation of the gap between the individual perception of opportunity and the hierarchical one? Are changes in intellectual right property necessary (Intellectual Property and entrepreneurial strategies)? How to promote the creation of intrapreneurial opportunities in a firm?

However, to date, one of the weaknesses of this approach is probably the lack of empirical analysis of entrepreneurial opportunity. This leaves a number of conceptual debates unanswered and highlights insufficiently public policy issues.

Cross-References

▶ Business Climate and Entrepreneurialism
▶ Entrepreneur
▶ Entrepreneurship and Small Business Agility
▶ Environmental Determinants of Entrepreneurship
▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)

References

Acs ZJ, Audretsch DB, editors. Handbook of entrepreneurship research, an interdisciplinary survey and introduction. Boston: Kluwer; 2003.

Alvarez SA, Barney JB. Opportunities, organizations, and entrepreneurship. Strateg Entrepr J. 2008;2(4):265–7. Special Issue: Opportunities, Organizations and Entrepreneurship: Empirical Implications and Application.

Casson M. The entrepreneur. Totowa: Barnes & Noble Books; 1982.

Gaglio CM, Katz JA. The psychological basis of opportunity identification: entrepreneurial alterness. Small Bus Econ. 2001;16(2):95–111.

Hayek FA. The use of knowledge in society. Am Econ Rev. 1945;35(4):519–30.

Holcombe R. The origins of entrepreneurial opportunities. Rev Aust Econ. 2003;16(1):25–43.

Kirzner I. Competition and entrepreneurship. Chicago/London: University of Chicago Press; 1973.

McMullen JS, Plummer LA, Acs ZJ. What is entrepreneurial opportunity? Small Bus Econ. 2007;28: 273–83.

Sarasvathy S, Dew N, Velamuri R, Venkataraman S. Three views of entrepreneurial opportunity. In: Acs ZJ, Audretsch DB, editors. Handbook of entrepreneurship research, an interdisciplinary survey and introduction. Boston: Kluwer; 2003. pp. 141–60.
Schumpeter JA. The theory of economic development. Cambridge: Harvard University Press; 1934.
Shane S. A general theory of entrepreneurship: the individual-opportunity nexus. Northampton: Edward Elgar; 2003.
Shane S. Technological opportunities and new firm creation. Manage Sci. 2001;25(1):217–26.
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Academy of Management Review. 2000;25(1):217–26.
Venkataraman S. The distinctive domain of entrepreneurship research. In: Katz J, editor. Advances in entrepreneurship, firm emergence and growth. Vol. 3. Greenwitch, CT: JAI Press; 1997. pp. 119–38.

Entrepreneurial Organizations

Thierry Burger-Helmchen
BETA- Bureau d'Economie Théorique et Appliquée, EM Strasbourg, Université de Strasbourg, Strasbourg, France

Synonyms

Entrepreneurial firms

Key Concepts and Definition of Terms

Entrepreneurial organizations are structures that promote the emergence and development of ideas from all members of the firm. To be functional, such an organization must have specific features that allow alternative views to emerge. An entrepreneurial organization combines several aspects of entrepreneurship and firm flexibility, namely, specific attention processes to make it possible for junior and senior managers to attract the attention of the decision makers, specific decision mechanisms (with adapted criteria, incentive, and remuneration schemes) that explain the acceptance of ideas, and a flexible, agile structure to allow the implementation. Entrepreneurial organizations differ from managerial organizations by their structures and characteristics; they have a specific innovation model, decision/financial model, selection process, human resource management and resources gathering, and utilization scheme.

The notion is related to corporate entrepreneurship, but it is distinct especially by the fact that corporate entrepreneurship is a management/cultural process that applies to existing firms to make them more dynamic (Stevenson and Jarillo 1990).

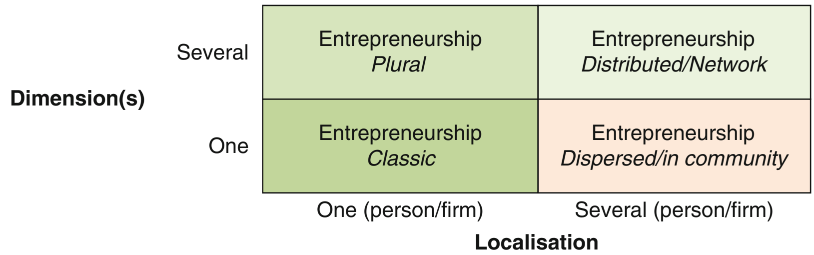
Theoretical Background and Open-Ended Issues

In the approach of Mintzberg et al. (2005), an entrepreneurial organization is centralized around a single leader who engages in considerable doing and dealing, as well as strategic visioning. Thereby, an entrepreneurial organization deals with the conceptualization of the business model and the way it is implemented. In a broader view, entrepreneurial organizations are not limited to a single entrepreneur in the firm.

Entrepreneurial organizations are strongly linked to the learning organization approach and knowledge-based approach of entrepreneurship. Entrepreneurial organizations can take different forms. Forms of entrepreneurship in the academic literature are numerous. As reported by Burger-Helmchen (2008a), one can find the following forms of entrepreneurship: academic entrepreneurship, diffused entrepreneurship, dispersed entrepreneurship, distributed entrepreneurship, disintegrated entrepreneurship, collaborative entrepreneurship, collective entrepreneurship, community-based entrepreneurship, corporate entrepreneurship, intrapreneurship, knowledge-based entrepreneurship, managerial entrepreneurship, modular entrepreneurship, network entrepreneurship, open entrepreneurship, plural entrepreneurship, and serial entrepreneurship.

Many of these notions overlap or are, simply speaking, synonyms; many of them could be pinpointed as entrepreneurial organizations with more than one entrepreneur. Figure 1 is a representation of the different forms of entrepreneurship

Entrepreneurial Organizations, Fig. 1 Various forms of entrepreneurial organizations



along two axes to distinguish them. The two axes represent (1) the localization of the entrepreneurial process or action and (2) the dimensions concerned by the entrepreneurial process.

The horizontal axis selects the location of the entrepreneurial process, by location we mean how many firms/persons are participating in the entrepreneurial process. Is it just one single entrepreneur, or are there several persons belonging to distinct firms? The vertical axis corresponds to the dimensions along which the entrepreneurial process takes effect. Does it modify the product, the business model, the organization, etc.? Are only one or several of these dimensions concerned? If we plot some of the entrepreneurial forms found in the literature on these axes, we obtain the distribution showed in Fig. 1.

The easiest situation corresponds to the case where there is one person performing an entrepreneurial act along one dimension. This case corresponds to the classic representation of entrepreneurship and of entrepreneurial organization. The Schumpeterian entrepreneur leading to the mark I innovation production corresponds to this point.

If we have several persons, possibly employed by several firms, we obtain a group of people involved in an entrepreneurial process. This corresponds to the notion of dispersed entrepreneurship or entrepreneurship in community. In an engineering approach, the tasks necessary to create a new product are split into different subtasks. Each group of engineers has to resolve the problem corresponding to a specific part, or subtask, of the project they are responsible for. More recently, this approach has been developed in organization studies together with the notions of communities (Cohendet and Llerena 2003). People can be working for different firms but be involved in the same community. Because different persons/firms are linked by the same practice, they can contribute to the creation of a new product, in this case the community is entrepreneurial. A current example of this form of entrepreneurship is the open-source community who creates new products by summing up the efforts of several persons dispersed around the world.

In this approach, there is only one dimension concerned, the product (or service) created by the entrepreneurial process. If several dimensions are concerned and different firms are involved, meaning that some firms are in charge of creating a new product or service, some other firms develop a new business model/market strategy, and/or some firms organize themselves in an entrepreneurial manner around those activities, we obtain a situation of distributed or network-based entrepreneurship.

Finally, the last field in Fig. 1 that we did not discuss yet is the plural entrepreneurship situation. Plural means that one single firm or person must not only create a new product or new services but also (if the product is really a novelty) find a new way of commercializing the product (a marketing/business model) and eventually develop an innovative organization of his or her activities. The more dimensions and localizations are concerned, the more entrepreneurial is the organization.

The success of a firm corresponds to the outcomes of entrepreneurial activities. Those activities must join into a coherent business strategy during the start-up phase. Therefore, this view is aligned with the concept of entrepreneurial strategy by Mintzberg et al. (2005). They define entrepreneurial strategy as

> . . .characterized by a visionary process: strategy exists first of all in the leader's mind as a long-term direction, a vision of the future and of the results of the organization. Such a strategic vision tends to be malleable, and due to this, entrepreneurial strategy often appears to be both deliberate and emergent, deliberate from the point of view of its global vision, and emergent in the way in which the details of the vision evolve.

Again, in entrepreneurial organizations, the entrepreneurial vision is not limited to the leaders' minds; thereby, those entrepreneurial organizations need a special attention and selection process (Ocasio and Joseph 2005).

Implementation for Theory, Policy, and Practice

The entrepreneurial mindset sees the environment and the stakeholders in a different way (Boisot and MacMillan 2004) and thereby influences the important resource allocation decision. The effectuation literature especially highlights this interpretation process and how it forges the entrepreneurial action within the organization (Sarasvathy 2004). The entrepreneurial logic influences behaviors, routine strategies, structure, and culture. In fact, the entrepreneurial mindset influences the firm in many domains, even if it is not noticeable at first sight. In the entrepreneurial organization, the concept of constant change is a dominant factor. Entrepreneurship creates new opportunities and promotes flexibility, creativity, and innovation.

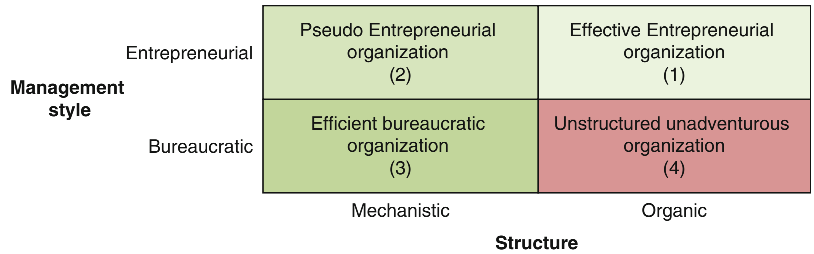
What Constitutes an Entrepreneurial Organization? A classification can be made based on the frequency of entrepreneurial acts and the degree of each entrepreneurial act (Morris et al. 2011). A firm can make a small number of really creative, innovative, highly differentiating acts or can make a large number of small, incremental advances and changes. Some researchers think that there is a link between the entrepreneurial intensity of an organization and several performance measures such as profitability, growth, sales, salaries, etc. (Morris et al. 2011). This could be particularly the case in turbulent changing environments. But it does not take into account the survival rate. Several approaches exist to differentiate the performance and environment that are more favorable for entrepreneurial organization or managerial organization, depending notably on the type of knowledge developed and the form of rivalry between firms. Empirical- and simulation-based approaches highlight the fact that entrepreneurial organizations are more efficient when uncertainty is high as in hypercompetitive environments (Burger-Helmchen 2008b).

Entrepreneurial Organizations Have Specific Architectures. The architecture of the entrepreneurial organization is important because it makes it possible to seize opportunities, to respond fast, and effectively to change. The setting up of architecture to exploit the distinctive characteristics of entrepreneurship are dynamic capabilities difficult to copy, mechanisms that build routines, culture to allow this to happen smoothly. The staff is not demotivated but motivated by the change and creativity of the other members of the organization. The value of an entrepreneurial architecture lies in its capacity to create organizational knowledge and routines, to respond flexibly to changing circumstances, and to achieve easy and open exchanges of information.

Entrepreneurial organizations exhibit more links to communities/networks (outside the firm) because the entrepreneurs are in the middle of a web of informal personal relationships rather than contractual formal relationships. At the basis, it is a learning organization. A learning organization has been defined as one that facilitates the learning of all its members and continuously transforms itself in response to the needs, wishes, and aspirations of people inside (and outside) it. Such an organization encourages systematic problem solving, encourages experimentation and new approaches, and allows more importance to be allocated to personal history. Therefore, entrepreneurial organizations are learning organizations.

An Entrepreneurial Organization Has Some Particularities of Size and Structure. Large organizations produce a bigger quantity of information that needs to be analyzed, shared, etc. It delays the decision making and kills creativity. To be entrepreneurial, a layer organization needs to organize into small groups or projects. But the decentralizing, delayering, outsourcing, and

Entrepreneurial Organizations, Fig. 2 Effective entrepreneurial organization



downscoping are not a guarantee that a firm becomes more entrepreneurial. Clearly, when the number of people reporting to the entrepreneur increases, the system becomes less effective.

Barriers to Entrepreneurial Organization. Many traditional management techniques are ineffective for such organizations but not always. As an entrepreneurial firm moves away from centralized, formal hierarchies to flatter structures with more horizontal communication, the need for management control diminishes. Several authors argue that the entrepreneurial behavior within the organization is positively correlated with performance when the structure is more organic (when authority is based upon expertise, not position) (Fig. 2).

The organization is more problematic when there is an incongruity between structure and style. This figure reports also what the authors call "cycling"; where firms change from one management style to another, a more bureaucratic style is needed (successful firms are in quadrants 1–3).

Conclusion and Future Directions

Entrepreneurial organization encourages the exchange and creation of knowledge to detect and exploit opportunities in a rhythm and way different from managerial organization. In particular, entrepreneurial organization encourages all the employees to propose new ideas. This implies that those firms have a specific type of attention. Subsequently, those entrepreneurial organizations have the flexibility to develop and exploit the proposed and accepted ideas. The number of actors that can propose ideas and the subjects of the ideas led several researchers to propose different forms of entrepreneurial organization. Depending on the structure and management style adopted, entrepreneurial organization can be more or less efficient than managerial organization.

Future research on entrepreneurial organization can benefit substantially from a richer conceptualization of the entrepreneur that is not limited to a certain position or title but recognizes the potential that entrepreneurial insight and creativity can be provided by all individuals in the organization. The necessity to be entrepreneurial along several dimensions requires a procedural approach to describe the evolution of the entrepreneurial activities. Previous work on that topic developed our knowledge of the common traits on the genesis and growth of the firms, for instance, they gave us a good understanding of the different phases of the development of firms (following a life cycle model), but by definition, this separation in phases (or steps) focuses on the important points in each phase, neglecting somehow the relationships between the different elements and their coevolution. The picture is then composed of the entrepreneur(s), the innovative products or services, the supporting activities, and the financial resources. The coevolution of all these elements in relation to entrepreneurship fosters the survival of the firm.

Cross-References

▶ Corporate Entrepreneurship

References

Boisot M, MacMillan YC. Crossing epistemological boundaries: managerial and entrepreneurial approaches to knowledge management. Long Range Plann. 2004; 37(6):505–24.

Burger-Helmchen T. Plural-entrepreneurial activity for a single start-up: a case study. J High Technol Manag Res. 2008a;19(2):94–102.
Burger-Helmchen T. Creation and co-evolution of strategic options by firms: an entrepreneurial and managerial approach towards flexibility and resource allocation. In: Laperche B, Uzunidis D, editors. Powerful finance and innovation trends in a high-risk economy. London: Palgrave Macmillan; 2008b. p. 183–206.
Cohendet P, Llerena P. Routines and incentives: the role of communities in the firm. Ind Corp Change. 2003; 12(2):271–97.
Mintzberg H, Ahlstrand B, Lampel J. Strategy safari. New York: The Free Press; 2005. new edition.
Morris M, Kuratko D, Covin J. Corporate entrepreneurship and innovation. 3rd ed. South-Western College; 2011.
Ocasio W, Joseph J. An attention-based theory of strategy formulation: linking micro and macro perspectives in strategy processes. Adv Strateg Manag. 2005;22: 39–62.
Sarasvathy SD. Making it happen: beyond theories of the firm to theories of firm design. Entrepreneurship Theory Pract. 2004;28(6):519–31.
Stevenson HH, Jarillo JC. A paradigm of entrepreneurship: entrepreneurial management. Strateg Manag J. 1990;11(4):17–27.

Entrepreneurial Personality

▶ Psychological Aspects of Entrepreneurial Dynamics

Entrepreneurial University

▶ Academic Firm
▶ Epidemiology of Innovation: Concepts and Constructs

Entrepreneuriat Education

▶ Entrepreneurship Education

Entrepreneuriat Training

▶ Entrepreneurship Education

Entrepreneurs' Discourse

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Entrepreneurship

▶ Academic Entrepreneur, Academic Entrepreneurship
▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Experiential Learning and Creativity in Entrepreneurship
▶ Financing Entrepreneurship
▶ Small Businesses - Value, Transmission, and Recovery
▶ Socialized Entrepreneur, Theories

Entrepreneurship and Business Growth

Najoua Boufaden
ISG – Institut Supérieur de Gestion, Paris-France, Paris, France

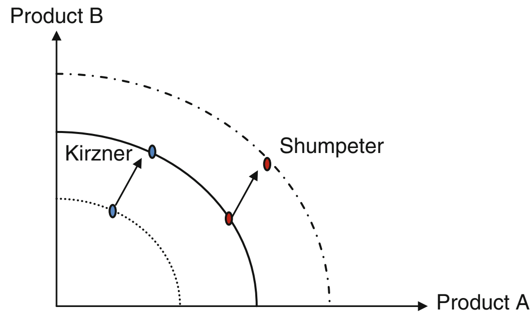
Synonyms

Entrepreneurship and economic growth; Entrepreneurship and small business

Introduction

The relationship between entrepreneurship and firms' growth, as well as economic growth more generally, has been the subject of a growing number of studies. This growing and renewed interest is due to several factors: first, the driving role played by entrepreneurship to promote economic development in Western countries, but also developing ones; second, a remarkable lack of studies on the causal relationship between entrepreneurship and economic growth; and third, new techniques have developed and individual data about entrepreneurs and entrepreneurship have been made available, permitting to test new hypotheses. Thus, added to the disparate definitions of entrepreneurship, studies that empirically measure that relationship are as rare in economics as in management.

Nevertheless, one main issue in economics has investigated the linkage between entrepreneurship, innovation, and growth at regional level (Audretsch and Kelibach 2007, 2008; Braunerhjelm et al. 2010). According to this approach, "entrepreneurs" and "capital entrepreneurship" are the missing links in the endogenous theory explaining business growth.



Entrepreneurship and Business Growth, Fig. 1 The Schumpeternian view vs. the Kirzernian view of entrepreneurship and the production possibility curve (Source: Hans Landström (2010), p. 15)

Definition

Entrepreneurship: Several definitions have succeeded each other since Cantillon's (1734). Since then, economists such as, Say (1857), Knight (1921), Schumpeter (1934), and Kirzner (1933) have been among the most influential contributors to the understanding of entrepreneurial behavior and its related processes. Even though, on the whole, their definitions differ from each other – in that they assimilate the notion of entrepreneurship to exchanges, risk, innovation, and business opportunities – they all complement one another. Indeed, Cantillon recognized that the shift between demand and supply in a market creates opportunities for buying cheaply and selling at a higher price; that sort of arbitrage would bring equilibrium to competitive markets. Based upon this approach, Kirzner states that the entrepreneurial function involves coordinating information, namely, identifying the gap between supply and demand, as well as acting as the broker between supply and demand, and making it possible to earn money from the difference. Finally, one more definition is worth mentioning: it is more contemporary with Scott Shane and Venkataraman (2000) and pertains to the same lineage as Cantillon's and Kirzner's, while stressing innovation more particularly; *"Entrepreneurship is 'an activity that involves the discovery, evaluation and exploitation of opportunities to introduce new goods and services, ways of organizing markets, processes, and raw materials through organizing efforts that previously had not existed."*

Entrepreneur: Traditional neoclassical economics has completely evacuated, from its analytical framework, the role of the entrepreneur in economic activity. Adam Smith made no distinction between a capitalist and an entrepreneur, whose role was reduced to acting as a coordinator between the various factors of production and capital owners. The idea that gives the contractor more than the role of a mere capitalist was born outside the neoclassical paradigm with such rare pioneers as Knight, Schumpeter, and Kirzner who deem that, "the entrepreneur is *someone who is alert to profitable opportunities for exchange. He or she is able to identify suppliers and customers and act as an intermediary*." Thus, the entrepreneur tries to discover profit opportunities and helps restore equilibrium on the market by acting on these opportunities (*entrepreneurial alertness*).

These definitions highlight the relationship between entrepreneurship and growth, where the entrepreneur is the main mechanism. That is, regarding the production possibility curve (see Fig. 1), Kirzner considers that the company is within the curve and reaches the edge of the production possibility curve by identifying gaps between supply and demand. However, Kirzner's entrepreneur does not create anything new. He is an intermediary who recognizes and exploits what already exists, but this action leads to better use of resources and therefore shifts the curve toward the edge of the production possibility curve.

Compared to Schumpeter's view, the entrepreneur creates something new rather than exploit existing resources. So, according to Schumpeter, the firm is on the edge of the curve. And the entrepreneur pushes the curve outwards by introducing innovations. Nevertheless, eventually, even though these two viewpoints look different on first reading, they are consistent and even complementary with each other, in that Schumpeter creates disequilibrium for further new possibilities and therefore growth. Besides, Kirzner acts on disequilibrium in the market for new growth.

Entrepreneurship as an Effective Mechanism to Explain Business Growth

The relationship between entrepreneurship and economic growth is far from established. However, it is recognized that Zoltan Acs and David Audretsch are two of the most prolific researchers in the field of small businesses and entrepreneurship, having contributed on the subjects of the evolution of small and medium enterprises (SMEs), entrepreneurial dynamics, innovation, and regional growth.

It is this approach that will be preferred here. These works, individually or in collaboration with David Audretsch and Zoltan Acs, consider that both incumbent firms and entrepreneurial activities are the main "missing links" in the literature to explain knowledge accumulation and its diffusion and conversion into economically relevant knowledge.

Braunerhjelm et al. (2010) suggest that the process of knowledge transformation resulting from fundamental research into economically exploitable knowledge is not a spontaneous and natural process. This approach complements the endogenous growth models that establish a direct link between investment in R&D (Research and Development) and economic growth – without demonstrating it, for all that. This entry is all the more relevant as empirical studies find no systematic correlation relations between R&D and GDP (Growth Domestic Product) growth in countries like Japan and Sweden, which have large stocks of R&D. This paradox suggests the lack of consideration for the mechanisms ruling the dissemination of knowledge spillovers. Within this analytic framework – and faced with the lack of an explanation regarding the dynamics of fundamental knowledge transfer to the economic sphere – that approach introduces entrepreneurship as the missing link in contemporary growth models. Thus, through his various business activities, from identifying opportunities, and from innovation to starting a business, the entrepreneur ensures the transformation of knowledge into economically useful and recoverable knowledge. Empirical studies show that there is regularity as to the relationship between entrepreneurship measured by starting a business (start-up) and economic growth, particularly through employment. The second innovative idea that has boosted the endogenous growth model is the introduction of entrepreneurship capital as a mechanism explaining variations in economic performance.

Capital Entrepreneurship

According to Audretsch (2007), the determinants of entrepreneurship are shaped by a number of forces and factors, including legal and institutional but social factors as well. The study of social capital and its impact on economic decision-making and actions stems back to classic literature in economics and sociology, in which social and relational structures influence market processes (Mark S. Granovetter 1985). In another relevant study explaining Silicon Valley's high economic performance, Saxenian (1990) suggested that the rich endowment of the city with what could be termed as "entrepreneurship capital" is the main factor to account for such performance.

> It is not simply the concentration of skilled labor, suppliers and information that distinguish the region. A variety of regional institutions – including Stanford University, several trade associations and local business organizations, as well as a myriad of specialized consulting, market research, public relations and venture capital firms – provide technical, financial, and networking services, which the region's enterprises often cannot afford individually…Equally important are the social relationships that develop with shared professional experiences and repeated interaction… These networks defy sectoral barriers: individuals move easily from semiconductor to disk drive firms or from computer to network makers. They move from established firms to startups (or vice versa) and even to market research or consulting firms, and from consulting firms back into startups. And they continue to meet at trade shows, industry conferences, as well as on the occasion of the scores of seminars, talks, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived…This decentralized and fluid environment also promotes the diffusion of intangible technological capabilities and understandings. (Saxenian 1990, pp. 96–97)

Thus, a region characterized by a rich endowment in entrepreneurship capital positively impacts the growth dynamics. Those contexts, based on a process of knowledge dissemination and spillovers, enhance individual propensity to create and innovate. And, inversely, regions with a weak entrepreneurship capital can inhibit starting up new firms.

Measuring the Relationship Between Entrepreneurship and Business Growth

It results from this framework that entrepreneurship capital is the fourth component inherent to economic development. So, just as physical capital, human capital, and knowledge, entrepreneurship capital is the fourth variable "input" of the conventional Cobb-Douglas production function. Empirical evidence supports these causal economic policies and suggests the development of entrepreneurial capital as a determinant of growth.

An Endogenous Growth Model with Entrepreneurship

Acs and Audretsch, as well as their collaborators, have widely contributed to the development of a growth model making it possible to measure the impact of entrepreneurship on growth. Their model (Audretsch and Kelibach 2008 et Braunerhjelm et al. 2010) suggests that not only is entrepreneurship induced by high investments in knowledge within regional contexts but regional growth also impacts entrepreneurship level of influence. Thus, an augmented production function that includes an explicit measure of regional entrepreneurship capital has been estimated. On this basis, it became possible to test the impact of entrepreneurship on economic growth on one hand and, on the other, the impact of knowledge investments and growth on entrepreneurship.

Two equations are specified simultaneously, taking into account the simultaneity bias:

$$Y_i = K_i^{\alpha} L_i^{\beta} R_i^{\gamma} E_i^{\delta} \tag{1}$$

$$E_i = f(y_i, x_i) \tag{2}$$

Where Y_i in Eq (1) is the economic performance of region i measured as GDP,
K_i is region I's endowment of entrepreneurship capital,
L_i is labor, R_i is regional R&D intensity, and E_i represents its endowment in entrepreneurship capital, while formally specifying that entrepreneurship contributes to the economic output of regions.

In Eq (2), y_i is a vector that measures region i's performance and xi is the vector of other variables influencing entrepreneurial activity in i. Two groups of factors shape the extent of entrepreneurship capital: (1) the generation of region-specific opportunities for entrepreneurial activity through knowledge and ideas and (2) a favorable general economic environment enhancing the creation of firms.

Variables Determining Entrepreneurship Capital

Two categories of variables determine entrepreneurship capital: factors stimulating entrepreneurial opportunities and factors influencing the economic context.

1. Factors Stimulating Entrepreneurial Opportunities

   Economic growth creates a growing market, which thereby generates greater exchange dynamics and therefore new business opportunities in Kirzner's sense. R&D intensity describes the potential of a region to create new knowledge, which in turn generates new opportunities to create knowledge-based firms, including through the mechanisms valorizing the development of fundamental research.

   According to the main assumption of the urban economic literature (Duranton and Puga 2004), the higher population density in cities eases local knowledge and informational exchange between individuals, leading to a better labor productivity. Therefore, these mechanisms induce faster diffusion and appropriation of entrepreneurial opportunities.

2. Factors influencing economic situations

   As suggested by many studies, the unemployment rate is linked to the entrepreneurial activity. However, the sign of that correlation has still not been established empirically so far. The same conclusion can be drawn concerning the impact of regional industrial diversity. No consensus on whether the firms benefit largely from a strong concentration of industry-specific knowledge (That is what, in the literature, is dubbed "Marshall-arrow-Romer" externalities) or from the variety of knowledge coming from different industry sources (Jacob's externalities). The impact of taxes on business start-ups is also being investigated. And again, in this case, the global impact of taxation is not systematically anticipated. Thus, local taxes can reduce the propensity to start up a new firm and hence the region's entrepreneurship capital. However, on the other hand, these taxes can help regions provide better business services and hence attract entrepreneurs.

Conclusion and Future Directions

Thanks to endogenous growth models, it has been possible to rehabilitate the role of entrepreneurship in economic growth, particularly through the concept of entrepreneurial capital. However, the concept of entrepreneurial capital is somehow a little too abstract and based on too aggregate parameters, like GDP or population density. Other parameters may need to be considered, further explaining young people's intentions to undertake. Support structures and outreach and training programs are all parameters that may influence individuals' predispositions to undertake, both in regional and national contexts.

Cross-References

▶ Entrepreneur
▶ Entrepreneurial Opportunities
▶ Entrepreneurship and Small Business Agility
▶ Entrepreneurship Policy
▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
▶ Institutional Entrepreneurship
▶ National Culture

References

Acs ZJ. Innovation and the growth of cities. Cheltenham: Edward Elgar; 2002.

Audretsch AD. Entrepreneurship capital and economic growth. Oxford Rev Econ Policy. 2007;23(1):63–78.

Audretsch AD, Kelibach M. Entrepreneurship and economic performance. Reg Stud. 2004;38(8):949–59.

Audretsch AD, Kelibach M. Resolving the knowledge paradox: knowledge- spillover entrepreneurship and economic growth. Res Policy. 2008;37:1697–705.

Braunerhjelm P, Acs ZJ, Audretsch B, Carlsson B. The missing link: knowledge diffusion and entrepreneurship in endogenous growth. Small Bus Econ. 2010;34:105–25.

Cantillon R. Essai sur la nature du commerce en général. London: Macmillan; 1755/1931.

Duranton G, Puga D. Micro-foundation of urban agglomeration economies. In: Thisse JF, Henderson JV, editors. Handbook of urban and regional economics, vol. 4. 1st ed. 2004. p. 2063–117. Chapter 48.

Granovetter MS. Economic action, and social structure: the problem of embeddedness. J Sociol. 1985;91(3): 481–599.

Kirzner IM. Competition and entrepreneurship. Chicago: University of Chicago Press; 1973.
Knight FH. Risk, uncertainty and profit. New York: Houghton, Mifflin; 1916/1921.
Landström H. Pioneers in entrepreneurship and small business research, International studies in entrepreneurship. New York: Springer; 2010.
Saxenian A. Regional networks and the resurgence of Silicon Valley. Calif Manage Rev. 1990;33(1): 89–112.
Say JB. Traité d'économie politique. New York: Kelley; 1803/1964.
Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard University Press; 1934.
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manage Rev. 2000;25(1):217–26.

Entrepreneurship and Economic Growth

► Entrepreneurship and Business Growth

Entrepreneurship and Financial Markets

Philippe Spieser
Groupe Escpeurope, Paris, France

Synonyms

Angel funding; Bootstrap transaction; Financial sponsor; Friends and family funding; Highly-Leveraged transaction (HLT); Seed funding; Seed money; Special Situation

"Entrepreneurship" and "financial markets" seem, at the first glance, to be somehow contradictory expressions. The entrepreneur, who is simply defined here, according to Lachman's (1999) definition as a person who uses a new combination of production factors, needs generally external sources of funds to set up and develop his company. Those financial means adopt many forms which cover different definitions and objectives. They show different profiles in terms of risk and return according to the financial business cycle which describes the revenues' in- and outflows as a function of time. But they have in common to be *private*, gathered precisely under the general term of *private equity* (here *PE*). This idea of privacy is far away from the concept of a financial market where securities are freely valued and traded. Nevertheless, PE financial flows and funds are not disconnected from the public financial markets' patterns, parameters, or vehicles. Different links, explicit or implicit, are to be discussed between PE and public markets.

Notions of "Private Equity" and "Private Equity Market" Refer Essentially to the Private Economic Sphere

Entrepreneur

Many definitions have been given for the notion of *entrepreneur* (see other contributions in this book). The most well-known theorist of this agent is the Austrian economist J. Schumpeter (1934). He stressed the role of innovation, such as new products and production methods, new markets, and forms of organization. Wealth is created when such innovation results in a new demand. From this viewpoint, one can define the entrepreneur as a person combining various input factors in an innovative manner to generate value to the customer with the hope that this value will exceed the cost of the input factors, thus generating superior returns that result in the creation of wealth. The entrepreneur needs money to start his activity and borrows this money from a *venture capitalist*. For the venture capitalist, the objective is the ability to achieve a significant capital gain resulting from the difference between the purchase and the selling price of the (private) shares. In order to start that new activity, which is by nature risky, the entrepreneur generally needs fresh money.

Private Equity

The expression "*private equity* (here:*PE*)" refers to specific actors, mechanisms, and money in relation with investment in private financial resources. The resources are made available for companies generally under the form of securities (equities) not involving any public offering and, consequently, not traded on a public stock exchange.

Private Equity Market

The private equity market consists of professionally managed equity investments in the unregistered securities of private (and sometimes also public) companies. Professional management is provided by specialized intermediaries (*limited partnership*, cf. *infra*), raising money from institutional investors and acquiring large ownership stakes. They take an active role in monitoring and advising the firms.

Private Equity Firms

It is a structure driven by an investment manager that invests in the private equity of operating companies in order to follow different objectives (like controlling or owning a substantial minority position) through a variety of financial means (like venture capital, leveraged buyout, growth capital) precisely in accordance with the specific investment strategies. A private equity firm will raise pools of capital or private equity funds that supply the equity contributions for these transactions; it will receive a periodic management fee as well as a share in the profits earned called *carried interest* from each private equity fund managed. Financially speaking, a PE firm looks to maximize the value of its investment, receiving a return on their investments through one of the following ways:

– An *initial public offering* ("IPO") – shares of the company are offered to the public, typically providing a partial immediate realization to the financial sponsor as well as a public market into which it can later sell additional shares.
– A *merging or acquisition process* – the company is sold for either cash or shares in another company.
– A *recapitalization* – cash is distributed to the shareholders (the *financial sponsor* and the private equity funds) either from cash flow generated by the company or through raising debt or other securities to fund the distribution.

The *private equity firms* can bear different names like *venture capital firms, angel investors, etc*. The different ways the PE financial resources are made available for companies have four names: *venture capital, leveraged buyouts, growth capital*, and *mezzanine capital*. This classification is not homogenous in the sense that it refers either to the steps of the firm's development or to the financial setup or objectives of the financing (cf. *infra*). The purposes of the working capital provided are different: to insure expansion, to launch new product development, or to finance restructuring of the company's operations, management, or ownership.

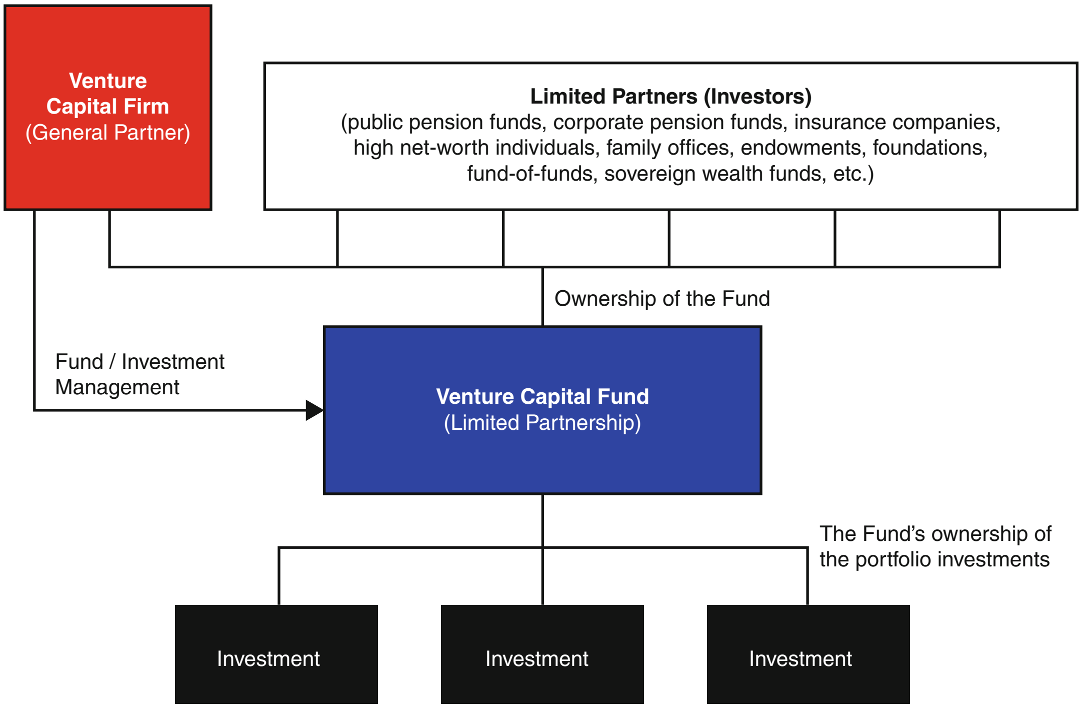
Private Equity Fund

A private equity fund is a structure raised and managed by managers of a PE firm (the *general partner*), building a collective investment structure designed to invest mainly in various equity securities according to one of the investment strategies defined by the PE firm. PE funds are legally *limited partnerships*, because they are granted through a limited partnership agreement, with a fixed term of (extendable) 10 years. Usually, a single private equity firm will manage a series of distinct private equity funds, attempting to raise a new fund every 3–5 years as the previous fund is fully invested. The general partner raises capital from institutional investors (pension plans, foundations, charities, etc.). The terms in the limited partnership agreement are the following:

Management fees – an annual payment made by the investors in the fund to the fund's manager to pay for the private equity firm's investment operations (1–2 % of the committed capital of the fund).

Carried interest (see above) – a share of the profits of the fund's investments (up to 20 %), paid to the private equity fund's management company as a performance incentive. The remaining 80 % of the profits are paid to the fund's investors.

Hurdle rate or *preferred return* – a minimum rate of return (generally 8–12 %), which must be achieved before the fund manager can receive any carried interest payments.



Entrepreneurship and Financial Markets, Fig. 1 Relations between VC firms, VC funds, and institutional investors (Source: H. Fantasia: the impact of the financial crisis in the French venture capital investment – report ESCP Europe and wikipedia)

PE funds are not intended to be transferred or traded but can be transferred to another investor, at the discretion and approval of the fund's manager.

One has nevertheless to point out that the world of PE remains specific in the world of "banking" or "market" finance; structures and people are not strictly confounded, mainly based on personal relations and confidence. The relations between PE firms, PE funds, and institutional investors are summed up in the following figure (Fig. 1).

Venture Capital

Venture capital (VC) refers to financial capital provided to firms at their early stage (start-up) when those firms are regarded as high-potential, high-risk, and promising-growth companies. The firms usually have a novel technology or business model in high technology industries, such as biotechnology, information technology, etc. So equity investments are made for the launch, early development, or expansion of a business. Venture capital is a subset of private equity; therefore, all venture capital is private equity, but not all private equity is venture capital.

Venture capital is often subdivided by the stage of development of the company, ranging from early-stage capital used for the launch of start-up companies to late-stage and growth capital; this last financial means is often used to fund expansion of existing business generating revenue but not yet profitable or generating cash flow to fund future growth.

The venture capitalists need to deliver high returns to compensate for the incurred risk he takes that makes venture funding an expensive capital source for companies. Venture capital is most suitable for businesses with large up-front capital requirements which cannot be financed by cheaper alternatives such as debt. In addition to angel investing and other seed-funding options, venture capital is attractive for new companies with limited operating history that are too small to raise capital in the public markets and have not reached the point where they are able to secure a bank loan or complete a debt offering. In exchange for the high risk that venture capitalists assume by investing in smaller and less mature companies, they usually get significant control over company decisions notwithstanding to a significant portion of the company's ownership.

Leveraged Buyout (LBO)

A leveraged buyout takes place when an investor buys a controlling interest in a company's core capital, a significant percentage of the purchase price being financed through borrowing. The assets of the acquired company are used as collateral for the borrowed capital. Since the cost of capital is cheaper than the cost of borrowing in a normal period of time, the operation is profitable, this mechanism being called *leverage effect* in the classical financial theory: the returns to the investor will be enhanced as long as the return on assets exceeds the cost of the debt.

Leveraged buyout uses a combination of various debt instruments supplied by banks and debt capital markets. Bonds or other papers issued for leveraged buyouts are commonly considered not to be first-category investment (*investment grades*) because of the significant risks involved. The companies involved in these transactions are generally mature and generate operating cash flows. In a typical leveraged buyout transaction, a private equity firm buys majority control of an existing or rather mature firm; this is distinct from a venture capital or growth capital investment, in which the investors invest in young or emerging companies and rarely obtain majority control.

Leveraged buyouts involve generally a financial sponsor without himself committing all the capital required for the acquisition; he will raise acquisition debt which is in line with the cash flows of the acquisition target to make interest and principal payments. A peculiar form is the leverage management buyout where the sponsor is constituted by the management of the company (*LMBO – leveraged management buyout*).

An LBO transaction's financial structure is particularly attractive to a fund's limited partners in the frame of private financial markets: it grants them the benefits of leverage but limits the degree of recourse of that leverage due to the fact that the borrower is not personally liable for the borrowed money.

Growth Capital

Growth capital refers to private equity investments (minority investments, in the general case) in relatively mature companies looking for capital to expand or restructure operations, enter new markets, or finance a major acquisition without a change of control of the business. So it intervenes after the venture capital operation.

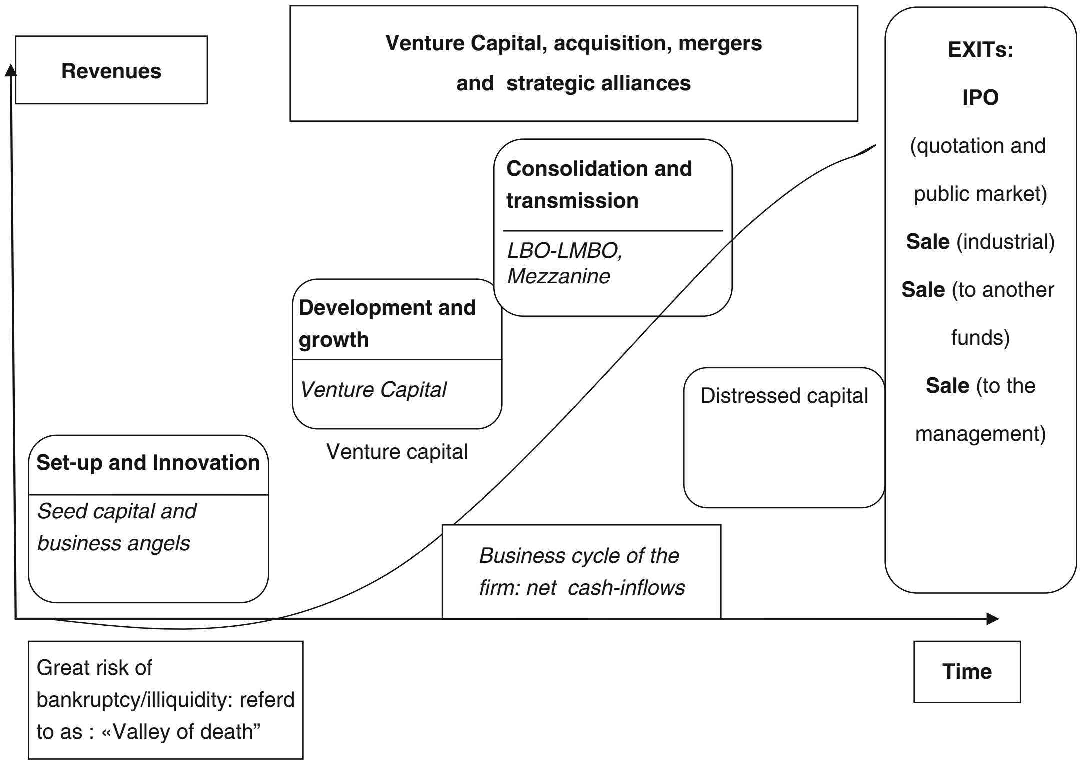
Mezzanine Capital

Mezzanine capital refers to *subordinated debt* or *preferred equity* securities (so financial means intermediary between equity and bonds) that is the most junior portion of a company's capital structure but senior to the company's common equity. This form of financing is often used by private equity investors to reduce the amount of equity capital required to finance a leveraged buyout or major expansion. Mezzanine capital, which is often used by smaller companies that are unable to access the high-yield market, allows such companies to borrow additional capital beyond the levels that traditional lenders are willing to provide through bank loans. In compensation for the increased risk, mezzanine debt holders require a higher return for their investment than secured or other more senior lenders.

Distressed Situations

Some PE funds choose to invest equity or debt securities of financially stressed companies, which is a strategy far from the investment in seed or venture capital. One can distinguish between "distressed-to-control" and "loan-to-own" strategies where the investor acquires debt securities in the hopes of emerging from a restructuring in control of the company's equity and "special situations" or "turnaround" strategies where an investor will provide debt and equity investments, often "rescue financing," to companies undergoing operational or financial challenges. The different terms and uses of financial PE sources of funds can be summed up here (Fig. 2).

The volume of VC has reached now a significant level. The Dow Jones VentureSource



Entrepreneurship and Financial Markets, Fig. 2 Sources of funds, business cycle, and "exit opportunities" (Source: Author and F. Prevost "Entrepreneur and private equity," RB editeurs, 2009)

indicates that venture capitalists from around the world invested $9.8 billion into 967 deals for companies based in the USA, Europe, Canada, Israel, Mainland China, and India during the first quarter of 2011. This represents a 20 % jump in investment but a 7 % decline in deal activity from the same period in 2010 when $8.2 billion was raised for 1,038 deals. VC investments in the USA accounted for two-thirds (66 %) of the total volume in the first quarter, with Europe (15 %) and China (14 %) next in line. The dominant sectors are in renewable energy, health care, and information technology.

But Actually, the Links with Public Financial Markets Are Constant and Unavoidable

Private equity and venture capital are closely linked to the financial markets via many channels, although they are logically and originally separated. Those links are put into light especially during crisis times. For example, the lower level of VC-raising capital in 2009–2010 are, according to the Europe PE and VC Association Research and in line with the overall constraints in public financial markets, *a liquidity shortage, a general uncertainty about the future*, and, lastly, *a difficult "exit solution"* – meaning, the choice of another investment opportunity after the PE and VC investment is over. The different channels are as follows.

1. The interest rate

   The first and probably the most important bridge between PE and the public financial market is *the interest rate*. It is simply the common benchmark for all types of investment opportunities. For all types on investors and according to the "CAPM" theory, (Capital asset pricing model, the dominant financial theory describing the relation between risky and unrisky asset returns) under some assumptions, the risk and the return of any risky asset are linked in a linear relation. In the risky assets, one must range of course all listed shares but also real estate, commodities, and PE investments. Since the risk is regarded as very high in this last opportunity, the expected return has to be very high too. This phenomenon explains why the internal rate of return in PE finance was and still is very high compared to the growth rate prevailing in the economies. In the same idea, the investment strategy of institutional investors is a global one, concerning all types of assets and (geographical or sectorial) markets, in the purpose of an optimal diversification. In the framework of the CAPM, if their attention is drawn to other assets showing less risk for the same return or higher return for the same risk, this will be made at the expense of VC. In other words, under a financial constraint, the risk/return relationship in the PE market is benchmarked by this same relation in public financial market, a phenomenon which is well illustrated during crisis when a "flight-to-quality" movement in favor of safe investments dried the PE activity.

The other links are as follows:

2. The existence of a "secondary market"

   The notion of "secondary market" refer to investments made in existing PE assets through the sale of PE fund interests (or portfolios of direct investments) in privately held companies to existing institutional investors like banks or insurance companies. If, by nature, the private equity asset class is illiquid and is designedly intended to be a long-term investment for buy-and-hold investors, this "secondary market" opens a liquidity window and simultaneously provides institutional investors with portfolio diversification along with, for example, geographical or sectorial diversification. Secondary investments also typically experience a different cash flow profile which is interesting to investors. The idea is that in private equity fund management, there is a J-curve effect due to the trend of PE funds to show negative returns in early years and investment gains in the outlying years as the portfolios of companies mature; this effect can be partly annulated by investing in new private equity funds. Often secondary investments are made through third-party fund vehicle which are structured similarly to *fund of funds*.

3. A growing tendency, for many PE vehicles, to be listed

   Many advantages have been underlined to justify this obvious trend followed by PE vehicles to get listed in markets. They can raise money more easily, which saves them to organize heavy and expensive road shows for fundraising. Most famous and wealthy funds are, to this respect, Kohlberg Kravis Roberts and Carlyle Group. This link is reinforced by the fact that important financial institutions like investment banks have directly created listed PE vehicles, for example, Goldman Sachs or Barclays. One can notice that the most quoted funds are Anglo-Saxon, because PE industry is more developed in the USA, Canada, and the UK than in the Europe. If they are listed, the performance of PE funds can then be directly compared to that of the common equity market, which is then a benchmark for investors.

4. The introduction to the market is the natural end of a PE investment

   The VC investment process goes naturally from a first step – identification of opportunities – to the last one – an "exit" solution (see above). There are five "exit" situations. The most logical one is an initial public offering, highly influenced by the financial market conditions: liquidity, market risk premium, and long-term private and public interest rate. This "exit" opportunity determines partly also the other four possibilities, namely, a sale of the shares to industrial investors, a buyback by the primary owners, a secondary buyout to another PE investor, and, last but not least, a write-off.

5. PE investments: a signal for markets

   The PE activity and VC investment take decisions about the sectors to invest in.

This drives the market's attention and indicates some trends for future IPO investments; it influences the public markets' investment decisions made by institutional investors as a whole.

Conclusion and Future Directions

PE and VC activities are by far not disconnected from public financial markets; they belong to the global investment policy (in terms of diversification, risk, return) of almost all categories of investors. Many observers underline the fact that new technology firms find more easily funds in the USA than in Europe, a phenomenon which partly could explain the dynamism of this sector in the American growth rate. The present gloomy situation of the financial markets (spring 2012), at least in the mature economies, makes the question of financing innovation and entrepreneurship more acute This challenge is to be related with the broader use of markets, instead of banks which are also shuttled by the needs of reinforcing their capital structure, in the financing of the economy in that part of the world. The future of PE is also partly determined by the perspectives in countries like China or India where the financial needs are important but where the political and economic systems are less adapted to an activity which is a symbol for capitalism.

References

Gough JW. The rise of the entrepreneur. New York: Schocken Books; 1969.
http://vcexperts.com/vce/library/encyclopedia/glossary.asp
https://www.venturesource.com/
Lachman R. Toward measurement of entrepreneurial tendencies. Manag Int Rev. 1980;20(2):108–16.
Mike KWR. Venture capital and private equity: a review and synthesis. J Bus Finan Account. 1998;25(5–6):521–70.
Rosenbaum J, Pearl J. Investment banking: valuation, leveraged buyouts, and mergers and acquisitions. New York: Wiley Finance; 2009.
Schumpeter J. The theory of economic development. Brunswick: Transactions Publishers; 1934.

Entrepreneurship and Innovation

► Entrepreneurial Behavior and Eco-Innovation

Entrepreneurship and National Culture (According to Hofstede's Model)

Igor N. Dubina[1] and Suzanna J. Ramos[2]
[1]Economic Information Systems, Altai State University, Barnaul, Russia
[2]Department of Educational Psychology, College of Education & Human Development, Texas A&M University, College Station, TX, USA

Synonyms

Cross-cultural entrepreneurship and business; Cultural dimensions; National culture

Introduction

To define national culture, researchers and practitioners generally use national boundaries as a proxy for differentiating between distinct cultures and their respective cultural characteristics. Similarities in national cultures derive from common history, religion, geography, and language. Although there are differences within national borders, these differences are assumed to be of less significance than those found between nations. The concept of national culture refers to a set of values, beliefs, and attitudes shared by individuals of a human group, which in turn influences individuals' behavior and social relationships (Hofstede 1980, 2001). The interactive aggregate of common characteristics that influences a group's response to its environment is what distinguishes one group from another.

The main driving force of national culture is its values. Cultural values determine which behavior is appropriate, thus influencing an individual's choice. The result is persistent differences in human behavior in different countries. Consequently, when people establish organizations, the characteristics of these organizations reflect the people's cultural values. Against this backdrop, cultural factors exert an influence on entrepreneurship – a process that involves identifying an opportunity, developing a business concept, acquiring the necessary resources to implement the concept, and then managing the venture to reap benefits.

Numerous studies have linked national culture to the strategic decision-making process that occurs within entrepreneurial organizations, particularly the cultural dimensions that contribute to entrepreneurship. This endeavor has highlighted the importance of sociocultural variables in explaining variations in entrepreneurship and economic development. Research interest has focused on understanding the influence of national cultural values on the individual entrepreneur as well as the cultural variables in explaining variations in entrepreneurial motivation, orientation, and behavior across countries. If different cultures possess different attitudes toward entrepreneurship, then it follows that certain cultures engender more entrepreneurial behavior than others.

The issue of what cultural aspects impact entrepreneurial behavior is examined empirically most often on the basis of Hofstede's model (1980). Hofstede contends that a nation is a social system which has its own culture – legal, educational, and political systems, which serves as a vehicle for mental programming of the nation's members. Therefore, a nation possesses its own culture. Hofstede's (1980, 2001) study on national cultures within organizations not only analyzes national cultures but also demonstrates the effects of cultural differences inside organizations. His research is particularly useful to understand behaviors and attitudes at work, such as leadership, motivation, or the behavior and relationships between members and how these factors affect the level of entrepreneurship in any given society.

Hofstede's model of cultural dimensions serves as the basis for theoretical and empirical research over the past 30 years on how national culture influences business and management (Hofstede 1980, 1993, 2001). The first four dimensions of the model were initially detected through a comparison of the values of similar people (more than 100,000 employees and managers) in 64 national subsidiaries of the IBM Corporation (Hofstede 1980). People working for the same multinational, but in different countries, represent well-matched samples from the populations of their countries, similar in all respects except nationality. The following is a description of the four cultural dimensions represented in the model and their relationships with entrepreneurship.

Power Distance

Power distance describes the degree "to which less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally" (Hofstede 2001, p. 98). This dimension measures how far inequality is accepted by a culture.

Cultures with a high score in power distance show existential inequality between the superior and the subordinate. A high power distant organization will most likely use formal forms of address or those that reflect status differences. Such organizations centralize power in a few hands as much as possible. Inequality is an inherent feature of society, so it accepts and expects more powerful individuals to possess certain privileges. High power distance countries include China with a power distance index (PDI) of 90, Russia (PDI: 93), and Malaysia (PDI: 104) (Hofstede 2001).

In contrast, low power distance cultures accept that power be distributed equally. Equality is valued and those with more power or status should not act in ways that call attention to their advantages. Hierarchies are not as firmly established compared to high power distance cultures. Cultures with a low power distance index include Austria (PDI: 11), Norway (PDI: 31), and the United States (PDI: 40) (Hofstede 2001).

Mitchell et al. (2000) contend that high power distance has a negative effect on venture creation. Their argument is based on the fact that in such societies, individuals from the lower classes may consider firm creation to be restricted to the elites – individuals who have access to both the necessary resources and experience. Consequently, the majority of the population outside this small group of elites will fail to develop valid cognitive schemas either for evaluating environmental opportunities or for undertaking entrepreneurial ventures. Further, since entrepreneurs have high needs for achievement and independence, Hofstede (1980) found that power distance negatively correlated with a belief in the importance of independence.

Uncertainty Avoidance

Uncertainty avoidance refers to "the extent to which the members of a culture feel threatened by uncertain or unknown situations" (Hofstede 2001, p. 161). This dimension measures the extent to which members of a culture fear uncertain or unknown situations, reflecting the society's intolerance of ambiguity and uncertainty.

Strong uncertainty avoiding countries typically feel threatened by ambiguous situations and design ways to reduce their stress and fear of the unknown. The stress resulting from uncertainty leads to the need to adopt formal rules and to be less tolerant of people, groups, or ideas that diverge from already familiar models. Individuals fear failure in these societies, and consequently, their members avoid undertaking risks. Examples of countries with a relatively high uncertainty avoidance index (UAI) include Argentina (UAI: 86), Turkey (UAI: 85), and Italy (UAI: 75) (Hofstede 2001).

Low uncertainty avoidance societies fully accept uncertainty. Such countries exhibit a higher level of tolerance for change and ambiguity, and accept and often embrace the risks associated with an uncertain future. In societies with low uncertainty avoidance, organizational rules can be violated for pragmatic reasons. Conflicts and ambiguous situations constitute a natural part of life in an organization. The United States (UAI: 46), Malaysia (UAI: 36), and South Africa (UAI: 49) are examples of low uncertain avoidance societies (Hofstede 2001).

Low uncertainty avoidance cultures are interested in exploring new ways of doing things, although this necessarily implies some level of uncertainty. Individuals in these cultures are more ready to assume risks and exploit any opportunities they can identify in their environment, even in situations where information is limited (Busenitz and Lau 1996). All these behaviors create an atmosphere where the members of these cultures are inclined to manifest more entrepreneurial inclinations.

Individualism and Collectivism

This dimension of culture describes "the relationship between the individual and the collectivity which prevails in a given society" (Hofstede 2001, p. 209). The individualism-collectivism dimension shows whether the interests of an individual or a group are more important. According to this dimension, all cultures can be characterized by the strength of social forces, which bring individuals together to form social entities.

Individualism is the degree to which people in a country prefer to act as individuals rather than as members of groups. Individualistic societies are characterized by an emphasis on individual initiative, self-sufficiency and control, and the pursuit of individual goals that may or may not be consistent with in-group goals or achievement. In an individualistic environment, people are motivated by self-interest and achievement of personal goals. They are hesitant to contribute to collective action unless their own efforts are recognized, preferring instead to benefit from the efforts of others. Examples are the United States (IDV: 91), Canada (IDV: 80), and New Zealand (IDV: 79).

On the contrary, people in collectivistic societies are connected to each other through strong and cohesive groups that protect them during their lives. It is assumed that people are loyal to these groups. In collectivistic cultures, there is a communal-based regulation of society. People connect their identity with groups more than with other characteristics of personality. Collectivism involves the subordination of personal interests to the goals of the larger work group; an emphasis on sharing, cooperation, and group harmony; a concern with group welfare; and hostility toward out-group members. Collectivists believe that they are an indispensable part of the group and will readily contribute without concern for advantage being taken of them or for whether others are doing their part. They feel personally responsible for the group product and are oriented toward sharing group rewards. Countries with a relatively low index of individualism include China (IDV: 20), the Philippines (IDV: 32), and Indonesia (IDV: 14).

Recent research on entrepreneurship has mostly focused on the issue of the role of individualism and collectivism. Individualism-collectivism seems to be one of the more salient dimensions of culture insofar as entrepreneurship is concerned. It is suggested that of all the elements necessary for successful entrepreneurship, the independent entrepreneur is the most critical. Individual autonomy and a sense of ownership of innovation encourage the risk-taking and persistence required for entrepreneurship.

Therefore, in individualistic cultures, entrepreneurship is valued and encouraged by the society since the entrepreneurial individuals usually show high levels of personal confidence, initiative, and courage. For example, individualism is an intrinsic aspect of American culture, which helps to explain the relatively intensive amount of independent entrepreneurial activity in the United States.

In collectivist societies, both private property and the protection of individuals' ideas are limited. In these societies, in which collective economic activity predominates, there may be fewer opportunities for individuals to develop the capabilities and skills needed to create new firms. However, it should also be pointed out that in the context of Asian cultures that are more collective and relationship oriented than Western cultures, entrepreneurship may be more of a family or group emphasis than on individual endeavor.

Masculinity and Femininity

This dimension reflects a culture's dominant values with respect to achievement, recognition, competitiveness, and interpersonal relationships (Hofstede 2001). Masculinity-femininity shows to what extent a culture is dominated by such masculine values as orientation toward achievement and competition. The detection of self-assertiveness and other "masculine" values, such as independence and career, refer to masculinity, while discretion, tolerance, and solidarity describe feminine behavior. Hofstede (2001) describes a masculine culture as one in which "people live to work" (longer work hours and short vacations) and a feminine culture as one in which "people work to live" (longer vacations and flexible working hours).

Masculinity as one pole of this cultural dimension is highlighted in societies where the social gender roles are clear: men are supposed to be assertive, tough, and oriented toward material success. Masculine societies are aggressive, task and performance oriented, with many occupations typically considered gender specific. In a masculine society, challenge, advancement, and the accumulation of money are important. Countries with a relatively high MAS score are Japan (MAS: 95), Italy (MAS: 70), and Ireland (MAS: 68) (Hofstede 2001).

Femininity, on the other hand, characterizes societies in which the social gender roles overlap: both men and women are assumed to be modest, sensitive, and concerned about the quality of life. Feminine societies are characterized by an emphasis on relationships and social interactions. Economic growth may not necessarily be the primary concern of the society. In a feminine culture, a friendly atmosphere, job security, and cooperation are paramount. Such countries include Spain (MAS: 42), Thailand (MAS: 34), and Portugal (MAS: 31) (Hofstede 2001).

Masculinity of a society refers to assertiveness, competitiveness, and achievements. The Western concept of the entrepreneur follows the "hero" metaphor. It is argued that without the visionary leadership and persistence demonstrated by this individual, little will be accomplished. In masculine countries, individuals are taught to appreciate strong and independent heroes who personify superiority (Steensma et al. 2000). These cultures view failure as a sign of mediocrity, so the need for achievement intensifies. Conversely, individuals from feminine countries tend to be less aggressive and assertive as they are taught by their societies to seek mutual gain (Hofstede 2001). With these arguments, masculine cultures are associated with more entrepreneurial behavior – the higher the masculinity level in a particular area, the higher the level of entrepreneurial behavior.

Conclusion and Future Directions

Generally, cultural values identified with the classical Hofstede's 4-dimensional model and associated with entrepreneurship are high power distance, high individualism, low uncertainty avoidance, and high masculinity (McGrath et al. 1992; Swierczek and Quang 2004). Countries with these features are more entrepreneurial (entrepreneurship rates defined as the percentage of new business owners in a country). The classical model of the four cultural dimensions has been further developed for the last three decades. A fifth dimension, long-term orientation (LTO), was added in 1991 based on research by Michael Bond (Hofstede 2001) and modified later (Hofstede and Minkov 2010). Hofstede et al. (2010) then added a sixth dimension, indulgence versus restraint. There are also several other models of cultural dimensions that have been suggested in contemporary publications, e.g., Schwartz and Sagiv (1995), Trompenaars and Hampden-Turner (1998), and House (2002). However, within a global context of entrepreneurship, there are still contradictive findings published in the literature and a limited understanding of the extent of a particular culture's influence on entrepreneurship and entrepreneurial behavior. There is a need for further examination of the relationship between cultural characteristics and individual and organizational opportunity-seeking propensities and the peculiarities of venture-creation decisions across cultures.

Cross-References

► Creativity Across Cultures
► Creativity and Confucianism
► Entrepreneurship in International Context
► Environmental Determinants of Entrepreneurship

References

Busenitz LW, Lau CM. A cross-cultural cognitive model of new venture creation. Entrepreneurship Theory Pract. 1996;20(4):25–39.

Hofstede G. Culture's consequences: international differences in work-related values. Beverly Hills: Sage Publications; 1980.

Hofstede G. Cultural constraints in management theories. Acad Manage Exec. 1993;7(1):81–94.

Hofstede G. Culture's consequences. Thousand Oaks: Sage Publications; 2001.

Hofstede G, Minkov M. Long- versus short-term orientation: new perspectives. Asia Pacific Bus Rev. 2010;16(4):493–504.

Hofstede G, Hofstede GJ, Minkov M. Cultures and organizations: software of the mind. New York: McGraw-Hill; 2010.

House R. Understanding cultures and implicit leadership theories across the globe: an introduction to project GLOBE. J World Bus. 2002;37(1):3–10.

McGrath RG, MacMillan IC, Scheinberg S. Elitists, risk-takers, and rugged individualists? An exploratory analysis of cultural differences between entrepreneurs and non-entrepreneurs. J Bus Ventur. 1992;7:115–35.

Mitchell RK, Smith B, Seawright KW, Morse EA. Cross-cultural cognitions and the venture creation decision. Acad Manage J. 2000;43(5):974–93.

Schwartz SH, Sagiv L. Identifying culture-specifics in the content and structure of values. J Cross Cult Psychol. 1995;26(1):92–116.

Steensma HK, Marino L, Weaver KM. Attitudes toward cooperative strategies: a cross-cultural analysis of entrepreneurs. J Int Bus Stud. 2000;31:591–609.

Swierczek FW, Quang T. Entrepreneurial cultures in Asia: business policy or cultural imperative. J Enterp Cult. 2004;12(2):127–45.

Trompenaars F, Hampden-Turner C. Riding the waves of culture: understanding diversity in business. Chicago: McGraw-Hill; 1998.

Entrepreneurship and Small Business

► Entrepreneurship and Business Growth

Entrepreneurship and Small Business Agility

Redouane Barzi
Ecole Nationale de Commerce et Gestion, Université Ibn Tofail, Kenitra, Morocco

Synonyms

Organizational behavior; Strategic management

Definition and Role of Entrepreneurship

Since the first definition of entrepreneurship by Cantillon in 1755, this concept has evolved and been defined differently by various scholars depending on their specific fields of studies: risk bearing, management, innovation, decision-making, profitability, opportunity seeking, and enterprising individuals. However, besides this heterogeneity in entrepreneurship definition, there is a wide consensus about entrepreneurship's importance in economic development. For example, the Schumpeterian approach states that entrepreneurship is a dynamic process of identifying economic opportunities and acting upon them by developing, producing, and selling goods and services. Kirzner approach stresses that entrepreneurship brings stability to the economic system.

Entrepreneurship becomes crucial, especially for small- and medium-sized enterprises (SMEs), because all governments worldwide recognize the importance of SMEs and their contribution to economic growth, social cohesion, employment, and local development.

Therefore, a serious attention has to be paid to entrepreneurship in SMEs, mainly in environments characterized by high uncertainty. In such context, agility becomes a strategic and organizational asset that managers have to develop, maintain, and enhance over time.

Entrepreneurship: Characteristics and Specificities

Definition

Entrepreneurship can be defined as a process by which an individual – for his own purpose or in an organization – pursues an opportunity under specific resources constraints (Stevenson and Jarillo 1990). In other words, it is the process by which an individual tests and investigates his ideas (Basso 2004; Bouchard 2009), whether in a new context, in case of a new business start-up or in an existing context, when a company already exists, also called "corporate entrepreneurship" (Shane and Venkataraman 2000).

Factors Encouraging Entrepreneurship

Several factors contribute to the development of entrepreneurship. Some authors propose models emphasizing individual, group, and\or environmental factors. Others defend models integrating organizational theory and strategic management.

As an example, Covin and Slevin (1991) studied the processes, practices, and activities of decision-making process that lead to the creation of new business. They were inspired by the works of Miller (1983) and highlighted entrepreneur's orientation toward risk taking, innovation, and proactivity. Lumpkin and Dess (1996) underline the role of competitive aggressiveness and autonomy in the entrepreneurship orientation. As such, Basso et al. (2009) think that competitive aggressiveness corresponds to proactivity and that autonomy is integrated into risk taking.

Schindehutte et al. (2000) underline the dynamic character of factors nurturing entrepreneurship. The dynamic interaction between managers' characteristics, employees, company, and external environment influences the entrepreneurship orientation. Other studies underscore the influence of national culture on the entrepreneurship orientation (Kreiser et al. 2010).

Different Facets of Entrepreneurship

Sharma and Chrisman (1999) explain that entrepreneurship can be studied according to several aspects. Indeed, Stevenson and Jarillo (1990) consider entrepreneurship from the point of view of entrepreneurial management. They define it according to six dimensions: strategic orientation, pursuit of opportunity, resource management, resource orientation, management structure, and reward philosophy. Brown et al. (2001) add two other dimensions to entrepreneurial management: growth orientation and entrepreneurial culture.

Entrepreneurship can also be considered from a strategic management view (Ferreira 2001). Entrepreneurial strategy depends essentially on the company life cycle, entrepreneur characteristics (abilities, values, belief system, and network), and external environment, but its influence is according to Ferreira of lesser impact. Holt et al. (2007) disagree with this conclusion and demonstrate that contextual and process variables influence entrepreneurial orientation more than individual characteristics.

Manimala et al. (2005) propose a model of organizational design for innovations. They stress on the importance of organization and its factors (training, time, available resources) but also underline the importance of entrepreneur's characteristics (knowledge, education) and management policy (rewards, motivation) to pursue an innovative project.

In their model "Corporate Entrepreneurship Strategy" (CES), Ireland et al. (2009) think that the individual entrepreneurial cognitions and external environment conditions can activate an entrepreneurial strategy. They support that this strategy is based on three elements: entrepreneurial strategic vision, pro-entrepreneurial organizational architecture, and entrepreneurial behavior and process.

Chang (1998) presents another model of entrepreneurship, in which he makes a distinction between intrapreneurship (within the organization) and exopreneurship (external to the organization).

Main Approaches of Entrepreneurship

Several studies about entrepreneurship are mainly interested in the results. This approach, called "causation," brings a particular attention about the purposes and objectives to achieve. It is to note here that an entrepreneur may follow several purposes (Markman and Baron 2003; Redien-Collot 2006).

However, Sarasvathy (2001) reveals that the entrepreneurship can also be studied through its processes and its effective modes of implementation. This approach, called "effectuation," is more interested by the deployment of entrepreneurial activities or to the available means to reach given results than by the end results. It is concerned by the individual ability to identify and manage contingencies in order to realize the expected results. So, it considers more risks and losses than return on investment.

Agility as an Entrepreneurial Objective in SMEs

A deeper knowledge of mechanisms and process leading to entrepreneurship is highly important in dynamic and uncertain environment, such as the one we are living in currently. According to Kuratko and Audretsch (2009:1), "*The twenty-first century business atmosphere can be characterized in terms of a new competitive landscape that encompasses increasing risk, decreased ability to forcast, fluid firm and industry boundaries, new structural forms, and an innovative mindset. [. . .] No organisation is immune to the immense pressure of these forces.*" In such context, agility can be a strategic and organizational asset, a sustainable competitive advantage, especially for SMEs which are more sensitive to environmental fluctuations.

Definition

Agility is a military concept derived from the field of aircraft combat (Richards 1996). Today, it is the capacity of a company to grow within a changing environment characterized by frequent variation in consumers' needs and requirements (Breu et al. 2001; Yusuf et al. 1999; Badot 1997).

Agility covers various areas such as the agility of competitors (Goldman et al. 1995), supply chain agility (Christopher 2000; Lin et al. 2006; Paché 2006), agility of business relationships (Preiss et al. 1996; Morgan 2004), agility of decision support systems (Huang 1999), and human resources agility (Forsythe 1997; Breu et al. 2001; Chonko and Jones 2005). Its attributes are different according to its field of practice.

Agility Attributes

Bessant et al. (2001, 1998), which have studied agility in English SMEs, stress the creation of strategic partnerships and networks in order to develop dynamic capabilities and a long-term agility. Coronado (2003) shows the importance of information systems in the agility of industrial SMEs, particularly within the production process.

Barzi (2011) defines the agility of the SMEs through four main dimensions: flexibility, reactivity, differentiation, and proximity. Their attributes are presented in the following chart (Table 1).

Entrepreneurship and Small Business Agility, Table 1 Attributes of SMEs agility

Dimensions of agility		Factors of agility	Attributes
Proximity (relationship, cultural, geographical, hierarchical)	**Flexibility**	*Human resources orientation*	Continuing training
			Versatile HR
			HR availability
			Staff participation
			Strong interpersonal relationship
			Good communication manager/staff
			Interenterprises teams
		Reasonable ambitions	Careful investment
			Firm reasonable size
			Flexible production
	Differentiation	*Customer orientation*	Good relationship – CRM
			Customer loyalty
			Excellent services
		Creativity orientation	New products
			Creation of needs
	Reactivity	*Commitment deadline*	Short production and delivery deadline
			Quick satisfaction of needs
		Easy making strategies	Nonformal choices
			Medium-term choices

Barzi (2011) emphasizes that proximity is the cornerstone of SMEs agility because it feeds the other dimensions. It strengthens customer and staff relationships by creating a new way of communication more appropriate for quick decision-making. All these four dimensions are in continuous interaction between each other that lead ultimately to a more progressive and incremental agility.

Therefore, the relationship between entrepreneurship and agility is very tight and complementary. On one side, entrepreneurship enhances agility because all the decisions and the actions taken by entrepreneurs should aim for the improvement of their company's agility to better meet the needs and the expectations of the market. On the other side, agility facilitates the decision-making of entrepreneurs and the implementation of their strategic choices. Entrepreneurs are better informed about the market and its opportunities and have deep knowledge about the resources to acquire and the skills to develop internally to meet these market's opportunities.

Conclusion and Future Directions

The dynamic forces that characterize today's environment call for a new organization and new management of SMEs. Entrepreneurs should change their way of thinking and the approach which they are dealing with environment to a better understanding of the market place. As an entrepreneurial objective, agility provides SMEs' managers the flexibility, the reactivity, the differentiation, and the proximity to compete effectively in hostile environment. It has to be an ongoing process, a continuous improvement program to meet the ever changing needs of today's customers.

Future studies will investigate possible differences related to agile attributes between companies of different sizes and sectors.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Creative Management

▶ Creativity and Innovation: What Is the Difference?
▶ Creativity from Design and Innovation Perspectives
▶ Creativity Management Optimization
▶ Entrepreneurial Organizations
▶ Individual Determinants of Entrepreneurship
▶ Innovation Systems and Entrepreneurship
▶ Open Innovation and Entrepreneurship
▶ Organizational Slack and Innovation

References

Badot O. Théorie de « l'entreprise agile », Editions L'Harmattan; 1997.

Barzi R. PME et agilité organisationnelle: une étude exploratoire. Rev Innov. 2011;35(2):29–45.

Basso O. L'intrapreneuriat. Paris: Economica; 2004.

Basso O, Fayolle A, Bouchard V. Entrepreneurial orientation: the making of a concept. Int J Entrep Innov. 2009;10(4):313–21.

Bessant J, Francis D, Meredith S, Kaplinsky R, Brown S. Developing manufacturing agility in small and medium-sized enterprises. Operations management: future issues and competitive responses, Trinity College, Dublin, European Operations Management Association; 1998.

Bessant J, Francis D, Meredith S, Kaplinsky R, Brown S. Developing manufacturing agility in SMEs. Int J Technol Manag. 2001;22(1–3):28–54.

Bouchard V. Intrapreneuriat, Innovation et Croissance: entreprendre dans l'entreprise. Paris: Dunod; 2009.

Breu K, Hemingway CJ, Strathern M, Bridger D. Workforce agility: the new employee strategy for the knowledge economy. J Inform Technol. 2001; 17:21–31.

Brown T, Davidsson P, Wicklund J. An operationalization of Stevenson's conceptualisation of entrepreneurship as opportunity based firm behavior. Strateg Manag J. 2001;22(10):953–68.

Chang J. Model of corporate entrepreneurship: intrapreneurship and exopreneurship. Borneo Rev. 1998;9 (2):187–212.

Chonko LB, Jones E. The need for speed: agility selling. J Pers Sell Sales Manag. 2005;27(4):371–82.

Christopher M. The agile supply chain: competing in volatile markets. Ind Mark Manag. 2000;29(1):37–44.

Coronado AE. A framework to enhance manufacturing agility using information systems in SMEs. Ind Manag Data Syst. 2003;103(5):310–23.

Covin J, Slevin D. A conceptual model of entrepreneurship as firm behavior. Entrep: Theory Pract. 1991;16(1):7–25.

Ferreira J. Corporate Entrepreneurship: a strategic and structural perspective. N Engl JEntrep. 2001;4:59–71.

Forsythe S. Human factors in agile manufacturing: a brief overview with emphasis on communication and information infrastructure. Hum Fact Ergon Manuf. 1997;7(1):3–10.

Goldman SL, Nagel RN, Preiss K. Agile competitors and virtual organisations: strategies for enriching the customer. New York: Van Nostrand Reinhold; 1995.

Holt DT, Rutherford MW, Clohessy GR. Corporate entrepreneurship: an empirical look at individual characteristics, context, and process. J Leadersh Organ. 2007;13(4): 40–54.

Huang CC. An agile approach to logical network analysis in decision support systems. Decis Support Syst. 1999;25(1):53–70.

Ireland RD, Covin JG, Kuratko DF. Conceptualizing corporate entrepreneurship strategy. Entrep: Theory Pract. 2009;33:19–46.

Kreiser PM, Marino LD, Dickson P, Weaver MK. Cultural influences on entrepreneurial orientation: the impact of national culture on risk taking and proactiveness in SMEs. Entrep: Theory Pract. 2010;34(5):959–83.

Kuratko D, Audretsch D. Strategic entrepreneurship: exploring different perspectives of an emerging concept. Entrep Theory Pract. 2009;33(1):1–17.

Lin CT, Chiu H, Chu PY. Agility index in the supply chain. Int J Prod Econ. 2006;100:285–99.

Lumpkin G, Dess G. Clarifying the entrepreneurial orientation construct and linking it to performance. Acad Manage Rev. 1996;21:135–73.

Manimala MJ, Jose PD, Thomas KR. Organizational design for enhancing the impact of incremental innovations: a qualitative analysis of innovative cases in the context of a developing economy. Creat Innov Manag. 2005;14(4):413–24.

Markman GD, Baron RA. Person entrepreneurship fit: why some people are more successful as entrepreneurs than others. Hum Resour Manag Rev. 2003;13(2): 281–301.

Miller D. The correlates of entrepreneurship in three types of firms. Manag Sci. 1983;29:770–91.

Morgan RE. Agile business relationships and technology. J Gen Manag. 2004;29(4):77–92.

Paché G. Concilier production au plus juste et agilité dans les chaînes logistiques étendues : un double éclairage opérationnel et stratégique, Gestion 2000, 2006;23(2): 23-40.

Preiss K, Goldman SL, Nagel RN. Cooperate to compete: Building agile business relationship. New York: Van Nostrand Reinhold; 1996.

Redien-Collot R. L'entrepreneur post-moderne et ses stratégies d'accomplissement. Manag Sci Soc. 2006; 3(1):115–30.

Richards CW. Agile manufacturing: beyond lean? Prod Invent Manag J. 1996;37(2):60–4.

Sarasvathy SD. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. Acad Manage Rev. 2001;26(2): 243–63.

Schindehutte M, Morris MH, Kuratko DF. Triggering events, corporate entrepreneurship and marketing function. J Mark Theory Pract. 2000;8(2):18–31.
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manage Rev. 2000;25:217–26.
Sharma P, Chrisman JJ. Toward a reconciliation of the definitional issues in the field of corporate entrepreneurship. Entrepreneurship: Theory Pract. 1999;23(3):11–27.
Stevenson HH, Jarillo JC. A paradigm of entrepreneurship: entrepreneurial management. Strateg Manag J. 1990;11:17–27.
Yusuf YY, Sarhadi M, Gunasekaran A. Agile manufacturing: the drivers, concepts and attributes. Int J Prod Econ. 1999;62(1/2):33–43.

Entrepreneurship and Social Inclusion

Jonatan Jelen[1] and Eric Michael Laviolette[2]
[1]Parsons The New School for Design, New York, NY, USA
[2]Novancia Business School Paris, Paris, France

Synonyms

Social entrepreneurship; Social ventures; Society and entrepreneurship

Introduction

Over the first decade of the new millennium, academicians, professionals, and the media have attempted to make tangible the practice of entrepreneurs – and the notion of entrepreneurship – with a socially inclusive perspective via the specific terminology of "social entrepreneur (ship)" (for some representative reviews, see Alvord et al. 2004; Paredo and McLean 2006; Guzmán and Trujillo 2008; Matei and Sandu 2010; Granados et al. 2011; Desa 2012). The ensuing proposed variants of more precise definitions are innumerable. While this entry's purpose is on one hand to be synthetic and positive about the current body of knowledge of this important emerging discipline, on the other hand, it also wants to serve as a jumping board for further developments and critical inquiry and is necessarily interpretive, even normative at times. Thus, in order to render justice to the challenging complexities and multiple dimensions of this field of study as well as its praxis, this entry advocates an admittedly integrative and decidedly large definition for the analysis at hand:

Social entrepreneurship means creating public value with private means to reconcile the paradigmatic imperative with the pragmatic challenge of postcapitalist society.

While arguable quite a sweeping definition, it, however, does not matter-of-factly include several other, more remotely related notions, such as social corporate responsibility, intrapreneurship, or generic creativity (i.e., uncommercializable innovation at the level or art, culture, and craft). Social corporate responsibility typically remains a function of organizational managers, paid researchers, and largely ethical and moral, socially required standards. It does not seem to possess the qualities of sociocentric and capital-agnostic, genuinely generative human individuals or small groups, but merely frames the self-preservative contingent and systemic ambitions of firms (as a priori constructed and consequently volatile systems) vis-à-vis their environment: they want to be more sustainable situationally and relationally. On the other hand, intrapreneurship also, while it may very well express creative, innovative, and potentially socially beneficial intentions, remains confined to the profitability-centric organizational realm, resulting in protected, private, and proprietary intellectual property. And finally, if our goal is to collect and transmit epistemic and ontological knowledge about the branch of social entrepreneurship as a learnable, practicable, and impactful discipline for future generations, we cannot be satisfied with mere induction based on laudable, noble, yet singular events or actions. To become learnable by individuals and for those individuals to be developed, to be adopted and adapted, to become *praxis*, it needs to transcend the stage of perpetual *practice* (as in "practicing," trying, experimenting). While it may always retain some facet of *art*, it also needs to become *science*.

Entrepreneurship and Social Inclusion, Table 1 Type of goods

	Excludable	Nonexcludable
Rivalrous	Private goods: food, clothing, toys, furniture, cars	Common goods (common-pool resources): fish, hunting game, water, air
Nonrivalrous	Club goods: cable television	Public goods: national defense, free-to-air television

The "Social" Element of Value Creation in "Social Entrepreneurship"

Venturing by individuals or groups of individuals for the benefit of the public is neither a recent phenomenon nor is it a spectacularly novel idea. Already at the dawn of early, even primitive communities or social groups, producing for others in the community was necessary, acceptable, and right out desirable. Societies are constructed organisms, partly a consequence of evolutionary and behavioral processes to overcome the limitations of mere subsistence level survival and unsustainable self-preservation violence, partly a cognitive construct of leveraging individual idiosyncrasies, specialization, and exchange of the resulting excess production. But societies do not only have or need an economic dimension to sustain themselves materially. They also need a sociopolitical sphere to maintain them ethically, morally, and possibly spiritually. The latter inspires the norms of the first and the previous provides the resources to nurture and cultivate the second. More importantly and more precisely, the economic sphere is itself a multidimensional construct.

The Challenge of Social Economic Goods

In fact, economic goods are defined by the two dimensions: rivalry (not enough to go around for everyone's insatiable consumption) and excludability (while used by someone, it cannot be used (any longer) by others). The resulting famous construct is that of private goods such as typical normal or luxury goods, that is, objects of individual consumption (both rivalrous and excludable), public goods such as sunshine and air (neither rivalrous nor excludable), impure public goods such as information and infrastructure goods and utilities (rivalrous but not excludable), and common-pool resources or club goods such as intellectual property or natural resources upon discovery and appropriation (not rivalrous but excludable). Table 1 below illustrates that typology (Samuelson 1954).

While the paradigm of private goods is essentially captured by traditional so-called egocentric entrepreneurship, it is the remaining three quadrants that have always motivated the sociocentric social entrepreneur. Historically, these three paradigms suffered an inherent imbalance due to underproduction and overconsumption as well as incentives for social loafing and free riding, thus giving rise to market imperfections. This was antithetical and hard to reconcile with the basis of perfectly competitive markets under assumed conditions of full information, rationality, transitivity, self-interested benefit maximizing and positional optimizing, their converging forces toward equilibrium and Schumpeterian "creative destruction" resulting in the only viable alternative of monopolistic competition. Then, presently, these three nonprivate paradigms have reemerged with a vengeance as increasingly complex and complicating social systems demonstrate a consumptive insatiability of social goods. We increasingly demand the provision of precisely those nonrivalrous and nonexcludable public goods (e.g., information, air, and sunshine), nonrivalrous and excludable common-pool resources (energy and other natural resources), and, the most resource-hungry category of them all: rivalrous, nonexcludable impure public goods (transportation infrastructure, education, utilities, health care, security). And finally, for the future, the material criticality has dramatically surged as a consequence of the information technology advances of the past three decades. Making the transition from a predominantly transactional industrial economy that favored the acquisition of goods and services for immediate depreciative consumption, to a transformational "experience" economy promoted through intangibles and perceptions, pluralizing societies have seen their delicate interplay between consumptive and productive patterns shift, intensify and become complicated at an unprecedented velocity, resulting in prosumers and coproducers, unhinging the traditional notions of economic interactions: scarcity becomes abundance, effectives replaces efficiency, immediacy outdoes measured response, accessibility destroys control, purpose must precede objectives, context imports over content, and appreciation of intellectual capital eclipses depreciation of produced capital. Such paradigm shifts will require solutions above and beyond the current paradigm of the invisible hand, self-organizing markets, benign self-interest, and generally self-structuring organic systems. At different times and in different settings, these issues were being addressed with solutions of varied and questionable success, ranging from corruptively inefficient statism to inadequately effective community-based peer production; some were politically fragile models based on local taxation for the provision of municipal services, and then recently, more mission-centric nonprofit models to provide what would be considered "public goods" became popular. Enter "social entrepreneurship," the panacea destined to reconcile the competing objectives inherent in the pursuit of social value through economic means. Therein lies the positioning potential but also the positioning dilemma of the social entrepreneur.

The Role of the Social Entrepreneur in Responding to the Challenge of Social Economic Goods

It remains to operational the social aspect of social entrepreneurship on the three main constituents of a value-creating business model, purpose, process, and product, commonly referred to as strategy.

The Outrageous Purpose: Transformational Value Propositions Defined by Vision, Mission, and Leadership While some exaggerated claims of Google's Sergey Brin and Larry Page, for example, to want to dominate the world of knowledge or readying itself to challenge oppressive political systems, or Mark Zuckerberg's controversial market penetration attempts with Facebook in China may squeeze a muse or foster admiration, they are precisely the kind of sociocentric purpose that qualifies a social entrepreneur. While it is certainly not unwise to want to solve or mostly – at best "satisficingly" – resolve socioeconomic problems, or address social "bads," even contribute to lower socially controversial negative externalities or aspire to increase positive externalities, it remains that social entrepreneurship cannot be merely reactive in responding to perceived dissonance and discord between current state and desirable state. In doing so, they may and have, for that matter, often created additional problems: starting a stray pet care facility may lead to more stray pets if society now knows it can rely on someone else's conscience for stray pets. To qualify as a social entrepreneur, one must possess the attributes and capabilities to see society in a complete and complex context. That in turn requires vision, the ability to conceive a future so vivid and tangible, emphatically and passionately communicable and communicated to others that it will result in movement toward that future, typically referred to as leadership ability. But while conventional definitions of leadership are centered about the personality or the character of a particular person, the leadership necessary here is not based on such personality cult nor on demagogy or moral coercion. It is the "leadership from behind" or the leadership *effect* that defines the motion toward the vision. To become charisma independent in turn, this type of leadership effect supposes a mission so compelling that it in fact displaces the leader. Inasmuch, the social entrepreneur's social dimension is ultimately defined by a *transformational* ambition, far beyond the mere transactional ambition of the simple social problem solver. Transformational leadership as a defining component of the social entrepreneur thus requires him or her to also think as a social designer, a game changer, and critical dreamer: it will take not only the ability to propose value with a solution, but it will also require the attributes of courage and passion to architect entirely new contexts and think ontologically and normatively about the course of society. This is a tall order.

The Unconventional Process: Path and Progress in the Eye of Adversity

– *Managers make decisions – social entrepreneurs make choices*. While there is no point in glorifying the heroism, persistence, or crisis competencies usually attributed to entrepreneurs, it is important to point out that social entrepreneurs cannot be restricted to being resource minded, optimizing, or economizing risk minimizers. As such, managers typically identify if some dissonance can be addressed as part of the problem, part of the solution, or part of the landscape. Unlike the confines of the organization, however, society at large is forged by competing value systems, shared cultural interpretations, and historically shaped, inert rituals. Prospectors, those desiring change and competent to effect it have more in mind than solving or resolving problems at hand. In Ackoff's paradigm (Ackoff 1978), they are destined to "dissolve" such situations previously perceived as problematic by (1) moving the entire landscape or (2) becoming the landscape itself. Those are choices. Unlike decisions, choices are not limited by endless information collection, data analysis and evaluation, and risk assessment. While respecting available information, choices are also and more importantly action centric. Inasmuch, social entrepreneurs are qualified by their action bias and give true meaning to the synonym "action plan" for the term strategy.
– *Social entrepreneurship is a mindset, while traditional entrepreneurship is a phase in an entrepreneur's life*. Traditional entrepreneurs start with a project, aspire to operationalize it, eventually become managers, and lastly possibly insider shareholders in their own company. If they deviate, we may call them unsuccessful or label them "serial entrepreneurs." Social entrepreneurs are perpetual.

The Product: Social Value + Social Benefit = Social Impact

– *Traditional entrepreneurs build products and organizations – social entrepreneurs create movements and networks*. Resource-agnostic, action-biased, social value proposition-driven, sociocentric, transformational individuals or groups cannot afford to lose sight of the social context by even merely periodically focusing on some "internality," be it the tangible outcome of product or service or the organization of plans, humans, and capital to implement it. The outcome of social entrepreneurship can and should therefore be shifting perpetually as social positions do. The product is not specific tangibles, experiences, and transactions; the product is impact to society. Their product can only be more social entrepreneurship, more social innovation opportunities, and generating, developing, and educating more social value creation-minded individuals. By definition, their innovation is open, their intellectual capital is shared or at least made accessible, and their value is not determined by the hierarchy they built, but by the network they extended and the amount of connections they can nurture and cultivate. Maximizing social impacts is only possible by increasing the rate at which new social entrepreneurs are developed. Thus, social entrepreneurs do not build organization hierarchies; they perpetuate a "pyramid scheme."
– *Traditional entrepreneurs produce, consumers consume. Social entrepreneurs both coproduce and prosume*. Analogous to Peter Drucker's proposition in the Post-Capitalist Society (Drucker 1994), where today's knowledge society is by definition socialist since the knowledge workers not only are the productive resources, but they also own the productive resources through investments and pension funds mediated by the public financial markets, social entrepreneurship is truly social because not only are its intent and outcome social, but so are its vehicles and tools of production, represented by the social networks implicating the very receivers of the social benefits in the production of these very – indeed their own – benefits.

The "Entrepreneurial" Element of Value Creation in "Social Entrepreneurship"

Peter Drucker's notion of social entrepreneurship for a "not-for-profit twenty-first century" proves too restrictive today (Drucker 2006). Confining social entrepreneurship to not-for-profit may have resulted in its early demise. Fortunately, not for profit really never meant not for profit. And fortunately, the corporate paradigm does not always rest on greedy shareholders. In the following, we analyze how to reconcile the pragmatic social imperative with the impractical financial challenge of financial sustainability for social entrepreneurship.

Irrelevance of the for-Profit Versus Not-for-Profit Controversy for Social Entrepreneurship Models

The for-profit vs. not-for-profit controversy as to the appropriate model for financially sustaining social ventures is grounded in an ironic historical context. Some of the most famous social benefactors happened to be some of the richest of the original capitalist, industrialists, and elitists of the previous centuries. While their charities and philanthropy created some amazing social results, their ulterior motives are questionable at best. Maybe it was self-serving ways to cope with guilt, prevent social unrest, or genuine concern for the lower classes of society. But it was neither social, nor was it entrepreneurial.

Social Entrepreneurship Is Neither Defined Nor Does It Depend on Philanthropic Capital Charitable giving, philanthropy, and donations are indeed antithetical to social entrepreneurship. They create a dependency of the purpose of a social venture on the whimsical availability of excess wealth. The focus of the social entrepreneur thus shifts from the value proposition to resource acquisition. It shifts from motivating the network to meeting the conditions of the giver. The conflict is further compounded by a mostly opaque process of such giving, the ensuing control ambitions of the giver, and the potential for undue influence by the giver. Finally, even if one overcame the ambiguities associated with charitable capital, one is left with the sheer insurmountable problem of operationalizing such structures. That is, how does one turn these project-centric episodes as they are conceived by the giver into a sustainable venture, that is, a going concern as is needed by the social entrepreneur. And ultimately, basing social entrepreneurship off of such charitable structures precludes it from becoming a teachable discipline and learnable practice. It relegates social entrepreneurship to pure craft and unsystematic artistry. Inversely, many a venture has emerged, even excelled, and sometimes overwhelmed our wildest expectations: Google, eBay, the Chinese Baidu, then Yahoo, even Amazon, Facebook and YouTube, MySpace, to name only the most prominent of the day. And they did not rely on donations. In fact, they are all hard-core for-profit corporations (Jelen 2009). Yet, the tremendous amount of social value and social benefit, the social change, and the social transformations that resulted are beyond doubt, even if we yet have to find the right metrics to capture such value.

Social Entrepreneurship Cannot Be Selfish, But Does Not Need to Be Selfless While the Smithian notion of self-interest pronounces much smoother than it is practiced, it remains a central tent to this second part of the present analysis. While typical egocentric entrepreneurial capital of the traditional kind promises returns to selfish financial risk takers in a project, the capital needed for social ventures does not have to be of diametrically opposed quality as is presumably selfless capital of the charitable kind. If capital is committed in the Smithian spirit of self-interest, respectful of all other self-interest, and knowingly flows to ventures that have an explicit intent and impact of social spillover, positive externalities, and public benefits above and beyond the private returns, it should leave intact the social quality of the venture. Constraining social ventures to the not-for-profit version of corporate activity reduces the incentives for private patient capital to zero. But excluding social ventures from private patient capital is indeed perverting the spirit of social value creation. On the other hand, accommodating the definition of the social venture to naturally include private patient capital also allows us to remediate the opacity of philanthropy. If capitalists want to give, they will now do so as shareholders in audited public corporations or auditable private equity firms and closed corporations with established oversight processes. If we thus disassociate the outcomes from the early restrictive operational definition of the social enterprise, and consequently leverage proven postcapitalist frameworks of public equity ownership and patient capital – along with value-adding work-structuration models for private organizations, networks, or hybrids – we can define a substantially richer and more promising set of opportunities for more dynamic, more resilient, and more effective creation of collective benefits for the twenty-first century.

From Entrepreneurship to Social Entrepreneurship to Social Innovation to Open Innovation to Social Inclusion

Part of the human condition, its organic predisposition with cognition in particular, drives individuals and groups to be creative, innovative, generative, and productive regardless of the quality, quantity, and immediacy of incentives. The particular quality of entrepreneurs is that they transcend mere (organic) opportunism with intention and initiative for (constructed) opportunities. Thus, generally defined as a venturing process of value creation, entrepreneurship can apply equally to generate private and public wealth. Yet, entrepreneurship has long been too narrowly defined, taught, and normed as exclusively related to private wealth creation, whereas the public wealth value creation was the area of state. In the postcapitalist era where state welfare is restricted because of political sensitivities, but moreover because of material and resource constraints, there are growing needs for social services that the state can no longer satisfy. As a result, social exclusion is growing in many countries, and it raises the needs for inventive ways to respond to them not only through state "intervention" but also through the creative generation of new ideas and exploitation of such opportunities by private actors. Entrepreneurship has often been excessively depicted as an expression of liberalism with an emphasis on private property and one's liberty to exploit the fruits of one's work. This conception has restricted the social side of any venturing process. Inherently, all entrepreneurship is a socialization process through which the entrepreneur creates weak and strong ties to exploit an opportunity. Such networking might result in more structured and stable relationships. In that sense, entrepreneurship is a process of social inclusion for the entrepreneur himself but also for other individuals who might join him or her in the project. Thus, an originally restricted notion is resolving graciously into a greatly expanded model for social value-creative ventures: information-technological ingenuity as a factor of production of the new experience economy has displaced concerns for the "old" factors volunteer-type labor and charity-like capital. Thus became possible Yunus' microfinance model, Social Impact Bonds, Open Innovation originated in the favelas of Rio De Janeiro and Sao Paolo, and New Yorkers converting a defunct and decommissioned railway structure into a delightful urban green public space, the High Line.

Conclusion and Further Direction

At the outset, we adopted an inclusive definition for social entrepreneurship: creating public value with private means to reconcile the paradigmatic imperative with the pragmatic challenge of postcapitalist society. Inasmuch social entrepreneurship is distinct from governmental projects, for example, that devote public means for public value creation. It is also distinct from traditional private entrepreneurship. The latter is typically only motivated if there exists the possibility to appropriate private value in excess of positive externalities or spillover social value that cannot be captured by the entrepreneur. In retaining the public value purpose and goal of the one and the profoundly constructive, productive, cognitive, and generative nature of the human condition of the other, a social entrepreneur is consequently someone less concerned with the nobility of the support for their generative processes and more with the impact of their results in terms of social value creation; he or she will be generative of this social value through commercialized creativity; and he or she will leverage aspirational social innovation with market-economic rationality into a purposeful venture and an entire sustainable system, much beyond merely resolving public needs and social problems, but aspiring to produce collective wants, communal experiences, and common cultural value.

While our focus was to develop the still popular notion of social entrepreneurship as principally juxtaposed to traditionally understood entrepreneurship, it may soon be a futile attempt to draw such distinctions in the light of the obvious: our collective interests and aspirations are taking on a dimension of unprecedented proportions in our lives and entirely new resource constraints and scarcity concerns are forcing us to think more sociocentrically. We will have to learn new ways of how to leverage limited financial, material, and intellectual resources at unprecedented scale to initiate social, global, and substantial change. The ingenious proposition of entrepreneurship in general and social entrepreneurship as a business *model* and a business *mode* with its explicit sociocentric purpose executed via private means is to create value, to realize opportunities, and to design, initiate, and motivate contextual change *before* crisis. In crisis, we are all entrepreneurs. And in social crisis, many of us quickly discover their Good Samaritan side. But we do not need to strive for more good Samaritans, or better Samaritanship. While such responsiveness is certainly important and has its place in the socioeconomic compact, the true nature of entrepreneurs and entrepreneurship is not to be merely reactive, protective, or defensive. They are true prospectors in Myles and Snow's paradigm. Entrepreneurs are not limited by opportunities resulting from accidents or incidents. They are not confined to *opportunism*. Social entrepreneurs transcend the paradigm of recognizing and realizing opportunities but want to intentionally design, create, and construct *opportunities* in their own right.

Cross-References

▶ Green Business and Entrepreneurship
▶ Green Enterprising and Green Entrepreneurs
▶ Social Capital of the Entrepreneur
▶ Social Ecology
▶ Social Entrepreneurship
▶ Social Innovation
▶ Social Networks and Entrepreneurship

References

Ackoff RL. The art of problem solving. New York: Wiley; 1978.

Alvord SH, Brown LD, Letts CW. Social entrepreneurship and social transformation. J Appl Behav Sci. 2004;40(3):260–83.

Desa G. Social entrepreneurship: snapshots of a research field in emergence. University of Washington. 2012. http://www.cbs.dk/content/download/64150/877865/file/Social%20Entrepreneurship%20%20Snapshots%20of%20a%20Research%20Field%20in%20Emergence%20(G.%20Desa%20revised).doc. Accessed 8 Jan 2012.

Drucker PF. The post-capitalist society. New York: Harper Business; 1994.

Drucker PF. Managing the non-profit organization. New York: Collins; 2006.

Granados ML, Hlupic V, Coakes E, Mohamed S. Social enterprise and social entrepreneurship research and theory: a bibliometric analysis from 1991 to 2010. Soc Enterp J. 2011;7(3):198–218.

Guzmán A, Trujillo MA. Social entrepreneurship – literature review (emprendimiento social – revisión de la literatura). Estud Gerenc. 2008;24(109):109–219. http://ssrn.com/abstract=1756171. Accessed 8 Jan 2012.

Jelen J. Financial sustainability for social entrepreneurship – pragmatic social imperative or impractical financial challenge? Int J Entrep Innov. 2009;10(3):165–74.

Matei L, Sandu C. The social enterprise: a literature review, APAS paper No. 389. 2010. http://www.apas.admpubl.snspa.ro/handle/2010/389. Accessed 8 Jan 2012.

Paredo AM, McLean M. Social entrepreneurship: a critical review of the concept. J World Bus. 2006;41(1):56–65.

Samuelson PA. The pure theory of public expenditure. Rev Econ Stat (The MIT Press). 1954;36(4):387–9.

Entrepreneurship Education

Jonathan Bainée
ENSTA ParisTech, Université Paris 1 Panthéon-Sorbonne – France, Paris, France

Synonyms

Entrepreneuriat education; Entrepreneuriat training; Entrepreneurship training

Entrepreneurship Education: Issues and Challenges

Entrepreneurship and, thus, small- and middle-sized firms (SMEs) have had a growing interest for the past two decades, from the academic world as well as from public authorities. This interest is part of many economic changes. In particular, technological change and the increasing incidence of innovation in most developed countries have reduced the importance of the size of the companies in the industry and favored the development of entrepreneurial activities. In addition, globalization would have dragged the comparative advantages of North American and European countries toward knowledge-based activities, while the "knowledge-based economy" would be relatively more conducive to entrepreneurship and to SMEs.

At the European level, the Lisbon Agenda (2000) confirms the significance of innovation as a driver of change in the economic growth of tomorrow. In this perspective, entrepreneurship can be considered as one of the main levers to operate, especially since it is part of specific contemporary dynamics. First, researchers in economics highlight the involvement of a growing number of active SMEs in the innovation process, particularly in the case of clusters and competitiveness clusters. Moreover, the increase rate of unemployment during the 2000s, also fueled by economic and financial crisis that begun in 2007, led governments of many countries to ease the creation of business or to promote self-entrepreneurship, in order to induce agents to create their own jobs. In addition, developed economies coped with the aging of their populations, including company leaders, whose business will have to find a buyer who could well manage them. Furthermore, a transmission of small business on five results on a bankruptcy filing within 6 years in France or in Canada.

The issues in terms of ability to manage the creation, transition, and business development are primordial, both in their qualitative and quantitative dimension. It is in this context, conducive to new needs of knowledge, that emerge entrepreneurship teachings designed to inspire and enable individuals to start and to grow entrepreneurial ventures. They can be addressed in two steps. First, a historical approach will show how teachings in entrepreneurship have evolved in their implementation based on a double dynamic of empowerment and "complication" of training programs in entrepreneurship, which seems structured around the controversy over the ability to learn to undertake business or initiate the risk culture. Second, practical teaching methods of entrepreneurship will be analyzed, making sure to highlight the multifaceted reality of innovative approaches and actions through an international benchmark conducted by the PIMREP (ParisTech Innovation Management Research and Education Program) network (PIMREP 2010, 2011) (► Higher Education and Innovation).

The Story of a Controversy: Can We Train to Entrepreneurship?

Historically, Myle Maces has provided the first entrepreneurship courses in Harvard in 1947 (Katz 2003). However, the 1970s mark the true genesis of a plethora of actions that affects other schools: high schools, universities (schools of business and engineering), and centers of entrepreneurship (ibid.), both nationally and internationally, starting by Anglo-Saxon cultured countries. This expansion is fueled by accreditation bodies of academic programs that enhance the efforts to encourage entrepreneurship in the design of programs, from the mid-1990s (Adcroft et al. 2004). During this particularly prolific period, two significant trends have come together to shape entrepreneurship education as we know it nowadays. Firstly, it is a process of empowerment of entrepreneurship training programs: "entrepreneurship in universities has so far been developed as an add-on to business education, first as an elective course, then more courses, and finally as a concentration, major or program" (Vesper 1999). Secondly, teaching programs are subject to growing complexity, in terms of teaching through theoretical approaches and in terms of broadening perspectives. According to this interpretative framework, it is possible to distinguish several periods that stand out by their approach to entrepreneurship, which seem to be structured around the controversy over the faculty and the opportunity to learn to undertake business or to initiate the culture of risk.

"Entrepreneurs cannot be manufactured, only recognised"

In early youth of entrepreneurship education, it has been mainly treated around the issue of business creation. The teachings are based primarily on the testimony of successful business entrepreneurs (► Entrepreneur; Fiet 2000) with the aim to share meaningful experiences of business creation and to highlight the elements of success of these success stories. Learn from experiences through analogies, even though each business creation is – by definition – specific, may seem paradoxical. It is this gap that interferes in a series of skeptical researchers against such teaching practices and critical of the ability to train in entrepreneurship. Most of the arguments are based on the idea that the concept of entrepreneurship education refers both to the teaching of know-how that are objectifiable and to teaching of skills (▶ Entrepreneurial Capability and Leadership). They cover two levels of analysis. The first relates to the figure of the entrepreneur himself, which economic literature has long strived to shape: attracted by risk-taking and marked by the need for achievement, it stands out for others by his taste for independence and deviance to the familiar and established. In this context, Chaharbaghi and Willis (1998) argue that "entrepreneurs cannot be manufactured, only recognised." The second criticism concerns the deterministic and contingent dimensions of testimonies and more globally, of the overall teaching methods mobilized. Some authors suggest that entrepreneurship takes a pattern of behavior that is rooted within a specific context and is isolated within that context, whereas Adcroft, Willis, and Dhaliwal (2004) state that "the entrepreneur being in the right place at the right time may involve elements of judgement but also involves elements of serendipity." As a consequence, entrepreneurship has long been considered as non-teachable because it cannot result from an optimized and infinitely reproducible approach.

"Entrepreneurship is not an innate quality, but a discipline of mind and action"

It is interesting to note that these criticisms are the seeds of a radical change in approaches to the issue of entrepreneurship in the 2000s. Indeed, beyond several empirical studies validating the specific value of entrepreneurship training, it seems to be largely in response to the criticism that academics undertake to enrich the educational treatment of entrepreneurship. The latter is more complex and therefore wins the groundwork for a separate discipline: "entrepreneurship is not an innate quality, but a discipline of mind and action that can be the appanage of a great number of students if only we train them" (Santi 2006). In any case, entrepreneurial skills must allow students to face a new problem by drawing on a heritage of knowledge and by reconstructing from them the elements necessary for the exploration of new solutions, although they take place in a complex and dynamic environment. The process that initiates such a change of mind – which will be only slightly challenged later – goes through a drastic evolution in the way we apprehend entrepreneurship, at the crossroads of several factors. On the one hand, the shared sense that entrepreneurship education should be divided into two approaches, both through action on the individual behaviors of students to stimulate innovative initiative and autonomy necessary for its development, that through the transmission of theoretical (and methodological) corpus necessary to analyze the essential elements of trends extension or, conversely, discontinuous elements. On the other hand, a process of empowerment of training curricula for entrepreneurship is coupled with programs that are getting more and more complex, in terms of theorization and in terms of broadening perspectives.

Multiple Dynamics Overlapped and Fertilized Entrepreneurship Education

During the 2000s, trainings in entrepreneurship are subject to multiple dynamics that overlap and fertilize. The first of these consists in promote a balance between theoretical and practical lessons, which greatly contributed to the empowerment and to the recognition of the entrepreneurship education. The purpose of such theoretical approaches, known as theory-based education (Fiet 2000), was to build a consistent and structured framework to maximize the probability of success for entrepreneurs. Specifically, they mobilize concepts and theories that have a clear applied and explanatory nature, such as agency theory, resource theory, or the economics of transaction costs (ibid.). Beyond the theoretical knowledge deepening that mainly concerns business schools, entrepreneurship trainings drastically expand the range of topics covered, as the legal aspects (idea protection), technical aspects (new product development, technological innovation), organizational aspects, marketing aspects, and especially the financial aspects (▶ Business Project; ▶ Angel Investors; ▶ Business Incubator) and individual stimulation (negotiation, leadership). Also, the entrepreneurship courses have not kept out of the profound mutations of pedagogical logic, since treatment of these last two themes went hand in hand with the shift from a passive pedagogy, in which instruction is designed as an "information delivery," to an active approach in which the purpose is to make the learner an actor of learning, which is referred to as experiential learning. This type of teachings is based primarily on computer and behavioral simulations or on creativity techniques (mind mapping, divergent thinking, brainstorming, or lateral thinking).

So far, transformations of entrepreneurship education have been drawn in broad strokes. It should be noted that they vary in space, in addition to vary over time. Indeed, if Solomon, Duffy, and Tarabishy (2002) find that business plan, case studies, and traditional teachings were still dominant educational tools in entrepreneurship education in the early 2000s, there have been mutations since then, both in terms of depth, that enlargement of views, or in teaching approaches. In this landscape renewed, what are the novelties concerning entrepreneurship education? Does the generalization of these developments have given rise to a standardization process of training in entrepreneurship? Some of the answers and lines of thought based on an international benchmark on training in innovation management led by the ParisTech Innovation Management Education Research (PIMREP) can be provided.

How Far Have We Advanced on the Learning Curve for Teaching Entrepreneurship? Findings of an International Benchmark

The PIMREP network was set up at the end of 2008 and encompasses many French high schools which belong to the ParisTech network (http://www.paristech.fr/index.php/eng/). After a study in 2009 on training in innovation in ParisTech schools, the PIMREP conducted an international benchmark in 2010–2011 in the same field and that is useful here. The aim was to identify trends and foster experience sharing between the members of the network and faculties abroad. The scope of this benchmark has covered eight institutions, including business schools (HEC Montreal, NCCU), technological institutes/universities (TU Munich, ETH Zurich, KTH, KAIST), and comprehensive universities (NUS, Aalto University). This selection demonstrates a commitment to observe the most innovative teaching practices on innovation and entrepreneurship (▶ Creative Pedagogy) and also intends to embrace a broad spectrum of contexts and of cultures in order to measure their relative importance on teaching approaches adopted. Each of these institutions has been visited and has been subjected to a questionnaire structured around a specific grid analysis. From this one, several trends have been identified. Training in entrepreneurship requires diverse teaching models that range from the acquisition of academic knowledge to learning that recreate a context of thought and action that are close to real-life entrepreneurship situations. Given the traditions and contexts of each institution, the survey shows a wide variety of experiences following two separate models, but with similar lines of development, but above all, these experiences appear more and more territorially (▶ Territory and Entrepreneurship).

An Analytical Grid to Characterize Programs in Entrepreneurship

The PIMREP network designed a system of reference to characterize the programs under study, which is built around different "educating situations" in innovation and entrepreneurship programs: awareness raising (involving presentations, testimonies, and introductive conferences), development of students' capacity for initiative (challenges, i.e., individual experiences with little assistance in terms of methodology or theory), training in methods and theories (lessons, seminar), and training in contexts of innovation (implication in entrepreneurship contexts focused on the integration of theoretical and methodological tools through tutoring). The survey consisted in analyzing the schools' degree courses with the following grid: type of teaching situations offered, type of students involved, "weight" in terms of time allotted and credits, and distribution throughout the degree courses. It aimed, on the one hand, to identify trends and typical configurations and, on the other, to identify and describe particularly interesting cases.

The Architectural Side of the Entrepreneurship Education

The first observation is that all these schools implement each of the teaching situations identified. Depending on their dominant culture (school of engineering, school of commerce, etc.), and according to other contingency factors (size, composition of the labor pool), the emphasis is placed on some of these teaching situations and, beyond, focuses on the issue of the creation or on the issue of business resumption. In addition, if the trainings in entrepreneurship are always available at each stage of university studies degree, the most ambitious educational activities, also the most demanding educational resources, are mostly related to specific curricula, as MSc, MBA, or EMBA. In this context, the master program is often called as bank storage for teachings or for case study bound for degree programs and PhD. Another finding is the fact that teaching staff are not only strongly multidisciplinary but consist of a large proportion of entrepreneurs previously or concurrently to their teaching. This proportion varies from significant to exclusive (TU Munich) and goes hand in hand with a changing role of trainers, from the role of teacher, to that of tutor, and up to the role of coach. Some workshops are self-managed by students, teaching staff being there only to guide and to answer questions from students. Please also note this revolution resonates with the emergence and spread of project-based teaching models.

The Pedagogical Side of the Entrepreneurship Education

Project-based teachings, i.e., concrete scenarios, real or simulated, based on collaborative or individual learning, greatly resonate to teaching teams. Frequently, on the basis of an original business idea, a gradual approach requires students to identify the major trends of the environment, to prioritize those most likely to have an impact on the development of the idea, and, finally, to explore possible changes or variations. In addition, on many occasions, multidisciplinary approaches (► Interdisciplinarity and Innovation) and those claiming to "design thinking", combining empathy and iterative process, were mentioned. However, one important trend is to give a more and more concrete perspective to teachings, in particular through the submission of actual projects by industry that can give rise to an oral assessment with the presence of top managers, also through networking with entrepreneurs from all backgrounds, and through the access to venture capital – simulated or not – of the students projects (► Networking Entrepreneurship), which are now major areas of improvement for trainings in entrepreneurship. The corollary is that even if for some training in entrepreneurship, pedagogical considerations dominate, in a growing number of other cases, territorial considerations seem to prevail (bavarian silicon valley in Germany, silicon valley of user-driven innovation in Otaniemi, Finland, etc.), especially in the context of ► Clusters (► Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)).

Conclusion and Future Directions

"Compared to many other disciplines, the discipline of entrepreneurship is in its infancy, with no standard framework or agreed upon best practices for entrepreneurial education" (Solomon 2007). This finding should be reconsidered in the light of the foregoing. Indeed, even if the learning curve for teaching entrepreneurship is still long, it seems clear that the practices of experiential learning are now well established, as well as the "learning by studying" of the early time has been replaced by the "learning by experiencing," the "learning by interacting," or the "learning by doing." New perspectives probably depends on a "territorialization" of the teachings marking a decompartmentalization of entrepreneurship training that yesterday freeing itself from the shackles of traditional disciplines, now probably tends to emancipate itself from the shackles of (higher) education. The challenge is now to articulate this education to all stakeholders that form the ecosystem of the entrepreneur (education and research institutions, national and local policymakers, entrepreneurs, private sector, etc.). Many approaches apprehend this issue, been called for by the United Nations, such as KIC (Knowledge and Innovation Communities) from the EIT (European Institute of Innovation and Technology), or the project PEEPS (Pôle de l'Entrepreneuriat Etudiant Paris Saclay – Paris student entrepreneurship center) carried by the PIMREP network.

Cross-References

▶ Angel Investors
▶ Business Incubator
▶ Business Project
▶ Clusters
▶ Creative Pedagogy
▶ Entrepreneur
▶ Entrepreneurial Capability and Leadership
▶ Higher Education and Innovation
▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
▶ Interdisciplinarity and Innovation
▶ Networking Entrepreneurship

References

Adcroft A, Willis R, Dhaliwal S. Missing the point? Management education and entrepreneurship. Manag Decis. 2004;42(3):521–30.

Chaharbaghi K, Willis R. Beyond entrepreneurship: new market values. In: Proceedings high-technology small firms conference, Vol. 1, University of Twente, 4–5 June 1998.

Fiet JO. The pedagogical side of entrepreneurship theory. J Bus Ventur. 2000;16:101–17.

Katz JA. The chronology and intellectual Trajectory of American Entrepreneuriat Education. J Bus Ventur. 2003;18(2):283–300.

PIMREP. Former à l'innovation à ParisTech – Benchmark international, Livre Blanc ParisTech Tome 2. 2011. p. 131.

PIMREP. Former à l'innovation à ParisTech – Effervescence & perspective, Livre Blanc ParisTech Tome 1, Décembre. 2010. p. 80.

Santi M. Peut-on enseigner l'entrepreneuriat?. In 8ème Biennale de l'éducation et de la formation, 11 au 14 avril 2006.

Solomon GT. An examination of entrepreneurship education in the United States. J Small Bus Enterp Dev. 2007;14(2):168–182.

Solomon GT, Duffy S, Tarabishy A. The state of entrepreneuriat education in the United States: a national wide survey and analysis. Int J Entrep Educ. 2002;1(1):1–22.

Vesper KH. Unfinished Business (Entrepreneurship) of the 20th Century. Coleman White Paper (USASBE National Conference, Jan 1999).

Entrepreneurship Financing

▶ Creative Destruction

Entrepreneurship in Agriculture

▶ Agricultural Entrepreneurship

Entrepreneurship in Creative Economy

Philippe Béraud[1] and Franck Cormerais[2]
[1]TELECOM Bretagne & CIAPHS, Université de Rennes 2, Campus de Rennes, Cesson Sévigné, France
[2]Université of Bordeaux 3 & MICA, Bordeaux, France

Synonyms

Agglomeration effect; Augmented cities; Collaborative economy; Creative entrepreneurship; Creativity spillovers; Cultural cities; Cultural entrepreneurship; Cultural policy; External benefits; Innovative entrepreneurship; Intelligent cities; Localized industries; Situated creativity; Social innovation; Territorial design; User innovators

Creativity, Entrepreneurship and the Creative Economy

Entrepreneurship is essentially a creative activity, even if creativity is not limited to the entrepreneurial creativity. Thus, creative economy shares some of the most significant properties of an entrepreneurial economy. Creative activities rely on innovations, vision, and talent of authors, creators, and performers. Development opportunities related to changes in cultural practices also require a high degree of alertness from creative economy stakeholders. Besides, creative economy must cope with high demand uncertainty. As entrepreneurial creativity, artistic and cultural creativity is an activity based on risk. Creative economy combines two types of entrepreneurs. A first type relies on the shifts that occurred in the cultural policies of cities and in the proximity dynamics of creative clusters. And the second type is linked to the economy of contribution and to its different application fields, especially digital economy and social economy.

What Is the Specific Nature of Entrepreneurship in the Creative Economy?

Creative Entrepreneurship

When people put in practice their creativity, ideas, and talent to build up a business or a self-employed business in the cultural and creative industries, they act as creative entrepreneurs. Creative entrepreneurs use their talent, creativity, and artistic knowledge as specialized assets in the creative economy (Howkins 2001). Like kirznerian entrepreneurs, they often have no productive or financial assets at first. They try to put in value their social capital and their artistic or creative ideas as a symbolic capital.

Besides, creative entrepreneurs must cope with the uncertainty of the demand for cultural and creative goods. From this standpoint, they look like a type of knightian entrepreneurs. They also run the risk to be imitated. The only way to protect their cultural and creative assets is to rely on property rights, if they can meet the cost and complexity of the intellectual property protection.

Part of entrepreneurs come from creative economy stakeholders, especially the "creative class" (Florida 2002) that grows with the development of "cognitive-cultural production systems" (Scott 2008). Another part consists of creative entrepreneurs-contributors coming from the digital economy, social networks, and social economy.

Creative Entrepreneurship in Creative Cities

Entrepreneurship in the creative economy is not only a process by which people use their cultural and creative talents to set up their own business. If the determining role of creativity and innovation appears in the definition of the creative entrepreneurs, it also introduces analysis on the functions of creative entrepreneurship in societal and cultural mediation. To be creative, an idea must be socially recognized. Creative entrepreneurs dispense a lot of efforts and ideas for the cultural and creative life of the city. And creative entrepreneurship is at the heart of the cultural metropolitan projects, as it has been shown in capital projects, such as New York, London, Paris, and Berlin, but also in the cultural projects of metropolitan-regional cities, such San Francisco, Los Angeles, Liverpool, Bilbao, Barcelona, Milan, etc.

Besides, process of artistic research and creation also benefits from the results of the prospective policy regarding the city and regional development, which is at the root of long-term planning strategies (Pratt 2004). Those strategies can stimulate the development of creative and cultural industries, in the broader perspective of a territorial design related to the cultural needs of cities

Thus, entrepreneurship depends on both the creative activities and territorial dynamics, not only because there are new talents, entrepreneurs, creative assets, and relevant public policies, but also because the city asserts itself through implementation of cultural and artistic projects, as a creative city. Therefore, it becomes a creativity platform, going beyond the definition of an *augmented city* born out of digital technology. The spatial concentration of creative industries carries with it important changes in terms of impact on clusters and entrepreneurship. It becomes a source of comparative advantages for the city.

Creative Entrepreneurs and Cultural Mediation

From this standpoint, creative entrepreneurs are also societal entrepreneurs. Thus, it seems possible to connect the nature of creative entrepreneurship with functional theories of the entrepreneur, in particular those of Leibenstein and Baumol, which partly follow the theoretical prospect opened by Schumpeter.

In Leibenstein's interpretation, the entrepreneur's behavior is guided by four principal objectives. Initially, the entrepreneur is an *intermarket operator*. Creative entrepreneurs often connect different cultural and creative activities to enlarge the wide range of their business or to improve their self-employment, such as in performing arts. They also show their ability to compensate for the cultural and creative market insufficiencies (*gap-filling*), such as in open-source software. Then, creative entrepreneurs act as *input-completers*. They try to join together the factors which become necessary to the realization of new cultural and creative activities or performances, such as in film and music. Lastly, they know how to create or develop *efficient organizations*, such as they do in the framework of cultural clusters or creative cities.

So, the influence of the entrepreneurship as a functional mediation in the cultural projects depends on the more or less ability of the creative entrepreneur to fulfill the functions of intermarket operator, gap-filling, input-completion, and efficient organization building. In addition, as Baumol has underlined, the repartition of entrepreneurial resources depends on the profit distribution between productive and unproductive activities, and this allocation is heavily influenced by the relative payoffs offered by the societies to such activities. From this standpoint, urban cultural policies offer heavy incentives to the artists, creators, and performers to retain the talented entrepreneurs.

Entrepreneurship and the Taxonomies of Creative Industries

Studies and reports on creative economy often put the stress on the numerous distinctions and taxonomies that endeavor to chisel out the limits and the respective scopes of cultural and creative industries (Table 1). But, in the major role played by creative entrepreneurship, there would indeed seem to be a characteristic common to both. By their very nature, these activities, from performing arts to fine art, digital arts, architecture, and design, assert themselves as entrepreneurship ecosystems. The dynamics of creation, specific to cultural and creative industries, demand that ideas, talents, competence, and expertise circulate and contribute to fluidifying and amplifying creativity and innovation, as complementary assets (Potts 2011). They also combine different kinds of exchange that can be market and nonmarket exchanges, as well as different kinds of relations, ranging from cooperation to competition.

Entrepreneurship and the Specific Economic Characteristics of Creative Industries

The cultural and creative industries refer to a wide range of activities which are concerned with the valorization of artistic ideas, innovative knowledge, creative process, and intellectual property rights. From an economic standpoint, Richard E. Caves identified seven properties that could highlight the specificities of cultural and creative industries and distinguish them from other economic and social activities (Caves 2000). Such properties need to be emphasized from entrepreneurship point of view:

- Creative entrepreneurs are risk takers, facing with the radical uncertainty about the demand, because of the unpredictable positive or negative reaction of the consumers/users for each new creative product.
- They also act as input-completers, coping with a wide variety of differentiated activities; each of them can lead to an infinite variety of products and uses. And they deal with the complexity of the creative products that use a wide range of skilled and specialized workforce, as in music, film, or multimedia.

Entrepreneurship in Creative Economy, Table 1 Classification systems for creative industries derived from different models

1. UK DCMS model	2. Symbolic texts model	3. Concentric circles model	4. WIPO copyright model
Advertising	*Core cultural industries*	*Core creative arts*	*Core copyright industries*
Architecture	Advertising	Literature	Advertising
Art and antiques market	Film	Music	Collecting societies Film and video
	Internet	Performing arts	
Crafts	Music	Visual arts	Music
Design	Publishing		Performing arts
Fashion	Television and radio video and computer games	*Other core cultural industries*	Publishing
Film and video		Film	Software
Music		Museums and libraries	Television and radio Visual and graphic art
Performing arts			
Publishing software			
Television and radio video and computer games	*Peripheral cultural industries*	*Wider cultural industries*	*Interdependent copyright industries*
	Creative arts	Heritage services	Blank recording material
	Borderline cultural industries	Publishing	Consumer electronics
		Sound recording	Musical instruments
	Consumer electronics	Television and radio video and computer games	Paper
	Fashion		Photocopiers
	Software		Photographic equipment
	Sport		
		Related industries	*Partial copyright industries*
		Advertising	Architecture
		Architecture	Clothing, footwear
		Design	Design
		Fashion	Fashion
			Household goods
			Toys

Source: UNCTAD, *Creative Economy, Report 2008*, p. 13

- Creative entrepreneurs have to develop efficient organizations. On one side, creative projects in music, film, and performing arts often require a high degree of coordination for the relevant uses of skills, and time becomes a very scarce resource. On the other side, creative products must be protected, by relying on copyright protection for providing durable rents to authors, creators, performers, and other stakeholders.
- They must also deal with skill structure and behavior at work. Artistic or technical skills are vertically differentiated in the creative industries; there is a ranking of talents that results in strong financial implications on the individual earnings and on the costs of production. Besides, workers in creative industries much care about individual skills (artistic or technical skills), than in other activities, and they want to freely use their skills.

Creative entrepreneurs have to deal with another complex economic characteristic. Creative goods have a specific cost structure, with high costs of production and low marginal costs of reproduction (Hesmondhalgh 2007). Contents activities' organization must cope with the sunkenness of costs. And the pervasiveness of the fixed and sunk costs in some capital-intensive activities can appear as a barrier to entry and to mobility and a barrier to exit for the entrepreneurs in the creative industries, because of the uncertain profitability.

The Spatial Dynamics of Creative Industries

Description

Creative industries can be characterized as *territorialized industries*, as activities the territorial anchoring of which constitutes a structural characteristic, with a strong influence on the conditions of valorization of cultural goods, on the location of creative economy stakeholders and so, on the development of creative entrepreneurship. The mobility of cultural and creative goods often comes with the territorial concentration of production. The spatial dynamics of creative industries tends to favor the organization of development poles, in creative clusters or in creative cities, with their clearly defined specificities (Cooke and Lazzeretti 2007).

So, the development of cultural and creative industries is based on the exploitation of a built-up territorial advantage, the result of the joint influence of creativity and innovation among creative economy stakeholders, entrepreneurial visions, proximity dynamics, cultural practices, and public policies. Entrepreneurs try to transform localized creative assets in specialized resources. These localized assets can be constituted via expertise linked to a recognized artistic and cultural specialization. They can also be related to public policies favorable to cultural industries and opened to the requirements of the artists, creators, and performers. And they allow creative entrepreneurs to increase their *pool of knowledge* by exchanging ideas, competence, and techniques. The valorization of these specialized assets – available locally under very favorable conditions – constitutes strong incentives for entrepreneurship in the creative economy.

How Do Creative Entrepreneurs Contribute?

Creative Entrepreneurship and the Economy of Contribution

The economy of contribution has introduced a paradigm shift in the approach of entrepreneurship in the creative economy. The schumpeterian entrepreneur, both producer and innovator, now copes with the major influence of "users-contributors" and the open and collaborative innovation. The market economy highlights the producer's role, from the perspective of profit maximization, and the consumer's role from the perspective of utility function. The economy of contribution gives an alternative choice with the contributor's role that mixes entrepreneurship, freely chosen participation in the creative and cultural activities, interest for nonprofit organizations, and the creation of societal value. The contributor's intervention within the activity depends on an individual arbitrage that reflects a desire for personal involvement. It also depends on the trust he or she may have for the other participants, on the level of interaction triggered by the participation in a certain activity, on the satisfaction felt from relationships with the others, and from the activity in itself.

How do relations between the economy of contribution, entrepreneurship, and cultural and creative industries function? The economy of contribution makes it possible in particular to identify the sectoral trajectories of the digital economy and the third-party sector. Thus, digital art, open sources, electronic games, multimedia applications, or innovations linked to Web 2.0 platforms came about thanks to creative entrepreneurs-contributors in the digital economy. Likewise, the organization of an important number of artistic and cultural activities is handled in the context of the third sector in relation with social entrepreneurs and nonprofit organizations.

Digital Economy, Social Economy, and Entrepreneurs-Contributors

With regard to the first sectoral dynamics, the development of information processing and transmission has favored the emergence of a large group of applications and services, the users' appropriation of which has become a massive phenomenon. Usage and communities highlight the preeminence of new behaviors, especially that of entrepreneurs-contributors who devote themselves to sharing and appropriating knowledge, who offer their expertise or seek to acquire it. So, the economy of contribution here refers to a group of specific entrepreneurial practices that concern the freely involved contributors' participations in the activity. Entrepreneurs-contributors accept to cooperate and to share their knowledge. This phenomenon has a deep influence on the way creative and contributive entrepreneurship diffuses through various creative and cultural activities.

The second trajectory of the economy of contribution, which influences the diffusion of entrepreneurship in the creative industries, refers to the social economy. The third sector is by nature a contributive model, in which social entrepreneurs serve a role of entrepreneurs-contributors. Strong interactions between actors create considerable external effects in the cultural and creative activities of the social economy: network spillovers, skills enhancement, and societal spillovers.

The economy of creative contribution is thus set up with a principal factor – the contributors' competence, which is itself influenced by the structuring of other factors that refer to variable combinations between individual trajectories and social determinations: education, training, experience, availability, mobilization, altruism, or leadership. The interactions between creative entrepreneurs-contributors are based on relational technologies and social relationships. They also relied on availability and alertness of the communities associated with creative and cultural practices.

Creative Entrepreneurs and Public Policies

The development of creative economy stakeholders and networks of entrepreneurs-contributors is not only the result of a combination of creativity, innovations, and private investments. Agglomeration effects in creative economy also largely benefit from public policy (Throsby 2010). The participation of the creative activities in local development, in employment growth, in the qualification of the workforce, and in the development of an expertise in careers linked to the fields of creation and culture all go to constitute the counterparts of a territorial anchoring supported by private investment and public policies (Table 2). By assuring stability and growth in creative and cultural activities, public policy contributes to support the development of new entrepreneurial models to ensure creativity as a pervasive asset in local economy.

Entrepreneurship and Externalities in Creative Industries

Territorial integration in clusters or cities of creative process and the development of creative entrepreneurship through the creative economy stakeholders or the economy of contribution are supported by external economies linked to the dynamics of cultural and creative activities (Bathehlt et al. 2004). The most general typology of externalities shows various situations in which the action of an economic agent has a positive effect on another agent without one or the other wanting to lead this action for such a purpose. Regarding creative and cultural industries, externalities can concern purely artistic activities (fine arts, performing arts, etc.) as well as activities linked to digital products (software, games, digital applications).

Creative industries are based on the dynamics of proximity to guarantee the accumulation and the sharing of specialized knowledge in the creation process, thus generating *knowledge spillovers*. These spillovers happen when creative entrepreneurs benefit from new ideas, discoveries, and artistic innovation from other cultural actors. The transmission of creation process and artistic innovation turns out to be all the faster and more pervasive as the spatial concentration of actors working in the same activity or in complementary activities contributes to the multiplication of *network spillover* effects.

Likewise, *training spillovers* are the result of a collective process of skill enhancement, which take the form of specialized segments of the labor market, of a training and research system, and of a mix of private investment and public policies. This collective process seems to be profitable for all the actors linked to a profession or a group of professions, thanks to mobility inside the same creative industry, but also from one creative industry to another. As for the *artistic spillovers*, they constitute a very important element of the creation process in cultural industries. They contribute to improve the standard level in each creative industry, having thus an indirect influence in the professional practice of the other participants in the profession.

Entrepreneurship in Creative Economy, Table 2 Creative industries policy options

Policy level	Objective	Option
Micro	Analysis and mapping of the economic and social impact of the creative industries	Situational analysis of value-chain cycles, review of the (non) existing policies and the ecology peculiar to each industry
	Supporting creative SMEs	Creative SMEs development initiatives: financial and fiscal support, business skills training, tools for start-up businesses and market strategies
Meso	Comparative analysis of the relationship between the creative and the relative industries	Establish creative clusters and creative-industry infrastructures to motivate best practices, sharing of knowledge and absorb the informal sector
		Organize networking and sectoral associations: facilitate partnerships, joint-ventures involving different stakeholders including NGOs and academia
		Expand the use of ICTs and promote the use of other new technologies to benefit from new business models in all stages of the creative chain
		Identify crucial interfaces and intermediaries among all constituents
Macro	Establishment of an informed, evidence-based policy-making system	Set up a monitoring system and collect necessary information to identify the most appropriate models
		Distinguish the gap between national statistics and real market activities for a assessment tools
	Cross-departmental institutional mechanisms	Set up a multidisciplinary center or an interministerial task force to facilitate coordination among different departments, such as culture, trade, finance, tourism, labor, technology, education, and migration
	Socioeconomic development	Identify the uniqueness, strengths and weaknesses of local creative industries and opportunities for international trade
		Examine the limitations of existing copyright schemes and other intellectual property rights and implement an appropriate competition law
		Promote cultural diversity and social inclusion policies, particularly tailored for the youth and women
	Creation of national identities	Apply creative industries "branding" as a national strategy to promote image
Meta	Analysis of the long-term impact of creative industries	Analyze the changes in aesthetics, lifestyle, and commodification over a long period and their impact on national strategies

Source: UNCTAD, *Creative Economy, Report 2010*, p. 262

By valorizing interdependence relations inside the same creative industry and between different but hinged creative industries and by reinforcing fluidity and the pervasiveness of the circulation of ideas, of skills, of talents, and of cultural goods, dynamics of proximity in entrepreneurial clusters or in cultural-oriented cities serve to multiplying spillovers. Thus, externalities are at the roots of entrepreneurship ecosystems in the creative and cultural industries.

Conclusion and Future Directions

The entrepreneurship ecosystems, the dynamism and reactivity of cultural networks, the creativity of actors, and the capabilities related to the economy of contribution obviously constitute dominating factors in creation transmission. Private initiative is at the roots of entrepreneurship in the creative economy. But the valorization of localized creative assets also highlights the increasing role of public policy and the ability of the latter to promote new cultural projects and to extend positive externalities. It is likely that entrepreneurship, public investment, and proximity dynamics in the framework of the cultural clusters and cities projects will continue to converge to be the driving forces of the creative economy.

Cross-References

- ▶ Clusters
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Nature of Creativity
- ▶ Proximity Relationships and Entrepreneurship
- ▶ Risk
- ▶ Risk, Uncertainty, and Business Creation
- ▶ Social Entrepreneurship
- ▶ Territory and Entrepreneurship

References

Bathehlt H, Malmberg A, Maskell P. Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. Prog Hum Geogr. 2004;28(1):31–56.

Caves R. Creative industries: contract between art and commerce. Cambridge, MA: Harvard University Press; 2000.

Cooke P, Lazzeretti L. Creative cities, cultural clusters and local economic development. Cheltenham: Edward Edgar; 2007.

Florida R. The rise of the creative class. New York: Basic Books; 2002.

Hesmondhalgh D. The cultural industries. London: Sage; 2007.

Howkins J. The creative economy. How people made money from ideas. London: Penguin; 2001.

Potts J. Creative industries and economic evolution. Cheltenham: Edward Elgar; 2011.

Pratt A. The cultural economy. A call for spatialized ‘production of culture’ perspectives. Int J Cult Stud. 2004;7(1):117–28.

Scott AJ. Resurgent metropolis: economy, society and urbanization in an interconnected world. Int J Urban Reg Res. 2008;32(3):548–64.

Throsby D. The economics of cultural policy. Cambridge: Cambridge University Press; 2010.

Entrepreneurship in Developing Countries

Samia Haddad[1] and Imen Selmi[2]
[1]Institute of High Commercial Studies of Tunis (IHEC), Tunis, Tunisia
[2]National Engineering School of Gabes (ENIG), Gabès, Tunisia

Synonyms

Entrepreneur; New business firm, creation

Introduction

The topic of entrepreneurship has been receiving much attention for decades in most developed countries, while investigations on this subject are scarce in developing countries. Indeed, until the late 1980s, entrepreneurship in developing countries has not interested researchers. However private sector as a development engine was born following economic liberalization required by international financial institutions to developing countries. For these financial institutions, notably the World Bank, private enterprise has been, for a long time, the missing link to socioeconomic development of these countries. Thus, the liberalization effected through structural adjustment programs of the early 1990s has seen the development of initiatives to promote the entrepreneurship in developing countries.

This entry tries to explore the fundamentals of entrepreneurship in developing countries and analyze the relationships among entrepreneurship, economic growth, and public policy in these countries.

The Entrepreneurship: An Overview of Concept

The entrepreneurship, despite the initial flurry of activity following Schumpeter’s contributions, was largely concerned over this period not with understanding the economic performance of countries but with understanding the process of entrepreneurship (Naudé 2010a). In fact, the author shows that entrepreneurship is the resource and process whereby individuals utilize opportunities in the market through the creation of new business firms. As a resource, entrepreneurship results in innovation, risk-taking, and arbitrage – the classic functions of the entrepreneur as identified by Joseph Schumpeter, Israel Kirzner, and others. Entrepreneurship is studied as the various activities undertaken by entrepreneurs throughout the life cycle of a firm, from conception to exit (Naudé 2010a).

Today, the bulk of the entrepreneurship literature is concerned with the individual choice to become an entrepreneur, the determinants hereof and personal characteristics, and the growth, success, failure, and exit of entrepreneurs from the market. As cited by Autio (2008, p. 2), Audretsch et al. (2007, pp. 1–2), stated "this literature has typically not considered the implications for the broader economic context. It so results a very little know about whether and how entrepreneurship either contributes or does not contribute to economic growth in developing countries".

Nowadays, many authors (see Baliamoune-Lutz 2009; Acs et al. 2008) have taken for granted that entrepreneurship is indispensable for economic development. In fact, they provided a number of references to substantiate this claim and wrote that the entrepreneurship clearly refers to the capacity for innovation, investment, and activist expansion in new markets, products, and techniques. For its part, Baliamoune-Lutz (2009, p. 3) notes that *entrepreneurship affects development through the process of innovation, investment, and market expansion*. In the same vein, Acs et al. (2008), p. 219 show that *entrepreneurship is considered to be an important mechanism for economic development through employment, innovation and welfare effects.*

Moreover, Acs and Szerb (2007), p. 112 recognize that *entrepreneurship can contribute to economic growth by serving as a mechanism that permeates the knowledge filter and provides the missing link to economic growth. It is a virtual consensus that entrepreneurship revolves around the recognition of opportunities along with the cognitive decision to commercialize those opportunities by starting a new firm* (Acs and Szerb 2007, p. 112). As well, the authors point out that entrepreneurship policy is different from traditional business policy that tried to constrain the corporation. In this regard, the authors expose the emerging of a new policy approach that focuses on enabling the creation and commercialization of knowledge. According to them, *the policy differs from small business policy that tried to confront the cost disadvantage of small firm due to scale economies. In contrast, entrepreneurship policy has a much broader focus* (Acs and Szerb 2007, p. 112).

A number of recent studies have focused on the role of institutional and policy reform on entrepreneurship (see, e.g., Djankov et al. 2008; Baliamoune-Lutz 2009). Institutional reform that affects taxes or liquidity constraints, for example, would have an impact on entrepreneurial activity (Djankov et al. 2008). Thus, *one channel through which institutional and policy reforms would affect growth could be through their interplay with entrepreneurial activities* (Baliamoune-Lutz 2009, p. 1). Iyigun and Rodrik (2005) assume that the impact of institutional reform depends on the level of entrepreneurial activity. More specifically, the authors show that institutional reform has negative growth effects when entrepreneurial activity is strong and positive effects when entrepreneurial activity is weak. This is because reforms could impose a cost on the existing entrepreneurs, while it may be neutral or even helpful to new ventures.

The Entrepreneurship in Developing Countries: Realities and Constraints

Entrepreneurial studies, especially neoliberal theories, are derived primarily from the general growth and economic and historical experiences of industrialization in developed countries. However, these theories are not necessarily transferable to developing countries, even in the context of globalization. Thus, entrepreneurship in developing countries is becoming increasingly a subject on which policies linger and to which they are paying attention. Desai (2009) exposes that much of the research on entrepreneurship in developing countries indirectly or directly categorizes activities. She states that several dichotomies commonly used to describe entrepreneurship in developing countries are worth discussing: formal/informal, legal/illegal, and necessity/opportunity (Desai 2009, p. 2). In fact, the author explains that in many developing countries, *there are few incentives for entrepreneurs to participate in the formal sector, particularly if they operate on a small scale* (p. 2). Immediately, the vast majority of entrepreneurs in developing countries are involved in micro- and small enterprises (MSE), often informal, contributing little to poverty alleviation and growth. Moreover, only a few new start-up firms survive for a long time; the majority fails within the first 2 years (Naudé 2010a). John Bennett's paper *Informal Firms in Developing Countries: Entrepreneurial Stepping Stone or Consolation Prize?* shows that the so-called informal sector is significant in most developing countries, noting that it may contribute up to 40% of a poor country's GDP. *As a result, the size of the informal labour force is important; it can reach more than 50% in some countries* (*cited by* Desai 2009, p. 2). Actually, *with developing countries, the choice of entrepreneurship and the returns on entrepreneurship have quite often been seen as dismal, with entrepreneurship (or self-employment) considered as being driven by necessity (for survival) and offering meagre returns* (Naudé 2010a, p. 8). In this view, the author exposes that often large informal sectors in developing countries are seen as symptomatic of this no-choice entrepreneurship and are seen as undesirable. Some even see the informal sector as a drag on economic development, lowering overall productivity, and competing with the formal sector (Naudé 2010a).

For its part, Desai (2009) demonstrates that the nature of informal entrepreneurship in developing countries generates illegal activities. She shows that "illegal" applies to the nature of the selected activity and depends on the explicit legal code and regulatory frameworks in the country. Nevertheless, legal entrepreneurship applies to activities that are permitted by law. Also, the author exposes that the dynamics of necessity/opportunity entrepreneurship are closely connected to formal/informal status. One reason for high rates of necessity entrepreneurship in developing countries is the size of the informal sector. Workers that become entrepreneurs to avoid unemployment will likely be starting low-skill, small-scale, subsistence activities (Desai 2009).

Many authors imply strong causality from entrepreneurship to economic growth in developing countries. In fact, some economists, such as Baumol, Lazonick, and Naudé, even report a negative relationship between entrepreneurial activity and economic growth in developing countries. According to Naudé (2010b, p. 5), *entrepreneurs in developing countries are neither irrelevant nor impotent*. The author claims that the relationship between entrepreneurs and development outcomes is complex, with entrepreneurship as much depending on economic development and growth and vice versa. So, *designing policies for development through the promotion of entrepreneurship in developing countries is complicated* (Naudé 2010b, p. 5). In this case, Baumol (1990, *cited by* Naudé 2010b) posits that governments cannot raise the supply or quantity of entrepreneurship but can merely influence the allocation of entrepreneurial ability. In this view, the author mentions that what the government should do is "get the institution's right," i.e., ensure the protection of property rights and a well-functioning legal system, and maintain macroeconomic and political stability and competitive tax rates (Naudé 2010b). In addition, Naudé (2010b) proves that general policies to facilitate the entry of entrepreneurs may disproportionately encourage entrepreneurs with low "entrepreneurial ability," leading banks to reduce their overall extension of credit. The apparent irrelevance and impotence of entrepreneurship is the danger that well-intentioned support policies for entrepreneurship may have unintended negative consequences. These include patronage, corruption and rent-seeking, and prolonging the life of inefficient and low-productivity firms (Naudé 2010b). Moreover, Schott and Jensen (2008), p. 195 argue that developing countries are prone to apply policies that *(1) are based on experiences in developed countries which have not proven to transfer fittingly to developing* *economies, (2) are only partly implemented and are not internally consistent as a result of a lack of resources to do so, and (3) are more beneficial on paper than on actual activity*. These measurements will generate a too low dynamic industrial in developing countries caused by a lack of depth of local and regional markets. In terms of productivity, the difficulty lies in the inadequacy and lack of training of individuals or the less integration of people trained in this entrepreneurial dynamism. Also, we must not omit the importance of entrepreneurial culture with these four dimensions: sociocultural, psychological, managerial, and economic policies. The reluctance of major developing countries to entrepreneurship could be explained by their lack of risk culture and deficiency in recognizing the sector. In this situation, there is a significant gap between the support needs of project and the means used by their country. The last brake facing entrepreneurs is about financing.

Indeed, the loan system in developing countries requires guarantees of a financial nature that it is difficult to mobilize. Consequently, entrepreneurs in developing countries face less efficient financial markets, more volatile macroeconomic conditions, and higher entry costs.

Conclusion and Future Directions

In sum, policies in developing countries that place too much stress on entrepreneurship as the key to economic development can undermine collective and cumulative processes of organizational learning required for innovation (Lazonick 2008, *cited by* Naudé 2010b). As a result, economic growth in developing countries slows down; high-ability entrepreneurs, with fewer incentives to innovate, will exit (Naudé 2010b). In this context, the keys to entrepreneurial development in developing countries seem to be the involvement of support structures in the political debate allowing greater involvement of the state in this process but also including spin-offs based on public-private partnership. The mechanism of entrepreneurship through spin-off was established as an objective of dynamism in economy, especially in industrial countries. Therefore, the use of this measure involves profound changes in the institutional structure of the global political and scientific community, thus allowing to reduce the problem of loose coupling between science and entrepreneurship activity. Consequently, a stronger coupling between science institutions and industrial practice would not only likely improve the quality of entrepreneurship research in developing countries but would also facilitate an economic development growth enacted by policy makers in developing countries.

Cross-References

- ▶ Entrepreneurship
- ▶ Entrepreneurship Policy
- ▶ Financing
- ▶ Start-Up

References

Acs ZJ, Szerb L. Entrepreneurship, economic growth and public policy. Small Bus Econ. 2007;28:109–22.

Acs ZJ, Desai S, Hessels J. Entrepreneurship, economic development and institutions. Small Bus Econ. 2008;31(3):219–34.

Audretsch DB, Grilo I, Thurik AR. Handbook of research on entrepreneurship policy. Cheltenham: Edward Elgar; 2007.

Autio E. High- and low-aspiration entrepreneurship and economic growth in low-income economies. Paper presented at the UNU-WIDER workshop on entrepreneurship in economic development. Helsinki; 21–23 Aug 2008.

Baliamoune-Lutz M. Entrepreneurship and reforms in developing countries. Research Paper No 2009/04, United Nations University, World Institute for development Economics Research; 2009. 18 pp.

Baumol WJ. Entrepreneurship: Productive, Unproductive, and Destructive. Journal of Political Economy. 1990;98(5):893–921.

Desai S. Measuring entrepreneurship in developing countries. Research Paper N°2009/10. United Nations University, World Institute for development Economics Research; 2009. 14 pp.

Djankov ST, Ganser C, McLiesh RR, Shleifer A. The effect of corporate taxes on investment and entrepreneurship. NBER Working Paper 13756. Cambridge, MA: National Bureau of Economic Research; 2008.

Iyigun M, Rodrik D. On the efficacy of reforms: policy tinkering, institutional change, and entrepreneurship. In: Eicher T, Penalosa CG, editors. Institutions and growth. Cambridge, MA: MIT Press; 2005.

Lazonick W. Entrepreneurial ventures and the developmental state: lessons from the advanced economies, United Nation University-World Institute for Development Economics Research. Discussion Paper no. 2008/01. 2008.
Naudé W. Entrepreneurship, developing countries and development economics: new approaches and insights. Small Bus Econ. 2010a;34(1):1–12.
Naudé W. Promoting Entrepreneurship in developing countries: policy challenges. *Policy Brief*, 4. United Nations University, World Institute for development Economics Research; 2010b. 8 pp.
Schott T, Jensen KW. The coupling between entrepreneurship and public policy: tight in developed countries but loose in developing countries. Estudios de Economia. 2008;35(2):195–214.

Entrepreneurship in International Context

Renaud Redien-Collot, Eric Michael Laviolette and Maria Bonnafous-Boucher
Novancia Business School Paris, Paris, France

Synonyms

Globalization and entrepreneurship; International entrepreneurship

Introduction

Globalization: An International Context for Complex Venturing

The globalization of the economy is not new, but it reaches an unprecedented level with the conjunction of multiple factors such as lower tax barriers for international trade, lower cost of transport system, and lower cost of communication through the Internet. Lower production costs are accompanied by the acceleration of international trade in the second half of the twentieth century.

Globalization can be considered as an opportunity for entrepreneurs, as it widens the perspectives for both supply and demand. On the supply side, entrepreneurial creativity is infused with a range of new ideas coming from other entrepreneurs across the world. Furthermore, it offers a worldwide platform for new partners and suppliers around the world, giving entrepreneurs a wider scope for adding value to their offer. On the demand side, responding to various market needs from different countries and cultures also enhances creativity and can lead to creating new products and markets. Thus, globalization increases the scope for detecting and exploiting market opportunities from around the globe.

However, globalization can also be a threat for entrepreneurs. It shifts competition at a higher level. Local markets are open to global competitors who can easily invade these markets with competitive products at a lower cost of production. If such market entrance might offer new products at lower prices for the customer, it can also contribute to the destruction of local producers who can hardly compete despite distinctive competencies.

In sum, internationalization is part of the business environment of every company. Even a small company operating on a local market only might have to face global competition depending on the market's scope and attractiveness. In that sense, every venturing is inclined to design a more complex strategy with an international insight, whether it concerns competition, suppliers, customers, or partners. Good or bad, globalization goes in hand with the internationalization of both large and small companies.

International Entrepreneurship or When Small Goes International

At first sight, it seems that large companies are more able to internationalize due to a sufficiently large domestic market and/or expertise in the strategy of internationalization. However, it's not only a matter of size. Young and small companies can equally be efficient in such processes. International entrepreneurship is the area which focuses on the internationalization of small and young companies. In that respect, we can distinguish different approaches to internationalization – stage or systemic relating to different profiles of companies: late developers and early developers.

Late developers are small companies, which internationalize after establishing a strong position in their domestic market. Usually, they are established SMEs which develop products and markets abroad progressively. This strategy is mainly incremental, also known as a stage approach. In that perspective, small firms will progressively develop organizational capabilities for internationalization such as the skills to plan the internationalization process in advance, to organize and develop in foreign markets, and to effectively monitor markets (OECD 2008). In order to analyze the process of internationalization of late SMEs and corporation, management science scholars initially concentrated on the process and organizational culture characteristic of small firms with a limited amount of capital and relatively few clients. Studies following this trajectory focused entirely on opportunities for and obstacles to internationalization. One such study described a highly rationalized progression involving four stages (Johanson and Wiedersheim-Paul 1975; Johanson and Vahlne 1977). From that perspective, internationalization is a major objective at the outset – which presupposes that the entrepreneur behind the company should have a broad vision of where he or she wants to take the firm, an advanced capacity to learn, a receptivity to new concepts and ideas, a high degree of diplomatic skills for the management of complex networks, and, since the time required to penetrate markets varies considerably, an ability to adapt to different cultural contexts. More recent studies have drawn attention to the fact that, for start-up companies, the process of internationalization does not follow such formalized schemas (Karlsen et al. 2003; Autio et al. 2000). If a stage approach seems particularly suited for small business internationalization, various scholars cited cases of born-global firms and small businesses experiencing rapid growth at the global level. Such counterintuitive cases have given rise to a new perspective in which SMEs are "born global" or "early developers." Such young and small companies, qualified as early developers, go international during the first years of their establishment. Such precocity is a new perspective on international entrepreneurship, and it is known as "Born Global strategies" (McDougall 1989; Oviatt and McDougall 1994, 2005; McDougall and Oviatt 1997). This approach provides an iterative and learning perspective on internationalization by focusing on the proactive role of the entrepreneur in a dynamic process of unique resource and competence building to conquer market opportunities abroad. This process is largely enabled by networks that constitute the most important source of change and opportunity (Ucbasaran et al. 2001) – especially weak-tie networks that challenge routines and established beliefs and stimulate creativity and innovation (Julien et al. 2004). Moen and Servais (2002) conclude that born-global firms reveal an important change in export behavior. In order to establish precocious export strategies, they identify and acquire competencies within their close and distant networks. In the same vein, Knight and Cavusgil (2004) demonstrate that born-global firms have a more sophisticated knowledge base than the late developers. They emphasize that born-global firms have a strong marketing orientation that is sustained by solid technological capabilities in their respective product and firm categories. Sharp data mining about markets, customers, and competitors guide their international operations. The born-global firms' networks help to update these precious data and, ultimately, support their marketing strategy (Rassmussen et al. 2001).

Whether entrepreneurs are early or late developers, globalization is revealing new entrepreneurial mindsets to think about the global and local strategies when small businesses go on international markets.

Global Mindset for Local Entrepreneurs

Large companies with established business models but sometimes declining ones usually strategize globally and operate locally. Strategic thinking is made at a global level before it is applied to operations at local levels. Such strategizing is relevant for large companies. Small companies with experimental business models strategize at a local level, but they can aim at global operation (outsourcing, partnership, etc.). For entrepreneurs, it has become apparent that decisions concerning internationalization and the successes and failures deriving from them depend less on specifically organizational characteristics (size, capital, resources) or on environmental factors and the context of domestic and international regulations in favor of internationalization and more on the profile, training, and international experience of the entrepreneur (Lloyd-Reason 2004). The character traits, experience, and motivation of the owner-manager determine the long-term success of start-up companies in terms of internationalization. Lloyd-Reason and Mughan (2002), and Manolova et al. (2002) highlight the degree to which the owner-manager must have mastered his or her skills before implementing monitoring and planning procedures prior to moving into international markets. The stance taken by Lu and Beamish (2001) is more radical: the internationalization process must emerge either when the company is founded or in its initial phases of development. Consequently, all training in the field of entrepreneurship (incubators, continuing education, initial training programs) should encourage the emergence of those skills and, equally, foster a desire on the part of students to seek out experiences or develop projects enabling them to develop such skills and identify the resources required for elaborating successful internationalization strategies.

Conclusion and Future Directions

Surprisingly, literature on entrepreneurship education and entrepreneurial support system does not yet focus on international entrepreneurship. Apparently, the paradigm of the born-global start-ups stresses business owners' genuine skills and the firms' spontaneous capabilities. Therefore, there is no comprehensive research concerning the different learning processes in the context of the internationalization of SMEs. Similarly, there is no mention of specific coaching and mentoring practice for entrepreneurs who are developing strategies of internationalization. Literature should explore the different issues concerning international entrepreneurship education and counseling in order to stimulate more experimentation within incubators and networks of entrepreneurs. From a social constructionist perspective, international entrepreneurship can thus be defined as "the creative enactment and envisioning of future scenarios and opportunities for service/product/organizational transformation that are socially constructed and realized through cross-border co-ordinations" (Fletcher 2004, p. 295). Such cross-border organizing takes place through the entrepreneurs' personal networks, but it can also be catalyzed through local business assistance organizations such as incubators and innovation centers (Bonnafous-boucher and Laviolette 2009).

Cross-References

▶ Accompaniment of Business Creation
▶ Business Climate and Entrepreneurship
▶ Creativity, Intelligence, and Culture
▶ Diversity and Entrepreneurship
▶ Entrepreneurial Opportunities
▶ Entrepreneurship and Business Growth
▶ National Culture
▶ Network and Entrepreneurship

References

Autio E, Sapienza H, Almeida J. Effects of age at entry, knowledge intensity, and imitability on international growth. Acad Manage J. 2000;43(5):900–24.

Bonnafous-Boucher M, Laviolette EM. Catalyzing international entrepreneurship. Int J Entrepr Innov. 2009;10(3):165–9.

Fletcher D. International entrepreneurship and the small business. Entrepr Reg Dev. 2004;16:289–305.

Johanson J, Vahlne J-E. The internationalisation process of the firm: a model of knowledge development and increasing foreign commitments. J Int Bus Stud. 1977;8(1):23–32.

Johanson J, Wiedersheim-Paul F. The internationalisation of the firm. J Manag Stud. 1975;12(3):305–23.

Julien P-A, Joyal A, Deshaies L, Ramangalahy C. A typology of strategic behavior among small and medium-sized exporting businesses: a case study. Int Small Bus J. 1997;15(2):31–48.

Julien P-A, Joyal A, Deshaies L, Ramangalahy C. Networks, weak signals and technological innovations among SMEs in the land-based transportation equipment sector. Entrepr Reg Dev. 2004;16(4):281–300.

Karlsen T, Silseth P, Benito G, Welch L. Knowledge, internationalization of the firm, and inward-outward connections. Ind Mark Manag. 2003;32(5):385–96.

Knight G, Cavusgil ST. Innovation, organisational capabilities, and the born-global firm. J Int Bus Stud. 2004;35:124–41.

Lloyd-Reason L. Globalization and entrepreneurship: policy and strategic perspectives. J Small Buss Enterp. 2004;11(2):266–77.

Lloyd-Reason L, Mughan T. Strategies for internationalisation within SMEs: the key role of the owner-manager. J Small Bus Enterp Dev. 2002;9(2):120–9.
Lu J, Beamish P. The internationalization and performance of SMEs. Strateg Manag J. 2001;16:101–18.
Manolova T, Brush C, Edelman L, Greene P. Internationalisation of small firms: personal factors revisited. Int Small Bus J. 2002;20(1):9–31.
McDougall PP. International versus domestic entrepreneurship: new venture strategic behavior and industry structure. J Bus Ventur. 1989;15(2):387–400.
McDougall PP, Oviatt BM. International entrepreneurship literature in the 1990s and directions for future research. In: Sexton DL, Smilor RW, editors. Entrepreneurship 2000. Chicago: Upstart; 1997. p. 291–320.
Moen O, Servais P. Born global or gradual global? Examining the export behaviour of small- and medium-sized enterprises. J Int Mark. 2002;10(3):49–72.
OECD. Removing barriers to SME access to international markets. Paris: OECD; 2008.
Oviatt BM, McDougall PP. Toward a theory of international new ventures. J Int Bus Stud. 1994;25(1):45–64.
Oviatt BM, McDougall PP. Defining international entrepreneurship and modelling the speed of internationalisation. Entrepr Theory Pract. 2005;29(5):537–54.
Rassmussen E, Madsen TK, Evangelista F. The founding of the born global company in Denmark and Australia. Asia Pac J Mark Logist. 2001;13(3):75–107.
Ucbasaran D, Westhead P, Wright M. The focus of entrepreneurial research: contextual and process issues. Entrepr Theory Pract. 2001;25(4):57–80.

Entrepreneurship in Open Innovation Systems

► Knowledge Capital and Small Businesses

Entrepreneurship Policies

Dimitri Uzunidis
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Entrepreneur; Innovation; Public policy; Regulation

Economic policy refers to actions that governments take in the economic field. It covers the system for setting interest rates and government budgets as well as the labor market, the size of the public sector, and many other areas of government interest in the economy. There are different types of economic policy, for example, trade policy, redistribution of income, the regulatory environment, antitrust, industrial policy, and so on. Since antiquity, governments have played an important economic role, for economic, social, and political reasons. Public policy is linked with state power. For example, the main subject for the mercantilist economists in the seventeenth to eighteenth century was how to collect a large quantity of resources from other countries and to keep them within the borders of their own countries. Some years later, Adam Smith and other classical economists would discover the secret of wealth: labor power. The creation and the development of new business has for many years been, for governments, a means of attracting new revenues by taxation. Ever since the industrial revolution, the development of innovative enterprises has been an important factor in the competitiveness of the economy. So, the objective of governments is to collect resources to strengthen their political and economic power. Different tools are available to them to achieve this objective: by strong political and economic regulation (based on public property and planning) and by the definition of framework laws (ownership, market regulation). Between these two options, we have a wide range of actions, from socialist to liberal. The Keynesian option consists of introducing rationality into market mechanisms.

So today, even in the free market economy, public authorities have an important role to play to promote industrialization, entrepreneurship, and the development of knowledge in science and technology. Governments have to build the framework to sustain economic activity and the durability of their power. Since the end of the 1970s, in a new context of deregulation and privatization, the economic role of the state has changed. The state in developed countries is less of an entrepreneur but more and more a manager of economic development. The creation of enterprises is an important economic challenge, to promote innovation, to create new jobs, and to support economic growth in different territorial areas. More generally, we observe a convergence between the behavior of the state and that of firms. Both have an entrepreneurial character. They take decisions according to a rational calculation between costs and benefits, even if public policy is a response to market failure. In this entry, we will present some generalities about contemporary economic and political context to explain how the nature of public policy has changed since the beginning of the 1980s. Thus, we will review the main characteristics of public policy (short-term and structural policy). Today, public policy is one of four elements to support economic growth by entrepreneurship. To explain this process, we have developed the concept of the organic square of entrepreneurship, which will be presented in the last part of this entry. There exists no magic formula to develop entrepreneurship and innovative enterprises. The four elements of the organic square of entrepreneurship are public policy, entrepreneurs' resource potential (see the entry on this subject), economic organization, and market situation.

Historical Context and Evolution of Public Policy in Developed Countries

After the Second World War and Keynesian Policy

After the Second World War, economic growth was supported by a strong public policy in the economies of Western countries in Europe and in the United States. According to the theory of the welfare state, the state was an important actor in economic and social life: to promote or to develop education, health, and social justice and to build infrastructures (airports, roads, harbors, and so on). Numerous enterprises in strategic activities were public (energy, steel industry, water, telecommunication, and so on). For instance, according to Galbraith (1967), Williamson (1968), and Chandler (1977), it seemed inevitable that exploitation of economies of scale by large corporations would become the main engine of innovation and technical change. In this context, J. K. Galbraith (1967) argued about a convergence between American and Soviet systems. Even if the economy of the United States was based on private property (and the Soviet economy on state-owned property), in both economies, the role of the state was very important in promoting industrial activities. We know that Galbraith spoke principally about the military-industrial complex which had an important role in both countries during the Cold War. But since the end of the Cold War and the downfall of the Soviet Union (at the beginning of the 1990s), public priorities have changed.

During the 1950–1970s, the objective of governments was not to promote the creation of new firms, but to develop big public corporations to rebuild the economy after the Second World War. The product of this policy was the development of a new salaried society. Today, in developed countries, 80–90 % of the working population is salaried. In these conditions, the spirit of initiative, according to J. A. Schumpeter or M. Weber, has disappeared. The objective of the new public polices is to rekindle this spirit of initiative which was the engine of heroic capitalism (see the section on the ▶ Heroic Entrepreneur, Theories). But this does not mean the decline of large firms, and a return to the perfect competition model (infinite numbers of buyers and sellers), but a new context to promote entrepreneurship in order to create new firms and to promote innovation and change in current enterprises.

The Crisis of the 1970s: A New Definition of Public Policy (A New Place for Market Regulation)

The economic crisis of the 1970s was also the crisis of this public policy based on Keynesian principles. Liberal policy, which was ineffective during the 1950–1970s, was promoted as the new solution for economic growth. For example, according to W. Baumol (Baumol et al. 1982) and the theory of the contestable market, a perfectly contestable market has three main features. It is a market that has (1) no entry or exit barriers, (2) no concealed costs, and (3) access to the same level of technology. The objective of Baumol is to demonstrate the superiority of the market economy over the state economy. The objective is to develop competition and mechanisms of market equilibrium: in this context, to create conditions for the perfect competition of neoclassical theory. For liberal economists, this is the guarantee of low prices and economic prosperity. The main objective is to reduce inflation. The decrease of the economic role of the state promotes entrepreneurship. For example, the privatization of public enterprises and in general the deregulation measures have created new opportunities for investment by entrepreneurs in different industrial sectors and in service activities (distribution of electricity, water, telecommunication, transport, and so on). To sustain economic growth, governments reformed the financial system: numerous public banks were privatized, and the financial markets, virtually nonexistent during the 1950–1970 period, have taken an important new place in the economy of capitalist countries.

On the other hand, in this new context of competition, the principles of the welfare state are revisited. The objective is not yet to distribute public aid but to help to find a new job or to create a business. For example, to realize this objective, new educational programs are developed to update and develop new competencies and skills. To summarize, the objective of the state is to create a framework (regulations and laws) to foster economic initiative and competition. On the other hand, the development of financial markets (as a consequence of deregulation policy) gives new opportunities to public authorities to raise revenues. But the cost of this new freedom is very high. Since the beginning of the 1990s, economic growth has been less stable, and economic crises have become numerous in developed and also in developing countries.

The Means of Action for Public Policy

Since the 1950s, developed countries have put in place a set of public instruments to drive and to push economic growth. The national accounts give a set of indicators to determine the economic situation and to intercede if needs be. To realize its objectives of economic growth and innovative development, the state has developed different principal means of action (Barro 1990). We can distinguish two types of public policy: (1) short-term policy and (2) structural policy.

The Short-Term Policy

The objective of short-term policy is to manage urgent problems, by definition for a short-term period, for example, to create businesses to create jobs and to attract foreign firms to create jobs. The results of public measures in this case must be quick (less than 1 year). Public authorities target in this case (a) firms whose costs of production are very high (e.g., heavy industries) and (b) potential businesses in low added-value sectors based on a determinate trade. The main measures of a short-term policy are the following:

1. Financial incentives: grants to create new businesses and help for investment, recruitment, subsidized loans, and so on. These different types of aids can be attributed by central government or by local authorities.
2. Fiscal incentives: reduction of taxes on investment, tax exemption for importing different types of production machinery or raw materials.
3. Indirect incentives: subsidized real estate or buildings (e.g., in the business sector), means of communication, access to public markets, and so on.

Structural Policy

Structural policy consists of a set of industrial and innovative measures whose objective is to build or to develop the scientific and technological potential of the country, by definition in a long-term perspective:

1. To promote the creation of innovative enterprises
2. To develop new technologies and knowledge and to facilitate technology transfer from scientific centers to businesses (and specially to large firms)
3. To help cooperation between scientific centers and businesses to develop new technologies and knowledge with a high scientific content at global level

4. To develop means of technological and commercial intelligence to canalize the strategies of businesses (large and small)

The results are cumulative and (by definition) of long-term nature. The objective of public authorities is to support entrepreneurial strategies to create jobs and innovation.

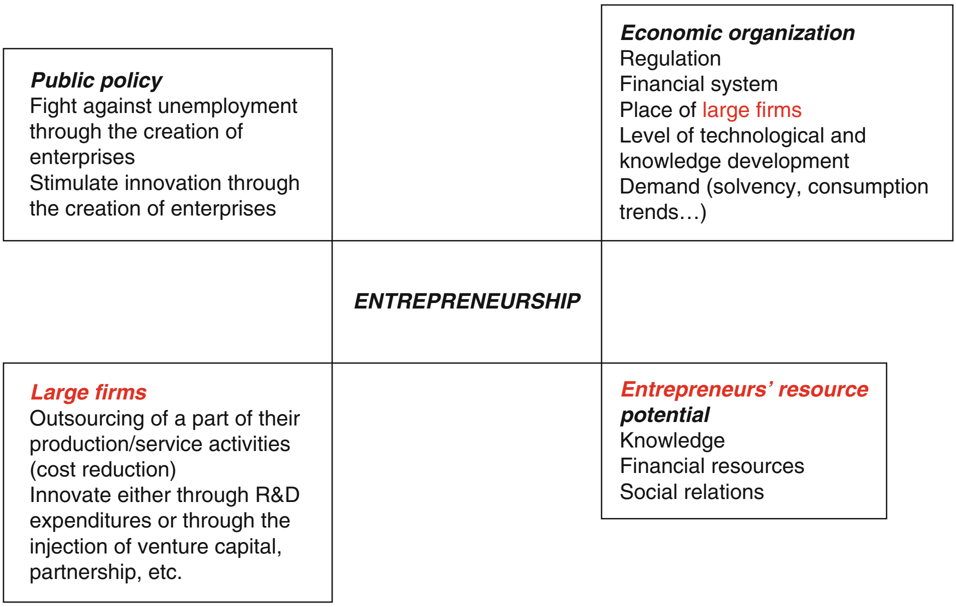
The main measures of structural policy for promoting investment are the following:

1. Massive public investments to develop means of communication and transport; education, research, financial support for innovation, health policy, and quality of life by the promotion of cultural activities
2. Introduction of means for financing research and innovative policy to develop relations between enterprises and scientific centers
3. Development of networks between firms (large and small) and scientific centers

In the event, we are confronted by two different types of strategy: the public strategy whose objective is to attract and to retain businesses, investments, and knowledge inside its borders and, on the other hand, the entrepreneurial strategy whose objective is to develop activities at the world level to capture new resources from different countries. So, in a world economy, the objective of public authorities is to capture resources to develop their scientific and technological potential. The indicators of countries' economic performance are based on national accounts (gross domestic product, balance of trade, and so on). Firms have their own strategy, and they (large groups) can declare their income in different countries where taxes may be lower. Such groups can develop a world strategy corresponding to their growth objectives. The main difficulty of public policy (but also the reason for the existence of public policy) is that the economic context (in today's terms, the capitalist society) is characterized by change. Change is created by the activity of entrepreneurs, and major change comes particularly in a context of crisis. Change also creates new investment opportunities (new needs causing an increase in demand, and so on). So, we are facing a paradox: the objective of public authorities is to promote economic change which is the main element of the economic competition between economies. But, on the other hand, public authorities intervene in the market to stabilize economic activity in period of crisis, for example. So if public policy has changed since the 1980s in an economic context marked by the liberal theory, we observe also that the state is also an important economic actor.

The Organic Square of Entrepreneurship and Public Policy

The organic square of entrepreneurship (OSE) is formed by four elements: (1) public policies, (2) entrepreneurs' resource potential, (3) economic organization, and (4) large firms. These four elements are linked by synergistic relations, but each element has the same importance. A ***public policy*** cannot by itself promote entrepreneurship and create innovative enterprises, but the role of the government is rather to create a business climate. For example, the composition of the ***resource potential of the entrepreneur*** depends not only on his own personal qualities but also on external and social factors. In particular, public support (to create jobs and to promote innovation) for the creation of new enterprises usually determines the financial resources entrepreneurs can access in order to set up or develop their business. The ***economic organization*** has several dimensions and different effects. The general level of growth in knowledge influences the knowledge gathered by entrepreneurs (through their education and that of their staff and through economic intelligence) and the technical level of their activity. A societal knowledge stock is composed of a set of knowledge stemming from activities by incumbents and start-ups, that is, knowledge refers not only to scientific discoveries but also to knowledge associated with novel ways of producing and distributing in traditional businesses, modifying business models, changing marketing strategies, and so on. In a context of economic deregulation, according to Coase (1937), ***large firms*** develop outsourcing for a part of their activities (industrial or services). For individuals, this strategy can be an opportunity to create a business.



Entrepreneurship Policies, Fig. 1 The organic square of entrepreneurship (OSE)

The characteristics of the financial system (possibilities or difficulties of being listed on the stock exchange, more or less conservative banks, and access to venture capital) have an impact on the capacity of the individual to become an entrepreneur and on the development of new businesses. Market concentration and the place of large companies also influence the dynamism of entrepreneurial activities. Finally, the overall economic situation determines the rhythm of new creation and also the types of activities conducted by such businesses (see Fig. 1).

State intervention explicitly promotes and guarantees the drawing up of coherent rules in order to organize public and private economic activity and, in our case, to facilitate innovation and business creation. Public policy directs and coordinates the different economic performers to create the organic square of entrepreneurship. State intervention can take different forms: financial assistance for activities which generate economic resources, creating devices that allow business creation, and the imposition of procedures for cooperation between public and private bodies with the objective of funding private investment projects likely to have wide-scale economic impact.

The creation of a pool of productive and financial resources (able to be appropriated at any time by companies and potential entrepreneurs) is considered to be the fundamental aspect of state intervention in innovation and entrepreneurship. Traditional scientific and technological policy has been replaced by one of research and innovation (structural policy). In order to be fruitful in terms of competitiveness, the state has to guarantee the efficiency of the procedures for transferring knowledge, technologies, and ideas between enterprises, entrepreneurs, public institutions, and other nongovernmental organizations (the "commercialization" of R&D, support for the creation of networks to boost innovation and competitiveness among firms, etc.) with regulations (protection of patent rights, antimonopoly measures, etc.), the tax system, the budget, etc., in order to favor the emergence of new innovative enterprises (short-term policy) (Laperche et al. 2008).

Conclusion and Future Directions

Historically, governments had played an important economic role in collecting resources to strengthen their power. Since the industrial revolution (and especially during the nineteenth century), public policies have become more sophisticated with the objective of changing and developing economic activity. Since the end of the Second World War, public policies have been developed to integrate a large range of activities (social, education, health, transport, energy, and economic regulation). The economic growth of the 1950–1970s was based mainly on large public companies and economies of scale. These companies and the public scientific system became the engine of economic growth. But the economic crisis of the 1970s was also the crisis of the Keynesian model. Public policies have since changed to promote entrepreneurship.

Today, it is clearly evident that economic growth is based on entrepreneurial activity. It is not an exogenous phenomenon. Entrepreneurial activity is influenced by a large range of elements: public policy (of course) but also the strategies of large companies and the economic framework (financial system, market situation, and so on). The role of the state is to canalize entrepreneurial activities which create innovation and jobs. The wealth of the state is based today on entrepreneurial dynamics and on financial markets. But this state wealth is also less stable. Since the beginning of the 1990s, economic crises have become more frequent and widespread. This instability can produce social unrest.

References

Barro RJ. Government spending in a simple model of endogenous growth. J Political Econ. 1990;98(5): 103–26.

Baumol W, Panzar J, Willig R. Contestable markets and the theory of Industrial Structure. New York: Harcourt Brace Jovanovich; 1982.

Chandler A. The invisible hand. Cambridge, MA/London: The Belknap Press; 1977.

Coase R. The nature of the firm. Economica. 1937;4: 386–405.

Galbraith JK. The new industrial state. London: Routledge; 1967.

Laperche B, Uzunidis D, von Tunzelmann N, editors. Genesis of innaovation. Systemic linkages between knowledge and market. Cheltenham: E. Elgar; 2008.

Williamson O. Economies as an antitrust defense: the welfare tradeoffs. Am Econ Rev. 1968;58:18–42.

Entrepreneurship Policy

Patrice Noailles-Siméon

RRI – Marne-la-Vallée University, Seillans Investissement, MemoPage.com, Paris, France

Synonyms

Development policy; Innovation policy

Entrepreneurship thrived in Mesopotamia, long before there was any entrepreneurship policy. This is underlined by Baumol, Landes, and Mokyr (2010). Throughout history, entrepreneurs, who are not all innovators, have had many different embodiments, from the large landowners described by Cicero, through the Cistercians and lords in the Middle Ages, to inventors such as Gutenberg and Edison and businessmen such as Ford and Eiffel.

The term *entrepreneur policy* became a "politically correct" policy topic in the 1990s. Today it is a requirement in policy topics, at the center of a society's ability to progress. Entrepreneurship policies are diverse. Based on a broad definition of *entrepreneur*, entrepreneurship policies include intrapreneurship policy, a large part of small business policy, and innovation policy, in addition to parts of development policy and even employment and immigration policies. Finally, it may touch cultural policy or even social integration policy.

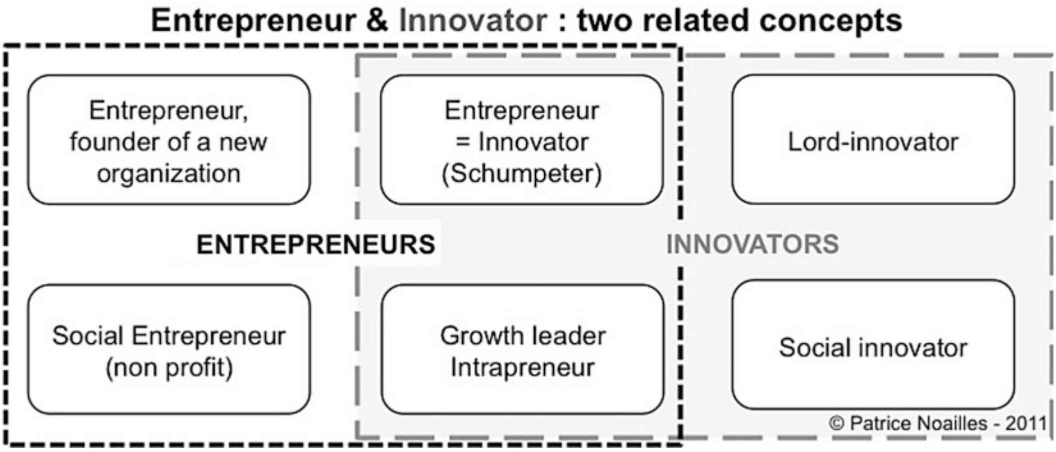
Definitions

Neither scholars nor policymakers have all the tools necessary to scientifically understand and govern entrepreneurship policies, which are still mainly pragmatic. However, it is possible to make clear some terms and debates.

Entrepreneurs

Theoretical and pragmatic approaches of entrepreneur are divided into – at least – four categories:

Entrepreneurship Policy, Table 1 Entrepreneur and innovator



1. *Entrepreneur as a "true" innovator*. This seems to be the definition of Shane and Venkataraman (2000) and was the definition of Schumpeter (1911–1982) as well as the OECD (2009).
2. *Entrepreneur as a creator of a new organization*. This included one-person companies, which can be part of an employment policy such as the "auto-entrepreneur" in France. This was the original meaning by Cantillon (1755), who required some risk in the activity of the entrepreneur.
3. *Entrepreneur as an intrapreneur or growth leader who develops businesses in existing companies*.
4. *Social entrepreneur, often called a nonprofit entrepreneur, who creates value for the society as a whole, mainly through the creation of an organization in a nonprofit environment*. This includes also a political changes in regulation, which may broadly affect business and the global capacity of value creation.

As shown in Table 1, "entrepreneur" is a concept similar to "innovator" but different. Entrepreneurs also may be copycats or simply business people in established activities.

Entrepreneurship Policy

Entrepreneurship policy enables entrepreneurs to start and develop new ventures. It aims to make it easier to create new enterprises and/or develop new products and services. National or global policies are the legal side and local policy is the societal side. It bears on low-technology economic activity as well as high-tech (although the latter is emphasized here). Overall, it encompasses a social dimension of risk acceptance, a view of life, and an ethic that allow individuals to become entrepreneurs. This seems to be the way in which the World Bank does business.

Entrepreneurship policy includes six main topics:

- Global economic and social environment (infrastructure, regulation stability, deregulation, free markets for finance, goods and labor).
- Creation process (1 day and no cost plus physical infrastructure, including "clusters" and start-up facilities).
- Development assistance (financing solutions (e.g., SBIC), market openness (e.g., SBA), R&D transfer).
- Entrepreneur concerns (management of risk, patents, tax incentives, insurance).
- Ethics and ideology (cultural and social norms, open city).
- Education and training programs.

Entrepreneurship policy belongs to the liberal side of economics, whereas innovation policy comes from a state-organized economy.

They have merged because entrepreneurship seems to be the best way to speed up innovation.

Entrepreneurship Policy Management: Decision Making, Governance, and Assessment

While entrepreneurship policies have progressively involved many different government sectors at several levels (national, regional, and local), there is no established organization for entrepreneurship policy, nor any established governance or official assessment!

Japan has a minister of state for innovation, not for entrepreneurship, but Japan is not more successful than other countries. The British government decided in 2007 that the prime minister would control innovation and entrepreneurship policy, however, Her Majesty's Treasury still manages a large part of it.

Entrepreneurship Policies

Entrepreneurship policies are not theoretical approaches; they are entirely pragmatic and efficiency driven. They began in United States in the 1930s, with the New Deal, and increased during the 1950s and after.

US entrepreneurship Policy: From SME to Innovation

US entrepreneurship policy, which originally was not known by this name, began as small and medium enterprises (SME) policy before dealing with research and innovation and then with jobs creation. Today, the Small Business Administration (SBA) and seven laws (SBA, Subchapter S, Business Angels, Small Business Investment Company (SBIC) and venture capital (VC) regulation, Small Business Innovation Research (SBIR), the Bayh-Dole Act, and patents) make up the current entrepreneurship system in the United States.

The SME policy of the United States was the model for numerous other countries: Taiwan (1954), The Netherlands (1954), Canada (1961), Australia (1973), the United Kingdom (1970), Ireland (1982), Finland (1993), and Spain (1996).

1932–1952: RFC and OSB for SME

The Reconstruction Finance Corporation (RFC) was founded in 1932 by President Herbert Hoover to finance all kinds of businesses and was integrated into the New Deal program by President Franklin D. Roosevelt.

The SWPC (Smaller War Plants Corporation) was created in 1942 to provide loans to private entrepreneurs and was dissolved at the end of the World War II; its activities were transferred to the RFC.

The Office of Small Business (OSB), part of the Department of Commerce, provided information to SMEs.

During the Korean War, the Small Defense Plants Administration (SDPA) was created to perform the same function as the SWPC. In 1952, it has been decided to shut down the RFC and President Dwight D. Eisenhower proposed the creation of a new agency combining the main functions of the RFC and OSB.

1953: SBA

The Small Business Administration (SBA) was created by the Small Business Act of 1953. Its function was to "aid, counsel, assist and protect, insofar as is possible, the interests of small business concerns." In addition, the SBA would ensure small businesses a "fair proportion" of government contracts and sales of surplus property. In 1954, the SBA began to make direct loans and to guarantee bank loans to SME.

In 2011, the SBA was a multifunction agency with a budget of US$ 500 million and eight major programs: Financial Assistance, Contract Opportunities, Disaster Assistance, Online Training, Counseling & Assistance, Special Audiences, Laws & Regulations and Compliance. New efforts for minorities and clean technology were implemented at the beginning of 2012.

1958: SBIC and Subchapter S

The Small Business Investment Company (SBIC) was established to finance privately owned venture capital investment firms with the help of the US government. These investment companies, dedicated to investing in start-ups and SMEs, can get a loan at low rate (1%) for double their capital. This allows leveraging of their efficiency, which is necessary to obtain fair profitability in the venture capital business.

The Subchapter S law was adopted in 1958 and reexamined several times since then. Through assessment reports and the study of Robert Gaston ("The informal supply of capital," 1988) this system has contributed to the emergence of one million business angels in the United States, investing from $30 to $100 billion annually.

1980–1982: SBIR-STTR, the Bayh-Dole Act, and Patents

To meet the industrial demand for US electronics at the end of the 1970s, the US Congress adopted three main laws regarding R&D and technology transfer. The idea was that America had to preserve its innovation capacity by better using its R&D capacity. Patents improvements and SBIR were adopted for better applied R&D, and the Bayh-Dole Act was enacted to accelerate – and even force – technology transfer.

The Small Business Innovation Research (SBIR) program is a partnership program between SME and federal research agencies. The STTR (Small Business Technology Transfer Program) takes a similar approach with SME and nonprofit US research institutions; this is clearly a mix with innovation policy.

Years 2010: Immigration – Towards a Startup Visa Act

The Kauffmann analysis determined than immigrants found companies at greater rates than native-born Americans do, and they are disproportionately more successful in starting high-growth and high-tech firms. This lead two senators to propose a new law granting green cards to foreign entrepreneurs and even to all STEM (science, technology, engineering, mathematics) graduates. This is also a mix with innovation policy.

2011: Patent Law

On September 16, 2011, the US Congress passed the America Invents Act, a new patent law following decades of debates and three "patent reform acts" of 2005, 2007, and 2009. This act modifies the US patent system from a "first to invent" to a "first to file" system, eliminates interference proceedings, and expands post-grant opposition. This act also defines the new organization for the US Patent and Trademark Office (PTO).

1945–1970: The Growth of Venture Capital – From VC Funds and Angel Investors to Crowd Funding

The modern form of venture capital began with the ARDC (American Research and Development Corporation) and a French-American Harvard professor, Georges Doriot, just after World War II. The legal status took time, however, and came along with private equity funds in the 1960s. In a strict sense, this is not a national policy, but in a market approach, venture capital funds and business angels (see below) are natural parts of a National Innovation System (NIS). Due to the necessity for due diligences and management fees, theses funds can only invest in developing projects, in an amount of more than US$ 1 or 2 million.

For seed capital and early-stage development, angel investors are able to invest any small amount without management costs and due diligence. They have the capacity to evaluate from either a specialist point of view or a proximity evaluation. According to professional associations and the Small Business Administration, the number of US angels investors is estimated to be around 300,000 per year. Angel investors are often retired entrepreneurs or executives who are investing not only for monetary return but also to help other entrepreneurs and to become a real partner.

In 2011, we saw the first beginnings of crowd funding on the Internet, allowing angel investors to invest small amounts (some thousands of US$) in a venture together with many others. Today, this activity is not clearly regulated. Crowd funding, which began in the independent music industry, could be considered as a kind of microfinance. Regulation has to be deepened in the United States as well as in Europe because this is a kind of public offering. On April 5, 2012, the Jumpstart Our Business Startups Act (JOBS Act) was signed by the President of United States. It intended to encourage funding of small businesses by easing various securities regulations.

Entrepreneurship Policies for Developing Countries (OECD-ONU-WEF-UNCTD/United Nations Conference on Trade and Development)

For many development organizations experience has shown that the most efficient approach to reducing poverty in low-income countries is the development of productive capacities, i.e., “productive resources, entrepreneurial capabilities and production linkages which together determine the capacity of a country to produce goods and services and enable it to grow and develop” (UNCTD).

On this basis, all international organizations now urge to development of entrepreneurship policies.

Europe: Science and Innovation

In Europe, there used to be conflicts between two kinds of policies: the centralized approach of innovation policy and the market approach; in other words, between liberal and not.

As the debate on innovation and entrepreneurship policies took place at the beginning of 2000 and ended with the Lisbon Agreement, it was only possible to build a general agreement, except on the global R&D expenditure, with a target of 3%. Entrepreneurship and transfer of technology policies were ignored, as there were wide differences among countries. The differences were also large in education systems. Each country is supposed to organize its own policy.

France, from “State Innovation” to Entrepreneurship

General de Gaulle looked for new ways of obtaining power and, after him, Georges Pompidou sought economic development. France had a state innovation policy during the 1960s and 1970s, with large national programs such as Ariane (rocket), Airbus (planes), TGV (train), Minitel (IT), nuclear plants (energy), and even computer chips (ST Microelectronics). Other programs for machine tools and computers were less successful. However, at the same time, the first company in the world to manufacture a microcomputer for business, named Micral, was created in 1972 by M. Truong in France, and as Apple was founded in 1977! However, Truong worked alone and didn’t find financing. After selling 100,000 professional microcomputers between 1972 and 1977, he sold Micral to a large company (Bull), which did not understand the product.

Innovation policy without entrepreneurship policy is a centralized model can be found in many countries, with still less success than in France. France has also tried some kinds of clusters, with the “technopoles” in the 1980s and now the “pôles de développement.” Results have been limited, according to a study by the French Parliament.

Three Global Entrepreneur Policy Models

There are three main kinds of combined entrepreneurship policies:

– Development policy; SBA is the base of this policy
– Innovation policy
– Employment policy, which came later, in the 1980s, with research financing and adapting the rules to create a society, and even one-person company.

For innovation, there are two major directions in addition to research financing:

– The Anglo-Saxon model, mainly based on market-driven innovation. This model seems to be efficient for breakthrough innovations.
– The Continental Europe model, relying mainly on big firms or the state to manage innovation system. This model works well for incremental innovation and for diffusion.

Theoretical Debates

Historical Evolution

There have been three major trends in the theoretical debates since the 1930s and a fourth trend is developing.

The Pure Pragmatic Way (Since the 1930s)

The work of the US Congress (and of politicians and their advisors) shows us the importance of being pragmatic in political decisions, since they have established the basis of entrepreneurship policy without even having the intellectual tools to build it!

There is still a pragmatic way that consists of treating each problem as it comes: "proof of concept center," "incubators," "accelerators," "death valley," "innovation death spiral," "prototype centers," and so on. Each problem has a limited solution. The ultimate problem is to organize and rationalize them all.

The Entrepreneur Theoretical Way (Starting in the 1960s, Emerging in the 2000)

From the 1960s, entrepreneurship began to be the subject of research, reports, and debates by scholars and in think tanks. These first steps were mixed with questions on innovation, as an entrepreneur was often seen as an innovator.

The scholarly debates on entrepreneurs actually began in the 1990s, and Venkataraman drew a picture for future academic work in 2000(Shane and Venkataraman 2000), but only for entrepreneurship, not for entrepreneurship policy.

The Global Economic Approach (in the 2000s)

Scholars and policy makers need global analysis and not only pragmatic and incomplete approaches. By this time, they had a global economic approach, but it was still not completely academic. In this context, there are two main kinds of debates: the *existence* and the *efficiency* of entrepreneurship policy (see below);

But there is a another economic question, which is the quality of entrepreneur. In classical economics, we see only three actors: the market, the consumers (mass), and the producers (companies). We never speak about individuals. There is no room for entrepreneurs. The question today could be "what is the place of entrepreneurs in economics."

An Emerging Question: The Role of Culture (for the 2010s)

Behind this question regarding the entrepreneur in economics, we find a more general debate in sociology and economics about the individual in these two sciences. The debates are between social sciences, from sociology to economics, and individuals. We also find the question of the relationship between sociology and psychology, between economics and management.

These debates have a common point: the importance of culture that regulates the individual behavior in the society.

Why Does Society Need Entrepreneurship Policy?

Remember that, until 1980, the academically correct approach to development or employment in the twentieth century was based on the idea that large firms were the major sources of economic growth and employment. Neither entrepreneurship, nor innovation, was a subject for economic study.

Nevertheless, during the 20 last years of the twentieth century, scholars and policy makers pointed out two key facts (Birch, Thurik, Audretsch et al. (2007) from 1979 to 2011):

– The major role of new firms is job creation, accounting for more than 80 % of job creation in the United States;
– The role of new enterprises is the innovation process and growth (Block and Keller 2008).

As a result, after being ignored in previous theories, the entrepreneur and the start-up became central in economic development.

At the same time, the theory of the contestable markets was developed (Baumol 1982) and gave a theoretical entrance for the new policy approach, which became a clear shift from the managed to the entrepreneurial economy. As a result, the premise of entrepreneurship policy is market failure together with the idea that when markets are efficient, innovation will destroy the equilibrium (Venkataraman 1997).

In a period of globalization, innovation is the only way to renew the competitive advantage of developed countries; and entrepreneurship is the most efficient way to foster innovation. Thus, much should be done to make the entry of actors of innovation easier. New policy must also deregulate, privatize, and enable knowledge uses through R&D transfer.

Systemic or Individualist Approach: Entrepreneur or Company?

Among policy-makers and politicians, efficiency is often the ultimate goal, without trying to find the theoretical explanation. For this reason, these people apparently speak indifferently of an "entrepreneur's ecosystem" as well as an "innovation system" or "systemic policy" or even of "rainforest" (Hwang and Horowitt 2012).

Nevertheless, there is a dispute over the theoretical bases of these policies:

– On one side, economists are at least quantitativist and work on the factors of entrepreneurship, trying to modulate policy measures according to efficiency. They gladly speak about marginal efficiency of the lower rate of corporation tax, while they speak much less of ethics and ideology. They speak about economic system and structure.
– On the other side, some economists are speaking about entrepreneurs and their way of life. In this approach, there is a diminishing interest in the infrastructure concepts as the National Innovation System or clusters as the key object of the politics. These "old" concepts are shifting from operating concepts to description concepts. And the key concept of entrepreneurship policy begins to be the entrepreneurs, their ethic, and their risk management or values, all that we can consider as an ecosystem.

Debates on Efficiency of Tools for Innovation-Entrepreneurship Policy

Management of the Knowledge Spillover? Localization, Proximity, and Quality Effect

The Knowledge Spillover Theory of Entrepreneurship tends to localize start-up close to the actual source of knowledge. The question still exist of how it works: in the 1970s there were many people around the Xerox-PARC and only one company named Apple! Clearly, there is no matter of quantity. If knowledge input increases by 100 %, you can't be sure of a similarly increase of innovation nor entrepreneurship. There is a quality effect, as with artistic creation, and a proximity effect, which nobody understands nor controls.

It is clear that there is no relationship between entrepreneurship measured by the number of new companies/inhabitants and the quality of innovation in the same area. The statistics in France and the United States are consistent on this point.

Local or Global? Efficiency of Clusters Policies

In the 1990s, policymakers and scholars became convinced that the local level is the key for entrepreneurship. In the mid-1990s, clusters were the alpha and omega of innovation policy seen by OECD. However, reports from international institutions were skeptical of the efficiency of the clusters in Japan or in France during the first decade of the twenty-first century. The OECD cluster policy of the 1990s has been progressively replaced by "fostering innovation" and is moving toward a global concept of enabling entrepreneurial acts.

Organized "top-down" clusters are not the best, whereas spontaneous clusters that are "bottom-up, such as Boston or Silicon Valley, are the most effective. If clusters are no longer *the* way to entrepreneurship, the "local" is still a key approach. The right concept of local seems to be "territory" that is still a fuzzy concept, meaning an area where people have a common view on life, a kind of ideology, and a proximity, allowing the building of a community spirit.

At the moment, there is still not established opinion and the local concern of entrepreneurship policies, except that there is a heavy local trend in entrepreneurship policies.

The Emergence of the "Entrepreneurship Culture" Concept

Entrepreneurship culture is a concept that comes from management. The subjects were "top-down innovation" or "firm culture," and consultants still use these concepts.

As there are many emerging concepts and probably no accepted model, everybody must stay aware of. After "fostering innovation," we'll discuss "innovation or entrepreneurship culture". But look out, you need both structures and mind!

Entrepreneurship Policy, Table 2 TEA index (%) in innovation-driven economies (Source: GEM Report 2011)

Country	TEA index
Australia	10.5
Belgium	5.7
Denmark	4.6
France	5.7
Germany	5.6
South Korea	7.8
Sweden	5.8
United Kingdom	7.3
USA	12.3

Entrepreneurship Policy, Table 3 Top ten and bottom ten of starting a business ranking in Doing Business 2011 report (Source: Doing Business Report – 2011)

Easiest	Rank	Most difficult	Rank
New Zealand	1	Iraq	174
Australia	2	Djibouti	175
Canada	3	Congo Rep.	176
Singapore	4	Sao Tomé and Principe	177
Macedonia	5	Haiti	178
Hong Kong	6	Equatorial Guinea	179
Belarus	7	Eritrea	180
Georgia	8	Guinea	181
USA	9	Chad	182
Rwanda	10	Guinea-Bissau	183

The Emergence of Measuring Entrepreneurship

After more than 10 years of controversial debates between scholars and policy makers, three series of indicators are under development in the world.

The TEA Index by GEM

Global Entrepreneurship Monitor (GEM), a worldwide organization whose guiding purpose is to measure individual involvement in venture creation, is developing a number of indicators that are progressively extended worldwide. The major index is TEA (Total Early-Stage Entrepreneurship Activity – see Table 2): the prevalence rate of individuals in the working-age population who are actively involved in business start-ups, either in the phase preceding the birth of the firm (nascent entrepreneurs), or the phase spanning 3½ years after the birth of the firm (owner-managers of new firms).

Doing Business

"Doing Business" is an annual report by the WEF (World Economic Forum) and the World Bank that provides open data on the way of doing business in each country. "Starting a business" includes four criteria: procedures (number), cost (% of income per capita), time (days), and paid-in minimum capital (% of income per capita). Table 3 shows the best and worst rankings.

Entrepreneurship Policy, Table 4 Topic categories for entrepreneurship indicators (Source: OECD-EIP report for 2009)

Indicators for determinants	Indicators for entrepreneurial performance	Indicators for impact
Regulatory framework	Firm-based indicators	Job creation
R&D and technology	Employment-based indicators	Economic growth
Entrepreneurial capabilities	Other indicators of entrepreneurial performance	Poverty reduction
Culture		
Access to finance		
Market conditions		

This assessment is far from accurate regarding the entrepreneurship policies in most developed and even developing countries, however, in 2011, it is the only available worldwide assessment.

Eurostat-OECD

In 2006, the OECD launched the EIP (Entrepreneurship Indicators Program) to build internationally comparable statistics on entrepreneurship and its determinants. In 2007, Eurostat jointed the project. The first reports were edited in 2008 and 2009, but there are not yet any worldwide statistics. OECD has made the choice to follow three series of indicators, as detailed in Table 4:

determinants of entrepreneurship, entrepreneurial performance, and impact.

Policies Assessment

As there is still no established measurement system, there is no possibility of global assessment or rating.

Several parliaments have made punctual assessments: the US Congress has realized assessments of the US policies, from SBA to SBIR. French Parliament made the assessment of "pôles de développement" or clusters in 2009.

Conclusions and Future Directions

There are two major conclusions and future directions for policy makers and scholars.

Some Rules of Thumb for Policymakers

As a general conclusion of this short review, it seems that almost all the financial and physical tools are useful and often necessary, but they don't give any guarantee of success if there is no cultural and societal policy.

At the end, in this matter of "entrepreneurship policy," which is still a new subject of scholarly studies, there is no established academic opinion regarding the way to success. Far from theoretical debates, policymakers need only some golden tenets to avoid major failures. According to the opinions expressed in publications edited by GEM, Kauffmann Foundation (Lerner 2009), Babson College, the World Bank UNACTD (UNCTAD Secretariat 2011), and others (Porter 2003), there are six golden tenets:

1. *Think people, not just structures*: there is no mechanical system producing entrepreneurs, but an ecosystem enabling people to become entrepreneurs. Think global entrepreneur ecosystem, not only environment;
2. *Think worldwide and local*; not too big and not too small. Entrepreneurship needs global connections but entrepreneurs live locally.
3. *Be politic and watchful*: give orientations and means; don't drive by yourself; take care that public initiatives need long time. Don't look for immediate effect. Implement a careful evaluation system (quality and quantity).
4. *Be yourself and be cautious*: success is never only a matter of copying. Correct choice of entrepreneurship policy instruments is determined by context. Use international standards to finance entrepreneurship and innovation, respect market opinion and use the well-tested tools from start-up funds to proof the central concept.
5. *Don't forget knowledge*, from education to R&D.
6. "*The entrepreneurial spirit*" *is the only way to drive the new economy*. Take care of establishment. You need many stakeholders to support entrepreneurs.

New Economics

Entrepreneur may find that entrepreneurship is not a current concept in economics. Entrepreneurship policy was founded to meet unsolvable problems in the 1930s. Because of its success, it was developed further in the 1950s. Today, management academics try to elaborate the conceptual analysis of entrepreneur and of entrepreneurship policy.

Apart from armies and some Indian companies or postal services in Europe, the big companies began to develop during the nineteenth century, with the steam engine, railways, chemical products, telephone, and even electric equipment. At the beginning of the twentieth century, these companies seemed to be the center of economic life. Even Schumpeter thought this way in the 1930s and 1940s.

The rise of big business seemed to confirm these global economic approaches, whether liberal or Marxist. Market, materialist, and centralized economies knew only structures and mass, not individuals. But the years 1950–1980 brought a new idea, which is the comeback of the entrepreneur as the main economic agent for creating jobs, developing business, and innovating.

This may be a major turnaround in economics. As sociology will take into account psychological questions, perhaps economics will have to join management; and the link between management and economics could be the entrepreneur. In fact, for policy makers, entrepreneurship policy is already the link between economic policy and the regulation of business.

Cross-References

- ▶ Accompaniment of Business Creation
- ▶ Entrepreneurship
- ▶ Innovator
- ▶ Risk, Uncertainty, and Business Creation

References

Audretsch D, Grilo I, Thurik R, editors. Handbook of research on entrepreneurship policy (with contributions of Lundström A, Stevenson L, Wessner C, et al.). Edward Elgar Pub, Northampton. Max Planck and EIM; 2007 – ISBN-10:1845424093 – New releases in 2009 and 2011.

Baumol W, Landes DS, Mokyr J. The invention of enterprise, entrepreneurship from ancient Mesopotamia to modern times. Princeton University Press, The Kauffman Foundation; 2010 – ISBN-10: 0691143706.

Baumol W. Contestable markets, an uprising in the theory of industry structure. Am Econ Rev. 1982;72(1). http://www.aeaweb.org

Block F, Keller MR. Where do innovations come from? Transformations in the U.S. National Innovation System, 1970–2006. IFIT – juillet; 2008.

Block FL, Keller MR. State of innovation: the U.S. government's role in technology development; 2011. Paradigm. ISBN-10:1594518246.

Cantillon®. Essai Sur la Nature du Commerce en Général. Fletcher Gyles in Londres/Holborn (in French); 1755. Download on http://books.google.fr/

French Parliament, Mission d'Evaluation et de Contrôle – by Cleys (A), J Gorge (JP) and Lasbordes, Information report on Clusters Prospects, Sept. 23, 2009.

Hwang VW, Horowitt G. The Rainforest, The secret to building next Silicon Valley. Regenwald: Los Altos Hill, California; 2012. ISBN-10: 0615586724

Lerner J. Boulevard of broken dreams – Why public efforts to boost entrepreneurship and venture capital have failed and what to do about it. Princeton University Press; 2009. ISBN 978-0-69114219-7.

OECD, Measuring entrepreneurship, a collection of indicators 2009. Download on http://www.oecd.org/

Porter M. The economic performance of regions. Reg Stud. 2003;37.6&7:549–78.

Schumpeter J. The theory of economic development : an inquiry into profits, capital, credit, interest, and the business cycle [Paperback]. Transaction Publishers; 1911–1982. ISBN-10: 0878556982//Download the French translation on http://classiques.uqac.ca/

Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manag Rev. 2000;25(1):217–26.

UNCTAD Secretariat. Investment, Enterprise and Development Commission. Key aspects of entrepreneurship and innovation policy frameworks for enhancing local productive capacities; 2011 – www.unctad.org

Venkataraman S. The distinctive domain of entrepreneurship research. In: Advances in entrepreneurship, firm emergence and growth, vol 3. JAI Press - Emerald Group; 1997. pp 119–138. ISBN-10:0762300035

Wessner C. Local heroes in the global village: globalization and new entrepreneurship policies (with Audretsch DB, Grimm H); 2005 – ISBN-10: 0387234632.

Web Sites

GEM, http://www.gemconsortium.org
OECD, http://www.oecd.org
World Economic Forum (WFE), http://www.weforum.org

Entrepreneurship Research

▶ Microfirms

Entrepreneurship Training

▶ Entrepreneurship Education

Environment

▶ Diversity and Entrepreneurship

Environmental Determinants of Entrepreneurship

Imen Selmi[1] and Samia Haddad[2]
[1]National Engineering School of Gabes (ENIG), Gabès, Tunisia
[2]Institute of High Commercial Studies of Tunis (IHEC), Tunis, Tunisia

Synonyms

Contextual determinants; Environmental factors; External factors

Introduction

The entrepreneurship literature have long been interested in the question: What are the determinants of entrepreneurship? Literature analyzing this question has – in the early researches – examined the impact of personality trait on the creation of a new venture. Then, from the 1980s, it has been recognized that the external environment plays also a crucial role in the process of new-firm foundation by researchers adopting a more holistic approach to study the entrepreneurship by taking into account both individual and environmental determinants.

Thus, individual factors are opposed to environmental factors. Individual factors are linked to the individual himself while environmental factors are related to the context in which the entrepreneur is situated. They refer to political, economic, social, and cultural elements that promote the foundation and the development of new ventures.

This entry contributes to review the literature which explored the effects of environmental factors on entrepreneurship activities.

Many authors have identified the environmental determinants of entrepreneurial behaviors of individuals. The most studied factors in the entrepreneurship literature are entrepreneur's family and friends, universities, work experience, territory, and national culture. It has been demonstrated that these factors have a considerable impact on entrepreneurship.

Entrepreneur's Family and Friends

Entrepreneur's family and friends play a crucial role in the decision to create a new venture. Muhanna (2007) notes that individuals whose relatives and friends are entrepreneurs are more likely to be entrepreneurs. He explains that growing in a social circle with many entrepreneurs allows individuals to consider them as examples of success. Thus, the entrepreneurial process is perceived as a recognized and valued behavior. They can also benefit from the experiences and advices of these people throughout the process of creation of their companies. Furthermore, the role of the family and friends can be manifested by forming entrepreneurial teams. Several entrepreneurs found their businesses with their colleagues at the university or at work to benefit from complementary skills and sources of funding.

In addition to these roles, Verstraete and Saporta (2006) stressed the importance of the family as a source of funding. In fact, financial resources are indispensable for the potential entrepreneur to start his new venture.

Education

Additional studies found that entrepreneurial intentions and actions are significantly associated with education. Aurifeille and Hernandez (1991) note that individuals with higher education level are more likely to become entrepreneurs. They argue that schools and universities are an important source of knowledge spillovers and they give people skills and abilities in a particular domain encouraging them to create new ventures.

An important number of researches have examined the impact of different entrepreneurship programs (entrepreneurship awareness, support, etc.) on the foundation of enterprises. Peterman (2000) indicates that entrepreneurship education intensifies perceived feasibility of starting a business and increases interest in entrepreneurial careers. It appears at a specific time in students' lives playing a crucial role in their career choices.

Prior Experience

One other important determinant studied in many researches is the prior experience of the entrepreneur. Ardichivili et al. (2003) describe the importance of prior experience in the development of market knowledge and in the recognition of successful opportunities. They demonstrate that most business ideas stemmed from prior experience. Generally, entrepreneurs create their businesses after having worked in the same activity of the new company and where they have acquired their skills and their experiences with the product or the technology used. The work offers also to the employee the opportunity to develop relations with the employer and experienced colleagues. These relations are important because they favor learning and develop different cross-curricular skills. Hsu (2007) takes into account the importance of prior venture founding experience in the development of negotiating abilities and network contacts which are very necessary to the firm's success (e.g., contacts with suppliers and customers). Consequently, the entrepreneur has a positive perception of his self-efficacy or self-confidence to succeed the creation of his enterprise.

Territory

Another prominent area of research has examined the impact of a favorable territory on the creation and development of successful enterprises. The board conclusion of this literature is that this type of territory offers a favorable business climate composed of a developed infrastructure and many institutions such as incubators, technology parks, and state-driven laws (Fayolle 2003). Territories may have many characteristics that attract potential entrepreneurs and encourage them to create their businesses. These characteristics can be an infrastructure suitable for the emergence of entrepreneurship, the agglomeration and urbanization benefits in a given environment – urban location and the existence of several enterprises in an industry have an influence on the creation of new ventures – and the presence of different institutions (financial institutions, institutions of support, etc.). The technology park is a relevant example of a territory composed of enterprises, universities, and structures of support. The purpose is to promote the creation and the development of new and innovative firms.

Thus, all these characteristics are particularly impactful on entrepreneurial activities because they facilitate and accelerate the foundation of new ventures. Consequently, they increase the overall likelihood of innovation and entrepreneurial success.

Many researches in the entrepreneurship literature find some evidence that family and friends, education, prior experience, and territory are important in determining entrepreneurship. Fayolle (2003) has studied all this determinants. He defined them as social and cultural factors. They relate to the different places known and frequented by individuals. Additionally, he was interested in contextual and economic factors.

Contextual Factors

Contextual factors are factors that generate a discontinuity in the personal or professional trajectory of an individual driving him to the entrepreneurship without a prior intention to create a business. They may be positive ("pull factors") or negative ("push factors") (Shapero 1975). "Pull factors" may be a meeting with a potential client or partner, recognition of an opportunity, etc. However, negative factors can be unemployment, layoff, unsatisfactory work conditions, etc.

Economic Factors

Economic factors relate to the availability of the required human, technical, financial, and informational resources which are very important to start a new business. In other words, the difficulties of access to these resources can be a serious obstacle to the creation of new ventures.

National Culture

Several researchers noted that the creation of new venture is also function of national culture. Audet et al. (2004) argue that the emergence of entrepreneurs cannot be realized without the cultural influence of their environment. According to these authors, the concept of culture is associated with "the existence of models of entrepreneurs in the social environment," "the social attitude towards failure," "the social status of the entrepreneur and the entrepreneurship as a career choice," "the media treatment of the entrepreneur," and "the perception of the presence of business opportunities." If the image of entrepreneurship as a career alternative is positive, it may be a factor which encourages a large number of individuals to the creation of new ventures. If it is negative, it may discourage many entrepreneurial activities.

A large empirical literature has tested the role of environmental factors influencing entrepreneurship. Typical explanatory determinants contain education, capital assets, previous professional experience, and professional status of the parents (Freytag and Thurik 2007). Furthermore, in his empirical study conducted on 65 entrepreneurs in South Africa, Muhanna (2007) demonstrates that education, previous experience, and social network in addition to other individual determinants such as self-confidence and risk tolerance are important for the choice to become an entrepreneur. It should be noted that most of the researchers have studied the impact of each determinant cited in this entry alone and only some researchers have examined the influence of all of these factors on entrepreneurial activities.

Conclusion and Future Directions

In conclusion, this entry sought to contribute a greater understanding of the environmental factors that encourage individuals to create new ventures. The study was focused on the most studied determinants in the entrepreneurship literature. These determinants are often examined separately by a great number of researchers in the field.

Attention was paid on the role of family, education, prior experience, territory, and national culture on the foundation of new enterprises.

As a recommendation, it is very necessary that public policies do not lose sight about the importance of these determinants. For example, providing a favorable business climate by developing the infrastructure and the multiplication of institutions supporting entrepreneurs (like incubators, technology parks, financial institutions) could be a key factor to encourage individuals to the entrepreneurship.

Furthermore, it would be necessary to many governments to better adapt their education system to the preparation to entrepreneurial activities. In order to achieve this objective, entrepreneurial education should include courses based on reality and practical cases. That will allow students to develop their entrepreneurial abilities and to have the motivation to create new businesses.

The image of entrepreneurship as a career alternative should be also improved and valued by media by providing proximity between individuals and successful entrepreneurs.

Such recommendations could be impactful on the promotion of entrepreneurship which is seen as a source of wealth, new jobs, and economic development for any nation.

Cross-References

▶ Business Climate and Entrepreneurship
▶ Business Incubator
▶ Clusters
▶ Entrepreneurship Education
▶ Entrepreneurship Policy
▶ Financing Entrepreneurship
▶ Love Money
▶ National Culture
▶ Social Networks and Entrepreneurship
▶ Territory and Entrepreneurship

References

Ardichivili A, Cardonzo R, Sourav R. A theory of entrepreneurial opportunity identification and development. Journal of Business Venturing. 2003;18(1): 105–23.

Audet J, Riverin N, Tremblay M. L'influence de la culture d'un pays sur la propension entrepreneuriale de ses citoyens: le cas du Canada. In: Riverin N, et Jean N, L'entrepreneuriat chez les jeunes du Québec: Etat de situation (2004), Chaire d'entrepreneuriat BombardierR-JA, HEC Montréal, 2005

Aurifeille JM, Hernandez EM. Détection du potentiel entrepreneurial, d'une population étudiante. Economies et Sociétés Séries Sciences de Gestion. 1991;17:39–55.
Fayolle A. Le métier de créateur d'entreprise; motivations, parcours, facteurs clés de succès. Eyrolles, Paris: Editions d'organisation; 2003.
Freytag A, Thurik R. Entrepreneurship and its determinants in a cross-country setting. J Evol Econ. 2007;17:117–31.
Hsu DH. Experienced entrepreneurial founders, organizational capital, and venture capital funding. Research Policy. 2007;36:722–41.
Muhanna E. Conceptual analysis of determinants of entrepreneurship; a South African perspective. Probl Perspect Manag. 2007;5(1):95–102.
Peterman N. Entrepreneurship and enterprise education; influencing students' attitudes towards entrepreneurship. Queensland: The University of Queensland; 2000.
Shapero A. The displaced, uncomfortable entrepreneur. Psychol Today. 1975;7(11):83–9.
Verstraete T, Saporta B. Création d'entreprise et entrepreneuriat, Editions de l'Association pour la Diffusion de la Recherche sur l'Entrepreneuriat et la Gestion (ADREG), France; 2006.

Environmental Factors

► Environmental Determinants of Entrepreneurship

Environmental Innovations

► Green Business and Entrepreneurship

Environmental Management

► Small Businesses and Sustainable Development

Environmental Scanning

► Information Monitoring and Business Creation

Epidemiology of Innovation: Concepts and Constructs

Elias G. Carayannis[1], Nikolaos G. Evangelatos[2] and David F. J. Campbell[3,4]
[1]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA
[2]Intensive Care Unit, Klinikum Nürnberg, Bayern, Germany
[3]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[4]University of Applied Arts, Vienna, Austria

Synonyms

Academic firm; Creative destruction; Entrepreneurial university; Global innovation ecosystems; Higher order learning; Innovation diffusion; Knowledge for growth; Knowledge production; Mode 1, Mode 2, and Mode 3 knowledge production systems; Quadruple innovation helix systems; Regional, sectoral, and self-similar innovation networks and knowledge clusters; Smart specialization strategies; Strategic management of technological learning; Technology and business life cycle

The Conceptual Sociotechnical, Socioeconomic, and Sociopolitical Context for the Epidemiology of Innovation

With the onset of organized human activity going back thousands of years, and surely since the industrial revolution, science, technology, innovation, and entrepreneurship have evolved to be major determinants of the way humans live. In the Western world, science, technology, and economy are interrelated and have allowed for both the growth of the economy and the emergence of national and supranational structures and so-called globalization. Due to this common perception, the last decades are characterized by a steadily rising interest of scholars for the many interactions between science, technology, and socioeconomic development and its sociopolitical implications. There is an extensive debate concerning the influence, evaluation, role, connections, and transfer of science and especially technology upon, within, and between societies and in particular within and across sectors of economic activity and geographic regions. The same reasoning may apply to business, industries, sectors, and clusters at the macro-, meso-, and micro-levels.

The recent economic downturn has highlighted the dynamic interplay between economic forces and general health and well-being of consumers and businesses. Examples in the popular media describe situations in which job loss or other unexpected events (e.g., the onset of a chronic condition or an increase in variable rate debt service payments) can cause many households to become insolvent, and ultimately to file for bankruptcy. Similarly, in the housing market, foreclosures within a community depress property values for other homeowners and business owners within that community, making it more difficult for them to sell or refinance their assets. This leads to a type of "social contagion," where a single event or a series of events can lead to deleterious consequences for an entire community. Traditional economic and financial theories have failed to adequately incorporate these sociocultural, institutional, and other evolutionary forces into their empirical and theoretical frameworks.

One field of study that has incorporated a comprehensive approach to human decision making and policy design is public health, and its empirical subfield of epidemiology. Public health not only recognizes that the outcomes of effective decision making are multifaceted (and explicitly incorporates this fact into its theoretical and empirical models) but also recognizes that those outcomes are driven by (and collectively drive) social norms, institutions, and public policies. In short, public health adopts ecological and evolutionary principles as core tenets.

In this broader context, the theoretical concept of innovation, based on the ideas of Joseph Schumpeter, has evolved and been used in the study of many aspects of those interactions. Innovation has been studied in a variety of contexts (e.g., technology, manufacture, commerce, and social systems) and has been proven a useful tool for both situation analysis and policy making in a sectoral, regional, national, and supranational perspective. Although further interdisciplinary research of such a complex social phenomenon is needed, certain conclusions can already be drawn on the role of innovation. It is widely accepted that innovation enriches economic evolution by increasing its substrate, namely, the technologies that are used.

Since the emergence of the so-called endogenous theory of growth, the research interest has been focused on the micro-level and takes into account the fact that innovation does not occur in isolation but depends on a "selection" environment. This is highlighted by its tendency to cluster in sectors, causing structural, organizational, and institutional changes.

Taking into account that nations, regions, and sectors as well as firms and universities are open, esoteric, heterogeneous systems, it seems reasonable to assume that the ability of such a system to produce or adopt innovation plays an important role to their economic performance. Indeed, the way these systems learn, accumulate, convert, and transfer innovation concepts and practices, that is, the diffusion of innovation, is a condition sine qua non for economic performance and development. The study of innovation diffusion has therefore fairly attracted the research interest of many scholars and has led to the development of many relevant theories and empirical models.

Definition of Terms: Epidemiology, Innovation, and Interrelations Thereof

Epidemiology

Epidemiology is "the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the prevention and control of health problems" (Last JM. A dictionary of epidemiology, 4th ed., Oxford University Press, 2001).

Being a fundamental science of public health, epidemiology uses quantitative methods and has made major contributions to improving population health.

Traditionally considered a biomedical science, epidemiology is in reality an interdisciplinary science with contribution to other scientific fields, among others, in biostatistics, social and behavioral sciences, demography, and geography. This evolving conception of epidemiology as a liberal art has also found applications in emerging fields of studies (N Engl J Med 1987; 316:309–14). In the field of computer science, the use of biological analogies has led to the development of various theoretical models for the prediction of the rate and extent of propagation of a computer virus infection (Journal of Computer Science 1 (1): 31–34, 2005). Furthermore, the use of epidemiological investigations and interventions has been increasingly focusing on social networks leading to a better understanding of the processes that determine how networks form and how they operate with respect to the spread of behaviors that affect public health (Norsk Epidemiologi 2009; 19(1): 5–16).

The origins of epidemiology can be traced in Hippocrates and his alleges about the impact of environmental factors on the occurrence of disease. In the years of Renaissance, which reintroduced classical Greek texts in combination with the development of commerce and the exploration of the new world, an underlying belief of a relationship between physical phenomena and mathematical axioms was common among scholars and university professors. This trend to quantify phenomena signifies the birth of modern epidemiology as well as the birth of social sciences.

It is in this same spirit that Descartes' conception that organisms in general and the human beings in particular (possibly even the human mind) are no other than special-purpose machines started to dominate the Western world (ref). At approximately the same time and place, the sociopolitical conditions, referring mainly to merchant, had as a consequence the establishment by the revolutionary French Academy of Sciences, with Laplace as chairman, of the International System of Measures and Weights (ref). This trend to mechanize and measure almost everything was the matrix out of which resulted the possibility to quantify and represent everything that happens in the human body in state of health or disease. In the late seventeenth century, William Petty published his pioneering work "Political Arithmetick," promoting the assumption that society could, in a clear analogy to an organism, be studied with the use of mathematics. The term "epidemiology" was coined in 1802 with the publication of *Epidemiologia Espanola* by Don Joaquin Villalba.

Despite diverging paths between epidemiology and the social sciences, they both rely to a great extent on each other through a diffusion of methods and ideas mainly due to the same substrate of their research, namely, groups of entities. In the second half of the twentieth century and the emergence of social constructivism, social sciences begin to use theoretical tools from epidemiology in an attempt to quantify their research and gain scientific merit. On the other hand, epidemiologists try to track origins and patterns of contagion to social behaviors. This new mutual grafting is signified by the emergence of new scientific journals such as the *Journal of Health and Social Behavior* and *Social Science and Medicine*.

Having already stated that research in dynamics of innovation diffusion has revealed patterns resembling the spread of a disease over a human or animal population, it is reasonable to investigate whether the diffusion pattern of innovation can be studied using principles derived from epidemiology.

Innovation

Although a theoretical link between innovation and economic growth is almost self-evident, it was not until after World War II (Bush 1945) and the work of Solow that innovation took a central place in formal economic models. Innovations provide the necessary substrate for business opportunities and future innovations as well, thus allowing for sustainable economic growth. Those premises, which rely to a major extent on the work of Joseph Schumpeter, were further elaborated by economists who used mathematical tools and implemented those ideas to new dominant economic models. Therefore, during the last decades, innovation has been intelligibly recognized by several nations as a major determinant of economic growth.

The importance of innovation for long-term economic growth is almost self-evident. The significance of innovation for economic performance was impressively illustrated by research work of Professor M. Abramowitz. The core of his argument was that increase in the output of the economy results either from increase of inputs that go into the productive process or by increase in productivity, that is, increase in output per unit of input or output per worker. Abramowitz measured the growth of both input (of capital and labor) and output of the American economy between 1870 and 1950 and discovered, surprisingly, that the measured growth of input accounted only for about 15 % of the measured growth of output. Therefore, the residual 85 % should be attributed to other factors that could stimulate growth, namely, technological innovation. According to many economists, productivity, income distribution, and unemployment are the variables most commonly used as indicators of national economic performance. Productivity lies in the core of every measurement that tries to evaluate economic growth and is largely dependent on investment in capital formation, in people, and in technical progress. A second level of agreement between economists is that of all these variables, technological innovation is the most significant and is considered to play a substantial role for long-term growth of productivity. Indeed, innovation is one of the very few concepts that economists diachronically and persistently recognize its significance. However, it was not until the late nineteenth and early twentieth centuries that innovation was placed central to the theories of economic growth by Marx and Schumpeter, respectively.

Karl Marx and Joseph Schumpeter adopted a similar approach which relied on the assumption that technological competition is the main form of competition between firms in the capitalistic environment and that innovations set up the stage for business opportunities and future innovations as well, thus allowing for sustainable economic growth. Their ideas were further elaborated by economists who used mathematical tools and implemented those ideas to new economic models such as the “new growth theory” or the “endogenous growth theory.”

The theoretical concept of innovation has been elaborated by researchers especially during the last decades of the twentieth century and many of its characteristics, categories, and types have been elucidated. Although the boundaries between different types or ways of innovation are often fuzzy, the relevant research has highlighted four major areas in which innovation takes place. Analytically, the term “innovation” refers to either the capability to introduce or improve products or processes or the capability to define or redefine the positioning of the firm or products or the dominant paradigm of a firm. Since Solow introduced innovation in formal economic growth theory, a constellation of models has been proposed to conceptualize innovation and its relationship with growth. Among the most sophisticated and influential approaches are those highlighting the role of knowledge in the process of innovation. Indeed, change and learning are two sides of the same coin. This means that innovation entails knowledge either (and mainly) as a precondition or as the cause of new problems, theoretical or practical, which demand new skills and knowledge in order to be solved.

During the last several decades, a vast amount of literature has shed light on the relationship between knowledge and innovation. It is almost incontrovertible that a process of continuous learning plays a most important role in the economic performance of firms and nations mainly through its impact on innovation. These led to the recognition of knowledge-based innovation as a premise for infinite economic growth and to the concepts of knowledge-based economy and learning economy. In the new global economy, the economic performance of firms and nations relies mostly on their learning and adopting abilities, since the latter lead in turn to technological capability. This can be conceptualized as the knowledge and skills necessary to choose, install, and operate new technologies and furthermore to improve and develop them. In other words, learning is in the core of what is called innovation diffusion.

Innovation is a complex, nonlinear phenomenon and in order to study it, all factors should be taken into consideration that influence it and enhance its diffusion in a certain environment. Indeed, the interactions with the factors of the "selection" environment are a dynamic phenomenon, where the impact of every factor on the economic performance of a certain actor (e.g., a firm) is almost unpredictable and therefore difficult to measure. However, multifactor performance indicators, focusing on the knowledge dynamic of the firm under evaluation, are the core of almost every attempt to determine their innovative status. Those approaches take into account the importance of information, skills, and know-how to economic success with an emphasis on knowledge varieties, growth, and diffusion as reflected in innovations related to organization management, marketing, and industry environment and human resources.

The current era is marked by significant changes in the global socioeconomic environment, propelled to a great degree by the exploitation of advances in science and technology. Perhaps the most striking example is the generation and organization of the Internet, which has led to the rearrangement of the global environment. One of the major aspects of these changes is the so-called globalization, indicated by the birth of supranational structures such as the European Union and the establishment of highly complicated networks between nations, organizations, and human agents which unify and transform almost every aspect of social life including economical models, procedures, and interactions. On the other hand, regional, national, and supernatural characteristics seem to affect dramatically the different innovation systems in the contemporary economy. It is otherwise difficult to explain the increasing positive analogy between knowledge-intensive economic activity and spatial clustering. In this constantly changing environment, the reevaluation of certain premises concerning traditional core performance areas especially in economy is almost imperative, since economic growth plays a substantial role in nations' and peoples' welfare. It is within this wider context that new notions such as the knowledge-based economy or the learning economy have emerged, while others such as the theoretical concept of innovation and more specifically the diffusion of innovation are now central in almost every theoretical approach of economic growth.

Although Schumpeter referred to innovation and recognized characteristics of the latter such as the tendency to "cluster" in certain contexts, he did not move his analysis any further concerning the origins or the management of innovation. Over the last few decades, a wave of research on innovation has swept the debate about theories of the growth of firms. The results of such an enormous literature cannot be easily summarized. Nevertheless, the point that almost every study highlights is that radical and mainly incremental innovations, firm-specific technological knowledge accumulation, networking relationships, interaction with users, and integration of R&D activities, all play substantial role through a process of continuous interactive learning to the growth of firms. Again learning and knowledge, scientific or technological, tacit or codified, plays a central role to the economic performance. By 1996, the OECD report for knowledge-based economy recognized knowledge and knowledge networks as a premise for infinite economic growth through their impact on innovation.

Aspects of the role of learning or knowledge have been extensively developed by many economists. Although innovation and learning are not interchangeable notions, research has shown that learning, at least in the form of learning orientation of a firm, constitutes a major input in a process where innovativeness can be viewed as the output. In the constantly changing environment, firms have to respond to many challenges. Sustainable competitiveness relies foremost on the ability of economic actors to adapt to the emerging and rapidly changing techno-economic environment. As mentioned elsewhere, this ability is mostly illustrated and embodied in the ability of nations, regions, and sectors to be innovative. Innovation in turn, either in the

Science, Technology, and Innovation (STI) mode or the Doing, Using, and Interacting (DUI) mode, relies on learning and adopting. The context of the learning or the knowledge-based economy not only reflects the increasing volatility of the products and the profound changes in the ways of production but also entails a normative dimension in the sense that facilitates us to adapt to the new socioeconomic environment and to develop suitable policy tools. Indeed, in the new global economy, the economic performance of firms depends on their learning and adopting abilities, since the latter result in technological capability, that is, knowledge and skills necessary to choose, install, and operate new technologies and furthermore to improve and develop them.

A wide body of literature conceptualizes firm-level technological progress, which leads to sustainable competitiveness, as a learning process and in particular higher order technological learning (Carayannis 2000). In that sense, innovation is a key to economic vitality and a crucial factor which affects the learning ability of firms to take advantage of and to create new business opportunities. The radical influence of the works of Romer and Lucas on the neoclassical theory of economic growth resulted in the redirection of emphasis on the human capital as a major determinant of technological progress and, in turn, of long-term economic growth. Lucas expressed it more explicitly arguing that the main propellant of growth is the accumulation of human capital in the form of knowledge either codified or, to a perhaps greater extent, tacit.

Since innovation is regarded as a nonlinear, evolutionary, and interactive process between the firms and their selective environment, it is almost self-evident that in trying to conceptualize it, any factor should be taken into account that plays a role in that concept. The term "innovativeness" entails two different dimensions, namely, "innovation performance" and "innovation capabilities." The concept of "innovation performance" refers to the current innovation activity as measured empirically. On the other hand, the theory that underlies the term "innovative capabilities" is mainly conceptual. It is future oriented and focuses on abilities to innovate that may not be currently realized. Therefore, it is not directly observable and it is hard to measure. As economic thinkers have long started considering knowledge as a major determinant of innovative capabilities and therefore economic growth, intangible inputs of information, skills, and competence in the form of learning through experience, interaction, and networks play a significant role in competitive advantage along with traditional, codified, formally produced scientific knowledge and the conventional tangible economic inputs of growth such as land, labor, and capital. The ability of a firm to learn and adopt, in other words, the diffusion of innovation within a certain environment plays a significant role in the economic performance of firms. The ways innovation diffuse between firms of the same cluster or the same sector should be taken into consideration in any attempt to evaluate the innovation profile of the latter.

Beyond the level of the firms, the importance of the diffusion of an innovation may well precede the innovation per se if taken into account that it is a sine qua non for the multiplicative influence of the latter. Indeed the adoption of new ideas and practices, that is, innovations, from firms leads to a second-order spread to other firms. This is a precondition for the adoption of a certain innovation from a certain number of firms that constitute the critical mass for its establishment. It is for the above reasons that the study of dynamics of innovation diffusion between firms and sectors has attracted the research interest of many scholars who seek to identify which policy measures should be adopted in order to achieve competitiveness and better economic performance.

Diffusion of Innovations

In Latin, the word "diffundere" means "to spread out." Essentially being one of the several transport phenomena that occur in nature the notion of diffusion has been extensively researched and used apart from the physical sciences from the social sciences as well, with anthropology being one of the first scientific fields shedding light on the characteristics of this phenomenon. In his influential paper, Kroeber notes that this certain pattern of diffusion which he calls stimulus or idea diffusion "occurs in situations where a system or pattern as such encounters no resistance to its spread, but there are difficulties in regard to the transmission of the concrete content of the system. In this case it is the idea of the complex or system which is accepted, but it remains for the receiving culture to develop a new content."

After World War II, the accumulated body of research in the field of diffusion started having application in market research. The ongoing industrialization and competition for market share highlighted the importance of notions such as the diffusion which in turn led to the increased finance and research interest from the academic community. In recent decades, the concept of innovation is considered a core topic of research in many heterogeneous scientific fields, ranging from anthropology to politics and from education to marketing.

In the field of innovation, the relevant research is based on Rogers' fundamental theory of innovation diffusion (Rogers 1962). According to him, innovation is "an idea, practice or object that is perceived as new by an individual or other unit of adoption," whereas diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a social system." Going further, Rogers (1962) discusses five factors that impact the rate of adoption: (1) relative advantage, (2) compatibility, (3) complexity, (4) trial-ability, and (5) observability.

In this seminal work, Rogers (1962) argues that diffusion is a generic process not depending on the type of innovation or other spatiotemporal characteristics, displaying the same regularities across many typological boundaries. Further research has highlighted certain characteristics of these patterns of diffusion aiming at the design of relevant models of the spread of an innovation mainly in marketing.

Most relevant research has tried to represent the several reactions of the diffusion process with mathematical equations presenting a formalistic approach to the study of this phenomenon. Gatignon and Robertson (1986) differentiate between theoretical (descriptive), normative, and empirical models. It is worth noticing that research in dynamics of innovation diffusion in the field of marketing has mainly focused on the temporal pattern of this diffusion as an innovation spreads over a population following a pattern that resembles the spread of a disease over a human or animal population. It is thus only fair to investigate whether the diffusion pattern of innovation and the diffusion pattern of diseases share similarities and obey the same general rules.

Epidemiology in the Study of Innovation Diffusion

The current era is characterized by the emergence of new fields of study that transverse the traditional boundaries between scientific fields. The new evolving concepts of globalization and the emergence of the new vast markets of East Asia pose great challenges to the political and economic field. Researchers from different disciplines are trying to explain and interpret the different phenomena using not merely traditional theoretical tools from their tract but also enriching their armamentarium from ideas and methods from other disciplines. For traditional industrial powers such as the USA and the EU, the massive transfer of manufacturing to East Asia has highlighted the need for a paradigm shift in the economy. Innovation plays a more important role than ever since these regions have to innovate since they cannot rely on manufacturing anymore. An important and well-studied aspect of the innovation concept is the diffusion of the latter. The significance of diffusion relies on its multiplicative effect which is often many times more important than the innovation per se. As already mentioned elsewhere, diffusion of innovation has been extensively studied and many fruitful conclusions have been drawn. However, there are many aspects of this phenomenon that need an alternative approach for their research. Epidemiology has gained popularity in the last decades as it represents a "generic" science, offering methods of study that can be applied to many different scientific fields. In the last years, epidemiological tools and methods have already been incorporated into economic-related fields of study such as epidemiology economics and pharma-economics. Taking into account the similarities between diffusion of innovations and diffusion (in terms of contagion) of diseases in a certain "selection" environment, it can be argued that epidemiology can be used in the study of innovation diffusion among economic entities. However, it should refer to potential limitations of an attempt mainly due to prevailing differences between spread of diseases and diffusion of innovation such as the fact that adoption of innovation is a conscious act that usually offers an advantage to the adopter who, in contrast to a host infected from a disease, does not activate his immune system in order to eliminate the offending agent.

In medicine, the dynamics of disease transmission, that is, contagion, is based on a schema consisting of a source or reservoir of infection, a transmission mode, and a susceptible host. In this model, the source of infection is defined as the person, animal, object, or substance from which an infectious agent passes or is disseminated to the host (immediate source). The reservoir is the natural habitat of the infectious agent. A carrier is an infected person or animal that harbors a specific infectious agent in the absence of discernible (visible) clinical disease. A carrier serves as a potential source of infection to others. The transmission can be direct or indirect. The susceptible host provides a portal of entry and those environmental circumstances where the infectious agent can replicate, exit the organism and again, directly or indirectly, affect others. A schematic representation of the above-mentioned characteristics would then look like the following:

Host---exposed host---infected host---cured host.

In such an attempt, the first step is to define the economic entity being referred to, that is, the host. Although in a networked economy different economic levels (firm, sector, cluster) are connected with each other, we need to identify the basic entity that will later serve as the host of the contagious agent.

In this view, the most appropriate analogy is between a human organism living in a certain environment and a company active in a networked cluster. Indeed, if it is taken into account that human beings are similar to their basic functions, choosing the level of company as analogue to the human level eliminates potential confounding factors that would be implicated if economic entities of different scales are chosen such as a company, a cluster, a sector, or a market economy. The sample of a possible epidemiological study referring to business entities should be kept as homogenous as possible since that would allow for the extrapolation and generalization of the relevant results.

Special Case-in-Point: The Academic Firm

The "academic firm" represents a type of firm (firm-based organization) that focuses on encouraging, supporting, and advancing knowledge production (research, research and experimental development, R&D) and knowledge application (innovation) within the context of the Quadruple Innovation Helix (Government, University, Industry and Civil Society) (Carayannis and Campbell 2009). The academic firm is also inclined to generate profit (revenues), but follows here more the logic of a "sustainability" in balance with knowledge production and the principles of knowledge production. The contrary concept to the academic firm would be the "commercial firm," which is primarily being motivated and driven out of an interest of maximizing profit (revenues). Between these two conceptual poles of understanding, there are various possibilities of a gradual or also unconventional (radical) combination of principles for the empirical organization of a concrete firm, its organizational manifestation. The shortcut for a definition therefore is: "The Commercial Firm concentrates on maximizing or optimizing profit, whereas the Academic Firm focuses on maximizing or optimizing knowledge and innovation" (Carayannis and Campbell 2012, p. 27).

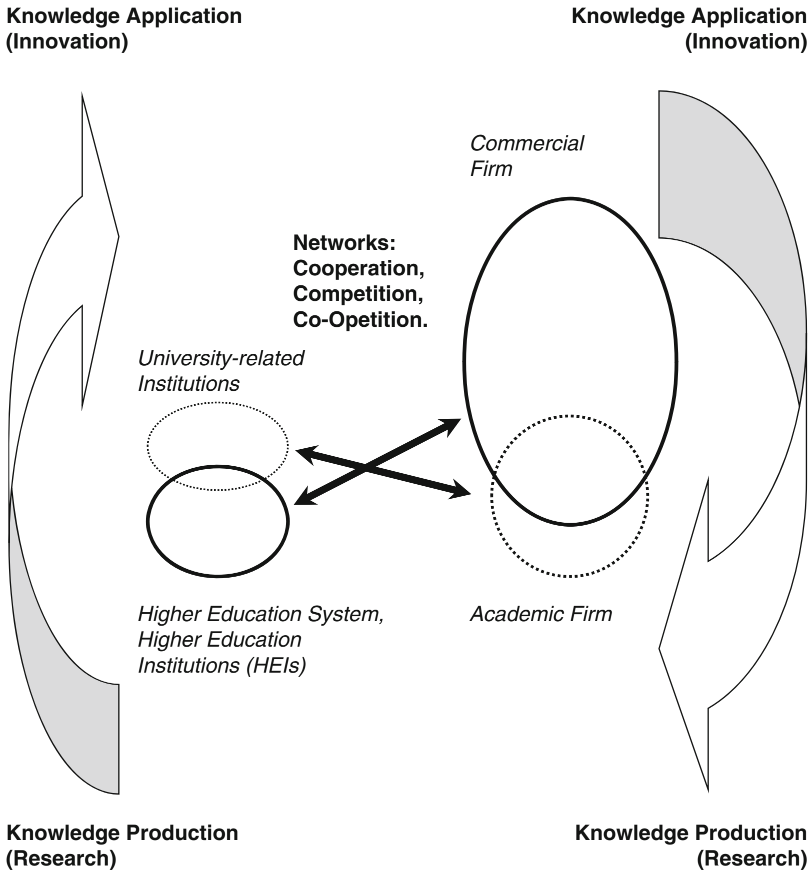
Knowledge and innovation are crucial key drivers for the academic firm. Academic firms can follow the logic of linear innovation, but also the logic of nonlinear innovation. The model of linear innovation often is being assigned to Vannevar Bush (1945). This model assumes a sequential "first-then" relationship, where there is first basic research at universities that gradually diffuses out into society and economy, and where firms then translate the lines of basic research into application and economic as well as commercial uses and profits. But nonlinear innovation favors a different approach. Nonlinear innovation is interested in a more direct and parallel coupling of knowledge production and knowledge application, where there are mutual interferences and parallel as well as parallelized interactions between basic research and knowledge application. The organization of nonlinear innovation encourages creative organizational designs (Campbell and Carayannis 2012). In context of firm-based organizations, also for the academic firm, the processing and advancement of nonlinear innovation may imply the following: (1) firms (academic firms) engage simultaneously in different technology life cycles at different levels of technology maturity; (2) firms (academic firms) accept to a certain extent, even encourage, cross-employment of their employees with other institutions, for example, academic institutions, such as universities or other higher education institutions. Cross-employment, as a concept, identifies forms and varieties of multi-employment, where an individual person is being simultaneously employed by more than one organization (by at least two organizations): Should those organizations also root in different sectors, then cross-employment displays characteristics of a trans-sectoral network-building (Campbell 2011).

Academic firms express a particular interest to network with universities, other higher education institutions, university-related institutions, and all forms and manifestations of organizations that conduct an academically based type of research or basic research. Academic firms explore also possibilities, options, and opportunities of networking with other firms (academic firms, but also commercial firms). There always remains the challenge, how to balance and how to refer to each other (out of the perspective of the firms) with regard to cooperation and competition. Furthermore, networks can integrate aspects of cooperation and competition. The organizational design of patterns of cooperation and competition allows creativity, and can also be captured and described by the notion and concept of "Co-Opetition" (Brandenburger and Nalebuff 1997) (see Fig. 1).

Knowledge production in context of universities and the higher education system has been explained on the basis of the models of "Mode 1" and "Mode 2" of knowledge production. Mode 1 emphasizes a traditional understanding and refers to university basic research, with no particular interest in knowledge application, and being organized in context of academic disciplines. Here, the established peers of the academic disciplines define and decide on quality (acceptance and rejection of work). Mode 2 already expresses a greater interest in knowledge application and is characterized by the following principles: "knowledge produced in the context of application"; "transdisciplinarity"; "heterogeneity and organizational diversity"; "social accountability and reflexivity"; and finally "quality control" (Gibbons et al. 1994, pp. 3–8, 167; see furthermore Nowotny et al. 2001, 2003 and 2006).

"Mode 3" universities or higher education institutions are inclined to seek and to explore creative, novel, and innovative combinations of Mode 1 and Mode 2. One key interest of Mode 3 is "basic research in the context of application" (Campbell and Carayannis 2013, p. 34). Mode 2 as well as Mode 3 universities clearly meet and fulfill some of the characteristics of the "entrepreneurial university." However, it is important to realize that a Mode 3 university is more than an entrepreneurial university, in the sense that Mode 3 universities are still interested in focusing on and in conducting basic research. But the Mode 3 university does not assume an intrinsic contradiction between basic research and innovation (knowledge application): in fact, quite contrarily, the Mode 3 university sees benefits and opportunities in a parallel (nonlinear) approach to knowledge production and knowledge application, to forms of combinations between basic research and innovation.

Epidemiology of Innovation: Concepts and Constructs, Fig. 1 Knowledge production, linear and nonlinear innovation interaction between academic firms, commercial firms, and universities (higher education institutions) (Source: Authors' own conceptualization based on Carayannis and Campbell (2009, p. 211; 2012, p. 25) and on Campbell and Carayannis (2013, p. 29))



Mode 3 universities (higher education institutions) have the opportunity of offering and developing "Creative Knowledge Environments" (on creative knowledge environments, see Hemlin et al. 2004).

Mode 2 and Mode 3 higher education institutions are the perfect organizational vis-à-vis of academic firms to engage in trans-sectoral networks and to perform good knowledge production. Here, a creative and innovative hybrid overlapping in regular frequency occurs or should possibly occur. This represents a coming-together and networking on equal and fair grounds. Not the universities (higher education institutions) should adapt one-sidedly to firms and their economic needs, but both sides should learn mutually from each other to the benefit of all involved parties, actors, and institutions. The assertion is: "While the entrepreneurial (Mode 2) university represents a partial extension of business elements to the world of academia, the academic firm could serve as an example for an extension of the world of academia to the world of business. Academic firms are knowledge-oriented, interested in engaging in networks with universities (the higher education sector), encourage 'academic culture and values' to motivate their employees, allow forms of academic work (such as academic-style publishing), and support continuing education and life-long learning of and for their employees (flexible time schemes, honoring life-long learning and continued continuing education with internal career promotion)" (Carayannis and Campbell 2012, p. 27).

Conclusion and Future Directions

Epidemiological tools and methods have already been incorporated in economic and economically related fields of study such as epidemiology economics and pharma-economics. It is therefore fair to argue that these methods could also be applied to other economic issues such as the study of the diffusion of innovation. The recent global economic developments have revealed the existence of clear analogies between medicine and economic science underlined by the usage of relevant expressions in scientific papers (e.g., economic recovery, economic health, financial health). It is often written that the economic crisis manifests itself like a "financial disease" and spreads throughout the financial markets. Traditional empirical and theoretical frameworks have failed to incorporate the effects of these types of "social contagion" in their predictive models. It is therefore of crucial importance to explore if these analogies between medical and economic terms could be used as the basis for a new conceptual framework that links these metaphors to economic science concepts and to innovation in more particular. Development of relevant models could theoretically lead through the real-time identification of early signs and symptoms to the adoption of appropriate measures and control of possible contagion.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Academic Firm
- ▶ Ambidexterity
- ▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
- ▶ Artistic Research
- ▶ China's National Innovation System
- ▶ Creative Knowledge Environments
- ▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation
- ▶ Epistemic Governance and Epistemic Innovation Policy
- ▶ Global University System in World Society
- ▶ Higher Education and Innovation
- ▶ Innovation System of India
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Multi-level Systems of Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Nonlinear Innovations
- ▶ N-Tuple of Helices
- ▶ Palliative Care and Hospice - Innovation at End of Life
- ▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Systems Theory and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)
- ▶ Triple Helix of University-Industry-Government Relations
- ▶ University Research and Innovation

References

Brandenburger AM, Nalebuff BJ. Co-opetition. New York: Doubleday; 1997.

Bush V. Science: the endless frontier. Washington, DC: United States Government Printing Office; 1945. http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm#transmittal

Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als Chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE. 2011. http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500. 2 Feb 2011.

Campbell DFJ, Carayannis EG. Lineare und nicht-lineare Knowledge Production: innovative Herausforderungen für das Hochschulsystem. Z Hochsch. 2012;7(2):64–72. http://www.zfhe.at/index.php/zfhe/article/view/448.

Campbell DFJ, Carayannis EG. Epistemic governance in higher education. Quality enhancement of universities for development. Springer briefs in business. New York, NY: Springer; 2013. http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6

Carayannis E. The strategic management of technological learning. Boca Raton: CRC Press; 2000.

Carayannis EG, Campbell DFJ. "Mode 3" and "quadruple helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manag 2009; 46 (3/4): 201–34. http://www.inderscience.com/browse/index.

php?journalID=27&year=2009&vol=46&issue=3/4 and http://www.inderscience.com/search/index.php?action=record&rec_id=23374&prevQuery=&ps=10&m=or
Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development. Springer briefs in business. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3.
Gatignon H, Robertson T. An exchange theory model of interpersonal communication. Adv Consum Res. 1986;13:534–8.
Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.
Hemlin S, Allwood CM, Martin BR. Creative knowledge environments. The influences on creativity in research and innovation. Cheltenham: Edward Elgar; 2004.
Nowotny H, Scott P, Gibbons M. Re-thinking science. Knowledge and the public in an age of uncertainty. Cambridge: Polity Press; 2001.
Nowotny H, Scott P, Gibbons M. Mode 2 revisited: the new production of knowledge. Minerva. 2003;41:179–94.
Nowotny H, Scott P, Gibbons M. Re-thinking science: mode 2 in societal context. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006. p. 39–51.
Rogers EM. Diffusion of innovations. New York: The Free Press; 1962.

Episodic Future Thought

▶ Imagination

Epistemic Base

▶ Epistemic Governance and Epistemic Innovation Policy

Epistemic Engineering

▶ How Does Material Culture Extend the Mind?

Epistemic Governance and Epistemic Innovation Policy

David F. J. Campbell[1,2] and Elias G. Carayannis[3]
[1]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen-Adria-University Klagenfurt, Vienna, Austria
[2]University of Applied Arts, Vienna, Austria
[3]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA

Synonyms

Epistemic base; Knowledge paradigms; Linear innovation; Network governance; New public management; Nonlinear innovation; Philosophy of governance; Quality assurance; Quality dimensions; Quality enhancement; Quality management; Underlying epistemic structure

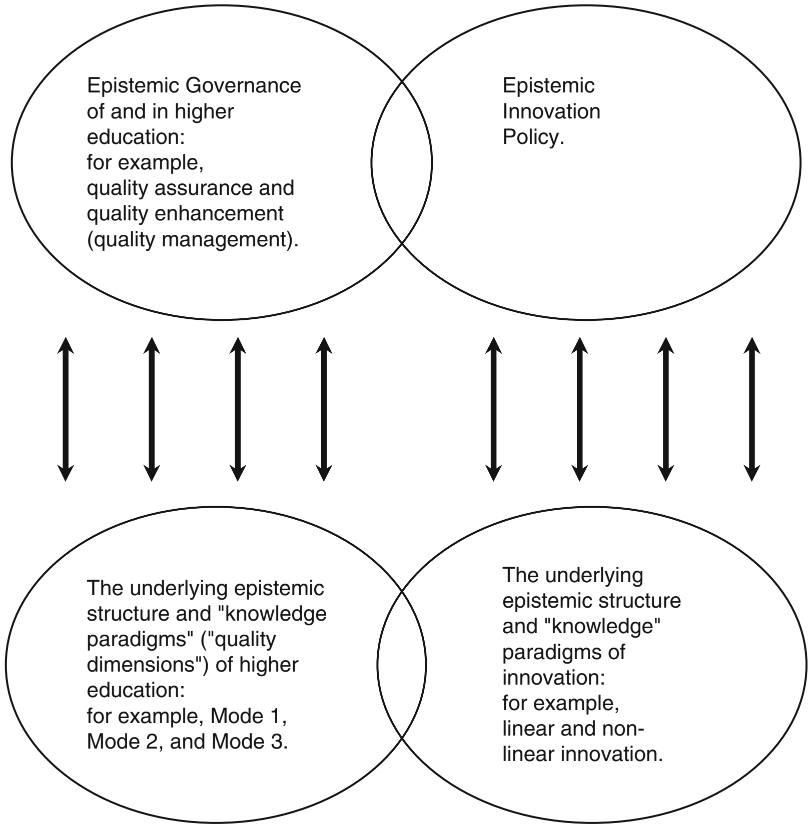
The Conceptual Definition of Epistemic Governance and of Epistemic Innovation Policy

The concept of epistemic governance is based on the understanding that the underlying epistemic structure, the underlying epistemic base, and the underlying epistemic paradigms of those organizations, institutions, or systems (sectors) are being addressed, which should be governed. In context of higher education, governance can refer not only to internal governance within a university (higher education institution) or within the higher education system but also to external governance, for example, governance measures of a government for universities. A more detailed definition of epistemic governance would stress as follows: "'Epistemic' governance of and in higher education therefore requires that the underlying epistemic structure of higher education and, more particularly, also the underlying paradigms of the produced knowledge are being addressed. Epistemic governance refers directly to the underlying 'knowledge paradigms' of higher education that carry and drive higher education" (Campbell and Carayannis 2013, p. 27). Here, in this definition, the focus is placed on "epistemic" in the context of "epistemic governance." Consequently, one important implication therefore is "good, sustainable and effective (external and/or internal) governance of organizations, institutions or systems (sectors) is in the long run only possible, when the underlying epistemic structure, the underlying epistemic base or the underlying epistemic paradigms" are indicated (Campbell and Carayannis 2013, p. 27). The epistemic structure reveals also what the self-rationale of an organization or a system is. Alternative definitions of epistemic governance may lean more toward the aspect of governance within the context of epistemic governance: "In this context the conceptual framework of 'epistemic governance' aims to address the power relations in the modes of creating, structuring, and coordinating knowledge on socio-ecological issues. . . . Finally, the production and use of knowledge is seen to be linked to questions of relational, structural, and soft power, and to the relationship between science and policy" (Vadrot 2011, p. 50).

Is it possible that there is an organization, institution, or system without an underlying epistemic structure? This may (or may not) be true for some organizations or institutions; however, for a whole system or sector, this appears to be unlikely and improbable. Particularly in the case of universities, higher education institutions, and higher education systems, it is evident that these rely, operate, and behave on the basis of an underlying epistemic structure. "Knowledge paradigms" refer to the conceptual understanding of knowledge production (research) and knowledge application (innovation) in the higher education system (universities) or the economy (firms). For describing and explaining how knowledge production is functioning within the higher education sector or a university-type system, the concepts of "Mode 1" and "Mode 2" of knowledge production were introduced more recently (Gibbons et al. 1994; see also Nowotny et al. 2001, 2003, 2006). University research in a traditional understanding of Mode 1 concentrates on basic research, mostly organized within the matrix of academic disciplines, and not formulating a particular interest for the practical use of knowledge and innovation. Mode 1 is being challenged by Mode 2. Mode 2 expresses a greater interest for knowledge application and a knowledge-based problem-solving by referring to the following principles: "knowledge produced in the context of application," "transdisciplinarity," "heterogeneity and organizational diversity," "social accountability and reflexivity," and "quality control" (Gibbons et al. 1994, pp. 3–8, 167). Success and quality are being approached and defined differently in the analytical architecture of Mode 1 and the Mode 2. For Mode 1, the answer is "academic excellence, which is a comprehensive explanation of the world (and of society) on the basis of 'basic principles' or 'first principles', as is being judged by knowledge producer communities (academic communities structured according to a disciplinary framed peer review system)." For Mode 2, success and quality are a "problem-solving, which is a useful (efficient, effective) problem-solving for the world (and for society), as is being judged by knowledge producer and knowledge user communities" (Campbell and Carayannis 2013, p. 32). Mode 3 knowledge production represents the conceptual and organizational attempt of trying to combine Mode 1 with Mode 2 (Carayannis and Campbell 2006, 2009, 2012). A Mode 3 university, higher education institution or higher education system, is a type of organization or system that explores ways and approaches of not only integrating different principles of knowledge production and knowledge application (such as Mode 1 and Mode 2), thus promoting diversity and heterogeneity, but also creating creative and innovative organizational contexts for research, teaching (education), and innovation. Therefore, Mode 1, Mode 2, and Mode 3 qualify as examples for "knowledge paradigms" in higher education.

Quality management (QM) within universities or other higher education institutions refers to quality assurance but increasingly also to quality enhancement. Advances in the quality of a university and support of university development represent objectives of quality management. Therefore, also quality management should be designed, implemented, processed, and developed in accordance with the principles of epistemic governance: “This emphasizes our understanding that all forms of comprehensive and sustainable quality management in higher education must also refer to the underlying epistemic structure of higher education (at least implicitly)” (Campbell and Carayannis 2013, p. 27). For example, it makes a difference, whether a university or university unit operates according to Mode 1 or Mode 2 or a combination of both in Mode 3. This must be reflected by the specifically applied approaches in governance and quality management. For that purpose, it appears also to be necessary to connect and to link the underlying epistemic structure and the knowledge paradigms to concrete “quality dimensions” so that governance and quality management can refer to knowledge paradigms as well as quality dimensions. Possible quality dimensions are quality, efficiency, relevance, viability (sustainability), and effectiveness (Campbell 2003, p. 111; Campbell and Carayannis 2013, p. 52). When knowledge paradigms are being translated into quality dimensions, this may make it then for governance and quality management easier to address epistemic issues in relation not only to knowledge production but also to knowledge application. According to Ferlie et al. (2008, 2009), there exist currently two main narratives of and for governance in higher education: New Public Management (NPM) governance and network governance. While NPM already appears to be more conventionally established, network governance represents a more radical frontier for contemporary governance, with not so clear implications, fostering perhaps a demand for creating also new types of organizational manifestation in higher education. “Cross-employment” (Campbell 2011; Campbell and Carayannis 2013) may serve here as one possible example, where one and the same person is being simultaneously employed by more than one organization (by at least two organizations), either within higher education or trans-sectorally connecting higher education with organizations outside of higher education. Cross-employment qualifies as a form of multi-employment.

Ramifications of epistemic governance should also be thought of in a wider context. Principles of epistemic governance apply to innovation and innovation policy as well and the concept of “epistemic innovation policy.” Innovation policy should address the underlying epistemic structure and knowledge paradigms of the innovation and type of innovation to be governed. Two examples for knowledge paradigms in context of innovation are linear innovation and nonlinear innovation. The more traditional model of linear innovation is being frequently referred to the concepts of Vannevar Bush (1945). The core understanding here is as follows: the linear model of innovation underscores that first there is basic research in a university context. Gradually and step-by-step, this university research diffuses out into society and the economy. Firms and the economy as a whole pick up these lines of university research and develop them further into knowledge application and innovation, with the goal and interest of creating economic and commercial success and success stories in markets outside of higher education. Within the model of linear innovation, there operates a sequential first-then relationship between basic research (knowledge production) and innovation (knowledge application). Nonlinear innovation follows a different logic (Campbell and Carayannis 2012). The model of nonlinear innovation expresses an interest in drawing more direct connections between knowledge production and knowledge application. Here, basic research and innovation are being coupled together not in a first-then but within the structural design of an “as well as” and “parallel” (parallelized) relationship (Campbell and Carayannis 2012). Networks for nonlinear innovation operate differently than networks of linear innovation but may overlap substantially. Examples for nonlinear innovation are either firms or other types of organizations operating across a variety or ensemble of technology life cycles with differing degrees of technology maturity on the one hand or specific constellations of cross-employment on the other hand, where persons work (at the same time) concurrently at organizations, where in one case the organization (organizational unit) focuses on knowledge production but in the other case on knowledge application. Nonlinear innovation also cross-connects to Mode 3 knowledge production. One key interest of Mode 3 is to



Epistemic Governance and Epistemic Innovation Policy, Fig. 1 Epistemic governance of and in higher education, and epistemic innovation policy (Source: Authors' own conceptualization based on Campbell and Carayannis (2013, p. 28))

encourage and to promote "basic research in the context of application" (Campbell and Carayannis 2013, p. 34). Furthermore, also Mode 2 appears to be compatible with a more nonlinear logic of innovation (see Fig. 1).

Conclusion and Future Directions

Epistemic governance and epistemic innovation policy formulate a critique against too-narrowly defined approaches to governance, where governance follows one-sidedly bureaucratic or technocratic considerations. Instead, epistemic governance (also quality management and quality enhancement) and epistemic innovation policy should be regarded as a plea for a more comprehensive understanding, where the explicit-making comprehension and reflection of knowledge, knowledge production, and knowledge application are keys for a successful governing and governance. In that respect, epistemic governance speaks and argues also in favor for the practical feasibility of a "Philosophy of Governance." Epistemic governance, as a concept and as a practice, qualifies as a novel form of governance, representing a new and innovative frontier and frontier line of and for governance, with a hybrid overlapping to other concepts and measures such as network governance, cross-employment, and epistemic innovation policy. There is also a governance of innovation and innovation policy, so the cross-connections between epistemic governance and epistemic innovation policy demand further elaboration and a more advanced fine-tuning for practical purposes. In conceptual terms, epistemic governance and epistemic innovation policy still require to be broadened and expanded. For example, also universities of the arts are being regarded as institutions that contribute considerably to national and multilevel innovation systems (Carayannis and Campbell 2012, pp. 14–17). From that universities-of-arts-based input, important interdisciplinary and transdisciplinary impulses ought to be expected. The specific and potential roles of arts universities and artistic research, also in connection to their governance and epistemic governance, are to be further developed. The same applies to cross-connections between artistic research, artistic innovation, and epistemic innovation policy.

Cross-References

▶ Academic Entrepreneur, Academic Entrepreneurship
▶ Academic Firm
▶ Ambidexterity
▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Artistic Research
▶ China's National Innovation System
▶ Creative Knowledge Environments
▶ Cross-Employment
▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation
▶ Global University System in World Society
▶ Higher Education and Innovation
▶ Innovation Policies (vis-à-vis Practice and Theory)
▶ Innovation System of India
▶ Interdisciplinary Research (Interdisciplinarity)
▶ Joseph A. Schumpeter and Innovation
▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship
▶ Mode 1, Mode 2, and Innovation
▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
▶ Multi-level Systems of Innovation
▶ National Innovation Systems (NIS)
▶ Nonlinear Innovations
▶ N-Tuple of Helices
▶ Palliative Care and Hospice - Innovation at End of Life
▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
▶ Systems Theory and Innovation
▶ Transdisciplinary Research (Transdisciplinarity)
▶ Triple Helix of University-Industry-Government Relations
▶ University Research and Innovation

References

Bush V. Science: the endless Frontier. Washington, DC: United States Government Printing Office; 1945. http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm#transmittal.

Campbell DFJ. The evaluation of university research in the United Kingdom and the Netherlands, Germany and Austria. In: Shapira P, Kuhlmann S, editors. Learning from science and technology policy evaluation: experiences from the United States and Europe. Camberley: Edward Elgar; 2003. p. 98–131.

Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als Chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE (February 2, 2011); 2011. http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500.

Campbell DFJ, Carayannis EG. Lineare und nicht-lineare knowledge production: innovative Herausforderungen für das Hochschulsystem. Z Hochsch. 2012;7(2):64–72. http://www.zfhe.at/index.php/zfhe/article/view/448.

Campbell DFJ, Carayannis EG. Epistemic governance in higher education. Quality enhancement of universities for development, Springer briefs in business. New York: Springer; 2013. http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6.

Carayannis EG, Campbell DFJ. "Mode 3": meaning and implications from a knowledge systems perspective. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006. p. 1–25.

Carayannis EG, Campbell DFJ. "Mode 3" and "quadruple helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manag. 2009;46(3/4):201–34. http://www.inderscience.com/browse/index.php?journalID=27&year=2009&vol=46& issue=3/4 and http://www.inderscience.com/search/index.php?action=record&rec_ id=23374&prevQuery=&ps=10&m=or.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development, Springer briefs in business. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3.

Ferlie E, Musselin C, Andresani G. The steering of higher education systems: a public management perspective. Higher Educ. 2008;56(3):325–48. http://www.springerlink.com/content/n22v788851377144/fulltext.pdf.
Ferlie E, Musselin C, Andresani G. The governance of higher education systems: a public management perspective. In: Paradeise C, Reale E, Bleiklie I, Ferlie E, editors. University governance. Western European comparative perspectives. Dordrecht: Springer; 2009. p. 1–20.
Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.
Nowotny H, Scott P, Gibbons M. Re-thinking science. Knowledge and the public in an age of uncertainty. Cambridge: Polity Press; 2001.
Nowotny H, Scott P, Gibbons M. Mode 2 revisited: the new production of knowledge. Minerva. 2003;41:179–94.
Nowotny H, Scott P, Gibbons M. Re-thinking science: Mode 2 in societal context. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006. p. 39–51.
Vadrot ABM. Reflections on Mode 3, the co-evolution of knowledge and innovation systems and how it relates to sustainable development. Conceptual framework for "epistemic governance". Int J Soc Ecol Sus Dev. 2011;2(1):44–52. http://www.igi-global.com/bookstore/article.aspx?titleid=51636.

Ethnic Entrepreneurship

▶ Diversity and Entrepreneurship

Evaluative Thinking

▶ Dialogical Critical Thinking in Children, Developmental Process

Everyday Creativity

▶ Business Creativity

Evolution

▶ Invention and Modification of New Tool-Use Behavior

Exit

▶ Firm Failure and Exit

Experience-Based Learning, Innovation

▶ Experiential Learning and Creativity in Entrepreneurship

Experiential Learning

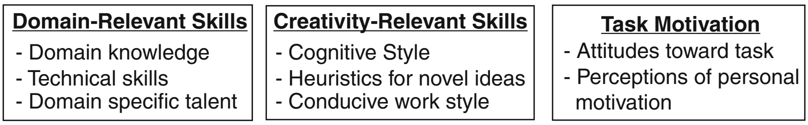
▶ Experiential Learning and Creativity in Entrepreneurship

Experiential Learning and Creativity in Entrepreneurship

Robert M. Gemmell[1] and David A. Kolb[2]
[1]Department of Strategy and Entrepreneurship, Robinson College of Business, Georgia State University, Atlanta, GA, USA
[2]Department of Organization Behavior, Weatherhead School of Management, Case Western Reserve University, Cleveland, OH, USA

Synonyms

Creativity; Entrepreneurship; Experience-based learning, Innovation; Experiential learning; Learning from experience



Experiential Learning and Creativity in Entrepreneurship, Fig. 1 Components of creativity (Amabile 1983)

Definition

Entrepreneurial creativity can be defined as the social and cognitive processes through which entrepreneurs develop novel and useful ideas that transform and create new markets (Gemmell et al. 2011). Innovative entrepreneurs form new businesses by applying creative ideas to produce unique and transformative new products and services. Experiential learning theory (ELT), described by David Kolb as the "dynamic view of learning based on a learning cycle driven by the resolution of the dual dialectics of action/reflection and experience/abstraction" (Kolb 1984), has dramatically expanded researchers' understanding of how entrepreneurs use creativity to solve customer problems and produce innovative new products and services.

Theoretical Background

The Kolb experiential learning theory (Kolb 1984) has been a useful tool for addressing the real-world challenges of entrepreneurial creativity and innovation. The core principles of experiential learning permeate other similar theories of learning, demonstrating the vast impact of experiential learning on learning and creativity scholars. There are many theories of creativity; however, Teresa Amabile's Componential Framework (Amabile 1983) and the classical Wallas' stages of creativity (Wallas 1926) have proven most highly impactful to management studies.

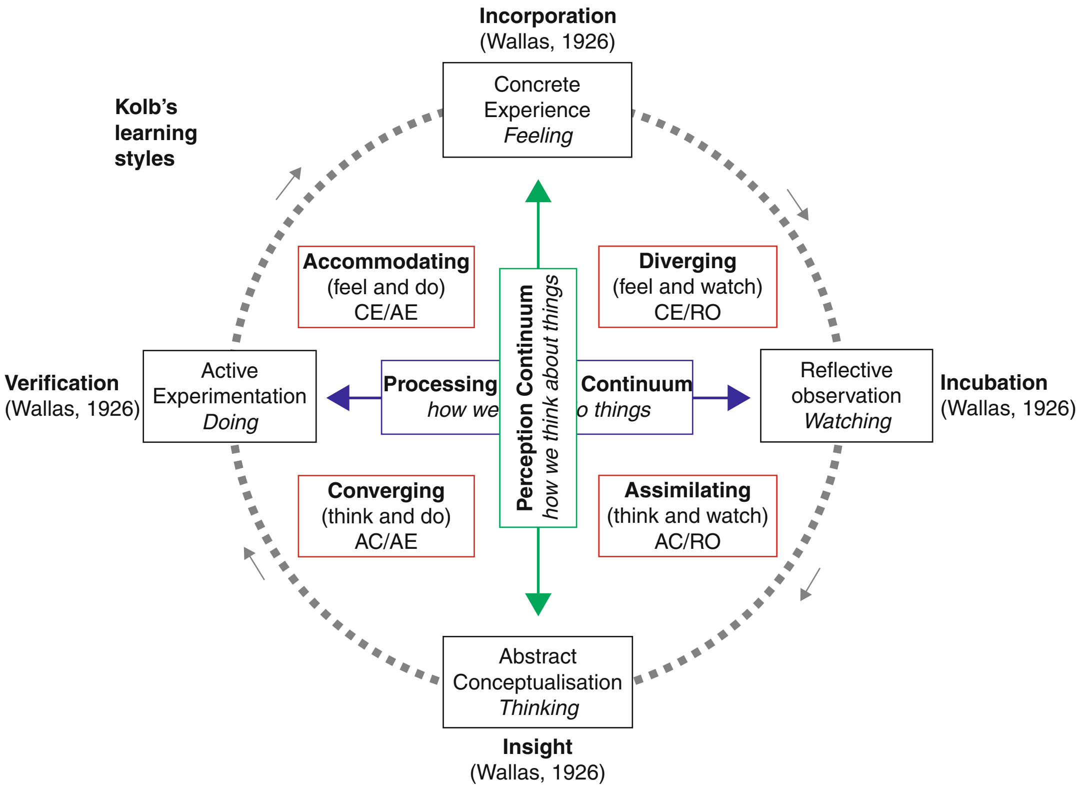
Learners have a preference for certain learning modes of grasping and transforming experience into understanding which are defined as the individual's "learning style." Learning style can be correlated to career choices, i.e., learners with a diverging style are often interested in the arts while convergent learners tend to be specialists in technical fields. Assimilative learners are usually interested in theory and abstract problem solving while accommodative learners gravitate toward action-oriented careers such as marketing and sales. Learners may also have a balanced or flexible style that allows them to adapt their learning on a situational basis.

Amabile's theory of creativity involves three components – domain knowledge, creativity skills, and motivation (summarized in Fig. 1 below).

Successful entrepreneurs learn two forms of knowledge: (1) domain knowledge related to a particular market or technology and (2) knowledge of how to be an entrepreneur ("entrepreneuring") (Minniti and Bygrave 2001). Entrepreneurs require a base of domain knowledge in order to perform creative transformational processes; however, base knowledge is a "double-edged sword" and can lead to entrenchment and inflexibility (Dane 2010). Recent research has shown that entrepreneurs tend to innovate within a relatively narrow space, demonstrating the extraordinary role of domain knowledge within the practice of innovation (Gemmell et al. 2011).

Knowledge is essential to entrepreneurial opportunity recognition, and asymmetries in both knowledge and learning style likely account for why entrepreneurs in the same environment do not all recognize the same opportunities (Shane 2000; Corbett 2007).

Amabile's second component, creativity skills, refers to cognitive style, heuristics, and creativity techniques. Cognitive styles are closely related to Kolb's learning styles and consist of an individual's preferred approaches to solving problems. Heuristics are algorithms or shortcuts for problem solving, and creativity skills are transformational techniques and processes utilized to facilitate development of novel ideas.

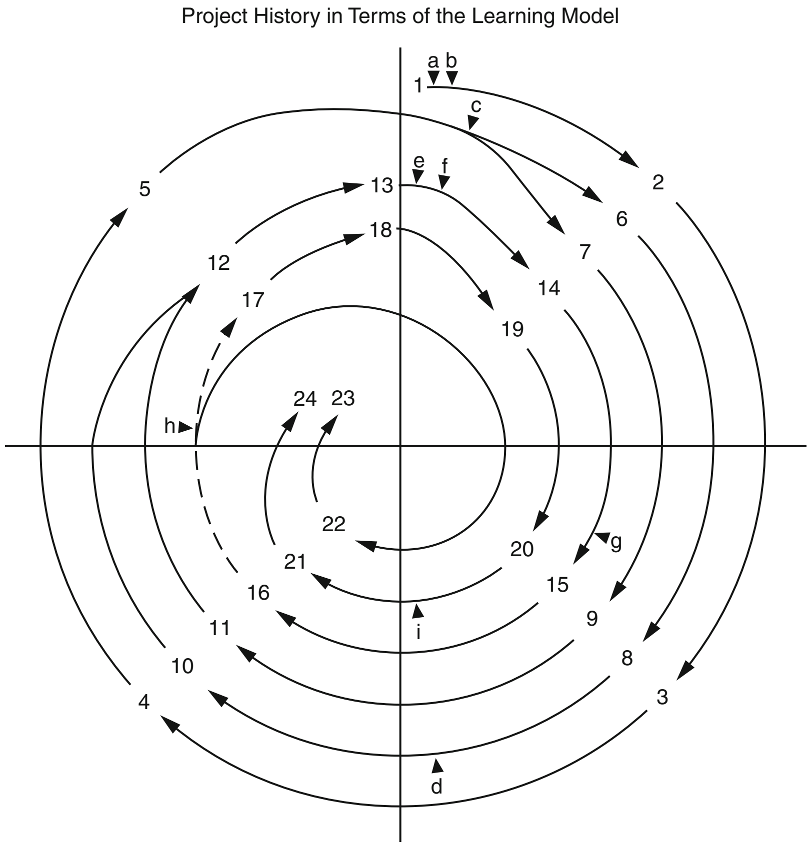


Experiential Learning and Creativity in Entrepreneurship, Fig. 2 Cycle of learning and creativity (Gemmell et al. 2011)

Intrinsically motivated individuals are compelled to creative action based on a sense of doing something important mostly for the joy of doing it (Amabile 1983). On the other hand, extrinsic motivation is derived from external pressures to perform, some of which might be perceived as useless or arbitrary. Entrepreneurs perform best under conditions of "synergistic motivation," i.e., a blend of intrinsic and extrinsic factors depending upon the stage of creative production (Amabile 1996). Intrinsic motivation matches well with relatively divergent stages of innovation while extrinsic pressure is often needed for relatively convergent stages such as production of documentation or a prototype.

Wallas' classical stages of creativity, as expanded upon by Csikszentmihalyi (1996), are merged with Kolb's experiential learning theory in Fig. 2 below to form an insightful "cycle of learning and creativity." Creative entrepreneurs typically engage problems through a direct concrete experience which triggers a variety of ideas and potential solutions. Following periods of reflection and subconscious incubation, entrepreneurs often have a flash of insight commonly referred to as an "aha" moment. The entrepreneur experiments with this trial idea resulting in additional experiences and refinement of the creative idea through cycles of learning.

The Kolb Learning Style Inventory is an individual assessment tool – as a result, the theory could be viewed as primarily an individual level model of learning. However, studies of innovation, problem solving, team learning, and organization learning have demonstrated the broad utility of Kolb's experiential learning theory across multiple domains and levels. Furthermore, the basic concepts in experiential learning theory have influenced other learning theories, some of which have endeavored to address the enormous



Experiential Learning and Creativity in Entrepreneurship, Fig. 3 Tracking R&D project in experiential learning space (Carlsson et al. 1976)

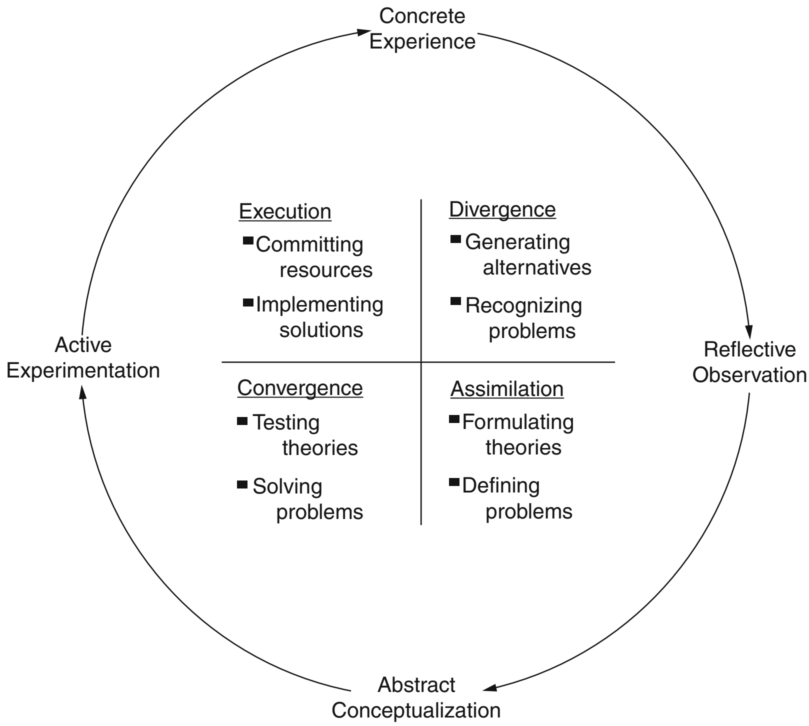
challenges of developing a comprehensive model.

Carlsson et al. (1976) used Kolb's experiential learning theory to study the processes of team innovation within an R&D setting. The research team studied biweekly reports written by members of the corporate R&D teams in order to map activities into the Kolb experiential learning space. The researchers found that activities followed the clockwise sequence of stages according to Kolb's experiential learning theory with minimal deviation (see Fig. 3 below). When steps were skipped or taken out of sequence, the impact on the project (delays, impasses, team conflicts) was generally quite evident. The mapping was an easy and effective method of tracking projects and assessing both the status and strengths/weaknesses of each project.

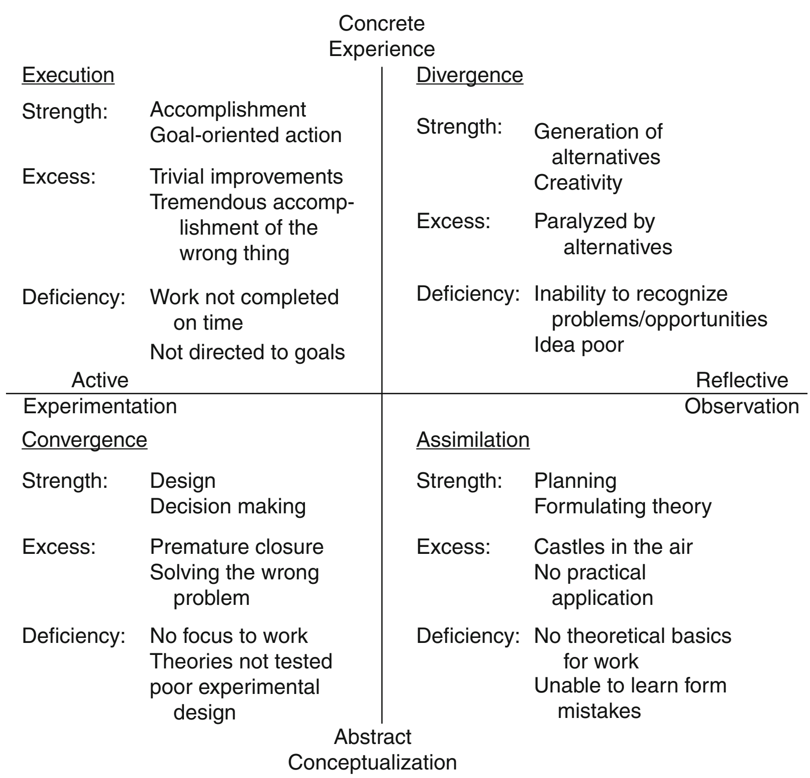
Managers would generally "look ahead" one or two stages in order to anticipate upcoming challenges. Managers were also able to address issues of entrenchment by becoming more directly involved when a team became "stuck" at a particular stage. The researchers found that project teamwork could be improved by allocating work by matching learning style of the individual with the learning stage orientation of the particular task (see Fig. 4 below).

Effective managers led the team around the model and resisted the temptation to jump across stages to accelerate projects. Interventional techniques were developed based upon the stage of the project (see Fig. 5 below). For example, teams struggling in the divergence stage were assisted with ideational techniques whereas issues with convergence could be addressed through analytical methods such as decision trees and mathematical modeling.

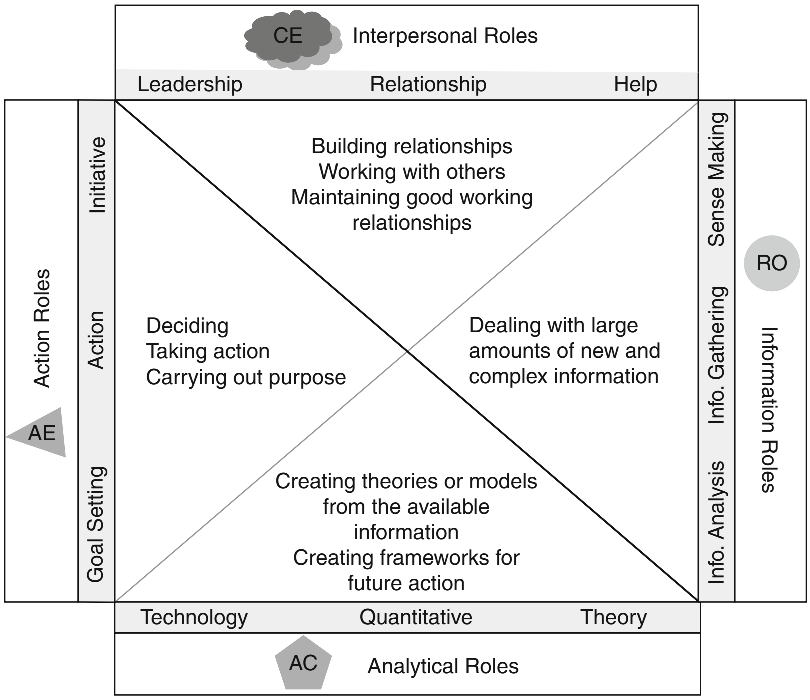
Contrary to the popular image of the entrepreneur as a loner, studies now show that most start-up firms would not even launch, much less succeed, without the collaborative efforts of



Experiential Learning and Creativity in Entrepreneurship, Fig. 4 R&D work stages in experiential learning space (Carlsson et al. 1976)



Experiential Learning and Creativity in Entrepreneurship, Fig. 5 R&D project intervention by experiential learning stage (Carlsson et al. 1976)



Experiential Learning and Creativity in Entrepreneurship, Fig. 6 Matching team members to project stages (Kolb and Kolb 2005)

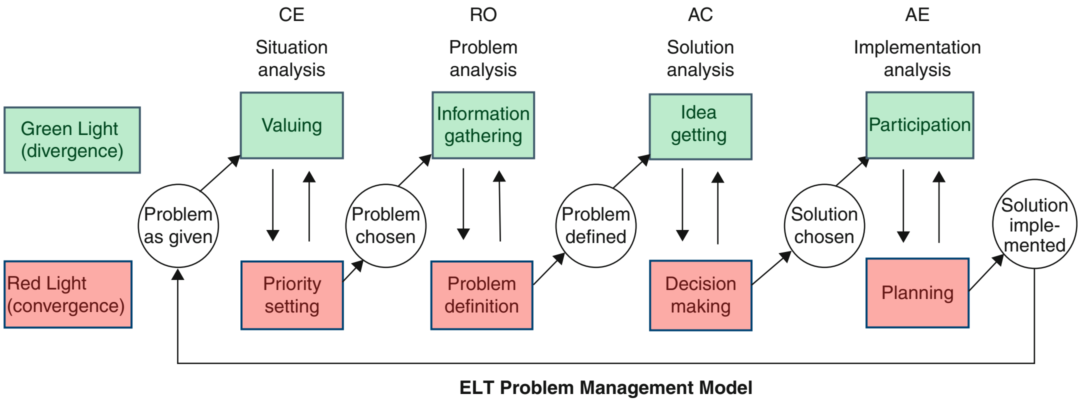
a partner and/or entrepreneurial team (Gemmell et al. 2011). The Kolb experiential learning theory has also been used effectively to examine the dynamics of team level learning and creativity. This application of experiential learning is a natural extension of Kurt Lewin's (1948) early concepts of learning space or conversational space for teams to reflect on shared experience.

Kayes and Kolb utilized Mills' team development theory (1967) to describe a five-stage progression toward increasingly more sophisticated goals and purpose: immediate gratification, sustained gratification through greater learning efforts, identification and pursuit of a collective goal, self-determination through conscious directed effort to achieve collective goals, and growth to achieve multiple increasingly complex goals requiring higher levels of innovation. The emergence of shared purpose is the defining moment when the team begins to operate as more than a collection of individuals, i.e., as a learning unit.

Team size is a balance between sufficient size to be effective without being too large to function and communicate and coordinate activities. Teams with similar superficial traits are attracted to each other and have an immediate sense of comfort (homophily); however, most researchers associate diversity with greater prospects for innovation (Ruef et al. 2003). Trust and a sense of safety (when expressing ideas to the group) are also important to team performance (Kayes et al. 2005).

Teams composed of individuals with learning style preferences covering the complete learning cycle will more easily function through the complete learning role taxonomy. However, a balanced team can be difficult to attain, especially since individuals are often attracted to certain career fields based upon their learning style (Kolb and Kolb 2005). It is desirable, although often difficult, to allocate teamwork by matching each project stage with someone whose style matches the demands of that stage (see Fig. 6 below).

Entrepreneurial teams struggle to align limited resources to either exploit known markets or explore new possibilities, knowing they lack the



Experiential Learning and Creativity in Entrepreneurship, Fig. 7 Experiential learning model of creative problem solving (Kolb 1982)

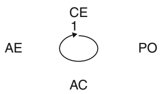
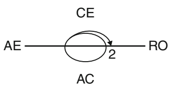
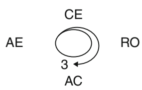
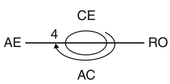
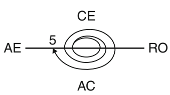
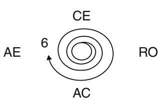
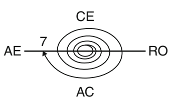
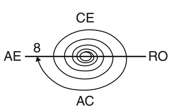
resources to do both and realizing that exploration could offer higher growth but exploitation lower risk (March 1991). Top management team (TMT) composition in a start-up firm influences the firm's preference for exploitative or exploratory strategies (Beckman 2006). Founding teams with a diverse work history (coming from different companies) are more likely to pursue an exploratory strategy because they bring different ideas and network ties into the firm. Conversely, teams composed of individuals who have all worked together previously are more likely to pursue an exploitative strategy by virtue of bringing mature exploitative routines and procedures from their previous company.

Kolb's experiential learning theory is also useful as a creative problem-solving framework to examine how entrepreneurs develop practical innovative solutions for the marketplace (Kolb 1982). Creative problem solving can be analyzed as moving through four stages, each of which is anchored in one of the four stages of experiential learning (see Fig. 7 below). Each stage alternates between a more exploratory "open" divergent cognitive process (green light) and an exploitative "closed" convergent process (red light).

The case study of entrepreneurial creativity shown in Table 1 below (Gemmell et al. 2011) shows the development of an idea from inception to product launch and offers some interesting extensions to the Kolb experiential learning theory. The case study clearly demonstrates innovation through iterative, action-oriented meta-cognitive learning by the entrepreneur. The entrepreneur in this case study consciously wrote problems and thoughts in a notebook, periodically recopying these notes to keep the problem fresh in his subconscious mind. After several months of mostly subconscious reflection, the entrepreneur experienced an epiphany (the "aha" moment) in which he realized that a troublesome product "defect" could actually be used as a creative solution to his customer's problem. Following this moment of insight, the entrepreneur skillfully used both intra-firm and strong extra-firm social contacts to further develop and refine the problem solution.

The entrepreneur also used social networks to essentially institutionalize his solution by sharing the idea with key management team members and with his board of directors to get their buy-in. This process of developing and maintaining shared vision is crucial to socialization and institutionalization of new learning (Pearce and Ensley 2004). Failure to perform this socialization process can result in dysfunctional organizational dynamics such as "not invented here." Sharing the idea with the board of directors helps to maintain an organizational culture of psychological safety since board approval means broader distribution of risk or effectively less concentration of risk on the shoulders of the CEO and management team.

Experiential Learning and Creativity in Entrepreneurship, Table 1 Case study of entrepreneurial creative idea development (Gemmell et al. 2011)

Kolb ELT map	Stage of entrepreneurial ideation
	**1. Problem Engagement (Individual)**: "I tend to write things down because it just kept it top of mind for me. I've got a note in a notebook somewhere where I wrote a note that says we need to have something we can sell directly to independent contractors, and that was the beginning of the thought.. It was enough of a reminder,"
	**2. Incubation (4–5 Months, Individual)**: "It just kept getting moved from one to-do list to the next one to the next one, and some background process in my brain was running around. I was talking to people about it. Customers, constantly talking to people about it."
	**3. Insight (Individual)**: "when I write things down like that. I have . . . these flashes. One day – it occurred to me that our technology was one weeks' worth of effort away from being able to do something that nobody else could do. So that's when it tripped over."
	**4. Social Experiment (Inner Group)**: "Great idea. We can make that work. We'll go off and get that done. . . the board was just like, "How is this going to make us more money?" So when I explained it to them, they were all excited."
	**5. Social Experiment (Close Outer Group)**: "And then in a 48-h period, I managed to scare up the two companies I wanted to partner with, get them both on the phone. I knew them, all the players there. I laid it all out and they agreed immediately."
	**6. Social Experiment (Close Outer Group)**: "She has this idea that instead of using VARs, why don't you talk to these companies that provide service? Without her and the guy from the employee outsourcing company - and the interesting thing about that is those relationships. . . are years old. . . the constant nurturing of these relationships is an important part of getting things done these days."
	**7. Social Experiment (Outer Group)**: "I talked to two or three of the value added resellers that thought they might be able to help out. . .But they didn't have any positive ideas. The interesting thing about that talking to that group was it was a roadblock conversation. "Hey, I've got this idea." Yeah, but."
	**8. Active Experiment**: "We've put up a webpage to take reservations for it just to see what kind of traction it would get in the industry. We're going to let the registration page run for five or six weeks. Then take stock of how many people are actually signing up for it and whether or not it's worthwhile in putting in the final touches."

Conclusions and Future Directions

Experiential learning theory provides a useful framework for better understanding the links between learning, entrepreneurial creativity, and innovation. Successful entrepreneurs take action to iteratively experiment, learn, and develop creative ideas.

There is growing recognition within the entrepreneurship research community of the significant and underserved role of social interactions and collaborative creativity and learning within the process of innovative new business formation. Recent data suggests the traditional assumption that simple theories of homophily and diversity do not fully explain the intricate workings of an effective entrepreneurial team or partnership.

In particular, there are open questions about the composition of an ideal partnership or team – what sort of mix of learning styles and learning flexibility (Sharma and Kolb 2009) produces the best results for an innovative start-up firm? How does this composition influence decision-making processes related to innovation?

Research has shown that entrepreneurial innovation requires a mix of both divergent exploration and convergent exploitation. Are certain teams, by virtue of their learning traits, more predisposed to innovate through exploration of new markets while others excel at innovative exploitation of well-understood markets? Is there a team learning trait composition that yields the ideal mix of both exploration and exploration (commonly referred to as ambidexterity)?

Cross-References

▶ Ambidexterity
▶ Business Creativity
▶ Cognition of Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Behavior
▶ Creative Problem Solving
▶ Creativity and Innovation: What Is the Difference?
▶ Diversity and Entrepreneurship
▶ Entrepreneurial Opportunity
▶ Ideas and Ideation
▶ Innovation and Entrepreneurship
▶ Psychology of Creativity

References

Amabile T. The social psychology of creativity: a componential conceptualization. J Personal Social Psychol. 1983;45(2):357–76.
Amabile T. Creativity in context. Boulder: Westview Press; 1996.
Beckman CM. The influence of founding team company affiliations on firm behavior. Acad Manage J. 2006;49(4):741–58.
Carlsson B, Keane P, et al. (1976) R&D organizations as learning systems. Sloan Manag Rev (Spring):6
Corbett A. Learning asymmetries and the discovery of entrepreneurial opportunities. J Bus Ventur. 2007; 22(1):97–118.
Csikszentmihalyi M. The creative personality. Psychol Today. 1996;29(4):36–40.
Dane, E. Reconsidering the Trade-Off Between Expertise and Flexibility: A Cognitive Entrenchment Perspective. The Academy of Management Review (AMR). 2010;35(4):579–603.
Gemmell RM, Boland RJ, et al. The socio-cognitive dynamics of entrepreneurial ideation. Entrep Theory Pract. 2011;5(36).
Kayes AB, Kayes DC, et al. Experiential learning in teams. Simul Gaming. 2005;36(3):330–54.
Kolb D. Problem management: learning from experience. In: Srivastva S, editor. The executive mind. San Francisco: Jossey-Bass; 1982. p. 109–43.
Kolb D. Experiential learning: experience as the source of learning and development. Englewood Cliffs: Prentice-Hall; 1984.
Kolb A, Kolb D. Learning styles and learning spaces: enhancing experiential learning in higher education. Acad Manag Learn Educ. 2005;4(2):193–212.
Lewin K. Resolving social conflicts; selected papers on group dynamics. Oxford, UK: Harper; 1948.
March JG. Exploration and exploitation in organizational learning. Organ Sci. 1991;2(1):71–87.
Mills TM. The sociology of small groups. Englewood Cliffs: Prentice-Hall; 1967.
Minniti M, Bygrave W. A dynamic model of entrepreneurial learning. Entrep Theory Pract. 2001;25:5.
Pearce C, Ensley M. A reciprocal and longitudinal investigation of the innovation process: the central role of shared vision in product and process innovation teams (PPITs). J Organ Behav. 2004;25(2):259–78.
Ruef M, Aldrich H, et al. The structure of founding teams: homophily, strong ties, and isolation among US entrepreneurs. Am Sociol Rev. 2003;68(2):195–222.
Sharma G, Kolb D (2009) The learning flexibility index: assessing contextual flexibility in learning style. Working Paper 28
Shane S. Prior knowledge and the discovery of entrepreneurial opportunities. Organization Science 2000; 448–469.
Wallas G. The art of thought. London: Jonathan Cape; 1926.

Expert

▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Exploration-Exploitation Balance

▶ Ambidexterity

Extended Cognition

▶ How does Material Culture Extend the Mind?

Extended Mind

▶ How does Material Culture Extend the Mind?

Extended Mind Thesis

▶ How does Material Culture Extend the Mind?

External Benefits

▶ Entrepreneurship in Creative Economy

External Factors

▶ Environmental Determinants of Entrepreneurship

External Relationships

▶ Collaborative Innovation and Open Innovation

External Venture

▶ Extrapreneurship

Externalities

▶ Business Climate and Entrepreneurialism

Externalization

▶ Extrapreneurship

Extrapreneurship

Pascale Brenet
IAE, Université de Franche-Comté,
Besançon, France

Synonyms

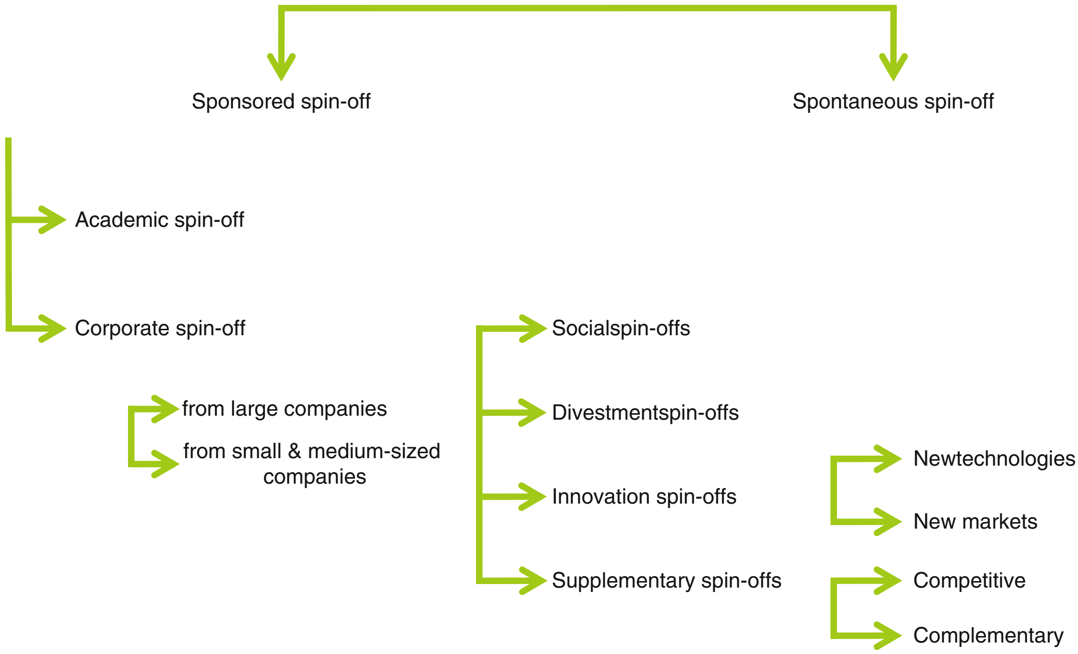
Academic spin-off; Corporate spin-off; Corporate venture; Divestment spin-off; External venture; Externalization; Opportunity spin-off; Social spin-off; Spin-off

A Promising Form of Entrepreneurship

Citizens, firms, and territories continuously focus on entrepreneurship. The fact that some countries have a low entrepreneurial capacity may be deplored, and it results in two phenomena: on the one hand, the small number of business start-ups and, on the other, the difficult emergence of growth potential businesses, or of middle-sized businesses, as opposed to very small businesses.

In the wide research field of entrepreneurship, extrapreneurship is relatively little explored. Yet it covers various situations which may inspire public or business policies by shedding a new light on them. Extrapreneurship indeed relies on exploiting opportunities and assets coming from an existing company. It enables experienced entrepreneurs to develop new technologies and explore new markets, thus creating value and growth potential businesses.

Studying extrapreneurship leads us to focus on the strategic choices of firms and on their boundaries. According to the resource-based view, spinning-off may be considered as a phenomenon which can generate business opportunities promoted by the relationships set between parent companies and spin-offs.



Extrapreneurship, Fig. 1 Spin-off typology

Spinning-Off: A Multiform Phenomenon Relying on Corporate or Public Research

A spin-off is a firm formed by one or several employees coming from the same parent organization. This creation formally or informally relies on the assets of this organization, be they tangible or intangible. Spinning-off is therefore different from creating a company ex nihilo. In extrapreneurship, the emergence of the new company is accomplished by breaking off with the organizational or institutional structure of the parent firm (i.e., by creating a new legal entity or setting up a new type of organization). The starting point of spinning-off is the discrepancy between the parent and the spun-off company: be it the desire for independence of an employee, diverging views on the opportunity to get involved in an innovating project, a divestment of the parent company, or the strategic intention not to pursue the promotion of an ongoing research. Extrapreneurship makes possible to exploit opportunities, assets, or skills which were born in the parent company.

This phenomenon takes various forms, and its typology is presented in Fig. 1.

This typology is based on several criteria:

– The spontaneous aspect of the creation or, on the contrary, the impulse or support given by the parent organization.
– The type of parent organization: public research or corporation. The latter being called corporate spin-off.
– The diverging point from which the spin-off is created and the latter's orientation: divestment or reorganization, grasping technological or market opportunities, reorganizing the value chain by outsourcing. This aspect refers to the degree of maturity of the activity that is spun off: mature activity from the parent company or, on the contrary, new or embryonic activity. Thus, some authors distinguish between opportunity spin-off and divestment spin-off.
– As regards the particular but widely spread case of supplementary spin-off which is a type of outsourcing, the typology can determine the degree of competition existing between the parent company and the spin-off, whether the latter becomes a competitor of its parent company or not.

Spontaneous Spin-Off

This type of extrapreneurship corresponds to the spontaneous departure of an employee who decides to create his/her own company, without having been incited to do so or backed by the parent company. The activity of the spin-off can be created with or without any connection with the parent company. Spontaneous extrapreneurship is a manifestation of the labor mobility, which allows knowledge to circulate and contributes to keeping up the vitality of labor pools. It can explain the existence of spontaneous clusters (Merlant 1984).

Social Spin-Off

Social spin-off is a practice which large companies may be compelled to in times of reorganization or which they set up more permanently so as to promote the mobility of their employees. Thus, they help weave a web of companies around their original site and compensate for the job losses that such a reorganization may cause. In such a case, social spin-off promotes the emergence of entrepreneurial initiatives based on the individual projects of employees which may have no actual connection with the activities of the parent company or its markets. The large company's involvement consists in supporting the project variously, including by providing financial support. This type of extrapreneurship is in line with the employment policy of parent companies and also with their image policy and relational strategy. It results from their social liability.

Academic Spin-Off

In this case, a researcher or a team of researchers decide to leave their original laboratory to promote a result of their research (Pirnay et al. 2003). This type of extrapreneurship has been widely developed for several years in North America, where some universities are well known for technology transfer. The creation of a company from public research requires a set of determining conditions. Universities and public research need to have a technology transfer policy and an expertise on the transfer of intellectual property to the spin-offs; they need to inform and train researchers about entrepreneurship and to define specific status for researchers becoming entrepreneurs; they have to welcome young entrepreneurs with incubators. And last but not least, there must be an appropriate financial environment with special connections with business-angel and venture-capital networks.

Technological Extrapreneurship and Corporate Venturing

Technological extrapreneurship consists in creating a spin-off by relying on a technology which has been initially developed in the parent company. Such a creation can be explained by the strategic and financial arbitrations of the parent company. Connections between the latter and the start-up may consist in a technological cooperation, in cofinancing the innovation or becoming a stockholder of the start-up and sharing intellectual property with it. Technological spin-off comes within the frame of innovation management and corporate venturing. The latter practice allows an existing company to explore new business opportunities with a limited investment, by resorting to the skills and the agility belonging to an entrepreneurially managed small firm, and finally by sharing risks with it.

In some industries requiring highly specialized knowledge, like biotechnologies, creating a company is always achieved by founders coming from public or corporate research or industrial research. Spinning-off is then the only way to create new companies.

In 1988, Marc Lassus and four engineers left the Thomson group and founded Gemplus since the group chose not to get involved in the development of microchips. As phone cards were spreading, France Telecom became the first customer of the young company. In the 1990s, Gemplus was part of the mobile phone market explosion and became the SIM cards world leader. In 2006, after merging with Axalto, Gemplus, now Gemalto, became the microchips world leader and was present on three main markets: mobile phones, financial transactions, and identity safety. In the close field of semiconductor devices, Thomson spurred the creation of STMicroelectronic as well as many other companies created in the 1980s.

Supplementary Spin-Off

Supplementary spin-off consists in outsourcing an activity which was previously led by the parent company. The company thus created becomes a supplier or retailer of the parent company, on a temporary or permanent basis, which may lead it to try to address other customers. Supplementary spin-off requires to move one or several employees of the parent company and may be followed by the transfer of industrial or commercial assets. The parent company becomes an outsourcing company, according to the logic of transactional firm defined by Fréry (1996). The spin-off results from the optimization of the value chain by the parent company which grants resources more efficiently, variabilizes fixed costs, and looks for flexibility and for the advantages of specialization.

Divestment Spin-Off

This type of spin-off comes within the field of portfolio management by the parent company which makes the decision to withdraw from some of its activities in order to use its resources for other activities. Thus, spin-off results from diversifying and refocusing choices which may lead to reconfiguring the parent firm's perimeter. This reconfiguration may follow an industrial or a pure financial logic.

A research (Wallin and Dahlstrand 2006) conducted on 101 companies which entered Stockholm stock exchange between 1992 and 1996 showed that 28 % of them were spin-offs and 11 % were sponsored spin-offs. In this study, spin-offs are defined as companies whose capital is held by a large company before entering the stock market, the latter keeping a share in sponsored spin-offs after their entrance. Wallin and Dahlstrand highlight the fact that these companies have three specificities distinguishing them from other quoted companies: they are larger at the time of their creation, their workforce grows faster in the years after they enter the stock market, and, finally, they are more widespread in high- and medium-technology industries.

Opportunity and Divergence: Spin-Off Seen Through the Resource-Based View

Extrapreneurship belongs to the field of entrepreneurship and may be distinguished from creating a company ex nihilo. It can have an impact on the creation of companies with value and growth potential. Notions of divergence and opportunity are essential to understand the spin-off phenomenon. They allow to review it through the resource-based theory.

Spinning-Off and Accessing Business Opportunities

The example of the founder of Gemplus gives a good illustration of the assets an extrapreneur may have: he knew the market, had developed technological and management abilities and management abilities, and acquired international experience within the parent company, which turned out to be particularly favorable conditions to create a high growth potential business (Daviet 2000). His evolution within the Thomson group enabled him to identify and measure the technological and commercial opportunities related to microchip development. Fayolle (2001) mentions the notion of "launch window" which makes perfect sense when used in the context of extrapreneurship. Verstraete and Fayolle (2005) defined the paradigm of business opportunities as a "social construction arising from interactions and confrontations between the people undertaking the entrepreneurial project and the context of their evolution." Many researchers underlined the difference between the achievements of companies created ex nihilo and those of spin-offs. This gap can mainly be explained by the founders' acquired experience and their better access to opportunities.

Paillot (2003) studies entrepreneurial socialization and defines it as the historical process of learning, integrating, and finding one's social place. Deciding to spin-off becomes part of a career course and constitutes an alternative (Fayolle 2001). Minniti and Bygrave (2000) highlighted a decisive factor related to such a decision: the difference between value being an entrepreneur and an employee.

Thus, drastically restructuring a company may trigger innovating entrepreneurial opportunities, as Buenstorf and Fornahl (2009) showed in a case study about the Intershop German company, created in 1992, introduced to the Neuer Market and to NASDAQ in 1998 and considered as the finest example of new economy. This company, which developed tools for Internet software and online business, used to have 1,218 employees in 2000 at the top of its development, but it considerably reduced its size after the Internet bubble burst (about 200 employees in 2007). Yet, in just a few years, about 40 companies, mostly working in the same field and located in the same area, were created as a result. Creating these companies, also called necessity spin-offs by Buenstorf and Fornahl, had a double impact. It first allowed to save employment in the regional area by compensating for the job cuts of Intershop. Then it allowed to create a software cluster, which was spurred by the parent company. Therefore, the company had a temporary success within its boundaries but a long-lasting effect on regional development.

Divergence: Spin-Offs' Starting Point

Extrapreneurship always has its origin in a kind of break or divergence within the parent firm. This is obvious in social spin-off, but it also exists in supplementary and technological spin-off. It may be linked to job cuts, to a different choice of investment which may lead to giving up an activity or a development, to a decision to exploit technological or market opportunities through a small company, or to the management of a business portfolio.

These divergences may lead the parent company to reconfigure its organization, change its boundaries, and, depending on each case, develop new activities or reconfigure mature ones.

Audretsch underlined the importance of such a break in the emergence of the new company since, as he noticed, each individual grants different potential to a single idea:

> Because of the fundamental characteristics inherent to new ideas, what an agent considers as a potentially valuable idea can be considered otherwise by the people who make decisions in his firm, (especially) if the new knowledge does not fit with the core competences of the firm, or if it is not in line with its technological course. (This) divergence (. . .) submits individual workers (or teams), who make intellectual contributions, to a fundamental choice: they can either ignore their idea and reorient their activities to be in line with the organization, or try and appropriate the value of this new idea in the organizational context of a new firm. (Audretsch et al. 2006)

Strategy of the Parent Company and Resource-Based View

Some researchers on entrepreneurship emphasize the role of the context and define it as a spurring, facilitating, or stimulating element in the creation of a new firm. As far as extrapreneurship is concerned, these contextual elements are obviously present, but there is another specific factor related to the conditions of incubation of the new venture within the organizational matrix of the parent company.

While there may be cases of spontaneous spin-offs, which are not backed and are ignored by the parent company, academic literature most frequently deals with initiated cases, which are supported or at least allowed by the parent company (Parhankangas and Arenius 2003). This leads us to question or review extrapreneurship from the point of view of the strategic choices of companies and of the evolution of their boundaries.

These choices may be interpreted according to the resource-based view which highlights the way a company articulates its resources in order to get competitive advantage and to position itself on the value chain. According to this theory, the parent firm reviews its business perimeter and makes development, divestment, or diversification choices by optimizing the connection between its inner and outer resources, be they material, immaterial, or financial. The resource-based view is useful in that it helps understand the direction and results of the diversifying movements of the parent firm. As such, it highlights the factors leading to the decision to spin-off. This theory shows that extrapreneurship helps reduce the resources of the parent company and its business portfolio when it considers that its externalized resources are too far or that they are not part of its core resources (Richardson 1972). However, building partnership or financial connections with the spin-off allows the parent firm to have a subsequent access to externalized resources or even to the results they generate.

The issue of firm boundaries in the spin-off process was dealt with by the theory of transaction costs. As far as supplementary spin-off is concerned, Johnsson and Hâgg (1987) consider that extrapreneurship corresponds to an intermediary situation between market and hierarchy since the two firms are interdependent.

Cross-References

- ▶ Business Emergence
- ▶ Clusters
- ▶ Entrepreneur
- ▶ Innovation and Entrepreneurship
- ▶ Spin-Off
- ▶ Start-up

References

Audretsch DB, Keilbach M, Lehmann M. Entrepreneurship and economic growth. New York: Oxford University Press; 2006.

Buenstorf G, Fornahl D. B2C-bubble to cluster: the dot-com boom, spin-off entrepreneurship, and régional agglomération. J Evol Econ. 2009;19(3):349–78.

Daviet S. Marc Lassus et les fondateurs de Gemplus, des pionniers de la carte à puce. In: dans Marseille J, dir. Créateurs et créations d'entreprises. Paris: ADHE; 2000. p. 496–516.

Fayolle A. D'une approche typologique de l'entrepreneuriat chez les ingénieurs à la reconstruction d'itinéraires d'ingénieurs entrepreneurs. Rev Entrepr. 2001;1(1): 77–98.

Fréry F. L'entreprise transationnelle, Gérer et Comprendre, Annales des Mines, Septembre 1996.

Johnsson T, Hägg I. Extrapreneurs – Between markets and hiérarchies. International Studies of Management & Organisation, vol XVII, n°1, 1987. pp. 64–74.

Merlant P. On l'appelle spin-off, in Les Héros de l'Economie, Editions Autrement, no 59, 1984.

Minniti M, Bygrave R. The social dynamics of entrepreneurship. J Bus Ventur. 2000;24:439–57.

Paillot P. Méthode biographique et entrepreneuriat: étude de la socialisation entrepreneuriale anticipée. Revue de l'Entrepr. 2003;2(1):19–41.

Parhankangas A, Arenius A. From a corporate venture to an independent company: a base for a taxonomy for corporate spin-off firms. Res Policy. 2003;32:463–81.

Pirnay F, Surlemont B, Nlemvo F. Toward a typology of university spin offs. Small Bus Econ. 2003;21(4): 355–69.

Richardson GB. The organisation of industrie. The Economic Journal. 1972;82(327):883–896.

Verstraete T, Fayolle A. Paradigmes et entrepreneuriat. Rev Entrepr. 2005;4(1):34–52.

Wallin MW, Lindholm Dahlstrand A. Sponsored spin-offs, industrial growth and change. Technovation n° 26, 2006. pp 611–620.

F

Façade Design

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Failure

► Firm Failure and Exit

False Memory

► Imagination

Family and Entrepreneurship

► Socialized Entrepreneur, Theories

Family Business

► Small Businesses - Value, Transmission, and Recovery

Family Enterprise Investment

► Love Money

Feeling

► Creativity and Emotion

Female Entrepreneur

► Microfirms

Female Entrepreneurship

Stefan Kesting and Sabina Jaeger
Auckland University of Technology-New Zealand, Auckland, New Zealand

Synonyms

Diversity entrepreneurship; Entrepreneur

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
DOI 10.1007/978-1-4614-3858-8, © Springer Science+Business Media LLC 2013

Characteristics of Female Entrepreneurship

Female entrepreneurs are the women founding, building, owning, and driving new companies in emerging and established industries. What is understood as entrepreneurship can range from being self-employed and, for instance, running a small catering service from home to owning a business venture worth millions of US dollars. Starting from Schumpeter's original portrayal, entrepreneurs are often seen as charismatic individuals who use inventions, resources, and creativity to push for commercial success of innovation. The classical theoretical view presents entrepreneurship as gender neutral. Research on the secret of entrepreneurial success highlights the personal characteristics of the individual. Scholars use descriptors such as inventive, energetic, risk taking, aggressive, dynamic, self-motivating, and tolerant of ambiguity. These "entrepreneurial traits" are clearly male attributes. Prior to 1980, entrepreneurial activity in most developed countries was dominated by men. Not surprisingly, research investigated men and their motives, behaviors, and characteristics. The phase of treating entrepreneurial behavior as gender neutral as well as without any other crucial distinctions across populations lasted until the 1990s. Since then, the research focus has shifted. The number and importance of female entrepreneurs grew, and now female enterprises contribute considerably to economic development all over the world. Thus, it is no longer appropriate to neglect the specific motives and performance of female entrepreneurs. Though still limited and fragmented, a specialized literature on women entrepreneurship is evolving and growing (Brush et al. 2006; Carrier et al. 2008; Klapper and Parker 2011; Patterson and Mavin 2009).

More insights into female entrepreneurship derived from a large body of research that compared the experience and human capital of male and female entrepreneurs. At the same time, research began to focus on environmental (available financial and other resources) and societal factors (networks, social capital) in order to explain the "gender gap" in entrepreneurship. More recent research challenges the concept of gender neutrality (with masculine undertones). Most studies seem to reject the notion that gender-related discrimination in laws and regulation should be the major reason for the disproportionate participation of females in start-up businesses. Some go so far as to place gender at the center of understanding the essence of entrepreneurial activities (Lewis 2006; Wagner 2007). Are female and male entrepreneurs really so different? If so, what are the main differentiating factors?

Numbers: The Status Quo

The ratio of female to male entrepreneurs is different across regions and countries. In many parts of the world, male entrepreneurs outnumber females by far. While there has been a great increase in the number of female entrepreneurs, research shows that participation is still low. For instance, female entrepreneurs make up 37.7 % of all entrepreneurs in New Zealand in 2010. And in the USA, according to their 2002 census, just over one quarter of all US firms in 2002 were owned by females. The trend in the USA for female new ventures is positive with a yearly increase of 20 % which amounts to doubling the overall growth rate. In Europe, female entrepreneurs also own and run just a minority of businesses. In the EU, female self-employment ranges from just over 20 % to 40 % depending on the country. Many European women report that they start businesses to avoid under- or unemployment. For much more women than men in the developed world, self-employment is a part-time activity. In the transitional economies of Eastern Europe and Central Asia, it varies from over 40 % (Latvia and Hungary) to just over 8 % (Tajikistan).

Research on female entrepreneurship in Latin America and the Caribbean found very high rates of female entrepreneurship in the poorest countries of the region. For instance, over 35 % of business owners in Peru are female. However, only 13 % of women entrepreneurs in the region indicated that they expected their firm to grow over the following 5 years. In many cases, opportunities and incentives are unfavorable for women to begin businesses, even when they have the abilities and knowledge.

The analysis of entrepreneurship focuses on the formal private sector; however, the "informal" sector plays an important role in many countries and particularly in developing ones (e.g., 70 % of official GDP in Nigeria). If female entrepreneurship is much more widely spread in this "shadow economy," such neglect may lead to a considerable omission.

Performance: The Status Quo

In terms of standard measures of performance like earnings, profits, return on capital, growth rates, etc., male entrepreneurs tend to outperform their female competitors. There is general agreement in the literature that female entrepreneurs tend to earn less income and that their businesses grow at a lower rate than those owned by male entrepreneurs, with no difference between developing or developed countries. Overall women's businesses tend to be smaller, utilizing less capital and finance from banks and other lenders than men's. This is due to women entrepreneurs concentrating in (sales, retail, and services) industries with lower capital intensities and lower average return on capital and is not due to their lower business effectiveness or capabilities. Even when studies find that female owners earn similar rates of return on assets as male owners, lower investment at the start leads to comparatively lower absolute income and profits for female entrepreneurs. Moreover, women's businesses tend to generate lower sales turnover than men's and therefore are less profitable than those of men, even in same industry comparisons.

How can these gender differences be explained?

Motivation and Characteristics of Female Entrepreneurs

Major reasons to pursue an entrepreneurial way of life, namely, to solve work issues, are shared among both genders; such is the desire to avoid low-paid occupations, to escape supervision, and to gain the opportunity and flexibility to coordinate family life and other social responsibilities with gaining income. The common ground for these motivations has been increasing in recent times with a trend toward more shared child-rearing practices and more joint responsibility for family life in modern societies. The increase in educational qualifications, professional skills, and labor force participation of women in general has promoted a reevaluation of the traditional distribution of family roles. However, while some women enter professional self-employment for similar reasons of career advancement as men, another group enters nonprofessional self-employment primarily to juggle family commitment and work hours. A 2005 Eurostat survey of entrepreneurs in 15 EU countries finds that much more women than men cite the ability to combine family life and childcare responsibilities with work as a motivation to start up their own business. Time-budget studies in developed countries show that women do work fewer hours in business and do more childcare and housework than men. In general, many women perceive their social and child-nurturing obligations as very important, so it is not a surprise that female entrepreneurs strongly identify flexible work hours as their most important incentive toward independent businesses. This is in contrast to male entrepreneurs who identify self-determination and the sense of success and achievement as their main drivers to enter entrepreneurship. Some studies suggest that women are less motivated by growth and profit than men and more by intrinsic goals such as personal fulfillment, flexibility, and autonomy. However, in the light of the aforementioned family obligations, at least the latter two goals can be interpreted as extrinsic motivation rather than intrinsic.

There is evidence showing a number of professional women shunning their corporate careers in favor of entrepreneurship. The "glass ceiling," flexibility, independence, control, and family are the most commonly cited reasons for why women become entrepreneurs.

A recent Dutch study finds that on average, women invest less time in business than men (Verheul et al. 2009). This can be attributed to both a lower preference for work time (driven by risk aversion and availability of other income) and a lower productivity per hour worked (due to lower endowments of human, social, and financial capital). Many young, well-educated, and financially well-off women choose part-time entrepreneurship today as the preferred option to pursue a career and professional development combined with family life while having young children. Sometimes, these women are referred to as "mumpreneurs." The necessity of earning a living is not the major issue here, but it is in most cases rather a lifestyle choice. Recent studies confirm this trend of increasing rates of married women with children in part-time entrepreneurship in their attempt to combine self-development and family life as a form of postfeminist entrepreneurship. The situation of part-time work might explain the lower success or performance rate of female entrepreneurial ventures than average compared with their male counterparts.

On the other hand, a number of studies point to job transition or reentry into the workforce following a layoff or voluntary leave as a major motivation for self-employment. The 2005 Eurostat Business Success Survey conducted in 15 EU countries finds that a much larger proportion of female than male respondents answer "to avoid unemployment" when describing their motivation for starting their own business. This supports the hypothesis that women more than men are pushed into entrepreneurial activities by changing economic environments and resulting lack of household income.

Research into the psychological characteristics of female entrepreneurs has led to a classification into three motivational types: the need achiever entrepreneur, the pragmatic entrepreneur, and the managerial entrepreneur. Need achievers have a high need for achievement, the managerial entrepreneurs have high self-attributed need for power and influence scores, and the pragmatic entrepreneurs are moderate on both motivations of achievement and power. Perhaps, the female situation differs from male characteristics within this framework because women seem to be less power hungry than men. Some Canadian studies suggest that running a small and stable business is the preferred modest practice among female entrepreneurs but not among male ones. Although, there is major support for a gendered somewhat general concept of entrepreneurship, recent empirical research sheds light on a wide range of perceptions and a variety of distinctions among female entrepreneurs.

Some studies argue that men and women perceive risk differently (Wagner 2007). However, evidence that female entrepreneurs have in general less appetite for risk taking compared with male entrepreneurs is inconclusive and sparse.

Preferred Industries and Environmental and Societal Factors

Female and male entrepreneurs start and run business in different industries, develop different products, and also have different goals. International studies in gendered entrepreneurship which concentrate more on environmental (macro) factors than on individual (micro) motivation stress that the chosen sector of activity is important in explaining differences in male and female entrepreneurship. Canadian studies find that "type of business" is a significant factor explaining gender differences among nascent entrepreneurs (Menzies et al. 2006; Pare and Therasme 2010). Moreover, women tend to be less likely to operate in high technology sectors, and they are much more predominant in the service sector (Verheul et al. 2006; Pare and Therasme 2010). In the USA, 69 % of women-owned firms were in the service sector. Other studies find that female entrepreneurs tend to concentrate on consumer-oriented sectors (Allen et al. 2008). However, there is also apparently a recent tendency for female entrepreneurs to move away from traditional female industries into male industries like manufacturing. Nonetheless, the overall situation appears to be that woman entrepreneurs still favor the service sector and in particular industries which do not require a high start-up capital. Therefore, female entrepreneurs are highly represented in areas such as sales, retail, and specialized care and catering services. This female industry concentration may explain the aforementioned gendered characteristics of smaller scale, more intense competition, and lower average returns.

Both male and female entrepreneurs choose normally industries and businesses for start-ups that are related to areas of former employment. Drawing on previous work, experience reduces the risk of failure and in most cases provides entrepreneurs with access to valuable networks. This practice, of course, reinforces the status quo concerning the choice of industries. For example, historically, there has been a concentration of females in clerical and administration jobs which normally require less-advanced qualifications but also restricted their potential income. Fewer women than men study business and technical subjects. Moreover, men are more likely than women to have had valuable previous work and business experience in industry and in managerial roles. It might explain why female entrepreneurs selected traditional "female" industries in the past and are still choosing them today, although other sectors might be more profitable and promising higher growth rates. The question, "What are the main reasons for these choices: societal pressure or traditional untested gender perceptions and roles?" remains unanswered. Research suggests that women are sometimes more influenced by external factors like family or community opinions than men. Societal norms vary around the globe and so can the geographical variances of female entrepreneurship and the difference in practices and performances.

Finance and Other Barriers/Problems for Female Entrepreneurs

Some studies focus on particular barriers faced by female entrepreneurs. Early research reports major obstacles for female entrepreneurs as problems with finance and credit and property regulations as well as lack of business and financial training. Today, these barriers seem to be more pronounced in developing countries in Africa and Asia and transition economies than in developed countries. Studies about women in these areas report more systematic difficulties with accessing finance than those conducted in North and South America and Europe. However, access to sufficient start-up capital for new ventures in the poorer regions of the world might not be entirely a gender issue; the reason for the capital shortage might be also a general deficiency in supply.

Lack of education, lack of business experience, and lower financial literacy leading to weaker loan applications and weaker credit rating scores are the proposed factors to the diminished equal opportunities of female entrepreneurs in the literature. Moreover, most firms led by women operate in the service sector. Since service sector firms are often very small, require little start-up funding, and tend to operate in volatile markets, all these factors may explain the reluctance of financial institutions to lend money. Evidence suggests that discrimination against women has diminished over the last 10 years and in many cases completely disappeared. However, females who perceive prejudice regardless if it is true or not will experience intrinsic limitations and may be less likely to ask for outside financing. This in turn will have an impact on the future growth of their businesses. Perceived discrimination can thus become a self-fulfilling prophesy. Another interesting obstacle has been identified as the physical appearance of the borrower, the less attractive and beautiful a female loan applicant is, the less likely she is going to get a loan approved.

The legal environment can also function as a barrier toward female entrepreneurship. If the legal framework discriminates against women as to freedom of ownership rights or asset transfers and adverse marital rules, this all can become a serious impediment toward doing business successfully. Even if the law explicitly does not require the husband's or father's signature to receive a loan for a female entrepreneur, in some countries, implicit social norms and differential treatment under the law can have similar deterring effects.

Overall, women seem to require much less funding and in particular lower loans to start up their businesses. While it is not clear if this is a result of institutional barriers concerning access to finance for females or due to gender differences in motivation, it definitely influences their choice of industry.

Policy Implications

In general, the literature suggests that improvements in the business environment can help promote high growth of female entrepreneurship. Women may have relatively less physical and "reputational" collateral than men, which might consecutively limit their access to finance. Therefore, public policies that circumvent the requirement of collateral and create alternatives to secure a loan can promote low-interest loans and small grants to females wishing to start up a business and might thus bridge the gap between genders. Assistance in terms of training programs in business skills and financial literacy and effective consulting services might also help aspiring female entrepreneurs. Interestingly, however, research into existing support programs indicates that there is no real gender difference. Male and female entrepreneurs seem to be virtually identical in terms of their needs for assistance. Females do not appear to need more assistance than males nor do they appear to require different types of assistance. The virtually identical ratings of service value among males and females also indicate that both genders are equally satisfied with the assistance received.

The strengthening of a legal framework unbiased toward gender and thus allowing females to operate under the same conditions as males would go a long way toward progress of female entrepreneurs in some countries.

There are of course also societal measures conducive to possibly improve the future development of female entrepreneurs. Some of these more general recommendations call for women to be encouraged to study fields other than liberal arts. Women need access to seminars on finance, management, marketing, etc. And finally, it is recommended that women seek assistance from experts, colleagues, and friends to establish formal and informal networks. Experienced female business owners emphasize that in order to further develop women's role in business, stereotypes concerning women as entrepreneurs need to be eliminated through public awareness workshops and more visible role models and that mentors for younger women are needed.

A Role Model from the Past

While Coco Chanel was arguably the most famous French self-made woman of the twentieth century, "Veuve" Barbe-Nicole Clicquot was certainly the most impressive female French entrepreneur of the nineteenth century (Mazzeo 2008). Widowed in her late twenties, in the middle of the Napoleonic Wars, without formal training and no experience, she had to take over a small struggling family vineyard from her husband and turned it into probably the most important champagne house of the nineteenth century. Madame Clicquot led the wine brokerage through several failed attempts to expand sales of her champagne to Britain and other parts of Europe and created an amazing vintage in 1811. Not only did she manage to protect this treasure in her cellars from looting by Russian occupying troops in her hometown Reims, but she also used the chance to introduce Russian officers to her sweeter, fortified champagne. As soon as the opportunity arose to export French wine to Russia in 1815, she seized it and shipped and sold her magic 1811 vintage ahead of all other competing vineyards with great success in St. Petersburg and Moscow. Because of this success, she is credited today for "internationalizing the champagne market" and "establishing brand identification." Moreover, Madame Clicquot invented and developed a process called in French *remuage sur pupitre* which is an efficient system of clearing champagne of the yeasty debris trapped in the bottle after secondary fermentation to create the bubbles. Even today, this procedure is indispensable to reduce wasting wine and does significantly increase the output of wine in numbers of bottles. Keeping it an industrial secret, this method helped her in gaining competitive advantage over her competitors for 20 years.

An Exemplary Case in the Present

In some instances, female founders of companies employ exclusively women to gain competitive advantage. The Japanese company Digimom presents an example for this. The motivation for such a practice was to tap into the underutilized female workforce in Japan. As the authors researching Digimom point out, one of the four most important success factors for the company is the right choice of industry (Futagami and Helms 2009), which is linked to an exclusively female workforce. The advantage is that Digimom's provision of IT services allows for flexible work from home. Such an option is much harder to offer in sectors other than the computer service industry.

Conclusion and Future Directions

It is interesting to note that women entrepreneurship is not a recent phenomenon, let us say, of the last century. In fact, the "champagner" story indicates that successful businesswomen can be found throughout history. The beginning of mainstream research into start-up ventures, clearly, centered on the entrepreneurial (in particular male) behavior traits. It was sought to understand what kind of prerequisites and characteristics the individuals had to have for entrepreneurial high achievement. Thus, classical entrepreneurial research produced evidence that featured decisiveness, aggressiveness, business acumen, and risk-taking behavior. The success in business, of course, was "male" and measured mainly through quantitative outputs and "hard" facts. During the last 20 years, research on female entrepreneurship developed, which questioned the necessity of male attributes for the female entrepreneur; thus, this new research branch moved away from the mainstream model of entrepreneurs to explore entrepreneurship with a gendered focus. It seems now widely accepted that female entrepreneurs are often different from their male counterparts. Women choose different industries and products than men and, in many cases, have different motivations and goals. Discrimination and differences in social roles might not be the only factors influencing these choices; females might have also a different attitude toward resources and the sustainable use of them. Current research into gendered entrepreneurship in developing economies, in particular, pertains to microfinance/microenterprise development and supports this notion.

What Should Be the Target of Future Research?

The developing field of gendered entrepreneurship needs a stronger theoretical base in order to mature. Integrative theoretical frameworks would provide better a base for scientific discussions. Currently, there is plenty of interesting empirical work, case studies, and other qualitative enquiries, such as narrative and interpretivist studies, being done, which increases our understanding of the issues and motivations of female entrepreneurs. However, a useful theoretical structure to integrate what we know so far is missing.

On the other hand, entrepreneurship scholars could explore more opportunities for interdisciplinarity in their work. Much is to be gained from inputs from other academic fields such as social sciences, gender and diversity, psychology, management, leadership, international business, international strategy, and so forth. Thus, multidisciplinary collaboration on female entrepreneurship should be pursued more often.

As the field matures, we might move away from looking mainly at negative aspects, the disadvantages, and barriers to female entrepreneurs in comparison to their male counterparts. It might pay to concentrate on the strong positive features of women entrepreneurs for future research.

In conclusion, future research should focus on the internationalization of female entrepreneurship, especially beyond the mainstream Anglo-Saxon context. The time is ripe for abandoning the rather ethnocentric stance that industrialized countries provide all the answers to successful (female) entrepreneurship. In order to achieve more sustainability and real action to tackle global poverty, research into female ethnic entrepreneurship might provide solutions. Many women entrepreneurs in developing economies are able to create successful ventures, albeit sometimes very modest ones, with little start-up capital and outside official financing. This fact should actually be celebrated as strength. Female entrepreneurs are obviously innovative and resourceful. And as resources diminish globally, the female entrepreneurial model might become extremely valuable in future.

Cross-References

► Entrepreneurial Capability and Leadership
► Entrepreneurship and Social Inclusion
► Entrepreneurship Policies
► Psychological Aspects of Entrepreneurial Dynamics

References

Allen IE, Elam A, Langowitz N, Dean M. Global Entrepreneurship Monitor (GEM) global 2007 report on women and entrepreneurship. Boston: Babson College and the Center for Women's Leadership at Babson College; 2008.
Brush CG, Carter NM, Gatewood EJ, Greene PG, Hart MM. Women and entrepreneurship: contemporary classics. Cheltenham/Northampton: Edward Elgar; 2006.
Carrier C, Julien PA, Menvielle W. Gender in entrepreneurship research: a critical look at the literature. In: Aaltio I, Kyro P, Sundin E, editors. Women entrepreneurship and social capital. Copenhagen: Copenhagen Business School Press; 2008. p. 39–66.
Futagami S, Helms MM. Emerging female entrepreneurship: a case study of Digimom workers. Thunderbird Int Bus Rev. 2009;51(1):71–85.
Klapper LF, Parker SC. Gender and the business environment for new firm creation. World Bank Res Obs. 2011;26(2):237–57.
Lewis P. The quest for invisibility: female entrepreneurs and the masculine norm of entrepreneurship. Gender, Work & Organ. 2006;13(5):453–69.
Mazzeo TJ. The widow clicquot – the story of a champagne empire and the women who ruled it. New York: Collins; 2008.
Menzies TV, Diochon M, Gasse I, Elgie S. A longitudinal study of the characteristics, business creation process and outcome differences of Canadian female vs. male nascent entrepreneurs. Entrep Manag. 2006;2:441–53.
Pare S, Therasme K. Entrepreneurs in the new economy: immigration and sex effects in the montreal metropolitan area. J Int Entrep. 2010;8(2):218–32.
Patterson N, Mavin S. Women entrepreneurs: jumping the corporate ship and gaining new wings. Int Small Bus J. 2009;27(2):173–92.
Verheul I, Van Steel A, Thurik R. Explaining female and male entrepreneurship at the country level. Entrep Reg Dev. 2006;18:151–83.
Verheul I, Caree M, Thurik R. Allocation and productivity of time in new ventures of female and male entrepreneurship. Small Bus Econ. 2009;33(3):273–91.
Wagner J. What a difference a y makes – female and male nascent entrepreneurs in Germany. Small Bus Econ. 2007;28(1):1–21.

Figure of Speech

► Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education

Financial Sponsor

► Entrepreneurship and Financial Markets

Financing

► Financing Entrepreneurship

Financing Entrepreneurship

Faruk Ulgen
UFR ESE-University of Grenoble II,
Grenoble Cedex 9, France

Synonyms

Entrepreneurship; Financing; Innovations

Entrepreneurship and Finance

The entrepreneurship and the finance were considered for a long time as two different fields of research. The entrepreneurship is usually defined as the action of undertaking economic activities, through a specific organization, which aims at the creation of market value and which can also concern process of innovation as it involves, in a dynamic setting, creating/discovering new opportunities. The finance deals with matters related to raise monetary funds or capital through the issuance and sale of debt and/or equity. It is concerned with resource allocation as well as resource management, acquisition, and investment.

In a monetary economy, the entrepreneurship and the finance are two connected phenomena. Any entrepreneurship activity requires some financing because the processes of production, investment, and marketing need various sources of financing. The realization of entrepreneurs' projects and particularly the implementation of innovative plans are dependent on conditions of their financing.

Theoretical Grounds

As Joseph Alois Schumpeter stated in *The Theory of Economic Development* (1934/1961), the money markets are the headquarters of the capitalist system such that the money (the finance) is the entrance ticket into the market. In *Business Cycles* (1939), Schumpeter also stressed that economic action cannot be explained without taking account of money. Therefore, the financial constraint (i.e., conditions of obtaining adequate access to capital) is one of the major obstacles to starting and/or growing a business. Then there is a relationship between the financial market development and the entrepreneurship, and the financial disturbances appear to have a substantial negative effect on investors' willingness to finance innovative entrepreneurship (Lerner 2010).

Various ways of entrepreneurship financing can be analyzed according to the level of development of monetary and financial markets, such as the financial bootstrapping, the venture capital funding (risk capital), business angels, and bank credit and other financial-innovations-led loanable funds affecting the realization and the effectiveness of the business plan. The economic evolution depends on entrepreneurs' behavior, and the entrepreneurs' activity depends on the conditions of the financing of their expectations.

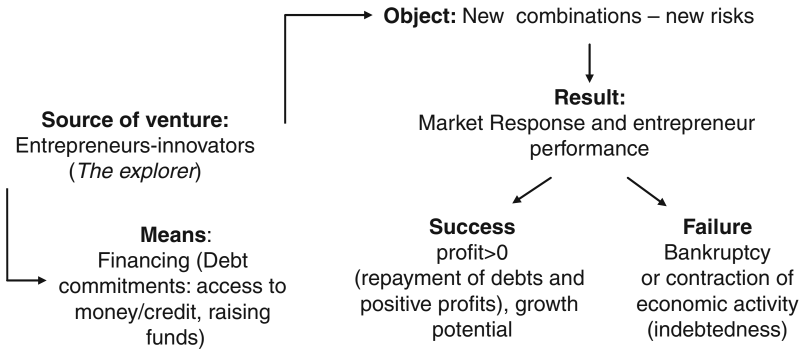
Schumpeter stresses that "*Economic action cannot (. . .) be explained without taking account of money*" (1939, p. 548). The monetary system's *modus operandi* is the first step of all economic propositions. Hence, the definition of the capitalist economy is a monetary one: "*capitalism is that form of private property economy in which innovations are carried out by means of borrowed money, which in general (. . .) implies credit creation*" (Schumpeter 1939, p. 223).

Hence, there is a very close interdependence between money/financial markets and economic evolution. Money markets are the *headquarters of the capitalist system* (Schumpeter 1934/1961, p. 126), where the settlement of plans for further development is decided. All kinds of economic projects are first brought into relation with one another and contend for their realization in it.

The entrepreneur-innovator, the *explorer*, cannot dispense with money. Dynamics enter the picture with the innovation decisions of entrepreneurs. To innovate means to change deeply the economic status quo (*the setting up of a new production function*, Schumpeter 1939, p. 87). The leading figure of the innovation is the entrepreneur who tries to design and execute new combinations. Innovation is the driving force of accumulation. But the sole presence of entrepreneurs is not sufficient to guarantee the system's evolution. In order to innovate by founding a new firm, constructing a new plant, and ordering new equipment from existing firms, entrepreneurs need means of financing.

In this respect, access to money is the power to command and to determine the level of economic activity, that is, the access to credit money. Credit money is the variable which authorizes an economic separation between entrepreneurs-innovators and other agents. The financing of enterprise has been assigned logical priority in the process of economic development since "this is the only case in which lending and the ad hoc creation of means of payment are crucial elements of an economic process the model of which would be logically incomplete without them" (Schumpeter 1939, p. 114). The innovator must have monetary funds before starting his dynamic activity (Fig. 1):

As stated in Ülgen (2003), Schumpeter (1939) maintained that the requisite fund is the entrance



Financing Entrepreneurship, Fig. 1 Entrepreneurship as a real and monetary change process

ticket to the social store of means of production. This fund is borrowed from a bank. Schumpeter (1934/1961) also emphasized that the individual can only become an entrepreneur by previously becoming a debtor. What he first wants is credit. Before he acquires commodities, he needs purchasing power. He is the typical debtor in capitalist society, "no one else is a debtor by the nature of his economic function" (Schumpeter 1934/1961, p. 103).

In the process of innovation, the rise of monetary needs and the rise of risk may dissuade some firms from engaging in innovative activities. The high costs of R&D imply some advantages for leader and R&D firms. Then the fate of new combinations is decided on money markets through daily price struggles between entrepreneurs and bankers/financial resource providers.

Entrepreneur and the Finance

Entrepreneurship

Entrepreneurship can be defined as an act of undertaking private/individual expectations-based projects. So the entrepreneur is a risk-taker who undertakes innovations with necessary finance and business acumen in an effort to transform things into economic values, which should be able to give further gains. This may result in new organizations or may be part of revitalizing existent organizations in response to a new opportunity. The most obvious form of entrepreneurship is that of starting new businesses (a start-up company). Entrepreneurship can also describe activities within a firm or organization including corporate venturing.

Usually, a more or less part of working people may have engaged in self-employment for several years depending on economic and cultural characteristics and habits of the country where they live. Participating in a new business creation seems to be a major driver of economic growth in advanced economies.

Many definitions for the notion of entrepreneur are available in economic literature. The most well-known scholar in this area is Schumpeter who stressed the role of innovations (new products, new production methods, new markets, new forms of organization, etc.). From this viewpoint, the entrepreneur can be identified as a person combining various production factors in an innovative way to generate value to the customer with the expectation that this value will exceed the cost of production, thus generating superior returns that result in the creation of profits. The entrepreneur needs monetary funds to start his activity or to expand an existing firm. She/he must borrow those funds from banks and/or from other financial investors who are called the lenders. For the lender, the objective is the ability to achieve capital gains.

Entrepreneurial activities can be of various kinds depending on the type of organization and creativity involved. Also various types of organizations exist to support entrepreneurs' financial needs as venture capital, angels, banks, business incubators, etc.

Internal Versus External Financing

In the financing process of entrepreneurial activities, different means and practices can be observed. While liquidity constraints in entrepreneurship present a persistent puzzle for enterprises and for theorists, the relevant way of financing a given project depends on the nature of the project itself as well as on the type and characteristics of the entrepreneur to be financed. Therefore, some stages of financing have to be noted in order to identify the nature of the project and the borrower. At the first stage, the issue is related to the starting of a new activity. Seed capital, personal resources, friends, family members, business angels, and small business investment companies (e.g., small industries development banks in developing countries) may intervene at this stage to provide the bulk of the funding. At the second stage, the financing through public equity and venture capital can be observed as the main financing tools. More developed enterprises can attract external financing for early-stage investments and then for later-stage investments. The third stage (later-stage) includes acquisition/buyout practices and also participation of venture capital companies. The presence of bank credit, especially in local financing (small firms, working continuously with the help of local banks) and in the financing of large firms, is also a common way of sustaining firms' economic activities. For successful entrepreneurs, the access to public markets through public offerings constitutes also a source of funding of new projects.

Internal Financing

The internal financing possibilities depend before all on the individual wealth of would-be entrepreneurs to cover required capital as regards the financing needs of a start-up company to invest in new projects as well as operating capital needs to finance everyday expenses. Entrepreneurs can tap friends and families to finance their businesses but they can also utilize credit cards to bootstrap their new venture.

A specific type of internal financing is the *sweat equity*. That refers to a partner's contribution to a project in the form of effort. Another type is the *financial equity* which is a contribution in the form of capital. Those forms are related to a partnership such that some parties may contribute to the firm through capital and others through sweat equity. For example, in a start-up company formed as a corporation, workers may receive stock or stock options and become part-owners of the firm. In return they can accept low wages below what they would demand in another context.

Financial bootstrapping is another way of dealing internally with the financing issue. That covers different methods for avoiding the use of external financial resources from banks and/or market investors. That is a collection of methods and ways of financing aiming to minimize the amount of outside debt and equity financing from banks and financial investors. The use of private credit card debt is the most known form of bootstrapping (see Rani and Rao 2008 for the Indian case), but a wide variety of ways can be imagined for entrepreneurs. While bootstrapping involves a risk for the founders, the absence of any other party gives the entrepreneurs more freedom to develop the company.

However, internal financing is not enough to realize all entrepreneurial activities. In many cases, internal resources are not sufficient to finance expected projects. Bringing in external financial institutions and investors can be beneficial not only for the collection of required capital but also for the acquisition of more professional knowledge, skill, and experience. Investors and banks are specialized in the analysis, accompaniment, and monitoring of productive activities. Outside lenders can provide financial oversight, accountability for carrying out tasks, valuable contact networks and experience to the project. They can remove financial obstacles by sustaining innovative and risky productive projects, but they can also erect financial barriers, and technical and strategic hurdles when they expect that new options are not able to generate higher profits through quick returns on investments (Ülgen 2007).

External Financing

The external financing of entrepreneurship can be allowed through different ways. The access of firms to different external financing obviously depends on the characteristics of firms and projects.

The bank credit is usually the dominant practice in firms financing in a market economy because banks control the major part of monetary and financial markets but also they are the headquarters of the capitalist economy as they can grant credit through credit money creation in response to entrepreneurs' needs of funding expansion strategies. Large firms which can easily access financial markets through equity financing must be accompanied by bank syndication credits to allow huge amounts of new capital required in acquisition operations.

Several types of conventional bank loans exist:

- Character loans are used when the entrepreneur does not have the assets to support a loan. The entrepreneur may need a loan based on her/his own personal financial position. This usually implies engaging personal assets of the entrepreneur.
- Installment loans: Available short-term funds are frequently used to cover working capital needs and help to have a track record of sales and profits.
- Straight commercial loans are used for seasonal businesses and to building up inventory. These funds are advanced to firms for 1–3 months.
- Long-term loans are frequently allowed for strong and mature companies. They can be available for up to 10 years.
- Lines of credit: For a given amount of credit allowed by banks to firms following the potential fund expected to be withdrawn by firms, firms pay interest on the portion that they use and they pay commitment fees up front to ensure that the rest of the fund will be available at their disposal.

Cosh et al. (2009), investigating the internal versus external financing decisions among several UK firms, identify factors leading firms to seek external finance. The evidence seems to point out that firms with higher capital expenditures and profits and firms with stronger growth objectives are much more likely to seek external finance. It also appears that the most important factors with regard to obtaining the desired level of bank finance is a firm's assets. Smaller firms without significant assets have difficulty obtaining bank finance and they try to obtain finance from private individuals. For instance, young innovative firms without enough assets or profits seek capital from venture capital funds.

Angel investor (synonyms: business angel, informal investor) is an individual who provides capital for a young start-up business, usually in exchange for convertible debt or ownership equity. As start-up companies projects are new ventures in an unknown future, some angel investors organize themselves into angel networks to share research and pool their investment capital in order to reduce risks. Angel capital fills the gap in start-up financing between friends and family who provide seed funding, and venture capital. It is usually difficult to raise huge amounts of money from friends and family. Also venture capital funds are not usually willing to fund low-investment projects. Angel investment plays then the role of financing for start-ups which cannot be financed through bootstrap finance or venture capital and bears extremely high risk in innovative projects. Because a large percentage of angel investments are lost completely when early-stage companies fail, professional angel investors seek investments with high returns (potential to return at least 10 or more times their original investment within 5 years).

In addition to angel investors and seed funding practices, *venture capital* is used by new young firms with limited experience that are not large enough to raise capital on financial markets and not considered to be able to secure a bank credit. A venture capitalist is a person or investment firm that makes venture investments, and these venture capitalists are expected to bring managerial and technical expertise as well as capital to new innovative projects. Venture capital is provided to early-stage, high-potential but high-risk start-up companies. The venture capital fund makes money by owning equity in the companies that it funds. These companies usually have a new business model in high-technology sectors (such as biotechnology, IT, etc.). The venture capital is a growth funding round investment as it occurs frequently after the initial seed funding of innovative entrepreneurship. Venture capital is a type of private equity. In exchange for the high risk that they assume by investing in smaller and new companies, venture capitalist usually gets significant control over firms' decisions and a significant portion of firms' ownership. Therefore, a core skill within venture capital is the ability to identify new technologies that have the potential to generate high commercial returns at an early stage by playing also a role in managing young enterprises at an early stage.

Informational Asymmetries and Uncertainty in the Innovation Process

Different ways of financing presented above underline some issues in the financing of innovative activities that new, nascent or young, and small entrepreneurs may be faced with. In this respect, two major issues can be presented following Mahagaonkar (2010).

The first one is well studied in the economic theory in more general terms through the analysis of imperfect markets and information asymmetries (Leland and Pyle 1977). These asymmetries are between banks/financial investors and entrepreneurs who need funds to realize new plans. Asymmetries arise when the firm has better information about the characteristics of its investment (degree of the risk, relevance of expected returns, etc.) than do capital providers. When economic agents involved in economic transactions act with less than perfect information and cannot foresee all the future possibilities and cannot monitor others' decisions and behavior, their rationality is limited (bounded rationality).

In this regard, the relation between a fund provider, the bank or a financial investor, and an entrepreneur who asks for the financing of her/his new project is an agency relation. That is a mandating or delegated relation between two or more agents in which the lender, called the principal, delegates a decision power to the borrower, called the agent. This later has to accomplish a task, undertaking a specific activity, on behalf of the lender as the lender grant money to the entrepreneur. The final profit of the lender depends on the action or decision of the borrower. In such an environment where the bounded rationality holds, the problem arises because all relevant and required information is impossible or costly to acquire and to process. That can provoke agency costs involved in monitoring the behavior of the borrower. These costs are mainly due to the existence of opportunistic behavior as the moral hazard and the adverse-selection.

The case of *moral hazard* is a problem of imperfect information or a form of ex post opportunism. The lender cannot observe the effective action of the borrower or she/he cannot know if this action is appropriate or not regarding the circumstances. Then, the contract between these two parties is imperfect and may generate additional costs for the lender. Moral hazard in innovation investing arises also because of the separation of ownership and management in modern firms. When the objectives of the parties are in conflict, investment strategies cannot be share-value maximizing. Such an ambiguity in the firm's decision and strategies can lead to an unwillingness of finance providers to fund entrepreneurs (Rampini 2004).

The *adverse-selection* is a problem of incomplete information or a form of ex ante opportunism in which one party (e.g., the borrower) does not reveal her/his private information on her/his intrinsic characteristics (quality, ability, etc.) or on the project that s/he wants to fund through credit at the time of negotiation. This reduces the benefits of the other party (the lender) who must suffer additional contractual costs. When there are several types of agents in the market, the quality-individuals must send some informative signals in order to show their true quality and allow the buyers to purchase their products or services. On the contrary, the market adverse-selects and the quality-individuals exit the market lenders trying to charge higher returns or interest rates according to higher risks they perceive. It is likely that information asymmetries are higher for nascent entrepreneurs who do not have any established track record. The case of start-ups and young innovative firms obviously belongs to this category of issue and constitutes financial barriers to entrepreneurship. Then, the risk-premium for innovative projects will be higher than that for ordinary investment because investors have more difficulty to distinguish between good and bad projects. The lack of experience and historical record, but also the little size and low guarantees that new or young firms can offer to banks and financiers make that the funding of new activities or projects suffers problems of adverse-selection.

The second factor is the fundamental uncertainty inherent in entrepreneurial innovations. New products, processes, organizations, etc., are intrinsically uncertain in their potential economic value. Therefore the entrepreneurship, which can be defined as the process of undertaking new and risky activities, may become discouraged because of difficulties of obtaining required financing related to uncertainty. This problem exists for all firms per se. But in the case of innovative activities, potential investors are more careful and may require further collateral to cover their commitments (Ülgen 2007).

Public Support for Innovation-Based Entrepreneurship Financing

In view of various financial hurdles impeding entrepreneurial innovations, there is increasing public support for the entrepreneurship financing. International and intergovernmental institutions, such as the OECD, implement different policy measures to simplify and streamline procedures in the existing support programs to make information and rules more accessible with respect to enterprise access to funding. These programs aim to frame and implement new ways to improve the role of banks and financial institutions for local entrepreneurship development, to strengthen the existing schemes of venture capital in favor of new and growing small and medium businesses (SMEs), to boost the number of business angels, and to seek their involvement as counselors to young enterprises.

In this aim, the *Competitiveness and Innovation Framework Programme 2007–2013* (CIP), which is a part of the *Entrepreneurship and Innovation Programme* of the European Union, allocates over 1.1 billion euro to enable financial institutions to provide about 30 billion euro of new finance for up to 400, 000 SMEs in Europe. This allocation addresses SMEs' needs for financing at various stages of development through the European Investment Fund and selected financial institutions. For venture capital, the program finances early and expansion stage of specialized sectors (e.g., eco-innovation). The program also provides financial guarantees by establishing risk-sharing arrangements with financial institutions that fund directly SMEs. Five hundred and fifty million euros constitute the *High Growth and Innovative SME Facility* (GIF1 and GIF2, seed and start-up investments and expansion stage), while 506 million is allocated to SME Guarantee Facility (SMEG). The latter provides guarantees to lead banks and other financial intermediaries to make more debt finance available to SMEs by reducing their exposure to risk, as an important part of the SMEs' difficulties in accessing finance is due to the perceived higher risk or to the lack of required collateral (see information on asymmetries, lack of capital, etc. above). SMEG provides loan guarantees for microcredit to microenterprises up to 9 employees; equity guarantees for seed capital, mezzanine financing, and risk-capital operations to support businesses up to 249 employees; and securitization structures to assist financial intermediaries in mobilizing debt finance for SMEs.

Obviously, the financing conditions of the entrepreneurship in an economy are related to the structure of the financial markets and banking system development. When markets and banks are usually intervening in new activities and projects, the formation of a technical and financial know-how can facilitate the funding of entrepreneurs' venture. But the evolution of financial markets can also harm the financing conditions of the enterprises when the monetary and financial system becomes more oriented through short-term speculative investments and less involved in the financing of productive activities.

Financial Development and Entrepreneurial Dynamics

Links Between Finance, Growth, and Innovations

The creative destruction process occurs also in the field of finance as new ways of financing and speculating may come into the picture when banks are considered not only as intermediaries between entrepreneurs and capitalists but also as innovators on money markets.

Schumpeter argued that the services provided by financial intermediaries (mobilizing savings, evaluating projects, managing risks, facilitating transactions) are essential for technological innovation and economic development as a monetary complement of the growth process. Recent works on the link between financial intermediaries and economic development show a renewal of interest for this Schumpeterian vision. King and Levine (1993) stated that Schumpeter might have been right about the importance of finance for economic development as financial services would stimulate economic growth by increasing the rate of capital accumulation and by improving the allocation efficiency of markets. King and Levine argue that the financial system can promote economic growth: "The link between growth and financial development is not just a contemporaneous association. Finance does not only follow growth; finance seems importantly to lead economic growth" (1993, p. 730).

Also Bencivenga and Smith (1991) model the effect that intermediaries can have on an economy's growth rate by encouraging a switch in savings from unproductive liquid assets to productive illiquid ones. If agents face some probability that investments will have to be liquidated at an inopportune time, they must self-insure against random liquidity needs and they invest in unproductive liquid assets. Because of long delays between investment expenditures and receipts of profits from capital, capital investors may face unpredictable liquidity needs, leading to delays in further investment or to liquidation of investment already undertaken.

Financial intermediation can promote growth because it allows a higher rate of return to be earned on capital, and growth in turn provides the means to implement costly financial structures. Saint-Paul (1992) emphasizes the role of financial markets in channeling savings toward investment and the fact that financial intermediaries are able to solve informational problems that would otherwise lead to inefficient outcomes. The best management of risk reduction and the liquidity services of financial intermediaries lead the economy to orient savings to long-term financial investment. Financial intermediaries tend to alter the composition of savings in a way that is favorable to capital accumulation because the banks are assumed to permit risk-averse savers to hold bank deposits rather than liquid unproductive assets. Therefore, funds that banks obtain on markets become available for investment in productive capital. Financial institutions play then a crucial role in the microeconomic resources allocation process thereby affecting the economic performance of firms. This is true when we take into account technological innovations because of the fact that technological change means new uncertainty.

Financial Development

These results underline the importance of the development of financial markets in the growth process. Kerr and Nanda (2009) present a comprehensive analysis on the links between the role entrepreneurship plays in the economic growth of a country through its financial market development. The financial development (*financial deepening*) is usually defined through the *breadth* (broad markets with wide transactions, numerous actors), the *depth* (deep markets with wide range of products), and the *liquidity* (liquid markets without restriction on financial transactions) of financial markets. It is assumed to spur growth through either a supply-push (increasing and improving availability of finance for the real economy) or a demand-pull process (demand for new financial products). The financial development is usually related to the liberalization process.

Following the way paved by Goldsmith, McKinnon, and Shaw in the 1960s/1970s, numerous works (see Levine (2005) for a literature review) assert that liberalized finance would improve the competitive incentives leading to innovations and then allowing banks to provide more efficient financial services (e.g., risk management, information acquisition, and monitoring). It is also assumed that the more competition and opened markets would foster growth and improve economic stability, at least at the long run. In this vein, deregulation policies have been implemented since the late 1970s, which provoked expansion of financial markets and modification of financing practices. With the extent of structural changes in financial markets, regulatory and technological barriers among different types of intermediaries have tumbled, while new financial instruments and usages have proliferated. Such an improved financial environment would support the Schumpeterian vision of creative destruction process by which innovations replace old methods and goods with better process, commodities, and services. As a result, financial intermediaries would make possible technological innovation and economic development.

Banks' innovations change the economic conditions as much as the entrepreneurial innovations. They affect the functioning of economic engine because they modify the monetary and financial conditions on which the whole economic structure is founded. Most of the recent monetary and financial innovations seem to increase the elasticity of finance. However, in view of the current financial disequilibria faced by numerous economies in the world, such financial innovation dynamics present a real challenge as regards the systemic stability.

New Financial Environment and Market Dynamics

Innovative dynamics of financial markets enlarge the operations of securitization that allow lenders and borrowers to match different types of availabilities with different types of needs to finance various economic activities. At the same time, growing interdependencies among financial institutions but also among individual lenders and borrowers generate high sensitivity of finance-related real activities as regards the sudden reversal of market expectations and opinions about the soundness of previous positions. The boundaries between the assumed positive outcome of financial innovations for the economic development (creative destruction) and their instability-generating sensitivity to ex post-observed disequilibria are very ambiguous and do not seem to be "panic-proof." Accumulated fragilities may come from unfettered and ill-framed financial liberalization that leads financial institutions to implement innovations which reveal to be detrimental to the sustainability of debt-financing economic development. Therefore, the financial development casts doubt on the creative nature of innovations and implies new macro-prudential regulatory rules in order to direct financial markets' innovative dynamics toward more productive economic activities beyond the short-sighted speculative transactions.

Impacts of Financial Turmoil on Entrepreneurship Financing

The ongoing economic crisis, officially announced at the end of 2007, seems to be continuous in spite of prompt and massive interventions of monetary and public authorities all around the world. Governments stepped in with several hundred billion dollars bail-out plans in hopes of saving financial system on the edge of global disaster and of riding out recession. Consequences of such a turmoil are more than anecdotal and point to the crucial importance of financing conditions on the entrepreneurship dynamics of economic expansion. As stated by Lerner (2010), in USA, venture capital investment dropped 30% in the fourth quarter of 2008 to its lowest level since 2005. Also, start-ups lay off full-time employees and cut projects in the hope of reducing their costs and exposure to the effects of the crisis, while investors and banks are retreating from new commitments and investing into the existing portfolio companies rather than in new generation start-ups. Some investors can also renege on previous commitments what stops suddenly the funding of young enterprises, leading them frequently to file for bankruptcy.

Innovation projects are risky, unpredictable, multistage, and usually long-term. They tend to be idiosyncratic and difficult to compare with other projects which could give investors some benchmarks to evaluate the return potential of projects. Therefore, during periods of crisis, these characteristics make difficulties worse for the financial support of innovative entrepreneurs. Entrepreneurial innovations are a part of the long-run growth process as they can drive booms, and downturns and changes in the conditions of their financing determine the effective path of economic development.

Conclusion and Future Directions

In an entrepreneurial market economy, every economic activity needs specific financing in order to be effectively realized. Entrepreneurship and financing mechanisms/tools are two related parts of the economy. The entrepreneur needs finance to fund her/his plans and innovation projects (founded on private expectations aiming at obtaining positive and high profits), and the financial funds and banks (money funders) have to find entrepreneurs to whom they could grant credit in order to realize profits from their own activities. In such an economy, economic development mainly comes from innovative projects which allow people to produce more and better products (goods and services). Innovations are related to industrial novelties as well as to new financial techniques, products, and processes.

Different situations can exist depending on the characteristics of entrepreneurs and specificities of projects to be financed as there may be different ways of financing and various financial institutions and techniques. New, young, and small enterprises, locomotives of change in immature and unconcentrated sectors, have specific needs of financing that large and mature firms, major sources of change in concentrated and worldwide global sectors, do not have (CPI). These latter's need of financing is usually satisfied on financial markets and by bank consortiums.

That is why it seems that finance and entrepreneurship, or in more specific terms, financing entrepreneurship is a research (and also economic policy) area where the issues are many and related to the functioning of a capitalist economy. In the capitalist economy, entrepreneurs are the real sources of economic dynamics, while banks and financial institutions and resources are the monetary dynamics of economic change. Changes in the conditions of financing of entrepreneurship affect, therefore, the path of economic development.

Hence, searching for relevant economic policies aiming at creating and implementing incentives to innovate in entrepreneurship and in financing mechanisms of productive activities through a consistent macroeconomic framework able to reinforce the systemic stability against financial markets disequilibria is one of the major issues that analysts and policy makers have to deal with. The economic action cannot be understood without taking account of monetary and financial conditions under which the entrepreneurship can or not be fully conceived as a source of continuous positive economic evolution.

Cross-References

- ▶ Angel Investors
- ▶ Creative Destruction
- ▶ Entrepreneurship and Financial Markets
- ▶ Informal Venture Capital
- ▶ Innovations
- ▶ Private Equity
- ▶ Risk, Uncertainty, and Business Creation

References

Bencivenga VR, Smith BD. Financial intermediation and endogenous growth. Rev Econ Stud. 1991;58: 195–209.

Competitiveness and Innovation Framework Programme (CIP). Financial instruments. entrepreneurship and innovation programme. http://ec.europa.eu/cip. Accessed 1 March 2012.

Cosh A, Cumming D, Hughes A. Outside entrepreneurial capital. Econ J. 2009;119:1494–533.

Kerr WR, Nanda R. Financing constraints and entrepreneurship. Harvard Business School Working Paper, 10-013 (2009).

King RG, Levine R. Finance and growth: schumpeter might be right. Q J Econ. 1993;108:717–37.

Leland HE, Pyle DH. Informational asymmetries, financial structure, and financial intermediation. J Financ. 1977;32(2):371–87.

Lerner J. Innovation, entrepreneurship and financial market cycles. OECD STI Working Paper, 2010/3 (2010).

Levine R. Finance and growth: theory and evidence. In: Aghion P, Durlauf SN, editors. Handbook of economic growth. Elsevier; 2005. pp 865–934.

Mahagaonkar P. Money and ideas. Four studies on finance, innovation and the business life cycle. New York: Springer; 2010.

Rampini AA. Entrepreneurial activity, risk, and the business cycle. J Monet Econ. 2004;51(3):555–73.

Rani S, Rao DK. Financing small enterprise: recent trends. Icfai J Entrep Dev. 2008;5(1):6–22.

Saint-Paul G. Technological choice, financial markets and economic development. Eur Econ Rev. 1992;36: 763–81.

Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard University Press; 1934/1961.

Schumpeter JA. Business cycles. New York: McGraw-Hill; 1939.

Ülgen F. A methodological analysis: a new way to assess the schumpeterian monetary paradigm. Energeia Int J Philos Methodol Econ. 2003;2(1–2):11–29.
Ülgen F. La dynamique de financement de l'innovation. Innovations Cahiers d'économie de l'Innovation. 2007;25(1):45–67.

Financing Innovation

Werner Hölzl and Michael Peneder
Austrian Institute of Economic Research (WIFO), Vienna, Austria

Synonyms

Corporate finance; Entrepreneurial finance; Innovation policy

Introduction

Innovation is the creation of better or more effective products, processes, and services and often associated with technological activities. At the level of firms (or other organizations) innovation activities are highly uncertain and require the commitment of resources. *Incentives* to invest and the *ability* to commit (or raise) the necessary funds are central.

Incentives to Finance Innovation

The *limited appropriability* of the returns of innovation activities implies that private returns often fall short of the social returns to innovation. This leads to a potential underinvestment in innovation. This problem is independent of the firm's actual financing capacity. It originates in the limited salability of new ideas. Since knowledge can remain in circulation no matter how many people use it, it tends to produce high social returns. In turn, the private returns of an innovation often fall short because of the difficulty to enforce any payment once the new knowledge has been disclosed. As a consequence, innovative firms face the dilemma that they might be unable to communicate the value of a new idea to a potential buyer without disclosing the idea itself, which in turn implies that a potential buyer may no longer be willing to pay for it (Arrow 1962).

In practice, innovative firms try to limit the problem of lacking appropriability by deliberately managing their knowledge flows. Geroski (1995) lists a number of strategic options for individual enterprises, among them intellectual property rights, secrecy, lead-time, and embodied knowledge ("sell products, not ideas"). Depending on the particular technology and market characteristics, some strategies will be more effective than others, but overall, an innovative firm cannot expect to fully prevent the unpaid diffusion of new knowledge, and the more distant the research is to the market, the more difficult it becomes, to fully appropriate the returns. As a consequence, the private incentives to finance innovation tend to be lower than what would be desirable for the society at large. Thus, limited appropriability is a primary rationale to government policies in the pre-competitive research.

Financing Gaps

Imperfections in capital markets are a second cause of underinvestment in innovation. In the hypothetical state of perfect capital markets, all projects are funded according to their own merit, and firm-specific financial factors, such as its equity ratio or the availability of collateral, can have an impact only on the terms of the contract but not the financing decision itself. Riskier projects simply call for higher rates of interest. In practice, however, interest rates are rarely used to discriminate between projects, and firms without sufficient collateral face credit constraints.

The financing constraints result from asymmetric information in the financial market. In particular, there are two problems of asymmetric information between the entrepreneur and the investor. *Adverse selection* is the problem of identifying the true quality of a project. If the entrepreneur cannot provide a credible commitment, the investor denies credit rather than raising the interest rate. The reason is that the latter would attract the riskier projects. In the case of *moral hazard*, entrepreneurs may alter their behavior at the cost of the investor after the funding decision. For example, they may reduce effort, or become less prudent to avoid the risk of a default. Investors can mitigate information asymmetries by means of expensive screening and continuous monitoring. But when the implied costs are too high, they must deny financing even though the project may again have been desirable for the society at large. The problem of asymmetric information is especially high for new technology-based firms that require large sums of money in order to make their innovation projects market-ready.

The Financing of Innovation and the Valley of Death

Many innovation projects are abandoned before the idea is developed into a marketable product. This failure is sometimes called the "valley of death" (Osawa and Miyazaki 2006) and is generally observed for large firms but presents a much larger problem for technology-based entrepreneurial firms. Large established enterprises are able to set up a portfolio of innovation projects, but more importantly they are able to finance their innovation projects with their cash-flow. Pecking order theory (Myers and Majluf 1984) predicts that taxes and asymmetric information lead to a pecking order of financing of investment and innovation projects. Own cash-flow is preferred to debt finance and debt finance in turn to equity finance. Transaction cost theory links the investment project with the form of finance and predicts that projects that are riskier and specific to the firm should be financed by own cash-flow or equity (Williamson 1987), and only low-risk projects should be financed by bank credit. These theories predict that the financing constraints of technology-oriented entrepreneurial firms are related primarily to an equity gap, as those firms have neither a large cash-flow nor enough collateral to be attractive for bank finance. Moreover, the access to the capital market (equity and bonds) is generally restricted to large and established firms (Hall 2009). Thus, the disadvantage of being small and new weighs even more in the case of financing *innovation* (Carpenter and Petersen 2002).

New Technology-Based Firms (NTBFs)

In response to this, financial institutions have evolved in order to deal with problems of asymmetric information. Specialized financial intermediaries and specialized financial instruments have developed that allow to provide the required finance to new technology firms.

By the complex nature of most innovation projects, screening and monitoring is very costly and requires expensive expert knowledge, while entrepreneurs are more reluctant to disclose information due to its fear of imitators.

To summarize, internal sources from own cash-flow are the dominant source of financing innovation for most established businesses. But the importance of external sources rises significantly for new technology-based firms (NTBFs) with high growth opportunities. Over time, also these innovative firms can reduce the financing constraints by building-up steadier and stronger cash-flows and reputation. Consequently, there is a "financing gap" that affects only a limited number of firms, but precisely those with the highest potential to foster radical innovations (Peneder 2012).

Business Angels and Venture Capital

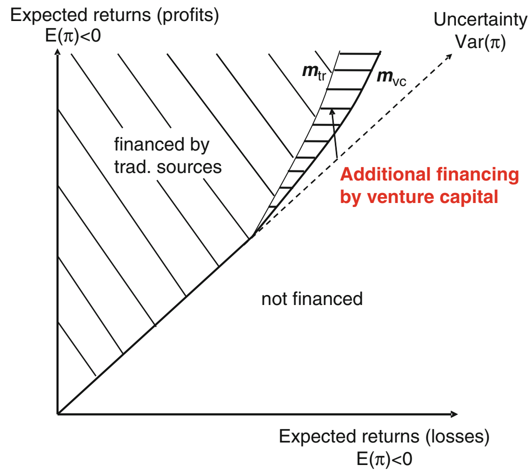
Among the specialized institutions that finance new technology-based firms (NTBFs) are business angels or venture capital firms and corporate venture capital (Gompers and Lerner 1999). Since these are discussed at more detail in separate entries the focus of this section will be on their joint characteristics with respect to the financing of NTBFs.

Business angels and venture capital associate with three economic functions that render them particularly important for innovation: First of all, as active investors and in addition to capital they contribute managerial experience, access to informal networks and professional business models, which is quite different from other financing sources and establishes a genuine *value adding function*. Second, both also serve a specific *selection function*, which involves the allocation of financial resources to the most profitable uses under conditions of high uncertainty and asymmetric information and which is characteristic of innovation projects. Finally and foremost, when bridging the aforementioned financing gaps and providing funds to businesses which otherwise would not have access to sufficient financing through traditional sources of capital, they serve a specific *financing function*.

They achieve these functions by virtue of their specialized business model, which encompasses a careful screening and subsequent monitoring of projects as well as the active participation in the development of a company, all of which mitigate the problems of asymmetric information. For the purpose of NTBFs, two characteristics are particularly notable. First, the investments are of limited duration. Second, dividends are not expected during the investment period, since investors aim to earn their profit on rising company values. Consequently, current cash-flow can be reinvested in the further build-up and expansion of the business.

Figure 1 provides a stylized presentation of the specific financing function. The diagram is plotted on two independent axes: the expected profits E(π) and the degree of uncertainty Var(π). The figure describes the expected profits and accompanying uncertainty of the project's success in the form of its variance. By means of bisecting all angles, the independent dimension Var(π) is drawn along a 45° degree diagonal line. The vertical axis depicts financing projects with a positive value of expected profits, and the horizontal axis depicts projects with expected losses.

In the ideal case of perfect markets without information problems, the amount of financially feasible projects for risk-neutral capital investors is determined through the expected profits and therefore, independent of the extent of uncertainty. All projects above the diagonal line will be financed, all others will not receive financing because their expected returns are equal to or less than zero. In imperfect markets with asymmetric



Financing Innovation, Fig. 1 Business angels and venture capital (Source: Peneder 2010)

information, additional costs *m* are generated through the need for more elaborate selection and monitoring processes in order to mitigate problems of adverse selection and moral hazard. The boundary of financially feasible projects moves upward and away from the diagonal by the distance *m*. The *financing gap* arises, as certain projects are no longer considered financially feasible due to increased monitoring, advising, and control costs. Given such a situation, business angels or venture capital funds take advantage of their role as specialized finance intermediaries. As a result of their diligent project screening and monitoring, as well as their accompanying advisory services, they shift the boundary of financially feasible projects outward.

Due to specialization advantages, the marginal costs of overcoming problems of asymmetric information are lower for projects financed by business angels or venture capital (m_{VC}) than for those using traditional financing instruments (m_{tr}). The additional costs for screening, monitoring, and advising m_{VC} are the price to be paid for overcoming principal-agent problems and thus, securing financing for projects with a high degree of uncertainty and informational asymmetries. In short, business angels and venture capital enable the pursuit of new financing opportunities and increase the number of feasible projects, thereby reducing the financing gap.

Policy

External effects (spillovers) and asymmetric information constitute two standard cases of market failure. But it is important to understand that market failures do not automatically call for policy intervention. The cost and the unintended consequences of policy actions need also be taken into account. Besides that, both *rationales* are quite distinct and relate to different policy targets and consequently different instruments (Peneder 2008).

Regarding the first rationale of distorted incentives to pursue innovative activities, policy *aims* to change the relative cost or returns of innovation. Regarding the second rationale of financing constraints, policy aims to bridge the gap in access to external funds. But the distinction between the two rationales is also important in setting the appropriate policy *targets*. Regarding the first rationale, public support is awarded primarily on the merits of a particular project or technology and not of the firm. In contrast, the second rationale of lacking access to financing calls for policies that specifically target a certain type of enterprises, such as the NTBFs. Finally, the two rationales call for different policy *instruments*. When compensating for positive spillovers and thereby raising the incentives to invest according to the first rationale, the menu of policies used by different countries to different degrees is typically comprised of *fiscal incentives* (i.e., tax credits and allowances, or rebates on wage taxes and social security contributions of R&D related personnel), the funding of pre-competitive (basic) research and the use of *direct funding* instruments, such as grants or soft loans. In contrast, typical policies that address the lack of access to external sources of finance according to the second rationale are soft loans, public guarantees, and/or public equity schemes.

The support schemes need much care in design to avoid the crowding out of private investors, such as business angels and venture capital. Otherwise policy does not only waste public resources, but can also inhibit the development of a mature and self-supporting ecology of private investors. Thus, public support should, therefore, focus on the most persistent gaps in early stage investments, particularly in the seed phase, when private investors are especially reluctant to enter. The use of soft loans needs to be made complementary to the private market. Public support should concentrate on the support of pre-competitive research and not aim at selecting single firms. Public guarantee instruments need to be applied with caution, since they may cause their own moral hazard with respect to the entrepreneur's risk behavior. Beneficiaries, therefore, should always have to carry part of the risk and pay an appropriate risk premium.

Conclusions and Future Directions

To support effective and evidence-based policies directed at the financing of innovation, much more research is needed in future on the impacts of the various instruments. While program evaluations are often called for, few of them have the opportunity to apply rigorous tests proposed in the literature on program evaluation. This is often related to the lack of access to individual firm data and counterfactual observations of enterprises not supported by the particular schemes and to the incomplete knowledge about the systemic aspects of financing innovation within specific institutional settings.

Cross-References

- ▶ Angel Investors
- ▶ Entrepreneurship and Financial Markets
- ▶ Financing Entrepreneurship
- ▶ Schumpeterian Entrepreneur
- ▶ Venture Capital and Small Business

References

Arrow KJ. Economic welfare and the allocation of resources for invention. In: Nelson RR, editor. The rate and direction of incentive activity (Seite fehlt). Princeton University Press: Princeton; 1962.

Carpenter RE, Petersen BC. Capital market imperfections, high-tech investment, and new equity financing. The Economic Jl. 2002;112:54–72.

Geroski P. Markets for technology: knowledge, innovation and appropriability. In: Stoneman P, editor. Handbook of the economics of innovation and technological change. Oxford: Basil Blackwell; 1995. p. 90–131.
Gompers P, Lerner J. The venture capital cycle. Cambridge, MA: MIT Press; 1999.
Hall BH. The financing of innovative firms. EIB Papers. 2009;14:8–28.
Myers S, Majluf N. Corporate financing and investment decisions when firms have Information that investors do not have. J Financ Economics. 1984;13:187–221.
Osawa Y, Miyazaki K. An empirical analysis of the valley of death: large-scale R&D project performance in a Japanese diversified company. Asian J Technol Innovat. 2006;14(2):93–116.
Peneder M. Firm growth, Schumpeterian entrepreneurship and venture capital. In: Cumming DJ, editor. Oxford handbook of entrepreneurial finance. Oxford: Oxford University Press; 2012. p. 424–66.
Peneder M. The impact of venture capital on innovation behaviour and firm growth. Venture Capital: Int J Entrepreneur Finance. 2010;12(2):83–107.
Peneder M. The problem of private under-investment in innovation: a policy mind-map. Technovation. 2008;28:518–30.
Williamson OE. Corporate finance and corporate governance. J Finance. 1987;43:567–91.

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Firm Failure and Exit

Nadine Levratto
EconomiX, UMR 7235 CNRS,
University Paris Ouest Nanterre La Défense and
Euromed Management, Nanterre, France

Synonyms

Bankruptcy; Exit; Failure; Insolvency

Insolvency as a Crucial Economic Phenomenon

Research on entrepreneurship use to insist upon business creation, firm growth, and market expansion which are then the shining side of economic activity (see the entry "▶ Entrepreneurship Policies"). However, a dark side of entrepreneurial ventures exists as risk becomes effective and causes the failure of the firm. Exit is generally considered a sign of failure of the firm, a consequence of poor performance: firms that underperform as they compete in the market will, sooner or later, exit the market. This process is worth knowing better at least for two main reasons. Firstly, the Schumpeterian concept of creative destruction which describes the process of transformation that accompanies radical innovation supposes the replacement of established companies by new entrants involves by the fact the exit of a certain amount of existing firms. Besides this renewal of productive system it ensures, exit can also have a positive value since individuals who have closed down the company they owned or managed in the previous year are more likely to engage successfully in a future entrepreneurial activity. Secondly, despite the efforts and measures adopted by the states, the rate of exit of new entrants barely decreases below 50 % before their fifth birthday, and the global rate of corporate bankruptcy demonstrates a rare stickiness except when the law changes. It is then essential to determine a pattern of failure and exit in accordance with these theoretical and factual dimensions.

The problems most scholars and practitioners face whenever it is a question to define, understand, or prevent firm failure start with the definition of insolvency and the differentiation with bankruptcy. However, the definition of a border line which separates going concerns from defaulting company is not the final purpose of research dealing with insolvency. Instead, an abundant literature is devoted to the identification of determinants of default or failure, thanks to the identification of discriminant functions that are able to discriminate between healthy companies and firms that are likely to fail in a near future.

Most of this research aims to identify the items of the balance sheet or the profit and loss account that are able to reflect the distress of the firm. However, focusing on the predictive signal of insolvency, this literature mainly deals with the symptoms of default and not with the causes. That is why a growing number of works goes one step beyond the question of expectation to study the causes of exit in order to prevent failure. The remaining portion of this entry is organized as follows. Section "Defining Business Failure" considers the variety of definitions of insolvency and puts some order in differentiating default, insolvency, and bankruptcy; Section "A Large Variety of Causes of Insolvency" presents the literature dealing with the prediction of insolvency looking at its more visible manifestations, whereas Section "Forecasting and Estimation of the Probability of Failure" insists upon the efficient causes or primary sources of failure which have more to do with the productive combination and the market positioning of the company than with the financial and accounting ratios.

Defining Business Failure

The attribution of success and/or failure to small firms is complex, dynamic, and problematic. Despite an abundant literature devoted to firm default, it still does not exist as unique and broadly accepted. Broadly speaking, insolvency is defined as an incapacity to pay debts upon the date when they become due in the ordinary course of business. This definition permits to make a distinction between healthy companies as they respect their contractual commitments and distresses companies which are just about to file for a petition. Such a definition has however a drawback. It tends indeed to create a confusion between insolvency and default mainly seen as the nonrepayment of a debt by the literature devoted to the functioning of credit market. The word "insolvency" refers then primarily to a corporate reality which is not so simple to define as far as one is concerned in differentiating defaulting firms from going concerns.

However, establishing a clear dividing line between the two previous kinds of companies is a key challenge in the proposal of a typology of companies according to their degree of robustness. It is all the more important that such a distinction is mandatory for bank in accordance with Basle 2, and coming Basel 3, principles and that an increasing number of research aims to propose an empirical analysis of distressed firms. To cope with these goals, two polar definitions of insolvency are currently used in economics; the first one is economic whereas the second one refers to judicial rules.

The Economic Conception of Insolvency

According to the advocates of the economic conception, insolvency is defined as a set of situations of failure such as the nonrepayment of a debt, the inability to pay dividends to the shareholders, the financial distress, etc. which can lead, or not, to the beginning of a judicial proceeding. In such an approach, the suspension of a company is then conceived like the result of a progressive process. It is characterized by the fact that, during all this process, the company is unable to fulfill in a regular way the commitment toward its various partners. Indeed, the problems which a company can encounter must be analyzed as a continuous and cumulative process: The failure starts with small difficulties which are gradually transformed into more serious problems. Some works, following Beaver (1966), thus tried to propose models in which the nonpayment is used like the signal of the failure of the company. Because of the low level of correct classification provided by this fuzzy definition, the term "default" is no longer used to empirically illustrate the concept of failure.

In order to escape the blind alley resulting from the strict assimilation between insolvency and default, some authors have considered other events. A company is then considered as insolvent if it is no longer able to meet its economic, financial, and social objectives on a regular basis. Some go even further by considering that firms enter in periods of decline when they fail to anticipate, recognize, neutralize, or adapt to external and internal pressures that threaten their long-term survival. The separation between the failing companies and the others based on different performance criteria is proposed by Platt and Platt (2002). They draw a line between going concerns and distressed firms having experienced either several years of losses or decreases in the distribution of dividends or a major restructuring. Beaver (1966) is representative of this approach and defines the failure as the result of the inability of a company to meet its commitments once they have reached maturity. The results are quite poor however and become even worse when the purpose is to discriminate between profitable firms and nonprofitable ones because no function properly separates the two classes. More recently, this approach has also been adopted by Bose and Pal (2006) who obtained prediction rates ranging between 65 % and 75 % in their attempt to separate companies a priori considered as financially healthy from those which are not.

The problems encountered in testing the different border lines between viable firms and those that are going to fail come from the fact that the separation between these two situations is both porous and blurred. That is why numerous studies agree that the cessation of payments is the final step of a process, sometimes called "a spiral of failure," from which a firm can escape, thanks to the adoption of corrective and preventive measures consisting in a modification of its operating cycle.

The Managerial Perspective

The second set of papers considers failure from a legal point of view. It is then defined on the basis of judicial criteria introduced in the insolvency law enacted in a given country at a given period. Most legal rules considered a firm as bankrupt when the judge decides it is not able to make its repayments when the claims fall due (Cabrillo and Depoorter (1999)). Insolvent companies always conform to this mix of legal and accounting logic. At each stage of the judicial process, accounting considerations are introduced to strengthen the rationality of the decision made by the judges. Indeed, the proceeding always begins with a cessation of payments and ends up with a liquidation or continuation plans. To fix a point of time to signal the transition from a reliable and sound company to a failing one, many scholars consider that the failure occurs from the moment a company presents to the courts the legal documents required for its liquidation or reorganization. The failure is then assimilated to the entry in the insolvency proceedings.

Although the meaning and nature of the proceeding may differ, the arrival in a commercial court which registers the cessation of payments gives a simple criterion to "objectively" separate two classes of firms: those that are governed in accordance with the rules of collective proceedings and those which are still operating in an economic world dominated by the respect of contractual commitments. As in the previous set of papers, the robustness of this conception rests upon the binary choice provided by the judicial perspective: Either the company is sound or it is insolvent. The judicial definition of insolvency has given rise to much research of which this entry provide only a brief glance.

Proposing an empirical analysis to check out the differences between legally insolvent firms and those only reporting financial difficulties, Agarwal et al. (2001) determine a performing function whose exact classification rates are above 93 % for both groups. It appears that models relying on a legal definition and separation of businesses into two classes lead to more reliable results than the ones based upon financial performance levels. Different reasons explain this superiority. Firstly, the differences between failing and viable firms are clearer as one is closer to the cessation of payments. Secondly, the transition between an economic order, dominated by commitments and contracts on one hand, and a judicial universe in which pure market logic is supplanted by a legal order on the other is clearer than an assessment based on corporate performance. Therefore, in the legal order, the sequence is structured by a threefold stage. Firstly, it consists in the statement of cessation of payment. Secondly, it is followed by an arbitrage between direct liquidation and rescue which depends on the particular situation of the insolvent firm and the context in which the decision is made. Thirdly, the validity of this decision is known later if the rescued firm effectively survives.

A Large Variety of Causes of Insolvency

Various studies have endeavored to identify the causes of corporate bankruptcy which can be as numerous and complex than factors leading growth (Entry "▶ Entrepreneurship and Business Growth" in this opus). They succeed in identifying the profile of a vulnerable enterprise whose probability to go bankrupt is higher than the "normal" risk of failure. Everybody agrees that weak firms are naturally predisposed to go bust. The stake is then to isolate some ratios or indicators that give an accurate representation of the firm fragility. Different families of causes of insolvency may be then compounded according to the facet of the company they concern. An exhaustive presentation is available in Caves (1998) which provides a review of prior literature.

Size, Age, and Activity

The analysis of the possible causes of insolvency began with the introduction of firm size, following the Gibrat's law often considered in models of firm growth. Most of the researchers agree upon the fact that the smaller the firm size, the greater the chance for the firm to go bankrupt, and, as a complementary rule, one may consider that the probability of a firm to go bust decreases with its size. The same relationship prevails with age as the smaller firms are the more likely to be the younger too. Most of the time, these structural variables capture information contained in firms' specific characteristics. Young failures can be attributable to inadequate resources and capabilities (relative to initial endowments). Older failures should be attributable to a mismatch between resources and capabilities and the demands of the competitive environment. These internal processes will manifest themselves in vulnerable business models which fail to generate positive cash flow. The strength of the relationship varies with the context and, mainly, with the business climate in the industry. A nonnegligible part of research proposes then models in which mortality dynamics depends on age, size, and population density mechanisms.

However, considering these structural variables as appropriate proxy to determine the probability of bankruptcy cannot satisfy those who want to determine which firms are the more likely to default in order to use this information to make a right decision such as financing or to advise managers. Progressively, other elements more narrowly dependent on the specific characteristics of the firms have been introduced. The inspiration directly flows from the resource-based view which has principally been employed in the study of above-normal performance but is also instructive in the context of below-normal performance.

Financial Causes

In contradiction with the Modigliani-Miller theorem which states that, under specific assumptions, the value of a firm is unaffected by how that firm is financed, a large number of works shed some light on the role plays by the financial structure in the vulnerability of the firm (an analysis of the crucial role played by finance and financing institution is available in the entry "▶ Entrepreneurship Financing"). One may consider that the interest coverage and market value of equity/total liabilities are negatively correlated with the odds of corporate bankruptcy. In the same vein, the likelihood of going bankrupt increases with the leverage level and capital intensity but decreases with the liquidity level and growth prospect of a firm. Some are also interested in the expectations and appetite of shareholders as the smaller the stock return, the greater the chance for the firm to go bankrupt. Following the pecking order theory, one can support the idea that companies prioritize their sources of financing (from internal financing to equity) according to which the principle of least effort, or of least resistance, preferring to raise equity as a financing means of last resort. Hence, internal funds are used first, and when they are depleted, debt is issued. When it is not sensible to issue any more debt, equity is issued (Myers and Majluf (1984)). The ability of the firm to finance its investments by itself appears as a crucial factor for its stability. Thus, a high initial level of financial resources (equity and long-term debt) can protect the firm from a risk of failure.

Sales and Market Position

Other explaining variables have to do with the business and the market position of the company. The firms able to sell their products are less likely subject to a cessation of payments. The higher importance of the capacity to create a good customer relationship is pointed out by Shumway (2001) who finds that market variables are more useful than financial ratios in predicting bankruptcy.

Corporate Governance and Shareholders

Becchetti and Sierra (2003) include a group membership dummy ill a prediction model estimated on a large sample of Italian manufacturing firms and find a negative relationship between probability of failure and business group membership between 1992 and 1997. This evidence can be enlarged. On average, firms integrated in large corporate groups are more likely to be supported by the parent company and thus less likely to be insolvent. More recently, a report Levratto et al. (2011) argued that the odds of going bankrupt increases with the level of restrictions imposed on corporate internal control.

All these different causes do not intervene independently in the process of failure but combine each other. The decline of a company begins most of the time by mismanagement and unmarketable products which may cause a decline in sales over several years (and a correlative decrease in earnings if nothing is done to improve the market position). In the worst case, the falloff in turnover results in a decrease in profitability, followed by a deterioration of operating conditions which are at the origin of a solvency crisis. At this stage of the vicious circle, the company's managers have a strong incentive to accept less favorable market conditions (rebates or longer terms of payment, etc.) in the hope of restoring sales and profitability. Such a reaction can however be counterproductive as it can cause an increase in trade debts and inventories, especially in the manufacturing industry. As a consequence, the company may be short of cash and, therefore, may face a liquidity crisis which could lead lenders to practice credit rationing and increase interest rates since the simultaneous increase of indebtedness and decrease in self-financing deteriorates the probability of repayment of such a debtor. Subject to a shortage of financial resources, to a decrease in the EBIT aggravated by an inability to repay the claims once they fall due, the company may decide to file a petition for bankruptcy before the creditors decide to present one to the commercial court. Once one of these two possible events happens, the insolvency turns into bankruptcy.

Forecasting and Estimation of the Probability of Failure

Understanding and predicting company default has been an area of extensive research for at least 40 years. The literature exploring corporate failure started with the simple univariate discriminant analysis approach, pioneered by Beaver (1966). His univariate analysis of a number of bankruptcy predictors states that a number of indicators could discriminate between matched samples of failed and nonfailed firms for as long as 5 years prior to failure. Models of that kind are appealing in their simplicity, but their main disadvantage lies in their inability to account for the coexisting effects of many different indicators of default. They have been rapidly outperformed by the use of multivariate analysis, whose the Z-Score model proposed by Altman (1968) is still considered as a key reference in the literature. Its performance rests upon the innovative use of multiple discriminant analysis in the field of economics and finance. Multiple discriminant analysis is a statistical technique used to classify an observation into one of several a priori groupings dependent upon the observation's individual characteristics. It is used primarily to classify and/or make predictions in problems where the dependent variable appears in qualitative form, for example, bankrupt or nonbankrupt. From this venerable model, an unmeasurable number of variants have been tested. Either the number of indicators compounding the final score was changed to improve the fitness of the index or the formula was adapt to fit better with peculiar situation such as specific activities (services, start-ups, etc.) or markets (emerging, blue ships, etc.). Another generation of risk index models introduces the concept of indexing the individual failure-predicting indicators; however, their approach shares the same weaknesses of univariate analysis and provides largely arbitrary risk metrics.

The most visible progress results from the introduction of nondeterministic and nonparametric methods in the estimation of the probability of failure. They mainly consist in adopting artificial neural networks, computational structure modeled loosely on biological processes, to the bankruptcy prediction. One of the first studies to apply neural networks to the bankruptcy prediction problem was the work by Odom and Sharda (see Zhang et al. (1999) for a survey on this method). Despite their growing success, neural networks are still criticized due to the lack of transparency concerning the estimation process: They are even suspected to be "black boxes" that is a real weakness, whereas accuracy and information disclosure are required from banks in determining the exposure at risk. That is why the judgment is still balanced. On one hand, neural networks, when they are effectively implemented and validated, show potential for forecasting and prediction. But, on the other hand, a significant portion of the neural networks research in forecasting and prediction still lacks validity.

Currently, several of the major commercial loan default prediction products are based on neural networks. For example, Moody's Public Firm Risk Model (Online: www.moodysqra.com) is based on neural networks as the main technology. Many banks have also developed and are using proprietary neural network default prediction models. Nowadays, there is a wide range of default prediction models, that is, models that assign a probability of failure or a credit score to firms over a given time horizon. The literature on this topic has developed especially in connection with Basel II, which allows banks to set up an internal rating system, that is, a system to assign ratings to the obligors and to quantify the associate probabilities of default.

The requirement of the microregulation of the banking system and the increasing need of more accurate expectations on the exposure at loss of financial institutions are probably going to push up research on firm insolvency. A better knowledge of the causes of firms' failure is not only wished for an improvement of financial sphere functioning. It can also deserve firms' interests and companies' advisors to implement better practices of growth (the entry "► Accompaniment of Business Creation" gives an idea of the role of external supports as a reason of success). From an academic point of view, one may consider that the existence of firm-specific failure determinants offers support to the resource-based theory of the firm and contributes a more fine-grained perspective to the study of organizational ecology.

Conclusion and Future Directions

Over the past 35 years, corporate insolvency has been at the origin of a broad and in depth literature aiming at embracing legal and industrial features. Seen as a promising way to have at disposal prediction models possibly used by banks, firm exit has increasingly become a fashionable topic. The increasing number of works is especially visible in two fields. An empirical analysis of firm exit or default determinants which tends to provide a better knowledge of explanatory variables on one hand and a methodological perspective on the other, mainly consists in testing new techniques. In these two fields, the progress is really perceptible. The main problem remains that default, exit, and insolvency are ex post phenomenon and that their occurrence is highly sensitive to the context. To depart from the determinist view which characterizes parametric models, scholars tend to prefer nondeterministic ones. However, they tend to hide the reason why firms fail. In the future, one can expect that semiparametric models will be preferred, even if that requires intensive tests to improve their reliability as prediction tools. It is the price to pay to get a comprehensive model of exit.

References

Agarwal A, Davis JT, Ward T. Supporting ordinal four-state classification decisions using neural networks. Inf Technol Manag. 2001;2(1):5–26.
Altman E. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. J Finance. 1968;23(4):589–609.
Beaver W. Financial ratios as predictors of failure. J Acc Res. 1966;4(Suppl):71–111.
Becchetti L, Sierra J. Bankruptcy risk and productive efficiency in manufacturing firms. J Bank Finance. 2003;27(11):2099–120.

Bose I, Pal R. Predicting the survival or failure of click-and-mortar corporations: a knowledge discovery approach. Eur J Oper Res. 2006;174(2):959–82.
Cabrillo F, Depoorter B. Bankruptcy proceedings. In: Bouckaert B, De Geest G, editors. Cheltenham: Edward Elgar; 1999. pp. 261–289.
Caves R. Industrial organization and new findings on the turnover and mobility of firms. J Econ Lit. 1998;36(4):1947–82.
Levratto N, Carré D, Tessier L, Zouikri M. La défaillance des entreprsies. Etude sur données françaises entre 2000 et 2010. Regards sur les PME, no 21, Paris, La Documentation Française.
Myers S, Majluf N. Corporate financing and investment decisions when firms have information that investors do not have. J Financial Econ. 1984; 13(2):187–221.
Platt HD, Platt MB. Predicting corporate financial distress: reflections on choice-based sample bias. J Econ Finance. 2002;26(2):184–99.
Shumway T. Forecasting bankruptcy more accurately: a simple hazard model. J Bus. 2001;74(1):101–24.
Zhang G, Hu MY, Patuwo BE, Indro DC. Artificial neural networks in bankruptcy prediction: general framework and cross-validation analysis. Eur J Oper Res. 1999;116(1):16–32.

Flexibility

▶ Divergent Thinking
▶ Ideas and Ideation

Flexible Retirement

▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation

Fluctuations in Economic Activity

▶ Business Cycles

Fluency

▶ Divergent Thinking
▶ Ideas and Ideation

Forces of Production Theories

▶ Innovation in Radical Economic Thought

Forecast

▶ Imagination

Forest Sector

▶ Innovation in Forestry: New Values and Challenges for Traditional Sector

Fostering Creativity Through Science Education

Mavis Haigh
Faculty of Education, The University of Auckland, Auckland, New Zealand

Synonyms

Innovation in practical work in science education; Open-ended investigative practical work in science education

Key Concepts

This entry focuses on the premise that creativity can be fostered through science education. There are two contrasting views of the nature of creativity – the first is the extraordinary, or high, creativity displayed by geniuses, and the second is the more everyday creativity, sometimes called possibility thinking, that occurs as an individual makes inventive decisions when faced with novel and/or demanding contexts. Craft (2001) used the notions of “big C creativity” (BCC) and “little c creativity” (LCC) to frame these two views of creativity within education. The concept "creativity" applies both when ideas and artifacts are produced for the first time in human history and when the ideas are new simply to the person who generated them. Both LCC and BCC require imagination, flexible thinking, and originality. It is generally LCC that we can foster through science education, though students involved in research projects may arguably be involved with aspects of BCC such as novelty and peer validation (Feldman et al. 1994).

Creativity is recognized as domain specific or dependent, which suggests that there is a particular kind of creativity associated with divergent thought when considering science ideas. It can be argued that hypothesizing, designing experiments, and problem solving all require a particular kind of creativity peculiar to science, as does the technical innovation that is often required as part of experimental design. However, scientific creativity is a subtle concept that is hard to pin down and is often used in different ways. Kind and Kind (2007) provide an analysis of teaching creatively, creativity's link with inquiry teaching, and creativity as an aspect of the nature of science.

Hu and Adey (cited in Lin et al. 2003) proposed a definition for scientific creativity when they developed a test for scientific creativity for secondary school level science. Their definition included three dimensions: process, trait, and product, and seven core elements: unusual use, problem finding, product improvement, creative imagination, problem solving, science experiment, and product design. They, and their team of researchers, have used this framework to compare the scientific creativity of students who have undergone the Cognitive Acceleration through Science Education (CASE) program with those who have not (Lin et al. 2003). The CASE program did appear to promote scientific creativity in secondary school students though the effects on different aspects of creativity varied, with items testing science experiment and product design having large effects and creative imagination having a smaller, but still statistically significant effect. The effect of CASE on creativity was shown to be often delayed until one or more years after the end of the intervention program. The research team argued that "the CASE programme improves students' cognitive processing, and only when this has been achieved can it be applied to problems requiring creative thinking."

The Place of Creativity in the Science Curriculum

Across the world, science education is increasingly being required through its curriculum documents to address the nature of science and its social practices as well as the content of science. This requirement is supported by the argument that "in a society where science increasingly permeates the daily discourse, some understanding of its underlying epistemic values, methods, and institutional practices is essential if the citizen is to engage with the issues confronting contemporary society" (Osborne et al. 2003). After carrying out a careful Delphi study with representatives of groups involved in science and science education around what ideas about science should be taught in school science, Osborne et al. listed nine key aspects of the nature of science that were considered as essential in school science curricula. One of these was an understanding that science is a creative endeavor. If creativity is fundamental to science, it arguably should also be a prominent feature of science education.

However, it is not sufficient to simply tell students about the creativity inherent in the scientific endeavor, though an appreciation of the role of human engagement and creativity in the development of scientific ideas might be addressed through carefully crafted historical study (Kind and Kind 2007). Instead, students need to be encouraged to do science in ways that foster creativity. Ways of fostering creativity in science education include making models to explain ideas and visualizing processes in an attempt to explain phenomena. Developing students' futures thinking within science education is another approach likely to foster creativity given that imaginative creativity is a significant feature of futures education. A study of socio-scientific issues within futures education approaches calls for student understanding of current situations to inform, imagine (create), and evaluate possible and preferable futures (Jones et al. 2011).

Encouraging questioning and problem-posing, formulating hypotheses and predictions, and designing and carrying out investigations to test these also offer students ways of authentically experiencing the creative aspects of the development of science ideas. Students also need experience in interpreting data and in making decisions about the status of evidence and the validity of inferences. Experience in defending their interpretations, especially should others offer conflicting interpretations, is also necessary. Notions of collaborative creativity can be fostered through deliberately encouraging students to work cooperatively, thus permitting a glimpse of the common effort involved in much scientific work (Osborne et al. 2003).

Student engagement in scientific inquiry holds the potential for fostering students' understanding about the nature of the scientific endeavor, including the role of creativity in the development of ideas in science. Many curricula emphasize the centrality of inquiry (sometimes framed as investigation) to school science. However, science education researchers hold variable views regarding the possibility and actuality of inquiry approaches in school science classrooms for providing a context for students to experience authentic scientific inquiry (e.g., Abd-El-Khalick et al. 2004; Kind and Kind 2007). It has been argued that there is a difference between the ideals of inquiry science in schools and its reality in practice. In part, this may be the result of teachers' differing perspectives of the nature of science. In part, it may be because teachers continue to tightly frame student investigations. If school inquiry science is to become more authentic, then it is likely to require teachers to reconsider their roles and the classroom activities they plan and for students to accept changes in teacher-student engagement and learning environments (Haigh 2010).

It is recognized that the processes of scientific inquiry require a sound understanding of context and concepts inherent in the investigation, a particular challenge to student novices and teachers alike. Minimal guidance by the teacher is unlikely to result in anything but frustration for the students. Teachers wishing to support their students' inquiry approaches are likely to have to address their students' lack of scientific knowledge by providing information as it is required, or at least direct the students to where the information may be found (Haigh 2010). Given that scientific creativity and rationality are likely to work together, it is also to be expected that teachers will need to directly teach rational processes such as careful empirical testing (Kind and Kind 2007).

The Potential of the Practice of Investigation in the Science Classroom

Although science educators continue to critique the notion that inquiry science in school can truly reflect the work of scientists, there is some research supporting engaging in investigative practical work as a means of fostering scientific creativity in secondary school students. Haigh (2010) carried out a 4-year empirical project where teachers facilitated their students in open investigative practical work in biology. This New Zealand research sought to find out how student's abilities at carrying out open investigative work can be enhanced, how teachers can be supported in this work, what the perceived benefits from such an introduction are, and what the perceived constraints might be.

The study was conducted in three phases, with phases 1 and 2 taking place in a large urban secondary school and phase 3 involving senior biology teachers and their students in 22 other secondary schools across New Zealand. In total, 27 teachers and approximately 500 students were involved in the study. The students encountered a number of partially open biology problems. The problems that the students were working with were deemed partially open as the teacher had set the context of the problem and focused the student thinking through directed questioning about the problem. The tasks were authentic and relevant to the students' school or home environments. They were linked to aspects of the New Zealand senior biology curriculum such as eutrophication, osmosis, transpiration, photosynthesis, and enzyme activity. The students were required to make decisions about the inquiry design, generate data, and draw conclusions after considering the status of their gathered evidence. Frequently, the process involved redesign and the generation of new data. When designing the investigation, they worked as individuals at first and then joined in groups where they were required to defend their approach to the problem and move to a group decision. As a group, the students had to work collaboratively to complete the investigation and generate findings. The group then had to argue for the reliability and consequence of their findings and prepare a report for a nominated audience such as a school newspaper or scientific journal. The processes followed by these students incorporated the essential features of the domain for inquiry-based science instruction that have been outlined by Minner et al. (2010).

Findings from this study indicated that both teachers and students identified that carrying out practical investigations provided opportunities for the students to think scientifically creatively, albeit largely within the LCC framework. The students were challenged to question initial assumptions: their own or those provided by teacher or text. Having to work through a number of what, how, how many, when, where, and why questions encouraged students' possibility thinking. Some students did things differently, that is, they took a distinctly different approach to solving the problem. Some had done things better, that is, they made changes to a previously used procedure in ways that improved the reliability and validity of their findings. The teachers reported that as the students worked with a number of similar investigations in different contexts, they became more innovative in what they planned and demonstrated an increasing flexibility of thinking. In addition, the students indicated that engaging in open investigative practical work brought with it a greater understanding of the creative and sometimes uncertain nature of science investigation; they had broadened their understanding of the importance of the collaborative nature of the scientific endeavor and the tentative nature of scientific knowledge.

However, Haigh's project also highlighted that aspects of teacher engagement may need to be altered if the potential of investigative practical work to foster and enhance creativity is to be realized; these are the dynamics of the classroom and the nature of teacher-student and student-student interaction. Specific activities and teaching strategies were also identified as enhancing the potential for students to creatively engage with the investigation. A classroom that encourages creativity embraces coconstruction of knowledge. The classroom will be learner-oriented. Students' existing knowledge will be recognized, and they will be supported to restructure these understandings where necessary. Students will be given opportunities to learn from others, the teacher, or each other through collaborative activities. Teachers will deliberately scaffold their students' investigative attempts. Haigh (2010) details a number of strategies suggested by the teachers and students in her study that enhance student engagement, critical thinking, and creativity during investigative practical work. The strategies support the students' shifts from following "recipe"-type practical work into more open practical work where students are required to pose and test possibilities. A teacher might help the students to analyze "recipe"-style investigations to determine why the author had chosen that particular approach, the students might plan an investigation and then critically compare their plans to one provided by the teacher or text, students will be expected to critically evaluate their own work on completion of the investigation, teachers will emphasize the value of cooperative working practices, teachers will help students to seek links between prior knowledge and the investigative situation, and the teachers will actively cue the students as they work through the various stages of an investigation.

A United Kingdom-based study around a collaborative curriculum development project also highlights the necessity for pedagogy to change if science education is to foster creativity. Teachers will need to teach creatively. A focus on the need for these changes should begin in teacher education programs if they are to have any impact on teachers' work and continue into ongoing professional dialogue. Braund and Campbell's (2010) study involved student teacher and teacher-mentor pairs devising, teaching, and evaluating novel lessons and approaches around teaching about ideas and evidence in science. A significant outcome of the study "was the perception of teaching shifting from delivery of standard lessons in prescribed ways to endeavours demanding creativity and decision making" (p. 203). However, when the student teachers began teaching as newly qualified teachers, the context of the school limited their ability to act as agents able to make a difference to the way the school at large taught science, leaving much of the teaching still largely the delivery of standard lessons in prescribed ways.

Conclusions and Future Directions

Providing opportunities for student to carry out investigative practical work in science has the potential for enhancing their creativity and their understanding of science as a creative endeavor. Collaborative investigative practical work provides many opportunities for social possibility-thinking and decision-making, at least at the LCC level. It may also, in part, meet Feldman, Czikszentmihalyi, and Gardner's (1994) three-part system of high creativity where individuals develop ideas that are validated by experts. With support, teachers can establish a classroom culture that supports students as they engage in logical and creative construction of scientific knowledge. However, there are questions around this aspect of science education that require further exploration. Some possible inquiries are as follows: Is there a tension between teaching for creativity and teaching for conceptual understanding in science? How might science teachers be better supported to teach creatively to enhance students' creativity? How can the tensions between open approaches to practical work in school science and the drive for accountability in education, often through rigid assessment, be addressed?

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Creativity Definitions, Approaches
▶ Scientific Creativity as Combinatorial Process

References

Abd-El-Khalick F, Boujaoude S, Duschl R, Lederman N, Mamlok-Naaman R, Hofstein A, Niaz M, Treagust D, Tuan H. Inquiry in science education: international perspectives. Cult Comp Stud. 2004;3:397–419.

Braund M, Campbell B. Learning to teach about ideas and evidence in science: the student teacher as change agent. Res Sci Educ. 2010;40:203–22.

Craft A. Little c creativity. In: Craft A, Jeffery B, Leibling M, editors. Creativity in education. London: Continuum; 2001. p. 45–61.

Feldman D, Czikszentmihalyi M, Gardner H. Changing the world: a framework for the study of creativity. Westport: Praeger; 1994.

Haigh M. Science classroom cultures and practices that foster creativity. In: Corrigan A, editor. Creativity: fostering, measuring and contexts. Hauppauge: Nova Science; 2010. p. 59–79.

Jones A, Bunting C, Hipkins R, McKim A, Conner L, Saunders K. Developing students' futures thinking in science education. Res Sci Educ. 2011. doi:10.1007/s11165-011-9214-9.

Kind P, Kind V. Creativity in science education: perspectives and challenges for developing school science. Stud Sci Educ. 2007;43:1–37.

Lin C, Hu W, Adey P, Shen J. The influence of CASE on scientific creativity. Res Sci Educ. 2003;33:143–62.

Minner D, Jurist Levy A, Century J. Inquiry-based science instruction – what is it and does it matter? Results from a research synthesis 1984 to 2002. J Res Sci Teach. 2010;47(4):474–96.

Osborne J, Collins S, Ratcliffe M, Millar R, Duschl R. What "ideas-about science" should be taught in school science? A Delphi study of the expert community. J Res Sci Teach. 2003;40(7):692–720.

Four P Topology

▶ Four Ps of Creativity and Recent Updates

Four Ps in Organizational Creativity

Russell Schneck
WorkingLessons, Red Hook, NY, USA

Synonyms

Four Ps of creativity

Key Concepts and Definitions

Organizational creativity refers to the people and process capabilities, and the conditions that develop and support these capabilities, in order for an organization to consistently produce innovative products, methods, business models, and experiences to meet the needs of its customers, employees, and stakeholders.

This conceptual view begins with the four Ps (Rhodes 1961) by considering creative product as the outcome of the interaction of person and process, operating within an organizational climate (press). These dimensions are defined:

Product – The communication of a novel and useful idea, concept, or theory

Person – Cognitive abilities, personality traits, and biographical experiences

Process – The methodology that produces a creative product

Press – The relationship of the creative person to the environment they are creating within

Within the context of organizational creativity, two additional dimensions need to be considered in combination with the four Ps. Teams are included to reflect that organizational creativity is often a collaborative effort. The influence of leadership must also be recognized since the successful application of the other capabilities and practices are directly dependent on this foundation.

Theoretical Background

Product

Theorists have highlighted that the study of creativity needs to begin with creative product since creativity is demonstrated by the existence of a creative product (MacKinnon 1978; Rhodes 1961; Rogers 1961). Rhodes (1961) specifically states: "Objective investigation into the nature of the creative process can only proceed in one direction, i.e., from product to person and thence to process and press" (p. 309).

Innovation is a creative product. More specifically, it is a creative product that reaches implementation (Kaufman 1993 cited in Vehar 2008). Innovation is the result of creativity, and this understanding means that it is necessary for organizations to develop and support creative capabilities in order for innovation to consistently occur.

Person

Much of the understanding of the creative person can be attributed to the impetus provided by Guilford and his presidential address to the American Psychological Association (Guilford 1950). Guilford's own work advanced the understanding of the cognitive abilities associated with creativity and established the importance of divergent and convergent thinking. Cognitive abilities are only part of the story. Beyond cognitive abilities, creativity can be attributed to personality traits and biographical experiences (Davis 2004).

Creativity is commonly equated to imagination, and this undeniably is an important characteristic, but it is a limited perspective. The topic of the creative person is complex, and it is well-researched area, with extensive information available. For example, Davis (2004) describes a meta-analysis of over 200 adjectives and descriptions from 50 sources to arrive at 16 categories of recurrent traits in creative people.

Guilford (1950) offers a conception that brings attention to a particularly important trait: "Creative productivity in everyday life is undoubtedly dependent upon primary traits other than abilities. Motivational factors (interests and attitudes) as well as temperament factors must be significant contributors" (p. 454). Continuing on the importance of motivation, Amabile (1987) offers insight into the importance of motivation, particularly intrinsic motivation: "There is abundant evidence that people will be most creative when they are primarily intrinsically motivated, rather than extrinsically motivated by expected evaluation, surveillance, competition with peers, dictates from superiors, or the promise of rewards" (p. 39).

Amabile's Components of Creative Performance (1983) informs the conception of the attributes necessary to consider in the creative person dimension with creativity-related skills, domain-related skills, as well as task motivation.

Process

Process can be the specific cognitive and affective abilities that are applied as well as a framework that defines the steps or phases that are common to creative problem-solving. The importance of innovation to organizational creativity, and the requirement of a creative concept to be taken to fruition for there to be innovation, demonstrates that process must advance creativity through implementation or commercialization.

Discussion of process can focus on defined methodologies such as creative problem-solving (CPS) (Osborn 1953) or synectics (Gordon 1961). Mumford et al. (1991) review well over a dozen processes beginning with the pioneering efforts of Dewey (1910) and Wallas (1926) to recognize a progression showing a continuous increase in understanding of the mechanisms that produce idea generation. The specific conclusions relating to this are articulated in this way:

> Researchers have also begun to display greater sensitivity to the dynamic, perhaps cyclical nature of process application, the goal-oriented nature of creative problem solving efforts, the significance of real world constraints, and the impact of motivational, developmental, and personality attributes which can condition the efficiency of process application. (p. 99)

In practice problem-solving is often conceptualized as descriptive expression of steps or phases. While there is no universally accepted approach, generically the process has four basic phases (Beecroft et al. 2003; Puccio 2002):

- Clarification
  - Define and clarify the opportunity or challenge
- Ideation
  - Generate ideas
  - Evaluate and select an idea(s)
- Development
  - Transform ideas into solutions
  - Test, refine, strengthen solution
- Implementation and Maintenance
  - Implement solutions
  - Evaluate solution over time

Teaching and training that supports the development or improvement of creativity and problem-solving abilities most often addresses process. The work of Scott et al. (2004) was a meta-analysis of 70 studies of creativity training program evaluations that concluded "that more successful programs were likely to focus on development of cognitive skills and the heuristics involved in skill application, using realistic exercises appropriate to the domain at hand" (p. 361).

This research brings the focus to an understanding that creative problem-solving is about having an awareness of the unique mental function required for the task at hand. This understanding is conceptualized by *The Thinking Skills Model* (Puccio et al. 2011) which articulates specific cognitive and affective abilities associated with each process step. With its focus on cognitive and affective abilities, The Thinking Skills Model connects the discussion of process to the creative person. The discussion of process also leads directly to the topic of teams, and their relationship to the four Ps, since a characteristic of effective teams is a commitment to a common approach, a process, of working together (Katzenbach and Smith 1993).

Press

The interaction of person, process, and teams that is required to generate creative products does not occur in a vacuum. The practice of organizational creativity must contend with a multitude of forces internal and external to the organization that influence the needs, requirements, and effectiveness of the effort. These forces, pressures, are the press.

Discussion of press includes a macro view of the dynamic operating environment, external forces that organizations cannot control but must respond to, and progresses to internal considerations that can be managed in a deliberate manner that will help develop and support organizational creativity.

The Dynamic Operating Environment. There are external pressures on an organization that are beyond the control of the organization. These include customer expectations, shareholder requirements, technology advances, competitive factors, economic conditions, legal and regulatory considerations, and globalization. This dynamic operating environment establishes the need for consistent and sustainable innovation simply to keep pace with the change made necessary by outside forces. But how an organization responds to these pressures also establishes the conditions that will support or detract from creative efforts.

Climate. The creative climate can vary among work teams even within the same organization. However, the more consistent the creative climate is throughout an organization, the more consistent and sustainable the creative contribution will be throughout the organization.

Ekvall (1996) defines creative climate to describe how behaviors and attitudes work to shape the creative output in an organization. Ten factors are identified which collectively describe the creative climate of the organization. These factors are (a) challenge, (b) freedom, (c) idea support, (d) trust/openness, (d) dynamism/liveliness, (e) playfulness/humor, (d) debates, (e) conflicts, (f) risk taking, and (g) idea time.

A discussion of press leads directly to the importance of leadership. Leadership that does not deliberately work to encourage organizational creativity by development and support of the four Ps can be an adverse part of the press that needs to be overcome. However, effective leadership is instrumental in creating the conditions that will develop and support organizational creativity, and this begins with recognition of the importance of each of the four Ps as well as teams.

Beyond the Four Ps

It is only by looking at the four Ps in combination with teams and leadership that a complete picture of product, person, process, and press in the context of organizational creativity is formed. The four Ps can be seen as the foundation of organizational creativity, but the additional considerations of teams and leadership are integral to the practice of organizational creativity and influence the dimensions of the four Ps as significantly as each of the four Ps influence and interact with each other.

Teams

Within organizations, creative products are often the result of collaborative efforts with multiple individuals making a contribution. A team is more than the sum of its parts. Teams need to be recognized as more complex entities than a collection of individuals. Interpersonal dynamics ensure that this will be the case. Teams are defined by a collective work product (Katzenbach and Smith 1993). This directly relates the function and importance of teams to the purpose of organizational creativity to produce creative product.

Amabile (1998) makes it clear, "If you want to build teams that come up with creative ideas, you must pay careful attention to the design of such teams" (p. 82). Effective teams are mutually supportive groups with a diversity of expertise, experiences, and thinking styles. Members of effective creative teams share and contribute to excitement about their objective, have a willingness to help teammates overcome challenges and setbacks, and appreciate the unique knowledge and perspective the other team members have to offer. "These factors enhance not only intrinsic motivation but also expertise and creative-thinking skills" (p. 82).

The conditions that promote team effectiveness extend beyond the composition of the group and require attention to the collective experience of the group. Tuckman's model for team development (Tuckman and Jensen 1977) highlights that teams will not be fully operational at inception and must be given the opportunity to evolve. The model presents five stages that teams progress through as they develop the ability to successfully work together.

1. Form: The team is brought together and learns about each other and about the opportunity and challenges it faces.
2. Storm: Personal conflicts are exposed. Team members confront each other's ideas and perspectives. Different ideas compete for consideration. Not every team gets through storming.
3. Norm: Team members often work through this stage by agreeing on rules, values, professional behavior, shared methods, and tools.
4. Perform: Teams are able to function as a unit as they find ways to get the job done efficiently and effectively without inappropriate conflict or the need for external supervision.
5. Adjourn: The required task is complete the task and the team is disbanded.

Leadership

The effective application of organizational creativity requires a foundation of leadership. The dynamic operating environment establishes the need for consistent and sustainable innovation. The executive leadership of an organization determines the approach the organization uses and, in thought, words, and deeds, sets the tone for how the organization responds to these pressures.

Leadership is a topic that is broad in scope. Particularly relevant to this discussion are mental models and the role that leadership plays in establishing and reinforcing the dominant mental models (Schwenk 1989) that define the beliefs and attitudes that govern perceptions, reasoning, and behavior in an organization. Senge (2006) defines mental models as:

> Deeply ingrained assumptions, generalizations, or images that influence how we understand the world and how we take action. Very often we are not consciously aware of our mental models or the effects they have on our behavior. (p. 8)

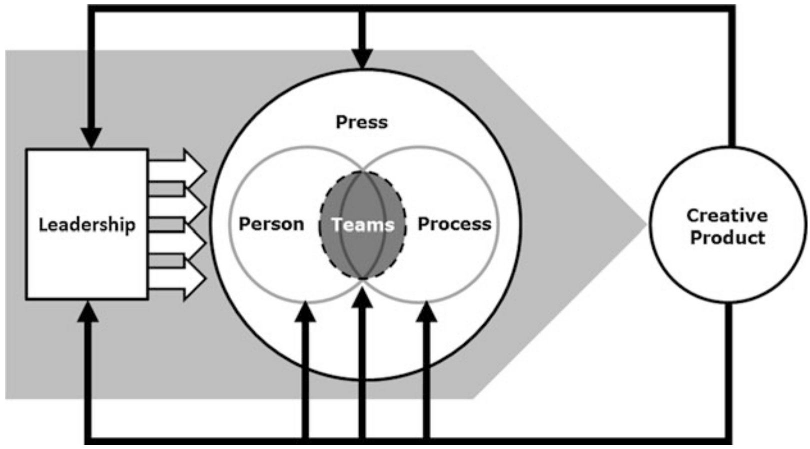
Caughron et al. (2009) extend the concept to organizations by conceptualizing dominant mental models "as a form of shared mental model that extends beyond the group level into broader social contexts such as organizations" (p. 11). Dominant mental models often reflect the influence of individuals in positions of authority (Schwenk 1989).

Organizational creativity will flourish when leadership supports and applies a dominant mental model that recognizes and promotes the value of creativity and the conditions that are conducive to creative performance.

With a foundation of leadership, it becomes possible to establish a supportive climate. Research supports the connection between leadership and climate. Ekvall (1999) provides a particularly compelling statistic; leadership behavior accounted for a range of 30–60% of the reported variances in his research of creative climate. Conditions that support organizational creativity cannot be sustained without leadership that brings intention and attention to the task of establishing and maintaining a creative climate.

By establishing a creative climate, the conditions exist for individuals, teams, and processes to develop in a way that will produce creative products. Since the work of Ekvall (1996) and Amabile et al. (1996) substantiate that climate, including perceived climate, influences creativity and innovation, it is reasonable to conclude that climate is also exerting influence on person, process, and teams, since it is the interactions of these dimensions within the climate that produces the creative product.

Figure 1 presents a view of organizational creativity with a foundation of the four Ps. Support and development of the organizational competencies required to achieve effective and sustainable creative performance begins with leadership. The arrows extending out from the leadership box reflect the influence of leadership on press, person, teams, and process. The model shows the interaction of person, teams, and process, operating within the influence of press to produce an outcome of a creative product. The arrows from product back to the other dimensions indicate that the assessment of product begins a feedback cycle leading to continuous learning and improvement. Ekvall (1996) recognizes that outcomes influences climate and resources which is a description of this feedback.



Four Ps in Organizational Creativity, Fig. 1 The four Ps in organizational creativity ©2012 Russell Schneck

Conclusion and Future Directions

Examination of the four Ps in organizational creativity has implications for leadership, organizational development, as well suggesting directions for creativity research.

Support and development of the four Ps is instrumental to organizational creativity. And while it may seem simplistic, the opposite corollary is also true; factors specific to organizational creativity that inhibit its practice can be viewed in terms of a failure to develop and support the conditions that contribute to organizational creativity. The implications for leadership and organizational development are clear.

Individuals must be provided appropriate training and support to develop domain-related expertise as well as creative problem-solving abilities. Process must provide a commonly understood framework that facilitates the type of outcomes that are expected and required. Teams must be created with attention to diversity of skills and perspectives. They must be given adequate opportunity to develop in order to perform effectively. There must be deliberate attention to establish and maintain a climate supportive of creativity. This needs to be actively monitored with interventions for improvement as needed. Leadership must support development of each of these components and consistently demonstrate a commitment to organizational creativity to ensure that the importance organizational creativity remains a dominant mental model. Evaluation of creative product provides the feedback that is necessary to support the ongoing development of organizational creativity.

The interrelated, interdependent nature of the four Ps of creativity is consistent with research considerations. Mumford (2003) expressed the need for more integrative models as well as increased attention to the effects of creativity on people and social systems. The former consideration could be viewed as a need to examine the combined influences that contribute to the production of creative product that is reflected by the interdependence of the four Ps. The latter describes looking at the complex phenomenon of creativity and the influence its practice has on the individuals and the system it is functioning within. This changes the nature of the examination from the influence of the four Ps on organizational creativity to the influence of creativity on the four Ps and on the organization.

Cross-References

► Convergent Versus Divergent Thinking
► Corporate Creativity
► Corporate Entrepreneurship
► Creative Behavior

- ▶ Creative Knowledge Environments
- ▶ Creative Leadership
- ▶ Creative Management
- ▶ Creative Mind: Myths and Facts
- ▶ Creative Personality
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Creativity Management
- ▶ Creativity, Intelligence, and Culture
- ▶ Entrepreneurial Organizations
- ▶ Four Ps of Creativity
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Innovation and Entrepreneurship
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Measurement of Creativity
- ▶ Measuring Organizational Climate for Creativity and Innovation
- ▶ Mental Models and Creative Invention
- ▶ Multiple Models of Creativity
- ▶ Organizational Creativity
- ▶ Research on Creativity
- ▶ Social Psychology of Creativity
- ▶ Techno-Globalization and Innovation

References

Amabile TM, Conti R, Coon H, Lazenby J, Herron M. Assessing the work environment for creativity. Acad Manage J. 1996;39:1154–84.

Amabile TM. How to kill creativity. Harv Bus Rev. 1998;76(5):77–87.

Amabile TM. Motivating creativity in organizations: On doing what you love and loving. Calif Manage Rev. 1987;40(1):39–58.

Amabile TM. The social psychology of creativity: A componential conceptualization. J Pers Soc Psychol. 1983;45:357–76.

Beecroft GD, Duffy GL, Moran JW. The executive guide to improvement and change. Milwaukee: ASQ Quality Press; 2003.

Caughron JJ, Shipman AS, Beeler CK, Mumford MD. Social innovation: thinking about changing the system. Int J Creat Probl Solv. 2009;19(1):7–32.

Davis GA. Creativity is forever. 5th ed. Dubuque: Kendall/Hunt; 2004.

Dewey J. How we think. Boston: DC Heath; 1910.

Ekvall G. Creative climate. In: Runco MA, Pritzker SR, editors. Encyclopedia of creativity, vol. I. San Diego: Academic; 1999. p. 403–12.

Ekvall G. Organizational climate for creativity and innovation. Eur J Work Organ Psychol. 1996; 5(1):105–23.

Gordon WJJ. Synectics: the development of creative capacity. New York: Harper and Row; 1961.

Guilford JP. Creativity. Am Psychol. 1950;5(9):444–54.

Katzenbach JR, Smith DK. The discipline of teams. Harv Bus Rev. 1993;71:111–46.

Kaufman G. The content and logical structure of creativity concepts: an inquiry into the conceptual foundations of creativity research. In: Isaksen SG, Murdock MC, Firestien RL, Treffinger DJ, editors. Understanding and recognizing creativity: the emergence of a discipline. Norwood: Ablex; 1993.

MacKinnon DW. In search of human effectiveness: identifying and developing creativity. Buffalo: Creative Education Foundation; 1978.

Mumford MD, Mobley MI, Uhlman CE, Reiter-Palmon R, Doares L. Process analytic models of creative capacities. Creat Res J. 1991;4(2):91–122.

Mumford MD. Where have we been, where are we going? Taking stock in creativity research. Creat Res J. 2003;15(2–3):107–20.

Osborn A. Applied imagination: Principles and procedures of creative problem-solving. New York: Charles Scribner's Sons; 1953.

Puccio GJ. Foursight: The breakthrough thinking profile–presenter's guide and technical manual. Evanston: THinc Communications; 2002.

Puccio GJ, Mance M, Murdock MC. Creative leadership: skills that drive change. 2nd ed. Thousand Oaks: Sage; 2011.

Rhodes M. An analysis of creativity. Phi Delta Kappan. 1961;42:305–10.

Rogers CR. On becoming a person: a therapist's view of psychotherapy. New York: Houghton Mifflen; 1961.

Schwenk CR. Linking cognitive, organizational and political factors in explaining strategic change. J Manag Stud. 1989;26:177–87.

Scott G, Leritz LE, Mumford MD. The effectiveness of creativity training: a quantitative review. Creat Res J. 2004;16(4):361–88.

Senge PM. The fifth discipline: the art & practice of the learning organization. New York: Currency Doubleday; 2006.

Tuckman BW, Jensen MC. Stages of small group development revisited. Group Organ Stud. 1977;2:419–27.

Vehar J. Creativity and innovation: a call for rigor in language. In: Puccio GJ, Burnett C, Cabra JF, Fox JM, Keller-Mathers JM, Murdock MC, Yudess MC, editors. Proceedings from an international conference on creativity and innovation management, vol. 2. Buffalo: International Center for Studies in Creativity; 2008. p. 17–27.

Wallas G. The art of thought. New York: Harcourt Brace; 1926.

Four Ps of Creativity

► Four Ps in Organizational Creativity

Four Ps of Creativity and Recent Updates

Mark A. Runco and Daehyun Kim
University of Georgia, Athens, GA, USA

Synonyms

Creative process; Creative products; Four P topology; Personality; Persuasion; Problem finding; Problem solving; Productivity

Introduction

There are many different definitions of creativity, even in the scientific literature on the subject. All of them emphasize originality; without originality, there can be no creativity. Yet there is more to creativity than originality. Originality is necessary but not sufficient for creativity. There must also be some effectiveness, usefulness, or fit. Without that, original things may be bizarre and useless. Creativity things are thus both original and effective. This applies to artifacts and products, such as inventions, artworks, and designs, but also applies to the personality traits that are shared by creative individuals. These traits give the individual the capacity to generate original and effective ideas. Indeed, the bipartite definition recognizing originality and effectiveness applies to all expressions and definitions of creativity.

Fifty years ago, an alliterative scheme was proposed in an attempt to account for approaches to creativity. It is usually called the *four P topology*, but as the title of this entry denotes, that label is out of date. This entry covers the four Ps, but it also goes into some detail about what has occurred in creativity and innovation studies since it was first proposed. As such, this entry is a kind of review of creativity studies, using the alliterative P framework as a way of structuring the various theories of and perspectives on creativity.

Person

One common perspective is that certain individuals have a personality profile that supports creative thinking and behavior. The core characteristics of this personality profile include openness to experience, wide interests, autonomy, nonconformity, and intrinsic interests. Each of these is actually a somewhat general label. Autonomy, for example, is sometimes labeled independence. More important is that there are logical ties among these traits. A nonconformist, for example, will appear to be autonomous, and someone with wide interests probably must have be open to (broad) experiences. The person perspective on creativity does not entirely focus on personality. It includes other personal tendencies and capacities, some of which are intellectual, temperamental, or attitudinal, and others reflect habit, values, and self-concept. Specific theories also include particular defense mechanisms (e.g., sublimation).

There are vocal critics of the personality (or "person") perspective on creativity. They point to the fact that the presence of most or even all of the traits listed above does not guarantee creative behavior. Additionally, it appears that there are notable variations among domains. Someone creative in the sciences may be dissimilar to someone who is creative in the arts, just to name one example. Individuals in different domains seem to have different profiles, so there is not a single profile of a creative person.

Still, all of personality theory is this way: Traits provide the potential to respond and behave in particular ways. They do not guarantee specific actions. Behavior is based in part on traits and capacities but also on the environment and context. This is why later versions of the 4P topology include potential as one of the Ps or categories. It is also why there are many theories of creativity that focus on the environment or context. The original 4P framework was developed over 50 years ago, at a time when environmental influences were labeled "press factors," the idea being that the environment imposes pressures on the individual.

Press and Place

The original "Analysis of Creativity" article, from 1961, labeled environmental factors "press," but actually there were two kinds of presses. According to Henry Murray, who wrote extensively about environmental influences, there are alpha presses and the beta presses. The alpha press is the environmental pressures that have an impact as part of the object world. The beta press is also a result of environmental pressures, but these have an impact only when individual perceives and assigns significance to them. This is an important distinction because each individual has different perspectives and interpretive tendencies and thus reacts to the environment in unique ways. The same environment may positively influence some people but not others. It is another example of why "potential" must be included in creativity theory. The environment may put someone in a position where creative action is likely, or even encouraged, but the actual impact is uncertain. Interpretations determine the actual result. Environmental press factors thus only have potential impact.

A clear example of alpha press could be stimuli that lead our sensory system to react automatically, such as a loud noise. When a loud noise stimulates the sensory system, people perceive the sound as unappealing. Music, however, is a beta press: There is room for interpretation and variations among individuals as to what is comforting, exciting, and aesthetically appealing.

There are probably more beta presses than alpha influences on creative behavior. In educational settings, different students may require different things before they are comfortable being unconventional and creative. This is illustrated by one of the many resources that may be considered when trying to construct an environment that is clearly conducive to creativity, namely time. Creative work often requires time. Time is an important resource. Time limits can motivate some students, while for others time limits are distractions that inhibit the creative process. In a corporation setting, budgets and their impact on resources of all sorts represent beta factors. Consider a company that relies on effective advertising to promote its products. When budgetary constraints are imposed, some organizations and members of organizations may not be able to produce effective, attractive advertising. For others, "necessity is the mother of invention," and limited resources can suggest innovative use of what is in fact available.

The Process Perspective

The paragraph above described how certain environmental factors may have an impact, especially after an individuals interprets their significance.... This is just one of the many ways whereby creative products – be they ideas, patents, inventions, designs, or whatever – depend on a process. The environmental factor is not perceived simultaneously with the interpretation; the latter follows the former. Time elapses. It is a process. And this is a huge simplification because in actuality, there are probably a large number of potential influences on the individual, and the process is in fact quite complex. It is not just one press factor and one interpretation. No wonder creativity is often viewed as a syndrome or even a "complex."

Many process theories of creativity delineate the process and attempt to identify specific stages. The best known stage model of the creative process was outlined by Graham Wallas in his book from1926, *The Art of Thought*. He described four stages: preparation, incubation, inspiration, and verification. In the preparation stage, individuals define problems and gather information which may contribute to solutions. Preparation may involve observing, listening, asking, reading, collecting, comparing, contrasting, and analyzing. More current research includes problem identification and problem definition as part of preparation. These are quite important for creative thinking.

The second stage is incubation, which allows individuals to step back from the problems and contemplate a wide range of solutions and perhaps considering alternatives and previous relevant experience. In this stage, individuals are relaxed and take time away from the task. The length of optimal incubation depends on each individual. It could last minutes, days, and even several months. That is of course consistent with the idea of beta presses in that there are individual differences rather than an absolute and universal process or time limit.

"Illumination," the third stage, occurs at a moment of insight when an idea makes itself known. Illumination is often equated with "Ah ha!" or "Eureka!" moment. It is characterized by a sudden realization. Importantly, it may just be that the realization is sudden but the process leading up to it is, as Gruber (1985) put it in his case studies of famous scientific discoveries, *protracted*.

The final stage is "verification." During this stage, new ideas or solutions can be carefully evaluated and implemented and tested to insure that they work. This is quite important because creativity is more than originality. A creative solution must solve a problem. A creative idea must indeed work. If an idea or tentative solution is not effective, the individual can go back to the previous stages if they think that the ideas should be prepared or incubated again. This is known as recursion.

Although dating back to 1926, Wallas' stage model is still cited more than any other. Newer models have been proposed, but most parallel that of Wallas. There is a two-tiered model, for instance, which includes problem finding, ideation, and evaluation on the primary tier and knowledge (procedural and declarative) and motivation (intrinsic and extrinsic) on a secondary tier. Another fairly new model was proposed by Michael Mumford, in the *Creativity Research Journal*. It points to (a) problem finding, (b) information gathering, (c) information organization, (d) conceptual combination, (e) idea generation, (f) idea evaluation, (g) implementation planning, and (h) solution monitoring. The parallel between the newer models of the creative process and Wallas' (1926) model are no doubt quite clear.

Products

Creative products are remarkably varied. Rhodes felt that creative products were tangible forms which materialize from an idea. Later immediate products, such as ideas, were distinguished from ultimate products, like inventions, novels, and patents. There are intermediate products, as well, such as paintings, poems, designs, musical compositions, or some type of performance. These may be performed at a professional level, or they may be more personal with no competition, social judgment, or lasting impact. Note that some products may be intangible, but they can still be counted as products.

The vast majority of studies of creative products have examined socially judged products. These investigations tell quite a bit about professional levels of creative talent. They indicate what kind of political and cultural milieu is conducive to creative work and how productivity varies through the lifespan, just to name two types of analyses. But investigations of professional products say nothing about everyday creativity, intangible creative efforts (e.g., self-expression), and creative potentials. They have the advantage of being highly objective: Products can be counted and experts can be identified and employed for reliable judgments. But to apply findings to the creative process or to the fulfillment of potential requires inference. Investigating products is a bit like enjoying a sporting competition by looking at the final score. You only learn something about the result and have no idea how it came about. Perhaps the clearest finding from studies of creative products is that the quantity of productivity is related to its quality. Yet this too may characterize experts and eminent creators and not everyday creativity.

Persuasion

Simonton (1995) suggested that the original 4P framework is no longer adequate for coverage of

Four Ps of Creativity and Recent Updates, Fig. 1 Hierarchical theory of creativity

Hierarchical Theory of Creativity

Creative Potential

Person
- Traits
- Attitudes
- Motives

Process
- Problem Solving
- Problem Finding
- Incubation

Place and Presses
- Zeitgeist
- Culture
- School Settings
- Organizational Settings

Creative Performances

Products
- Immediate (ideas)
- Ultimate (Publications, Patents, Inventions)

Persuasion
- Attributions by Judges
- Historical Reputation
- Systems (Individual, Field, Domain)

creativity studies and that a fifth category, which he called persuasion, would be a useful addition. The central idea is that highly creative people or products change the way that others think. They are in that sense persuasive. There is some overlap with the product approach, then, at least when products and performances are socially judged. It is more of a social and attributional perspective, however, for the emphasis is on social reactions to creative work rather than on the tangible product. It does apply best to the highest level of creative activity, and especially the creative work of eminent individuals who are in a position to influence the way that others think. The persuasion perspective does not apply well to the creative efforts of individuals who are merely involved in self-expression rather than professional achievement.

One way to view the efforts that could be judged to be creative and thus are persuasive is with Csikszentmihalyi's (1990) systems theory. It describes how an individual may draw from an existing field and produce something of note. That may attract the attention of gatekeepers working within that same domain (e.g., architecture, mathematics, the visual arts), who change their ideas about what is useful and original. After a time, the entire field absorbs these new ideas, and they are no longer new and different but have become part of the knowledge base of the field. At that point, the ideas can influence individuals who are new to the field – and the cycle beings all over again. Clearly the first product of note, which got the cycle started, must be persuasive. Experts in the domain in question must attribute value and originality to it.

Hierarchical Theory of Creativity

An even newer and more dramatic restructuring of the original 4P topology was proposed by Runco (2007, 2008). It identified bridges and processes among the perspectives (e.g., creative processes required for creative products). It was a restructuring in that a hierarchy was formed. Several of the perspectives (i.e., products, persuasion) had assumed that creativity required a performance or manifestation of some sort (usually a product), while the others (personality, process, press) gave weight to aspects of creative potential. Indeed, the highest level of the hierarchical theory has two categories: creative potential and creative performances. Figure 1 presents a summary of this hierarchical theory.

The hierarchical theory makes assumptions about creativity explicit. It acknowledges that the things under creative potential do not guarantee actual productivity. It is practical in that it allows a discussion of the creative potentials of children, who are not productive and "persuasive," as well as the creative achievements of eminent individuals. It is a functional view, however, because it is easy to see how things representing creative potential might develop such that actual performance is likely. However, the actual creative performances are not always guaranteed. Then again, it could be that one of the attractions of the theory captured in Fig. 1 is that it points to things that can be encouraged (i.e., certain traits, supportive environments, divergent thinking) in order to insure that creative potentials of everyone – not just those already creatively productive – are fulfilled and creative accomplishment is highly probable. This would certainly be beneficial for society as a whole. There may be no greater benefit from creativity research than just that – the fulfillment of creative potentials.

Conclusions and Future Directions

Interesting new research is being conducted with all kinds of products of the creative process. There are studies of websites, for example, and even studies of culinary presentations. Personality research is also going strong, with a particular interest in self-efficacy as related to creativity. Related research is examining the role of values in the formation of the personality that is likely to invest in creative behaviors.

Future research should examine the hierarchical framework and especially its predictions about a separation of potential from performance. It would be enormously useful to be able to identify the kind of potential that is the most likely to eventually turn into actual creative performance. A related direction for research would be to find out what it takes to make the fulfillment of potential the most likely. Surely educators, parents, and managers would appreciate knowing how to fulfill potential! This is not to say that the original 4P framework is entirely outdated. Indeed, future research might use modern brain imaging methodologies in order to investigate the creative process. This has been the most difficult area to study because the process is a moving target, and a subjective one at that, but brain imaging might capture the workings of the creative process without stopping the flow. Clearly there is much yet to be done in studies of what is among the most important of human capacities, namely, creativity.

Cross-References

▶ Creative Personality
▶ Creativity, Experiential Theories
▶ Four Ps in Organizational Creativity
▶ Nature of Creativity
▶ Product Innovation, Process Innovation

References

Csikszentmihalyi M. The domain of creativity. In: Runco MA, Albert RS, editors. Theories of creativity. Newbury Park: Sage Publications; 1990.

Gruber HE. On the relation between 'aha' experiences and the construction of ideas. Hist Sci. 1981;19:41–59.

Rhodes M. An analysis of creativity. Phi Delta Kappan. 1961;42:305–10.

Runco MA. A hierarchical framework for the study of creativity. New Horiz Educ. 2007;55(3):1–9.

Runco MA. Creativity and education. New Horiz Educ. 2008;56(1):107–15.

Simonton DK. Exceptional personal influence: an integrative paradigm. Creat Res J. 1995;8:371–6.

Wallas G. The art of thought. New York: Harcourt Brace; 1926.

Fractal

▶ Polynomiography and Innovation

Fractal Pages

▶ Multiple Models of Creativity

Frame of Reference

▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Freedom and Constraints in Creativity

John Haworth
Manchester Metropolitan University,
Manchester, UK

This entry draws on practice-led research by the author into creativity and embodied mind in digital fine art (Haworth 2010) www.creativity-embdiedmind.com. Freedom and constraints are central to the creative process in fine art. This is particularly the case where the making of fine art utilizes digital media. Large numbers of images can be taken with the digital camera, and the mobile phone camera readily facilitates recording the visual in everyday life. With digital tablets and artists' software, images can be manipulated in situ, if desired. Access to laptop and personal computers makes possible extensive rapid manipulation and exploration of the visual. This can be combined with additional visual material and text scanned into the computer. Outputs from digital media can be presented in a wide range of formats, including video installations, CD-ROMs and e-books, large format and small-scale photos, and prints, on a wide range of materials, which can also be combined with additional drawing, painting, and collaged material. 2D and 3D structures can be produced without the intervention of the hand by rapid processing technologies. This extensive freedom results in a wide choice in the creative process and the necessity for selection, which is significantly influenced by constraints based on personal, cultural, systemic, and social factors.

A significant factor in the interaction of freedom and constraints in the production of art work is the nature of the creative process. Scattered throughout the writings of Merleau-Ponty is an Embodiment Theory of Art, which he uses to support his embodiment theory of perception (Haworth 1990, 1997). This views the artwork as "enriched being" in its own right, as distinct from an analog for an external truth or essence, as traditional aesthetic theory claims. It proposes that this enriched being is not produced primarily by intentional acts, the traditional view, but by the reciprocal influence of consciousness, body, techniques, and materials. It "gives visible existence to what profane vision believes to be invisible" (Merleau-Ponty, "Eye and Mind" 1964a, p. 166). Merleau-Ponty (1964a) drew on the writings of modern artists and concluded that the painter's vision is not a view on the outside but a concentration or coming to itself of the visible (p. 181). He considered that works of art contain matrices of ideas that have their origins in embodiment (Merleau-Pony 1964b in Signs, p. 77). He also claimed "that modes of thought correspond to technical methods, and that to use Goethe's phrase 'what is inside is also outside'" ("Sense and Nonsense" 1964c, p. 59). As Merleau-Ponty indicates, we do not see the world but see with the world. In artistic terms, different media with which we interact have different voices which play a part in the creation of enriched being, perception, and consciousness.

Research conversations undertaken by Haworth (1997) using the perspectives of Merleau-Ponty were held with internationally famous artists in order to gain further insights into the creative process. The artists included the printmaker Michael Rothenstein, who can be considered a paradigmatic case for Merleau-Ponty's theory of art. They also included the conceptual artist Sol LeWitt, whose statements emphasizing the importance of "the idea" would at first sight appear to contradict this theory. An investigation of the working process of Sol LeWitt, however, shows support for Merleau-Ponty's theory, while also pointing to the importance of capitalizing on randomness. These and other "research conversations" undertaken by the author into the creative process in fine art support the view of cognition as embodied action and emphasize the importance of both pre-reflexive and reflexive thought in guiding action. They show a search for viable alternatives, rather than a search for the ideal, and an intimate reciprocal influence between the person and the artwork in the various ways of probing the environment.

Johnson-Laird (1988) argues that freedom of choice occurs par excellence in acts of creation, but that the set of choices is constrained, and that the paradox of creativity leads to the view that there are many criteria on which the creator must rely and that by no means all of them are available to overt inspection. Some of these are common to many practitioners and constitute the genre or paradigm. Other criteria are unique to individuals and constitute an individual style of thought within the more general framework. Merleau-Ponty (1964b) in his writings on the embodied nature of creativity and consciousness emphasizes that an artist's style is not something developed consciously in order to depict the world but is an "exigency that has issued from perception" p. 49. It is a personal system of equivalencies that the artists make for themselves for the work, which manifests the world as they see it: "it is the universal index of the 'coherent deformation' by which he (the artist) concentrates the still scattered meanings of his perception and makes it exist expressively" (Merleau-Ponty 1964b).

Practice-Led Research

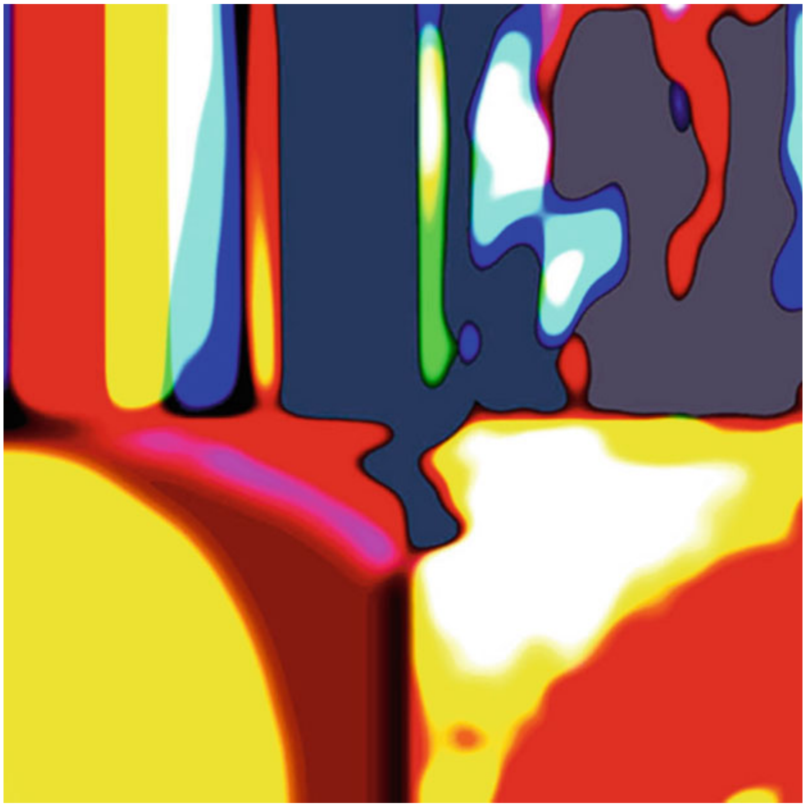
A project by the author combining research and practice investigated "creativity and embodied mind in digital fine art."

The project was funded under the Innovation Awards Scheme of the Arts and Humanities Research Board in the UK. It commenced in January 2002 and lasted for 1 year (Haworth 2010). The first person method of investigation used in the project was concerned with the practice of digital fine art printmaking, which at some stage in the working process involves the computer using Photoshop software, and in many cases commences with a photograph. The digital print medium, with its fine surface quality and potential to incorporate and transmute imagery, is particularly attractive as a conduit for the idea of the vibrant transience of reality. This is explored while probing the pixels and listening to the voices emanating from the medium. The resulting work shows the important interaction with technology in the way we see and portray the world. The prints also show an important influence of geographical place, culture, and events. The work has been exhibited internationally. Examples of the prints can be seen in the gallery at www.creativity-embodiedmind.com and www.absolutearts.com and on CD-ROMs deposited at the British Lending Library.

During the making of the prints, a log is kept of both the technical and thought processes involved. Notes are made on the interaction with the medium, and on the development of the work and emergent meanings, and reflections on the creative process. An account follows in relation to one of the prints (Fig. 1), as an example of the documentation undertaken, and an illustration of freedom and constraint in the creative process. A further print (Fig. 2) shows the potential of a personal body of art work for enhancing freedom of thought, stimulating innovative connections, and embryonic themes, though it is also recognized that routine themes can perhaps constrain creativity. Another print (Fig. 3) shows the value of an interdisciplinary approach to creativity.

This entry then addresses the interaction between freedom and personal, cultural, systemic, and social constraints noted in the introductory paragraph.

This print was made shortly after the tragedy of September 11th in the USA. However, it drew on elements which had been worked on before that date and imagery that emerged afterward. It is composed of four prints done separately but with an overarching concern about the vibrant transience of reality. The prints were fading edge, fragmenting edge, broken edge, and fallen square. Some of the material and imagery in these prints came from scanned textures and colors made using turpentine on printing inks on large pieces of paper, making marks with broad pallette knives. Other imagery was from the light of the sun setting on water on a harbor front, the surface of which was whipped by the wind. Some of the colors and lines came from front page pictures of the September tragedy. A previous edge print was about the contrasting sharp glow of life in the Arizona desert. The fragmenting square was in part about the breakup of this. When the four prints were put together and printed, the image



Freedom and Constraints in Creativity, Fig. 1 "Fragmenting Square": (90 × 90 cm on canvas and on paper)

looked uninspired compared with each of the individual images. The combined image was altered using the auto-levels and equalize functions, and the Gaussian blur filter which helped to combine and change some of the shapes, while at the same time integrating them. The contrast function was then used to reduce most of the blur, which seemed excessive in this print. Various areas of the print were then selected and colors changed. As is well known, the square has been an important element in the work of modernist artists searching for pure form and beauty and absolute truth and meaning. The postmodern age questioned the viability of this. September 11 saw further crumbling of the certainties. But perhaps the print contains delicate potentials for growth and relationships.

The print shown in Fig. 2 was made after visiting the Gerhard Richter retrospective exhibition at the Tate Modern and the occupation at St Paul's Cathedral in London. Photographs were taken of the occupation, which was protesting about inequality and the unfair way austerity was being implemented. The occupation was by people from different backgrounds coming together to discuss change. There were no set leaders, more a heterogeneous group. It followed similar occupations in different countries, including Tahrir Square. Another influence was a visit to Tenerife and an appreciation of the black volcanic lava which can help to sustain growth in the arid country and which is often formed in a circle with, sometimes, an outer band of lighter colored rock, the formation supporting a plant. Drawings of this and the circle at Tahrir Square were made, as well as shots taken of protests at the square shown on the TV. Fragmenting square hangs in the studio. Work on New Square was layered onto the digital image of fragmenting square, with different possibilities explored. Further explorations will be undertaken, in what could be an emerging theme. Interestingly, photos of the circular Large Hadron Collider are in today's papers 13 12 11 with news imminent of the Higgs

Freedom and Constraints in Creativity, Fig. 2 New Square 90 × 90 cm on canvas and on paper

boson and the implications for the origins of the cosmos.

"A day in the life of————" shown in Fig. 3 is part of a project on "The Way We are Now" combining the author's practice-led research into digital art with his research into well-being, funded by the Economic and Social Research Council in the UK www.wellbeing-esrc.com, Haworth (2011). This interdisciplinary work is an example of recent developments in art-science research in the UK, where artists and scientists combine to bring scientific insights to a wider audience, using the medium of art. "The Way We are Now" is a digital art work first presented at the 5th IMPACT International Print Making Conference in Tallinn, Estonia, October 2007. The conference had a concern with investigating slices of time and the production of political-poetic statements. The project used the mobile phone/camera to take a picture of what one was doing and answer several questions on subjective well-being in response to a signal preprogrammed on a random basis in the mobile phone, eight times a day for 7 days. Additional photos of events in the newspaper each day were also taken. The images for the 7 days were produced on a large format print on canvas. A paper on "The Way We are Now," including the image, can be downloaded from the websites at www.haworthjt.com. Prints could be produced for each of the four seasons. "A day in the life of———" is 1 day from a 7-day print. An innovation is that the answers to the questions on subjective well-being are color coded and shown alongside each image. "A day in the life of ——" with instructions on how to undertake the project, and the color codings, was shown in a gallery of art works specially curated to accompany an international conference on "Towards a Science of Consciousness" in Hong Kong 2009. The project could be undertaken by different size groups, locally (Kellock et al. 2011), regionally, nationally, and globally, and made available on a dedicated website, and shown in exhibitions,

Freedom and Constraints in Creativity, Fig. 3 "A day in the life of———" 60 × 163 cm on paper suspended from wooden poles

to produce a social mirror of consciousness. Some work along these lines is now being undertaken by other researchers and by the BBC.

The practice-based research making many digital art prints shows that the process of exploration with the computer generates and reveals possibilities and visual experiences, as well as speaking to initial expectations. The process of exploration becomes a vehicle for seeing which is influenced by the technology. Visual explorations undertaken with the computer can influence what one "sees" in the world, what comes into focus, and what demands attention, influencing what is recorded experientially, mentally, and digitally. In turn, this influences further explorations with the computer. Artistic vision is constantly reshaping itself in interaction with the world, including technology, geographical place, culture, and events. As cognition and emotion are intertwined, feelings influence seeing, as well as the reverse. Expression is also influenced by the tools and techniques that are available, and with the interaction with materials, with different potentialities and "voices" emerging.

As variations on images can be produced extremely rapidly in digital art, selection is necessary. This can involve a "feel" for the image, against an overarching concern, which itself may have taken years to emerge and be still unfolding. It generally involves a deep knowledge of the art world. The artist is situated in a tradition of art, which influences perception. It influences the way we see things and the possibilities we have for expression. Any artwork is influenced by a conscious awareness of tradition, even if it is fighting against that tradition. These potentialities are both informed and appraised by communities of practice. Thus, both "actor centered" and "veridical" decision-making are intertwined in the process of selection.

As part of a further Arts and Humanities Research Board award for practice-led research, a workshop was held on "Freedom and Constraint in the Creative Process in Digital Fine Art," Haworth et al. (2005) (see also workshop 2 at www.creativity-embodiedmind.com and Haworth (2006)). The workshop was attended by internationally known British artists and academics from different disciplines. Papers presented at the workshop showed that:

- Computer-aided art manifests a diversity of practice, in which the fusion of thought and action is critical to the creative process.
- Technology influences perception and thinking, while at the same time concepts, ideas, and feelings influence the use of technology.
- In the use of technology in the process of making art, many unexpected effects can occur. These can be critical to the creative process, enhancing freedom of choice. In turn, however, choice can be tyrannical, if it is not embedded in constraints, which may originate from the individual, group, and society.
- Advanced technology is leading to the emergence of a tacit digital creative practice and a nurturing environment.
- Dynamic interactive techniques enable the viewer to have an active role in creating or changing the art object.

In line with new conceptions of what it is to be a human being in the world, and how we come to understand things and act in innovatory and creative ways, the workshop emphasized that creative thought can be largely unconscious. Also, that creativity involves the interaction of thought, body, techniques, and materials. The importance of bringing tacit knowledge into visibility was recognized.

In a systemic view of creativity, Csikszentmihalyi (1988) argues that creativity is the product of three main shaping forces: a set of social institutions, or *field*, that selects from the variations produced by individuals; a cultural *domain* that will preserve and transmit the selected new ideas or forms to the following generation; and the *individual* who brings about some change in the domain which the field will consider to be creative. Abuhamdeh and Csikszentmihalyi (2002) consider that the *field* has a perpetual need for novelty and that as a result the field's aesthetic preference is guaranteed to change constantly. The field includes all the individuals who act as gatekeepers to the domain, including art critics, art historians, art dealers, art collectors, and artists. Arguably, digital art and its practitioners are expanding the range of ideas and forms considered acceptable by the field, while at the same time broadening and democratizing the field (see Paul 2004). It can also be added that social factors, including government policies and funding, also have a significant influence on both the field and the freedoms and constraints influencing creativity, such as education, training, and access to resources.

Of course, the field is not a unified whole. There are separate overlapping divisions. In the Manchester Buy Art Fare in 2011, one floor containing many galleries from around the country showed primarily works of art done by the hand, including paintings, drawings, and some non-digital prints. On the floor above, the Manchester Contemporary hosted more conceptual and digital art. An artist has the freedom to chose fields or, as is increasingly being done, combine traditions. But there are constraints of what feels right, of what sells, and of who art is for.

Conclusion and Future Directions

In conclusion, it can be seen that there is a complex interaction between freedom and constraints in creativity, involving personal, technological, and social factors. The enhancement of invention and innovation requires cognizance of all these factors and a consideration of who innovation is for.

Cross-References

▶ Cognition of Creativity
▶ Creative Behavior
▶ Creative Brain
▶ Creative Mind: Myths and Facts
▶ Creative Personality
▶ Creative Styles
▶ Creativity and Emotion
▶ Imagery and Creativity
▶ Imagination
▶ In Search of Cognitive Foundations of Creativity
▶ Mental Models and Creative Invention
▶ Multiple Models of Creativity
▶ Nature of Creativity

► Psychology of Creativity
► Research on Creativity
► Role of Intuition in Creativity
► Social Psychology of Creativity

References

Abuhamdeh S, Csikszentmihalyi M. The artistic personality: a systems perspective. In: Sternberg RJ, Grigorenco EL, Singer JL, editors. Creativity: from potential to realization. Washington, DC: American Psychological Association; 2002. p. 31–42.

Csikszentmihalyi M. Society, culture and person: a systems view of creativity. In: Sternberg RJ, editor. The nature of creativity: contemporary psychological perspectives. Cambridge: Cambridge University Press; 1988. p. 325–39.

Haworth JT. The embodiment theory of pre-reflexive thought and creativity. In: Gilhooly KJ, Keane MTG, Logie RH, Erdos G, editors. Lines of thinking, vol. 2. Chichester: Wiley; 1990.

Haworth JT. Beyond reason: pre-reflexive thought and creativity in art. Leonardo. 1997;30(2):137–45.

Haworth JT. Creativity, technology and embodied mind: proceedings of a workshop on freedom and constraint in the creative process in digital fine art. CD Rom, ISBN 1-905476-04-03. Manchester: Manchester Metropolitan University. British Lending Library; 2006.

Haworth JT. Explorations in creativity, technology and embodied mind. In: Freire T, editor. Understanding positive life: research and practice on positive psychology. Lisboa: Escolar Editora; 2010. p. 429–44.

Haworth JT. Creativity, embodied mind and well-being: innovative practice led research in digital fine art. CD Rom, ISBN978-1-900139-33-5 ISSN 1750 1571. Manchester: Manchester Metropolitan University. British Lending Library; 2011.

Haworth JT, Gollifer S, Faure-Walker J, Coldwell P, Kemp T, Pengelly J. Freedom and constraint in the creative process in digital fine art: an AHRB invited workshop. Creativity & cognition 2005. In: Conference proceedings, Goldsmiths University, London; 2005. pp. 310–17. New York: The Association for Computing Machinery, ISBN: 59593-025-6.

Johnson-Laird PN. Freedom and constraint in creativity. In: Sternberg RJ, editor. The nature of creativity: contemporary psychological perspectives. Cambridge: Cambridge University Press; 1988. p. 202–19.

Kellock A, Lawthom R, Sixsmith J, Duggan K, Mountian I, Haworth J, Kagan C, Brown DP, Griffiths JE, Hawkins J, Worley C, Purcell C, Siddiquee A. Using technology and the experience sampling method to understand real life. In: Hesse-Biber S, editor. Emergent technologies and social research. Oxford: Oxford University Press; 2011. p. 542–62.

Merleau-Ponty M. Eye and mind. In: Eddie JM, editor. The primacy of perception. Evanston: North Western University Press; 1964a.

Merleau-Ponty M. Indirect language and the voices of silence. In: Wild J, editor. Signs. Evanston: North Western University Press; 1964b.

Merleau-Ponty M. Sense and nonsense. Evanston: North Western University Press; 1964c.

Paul C. Digital art. London: Thames and Hudson; 2004.

Websites

www.absolutearts.com
www.creativity-embodiedmind.com
www.haworthjt.com
www.wellbeing-esrc.com

Friends and Family Funding

► Entrepreneurship and Financial Markets

From Personal to Impersonal Exchange in Ideas

Eskil Ullberg
Interdisciplinary Center for Experimental Science, George Mason University, Fairfax County, VA, USA

Synonyms

Development economics; Economic development; North–south economic integration; Patent exchange; Patent markets

Introduction

Technology – human ideas on using the laws of nature – has always been at the heart of economic development. With the patent system, first introduced in Venice in 1474, technical ideas became tradable in their own rights. Such exchange promises gains in impersonal markets based on the patents, changing the economic organization and structure, and shifting the risk bearing and risk sharing between specialized firms for invention, intermediary trading/investment, innovation, and customers, resulting in a potentially more efficient sharing of risk and thus potentially a more performing economic system.

The topic discussed here are mechanisms and contracts for coordination *between* hierarchies, rather than *within* hierarchies, based on the patent system as an exchange system. Government subsidies and secrecy are replaced by *markets* (using excluding and transferrable rights for economic gains through private investments) and *openness* (publication of the ideas for social gains) as policy, by the use of the patent system, providing private and tradable property rights on the ideas themselves. The performance and behavioral characteristics of such markets in patents with prices are elaborated upon with reference to experimental economics studies. The entry outlines the general economic proposition and discusses such exchange markets, based on principles and practices of the patent system and individuals, firms, and nations exchanging technology based on the patent system.

The first section deals with the economic history of the patent system (productivity). The economic principles (exchange) that it was built on and its impact on economic structure (specialization) then follows. Finally, emergent and experimental impersonal exchange mechanisms (coordination) are discussed.

The Patent System as a Trade System

Technology has always been at the heart of economic development. This knowledge has been kept private by a variety of means throughout history, but through the patent system, technology has become *tradable* in its own right. An excluding and tradable asset – a private property right on an idea to solve a technical problem – is created that opens for a market in technical ideas, a process that has been going on for more than half a millennium.

The theme here is the transition of trade in technical knowledge and ideas from a *personal* exchange of know-how, trade secrets, etc. to an *impersonal* exchange of patents in organized markets with transparent prices. This is thus a political economic problem. The transition has today reached a stage in which patents have become similar to physical assets with respect to validity, tradability, and geographic presence. This transition has an increasing impact on general economic activity, given the key importance technology has for economic development. The more tradable intellectual property rights (like patents) create the foundation for efficiency gains which are at the heart of economic activity. Similar gains from specialization to those of industrial products and services can be expected. The mechanism described is thus a *producer* market in patent-protected technical ideas used (or not used) in new products and services in the *consumer* market. There are three values to be concerned with here: technology value (personal exchange), patent value (impersonal exchange), and consumer value (product and service exchange).

Patents are tradable private property rights on technical ideas. Patents are granted by the state and give the holder excluding, transferrable and licensable rights for *technical* ideas in exchange for disclosure of these ideas through publication. Recently in the USA, nontechnical ideas related to business processes have also been granted patents. Other intellectual property rights have similar properties for other ideas, such as copyrights, trademarks, etc. There are currently seven intellectual property rights granted under the World Trade Organization (WTO) agreement on Trade-Related Aspects of Intellectual Property Rights (the TRIPS agreement): Copyright and related rights, Trademarks, Geographical Indications, Industrial designs, Patents, Layout designs of integrated circuits, Protection of undisclosed information. (In addition, provisions for national control of anticompetitive practices in contractual licenses are granted, to stop practices that may have adverse effect on trade and impede transfer and dissemination of technology.)

However, the standard literature on the economic analysis of patents has mostly been based on the *products* and expressed in terms of divergence between social and private gains

(Arrow 1962; Plant 1934; Nordhaus 1969, 1972) or increased return from international trade in products (Krugman 1990; Schumpeter 1934). In the standard analysis, patent rights on technology are mostly treated as product monopolies. However, there is a lot of different technologies, public and private as well as hundreds or thousands of patents from tens to hundreds of inventors/owner that go into a *single* product or service today. This takes the discussion of a product monopoly far from the core of the economic process at hand: creating new technical solutions, and combining it with extant technology that typically come from different sources, creating a coordination problem.

Such an analysis, based on *monopoly* pricing of *products* (product value) – which is a *static* analysis based on monopoly theory assuming perfect information and has no institutions – may miss essential gains from a patent system coming from the *dynamic*, and often highly *competitive* exchange in technology, between specialized agents trading the *patent rights* (technology value), and may lead to results that exclude trade aspects of technology altogether.

The results of exchange in ideas between agents, on the other hand, may then result in:

(a) The *risks are shifted* from the inventor toward the innovator (and ultimately the consumer) when competitive demand-side bidding is present. Such shift results in a more competitive technology market and thereby technology-based economic growth.
(b) The *dynamic* market efficiency (as measured by the use of technology by innovators) is likely to increase when demand-side bidding is present due to the dynamic value of the patent system.
(c) *Coordination* through price signals would guide the investments in new technology areas. This view means that the demand for new technology, due to need for productivity increase, in turn creates demand for research (not the other way around). North (1981, p. 17) comments "one can view the expansion of basic knowledge as a derived demand for technological advance". The contention in this entry is that it is very difficult ("impossible") to dynamically efficiently allocate resources for invention and execute the allocation of a patent right under real world conditions in a *linear* fashion without a market, thus trying to explain the key role of the patent system in this coordination process. There are simply too many combinations. The role of the patent system thus plays an important role in coordinating the ideas of the world in a market. Krugman (1985) contends that supply side investments in technology (by governments) – thus a linear approach – may simply lead to excess capacity and disappointment. The problem of comparative advantage between nations when it comes to technology (knowledge) may therefore be solved through markets in ideas with demand-side competition, expressing their expected values ultimately through prices.

The economic relevance of these arguments is shown in two controlled laboratory experiments exploring the performance and behavioral properties of markets in patents (Ullberg 2011).

The Economic History of the Patent System: Productivity

Intellectual property and technology in particular have always been at the center of economic development. Technological progress is considered by many sociologists, and economic historians and technology historians, the single most important factor that has raised the standard of living for mankind (Leslie White, Gerhard Lenski, Alvin Toffler, others). Such knowledge has been protected for private use through a variety of means of nondisclosure throughout history, such as guilds, trade secrets in firms, vertical integration, explicit nondisclosure agreements, joint ventures, mergers and acquisitions, and classified military secrets. Guilds had private rules to pay for inventive activity within the community with royalties on their use to keep the art private within that "industry." As firms became organized (hierarchy), they began remuneration of in-house inventors. But through the patent system, technical has become tradable, impersonally and in its own right. The development of the patent system has taken place over a period of more than 530 years, beginning in Venice in 1474.

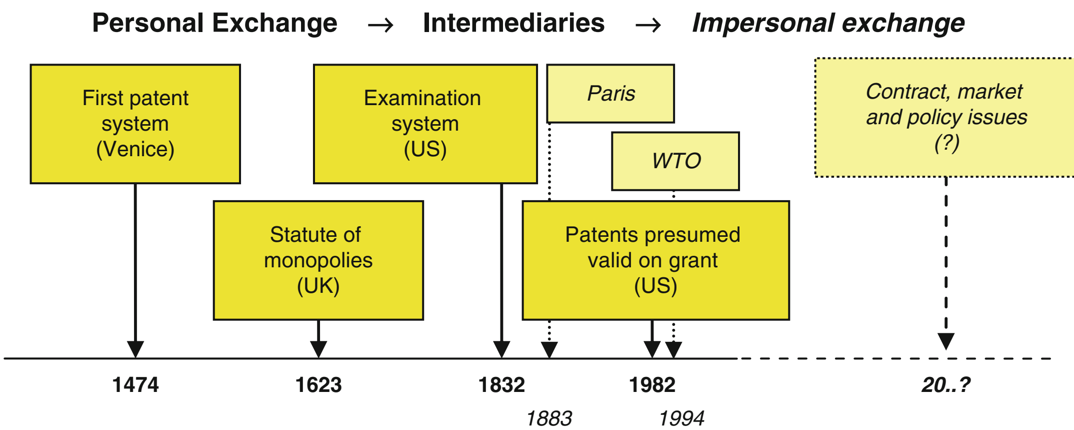
This step was thus preceded by the guilds system and other ways to keep knowledge private. An even earlier step is claimed by Kaufer (1989, pp. 1–2) to be a change in view in society of *manual* labor, during the early Middle Ages (520 AD-), from "not deemed worthy of educated men" to "manual labor as cooperation with God in the task of creation." Kaufer continues: "In the Middle Ages, the pace of technological change accelerated dramatically. Italian cities like Florence, Lucca, Milan and Venice became leaders in artisan production. However, secrecy, often enforced in the Italian city-states by draconian penalties, was used to protect technological advantages and avoid the disclosure of important know-how. This propensity changed with the emergence of a patent system." The recognition of the rights to intellectual work that was made in the fifteenth century – 950 year after manual work was considered worthy of educated men in Europe – appears to have opened the way for a *policy* on impersonal exchange in technical knowledge.

These initial "industrial" patents can be seen as issued to attract, i.e., *import*, technology for the benefit of economic development of the city and later nation state. The value was in the manufacturing of the inventions. This appears to be a *political economic* motivation. Venice had lost trade (years before fall of Constantinople in 1453) and needed to renew economic development. These patents spread north and in the UK were often sold or given to "the friends of the king" (Klee 1998) who traded them in exchange for market access to the UK for often *imported* manufacturing technologies. In 1623, in the UK, the crown's "industrial" monopolies were abolished after government abuse (using sale of monopolies to fund wars with France) and replaced by 14-year patents for product and process inventions, limiting the scope of protection from manufacturing areas to a much narrower product or process scope (de facto importing technology and exporting products). The parliament now controlled the issue of patents, not the King. The UK transition to a patent system can be seen as a battle of who should decide on what patents to be granted. The patents should also be given to the "true and first inventor," thus the originator of the idea, not the "importer" of the idea. The concept of "honoring the inventor" of 1474 now appears to be expressed in more stringent terms.

This step probably also introduced "blocking" as a strategy as competing technologies were developed. Another motivation across Europe was, according to some, to bring out technology from the guilds (who developed much of the technology in preindustrial Europe and much opposed the development of a patent system) and make the technical knowledge more useful to society by making it more public (through disclosure) and keeping its ownership private at the same time (giving excluding rights to inventors). The UK patent law is also the model of US patent law. In 1836 in the USA, examination was "invented" and patents were granted with presumed validity and in 1982, also in the USA, the benefit of the doubt was given to the inventor, the agent taking the risks. This last step turned patents into assets much like physical assets with respect to legal validity and tradability, starting what is now commonly referred to as the "Pro-Patent era."

When patents are granted by the patent office, they are only *presumed* valid. They can always be challenged in courts and *deemed* valid (upheld) or invalid (invalidated). Until 1982, the burden of proof was on the patent holder when a patent was challenged, giving the benefit of the doubt to *society*, but after 1982, the benefit of the doubt was given to the *inventor*, making the patent a much more asset-like *private* right.

On the international scene, the Paris convention from 1883 opened for international protection of patents and processes under non-discriminatory terms (national treatment) and giving the inventor a 1-year priority to file internationally (from date of invention/filing), expanding the *export* of patented technology, initially often accompanied by manufacturing ("foreign direct investments"), and in 1994 through the TRIPS agreement by WTO, minimum standards for patent protection were set



From Personal to Impersonal Exchange in Ideas, Fig. 1 From personal towards impersonal exchange in patents

for member countries, including provisions for transfer and licensing of patents, creating provisions for a global exchange in technology.

Regional and global harmonization attempts are the Patent Cooperation Treaty (PCT), the international filing system run by the World Intellectual Property Organization (WIPO) in Geneva, and the European Patent Convention (EPC), the European filing and granting system run by European Patent Office and Organization (EPO). The PCT has recently adopted provisions, making it one step closer to a global patenting system by amending Chapter II. PCT was originally thought of to be an "extension" of the Paris convention. In the end, all patents are still national or legal equivalents to national patents.

There are increasingly calls for global harmonization of the patent system. This may create a "one size fits all" patent system, asking nations to give up national sovereignty over patentability to a world economic organization. It may be preferable from an institutional learning and economic efficiency point of view to have, at least for now, competing national/regional systems. Competition means that certain economic qualities may develop better (such as exchange). This does not mean that the *procedure* has to be that different but that certain provisions are made for countries with national competitive advantage in certain areas. This is in any way how the system has been used historically. One can compare it with the international monetary system in this aspect. The trend, however, is clearly toward harmonization, especially since the TRIPS agreement. Legal harmonization was tried before 1883 but a system of *principles* of national treatment and priority year was put in place instead. At some point, a world economic standard may be useful on patents.

A central theme in the development of the patent system can be characterized as moving from a *personal* exchange (secrecy, guilds, joint ventures, etc.) toward an *impersonal* exchange of technical knowledge by means of developing more asset-like and internationally valid patents. The risk in such transactions is thereby reduced – through proper integration of information and rules in institutions with good governance – and incentives for trade are created. Efficiency gains can be expected from such impersonal exchange. See Fig. 1.

This long history and acceptance in a majority of nations makes the patent system one of the more global economic systems today, and least regulated from a trade perspective. Most recently, there have been calls for a global patent system (harmonization) from industry and WIPO and for patent reforms in many countries, including the USA. However, competing systems may foster better economically viable patent systems over time than a standard set by administrators from essentially the developed nations. The general theme now seems to be adaptations for a more standardized way to deal with patents in a global economy, a key issue being to keep the incentives to invent and trade technology with the developing nations, thus preserve property rights for a competitive market in new technology expanded to North–south exchange.

The Economic Principles of the Patent System: Social and Economic Exchange

A Market Exchange

The patent system includes both a *social* exchange mechanism, through its public disclosure of the invented technical solution, and a *market* exchange mechanism, by receiving an excluding and transferrable right to use that idea for a limited time.

With respect to market exchange, the patent systems of today typically give the holders these two rights: the right to exclude and to transfer or license that right, creating the fundamentals for a market in ideas. These rights are thus transferrable for the holder and limiting action rights for others. In statute law, Intellectual Property Rights, of which patents are one of today seven (in TRIPS), are construed as a "chose in action" which differ from physical assets which are construed as a "chose in possession." However, Coase's view that physical property rights are really a bundle of limiting action rights (". . .a right to perform certain (physical) actions.," (Coase 1960), p.44) suggests that there may be some important similarities in the economic value between these two assets.

The excluding right also gives the patent *two* strategic values: to exclusively use the technology in new, better products and services for a competitive advantage when compared by the consumer with alternatives not having these features or efficient processes, or to block others from using the competitive technology by "sitting on" the contract and instead using existing technologies of the firm. These values will be referred to as the *investment* value and the *blocking* value. Here a dynamic is introduced that appears not to be captured in the neoclassical product monopoly (the competitive selection, allocation, and exchange process of technical ideas appear not to be included, at least not explicitly).

These rights are today used in very sophisticated and strategic ways: to exclude others, to collaborate by cross-licensing portfolios of technology, to collaborate in global standards, to license for money, etc. Thus introducing exchange in technology through intermediary of monetary and financial markets. This allows extending the number of people and firms in the cooperation, thus potentially increasing the value from exchange in the ideas themselves.

Since scientific and technical research is a global activity since some time, manufacturing is almost global and product and service markets are becoming global, protection of new ideas is often sought where there is *competition* in research, manufacturing, or sale of products/services. The system is used to protect the coordination of activities performed in different nations, making use of national competitive advantages. This means that not only the main developed economies are critical for protection ("the West"), but also the developing economies where much manufacturing and also increasingly research is done and soon the least developed economies who begin to put an emphasis on education and property rights. The key issue then becomes *market access* for research, manufacturing, and sale of products/services. Patent active companies create portfolios of patents which they trade with other firms, for example, in manufacturing countries for market access in other countries through licensing, cross-licensing, etc.

Patents are in this aspect similar to other rights and assets that create market access. Today, for all practical purposes, a single product contains hundreds or thousands of patents, creating more of a competitive market for *technology* than anything close to a monopoly. For example, a car may contain 20003000 patents from 200-to 300 *different* patent holders (Source: EPO). A smartphone may contain 250,000 patent claims which may represent tens of thousands of patents from hundreds of patent holders. (Source: public news sources.) Such a fragmented patent landscape also creates a complex combinatorial problem to obtain access to a complete "technology portfolio" that is practically useful in a product. The latter problem is a market organization problem.

The lack of exchange mechanisms for these valuable and dispersed rights may also be a driving factor to try to develop mechanisms for exchange of quality patents. In the telecom business, where interoperability is a key, international standards are negotiated and when including patents (because patents are by definition state-of-the-art and therefore helpful in getting acceptance for the standards), patent holders must sign off their rights under "Fair, Reasonable, And Non-Discriminatory" terms (RAND or FRAND). These kinds of problems are described, for example, by Heller (2008) in Gridlock economy. An answer may be combinatorial auction markets to recombine "too narrow" rights in useful blocks. A characteristic of this development is therefore the use of the patent system for strategically using or blocking competitive market access.

A Social Exchange

The patent holder still has to pay for the right like in the early days. Firstly, inventors "pay" by disclosing the invention at a level such that a "man skilled in the art can reduce it to practice" (Typical patent system criteria for disclosure of inventions). This informs everybody else about where the company is going with their products (it takes time between invention and production). This "social contract" is a key incentive to further research by "teaching the world" about the inventions. A more subtle side of this is that by seeking patent protection you are also disclosing what *problems* you are working on as a firm which may reveal a future strategic positioning, making the timing of patenting a rather difficult issue.

However, such information obtained through disclosure data also informs competitors and research organizations where *not* to put their research money and therefore directs the research in *other* fields, an alternative to head-on technology competition. The social exchange thus has a coordinating function for research as well, driven by the economic potential of creating a competitive privately held technology. If commercially successful or not, it will be known in due time. Others may then try other areas with outcome observed. There is thus a possibility for one company to intentionally try a new field for the benefit of others – there may be something out there for everyone – hoping that others will reciprocate later, competing and cooperating at the same time. (This is not to be confounded with a joint-venture type of research effort). This may be seen as a *social exchange* among inventive companies made possible by the patent system.

As mentioned in the previous section, making private technology publicly known was also a motivating factor behind the patent system. Today, the publication system of the patent office (after the 18 months) allows for public information about patent applications, grants, and expired patents to be accessible by all. The patent products are therefore publicized by the state.

A possible R&D agenda for companies with respect to patents is therefore: (1) learning about technology through disclosures and staying out of infringement claims; (2) using expired technology and getting new ideas; (3) developing new ideas into their own inventions; and (4) protecting and using them for products or trade.

However, research indicates that about 50 % of ideas are protected by trade secrets (keeping the ideas private) and roughly 30–35 % are patented, making trade secrets still the most common way to protect ideas (EU Project research report).

Secondly, there is a fee to the patent office (the state), typically starting low and growing exponentially, allowing the inventor to pay if the invention is successful or drop it before any value has been realized.

In the USA, a fixed fee has been used but the fee structure is under change to a system more like the European exponential fees. These have the advantage that commercially viable patents are often renewed and other patents dropped. This has resulted in an *average economic life* of European patents of about 7 years (around 2005), far from the 20 years of *legal* life. The exponential pricing means "subsidy" of short lived /poor quality patents by longer-lived quality patents, an issue of interest for competition authorities.

This fee was originally given by "the friends of the king" to the king but now typically goes to the patent office (often ministry of justice or commerce) or directly to the treasury, often generating a revenue to the state. There is thus a financial incentive for the state to have quality patents, which are used for a long time. There is also an incentive for the inventor to reduce time to market (or the blocking right) not only for the limited time a patent is granted but also for the increasing renewal fees. The successful inventor then still "gives back" some of the profits to the state.

The scope of claims in one patent differs between systems. In the USA, many claims are allowed for one invention, whereas in Japan, only one claim is allowed per patent. This makes US and EU patents broader and, if upheld, powerful, whereas Japanese patents are weaker. The distinction is a result of an ongoing debate on the scope of a patent. Broad patents may lead to more risk-taking and investment in radically new ideas, whereas narrow patents may lead to smaller "inventive step" in the patents. See, for example Nordhaus, others. A resent short study by Crouch (2008) shows that the complexity of the applications is increasing in initial claims and total claims measured by issued claims.

These rights and obligations refer to the two parts of a patent: the disclosures (description of the invention) and the claims (list of granted excluding and transferrable rights). The patent system can therefore be considered an *exchange system* between inventors (information) and the state (money). This makes the patent system a complex policy issue and in a market analysis as in this case, the patent system becomes an agent (a legal environment).

The Economic Principle of Trade in Technology

The principles have thus remained more or less the same for the 530 years since its legal conception, but the Crown is now replaced by parliaments, broad "industrial" privileges replaced by narrower product and process inventions given to individual inventors or assigned to firms (after some compensation) and "unlimited" or variable temporal rights, largely with a standardized time period of 20 years.

An important characteristic of the historic narrative – briefly presented here – is that the development of the patent system appears to have been motivated by trade in technology. This motivation is different from the motivation referred to in most economic textbooks of creating incentives for *inventions* in a closed economic environment (Plant, Arrow, Nordhaus, et al.) without including national comparative advantages (as Richardo, Hecksher-Olin, et al.), economies of scale (as Krugman, et al.), or other motivational factors of trade. According to Plant, the patent system as such lacks theoretical economic principle (Plant 1934, p. 51), simply creating scarcity, but looking at the system as an exchange (trade) system introduces the *economic principle* of trade and specialization as a motivational ground for the patent system.

In summary, the intention appears to originally have been to attract inventions made *elsewhere* and *import* them to Venice to further economic development there. The first patents were related to water pumping, a German mining technology imported to Venice for use in mines on the main land controlled by Venice (Kaufer 1989). Later on, the international system (1883) allowed for export of patent-protected products, thus, *import* of technology for the receiving country, leading to economic development through, among other things, foreign direct investment. This appears to be the same mechanism at play as in Venice but at a product and process level.

Litigation or Cooperation

Negative effects of this kind of trade have also developed. Since 1982, the rights have become more valuable as the burden of proof changed and infringements leading to litigation became costly. The average court settlement was around $m1–2 in the 2000s.

This has led to the emergence of a "patent market" in litigation. In this market, the judges set the prices. In order to avoid litigation, licensing agreements are increasingly made as out-of-court settlements under the threat of litigation costs (and/or uncertainty outcomes). Such settlements may "crowd out" smaller inventors as court costs literally explode. This can be both a good and a bad development. So-called patent trolls amass patent portfolios secretly and then ask for licensing fees. The good part is that users are more careful with what technology is used, but the inventors must be able to defend their newly acquired rights.

The rights have thus become tradable and the licensing has allowed gains from specialization to emerge. One example is the university and (small) business patent collaboration (the Bayh-Dole act in the USA). Other examples are technologies such as IT and biotech where technology is often developed by smaller companies or specialized research centers and development by patent portfolio holding "marketing" companies. A broadening of patentable subject matter to nontechnology (business methods) has also been made, primarily in the USA. One motive has been to give protection for new non-technologies such as financial "technologies" and software. This is a very contentious issue and may well be reversed back to technology, the original patent system idea.

The change in the presumption of validity appears not to have been followed up by a legal procedure to give incentives to negotiate but to litigate.

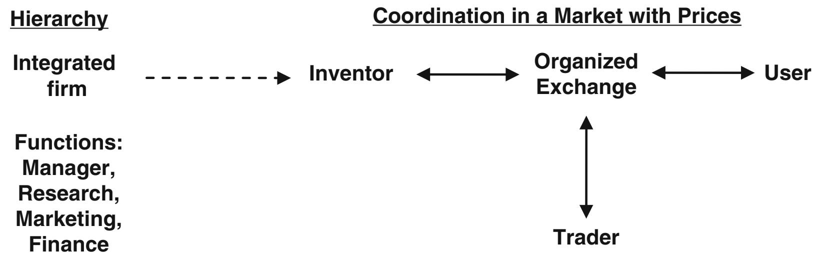
The Economic Structure and the Patent System: Specialization

Economic Organization and the Patent System

The development of the patent system as a trade system has given rise to specialized agents for different economic activities related to using technology, which is a *dynamic* economic change. The principle of personal exchange is here at work: the economic organization changes. After the 1836 patent reform in the USA, the possibility of impersonal patent trade led to a rise in *specialized inventors* and market trade in patents, facilitated by *specialized patent attorneys* acting as intermediaries in this market (Lamoreaux and Sokoloff 1999, 2001). However, after some time, the integrated hierarchical model dominated. The reason why mergers and acquisitions dominated as an innovation strategy for the first 150 years is likely to be a problem of: (1) transaction costs favoring M&A strategies; and (2) the way the patent system claims are organized, i.e., how the rights are construed, affecting the success of the underlying principle of tradability. It seems the patent policy focus has been on granting patents on technology and possibly less on the economic use of patents for trade. A shift to a "patent trade policy" may be economically efficient, facilitating the "trade value" of the patent system to be realized. Since the 1982 changes in the USA, when the legal validity and possibilities to litigate patents increased drastically, patent licensing has literally exploded and today accounts for up to \$0.5trillion in the USA, and \$1trillion in IP trade (including patents, copyrights, etc.), which is about 1 % of the USA's total trade in products and services. (See, for example, U.S. census bureau on international trade and licenses and www.inventionstatistics.com on US patent licensing.) Similar developments can be seen in other countries. The specialization enabled by the patent system has gradually changed the business model from the *hierarchically* integrated firm as basis for economic organization *toward* a business model in which specialized agents coordinate their activities through a market ultimately with *prices*. See Fig. 2.

Such trade and specialization in patents described in the previous sections clearly give reason to believe that there are also essential gains from trade in technology made possible through the patent systems. The development of the patent system to make patents more tradable like physical assets is thus resulting in a *reorganization* of the economic activity at the core of the economy.

Assuming the historic importance of technology to economic development, any changes in gains from trade in patents with respect to this "new" economic organization will therefore "multiply" into the whole economic system. Baumol (2002), Schumpeter (1934), and others contend that the greatness of the capitalist system lies in its incentive to create inventions. Several attempts in the last 10 years have been made to trade patents in more asset-like markets like



From Personal to Impersonal Exchange in Ideas, Fig. 2 Change in economic organization using a patent market

patent auctions, but to date, no organized markets with transparent prices similar to the impersonal trade of commodities in commodity markets and shares in financial market have emerged. An important reason for this market failure is that it appears to be difficult to find ways (rules) to create efficient trading – it has to reduce the risk the interaction between firms.

At the heart of the development from hierarchy to coordination in markets can therefore be seen the patent system's ability, as an institution, to *reduce risk* in the system in trading technical knowledge and the *dynamic efficiency* of the mechanism designs for such markets.

Impersonal Exchange Mechanisms for a Market in Patents with Prices: Coordination

In the previous sections, it was shown how the patent system gives economic incentives for a shift from personal to impersonal exchange in technology through the dual rights of exclusion and transfer which leads to a new economic organization of specialized agents. The coordination in a hierarchy (firm) is (gradually) replaced by coordination through a market (institution) with prices.

In this section, I propose to present key real world considerations placed on a dynamic microeconomic system design.

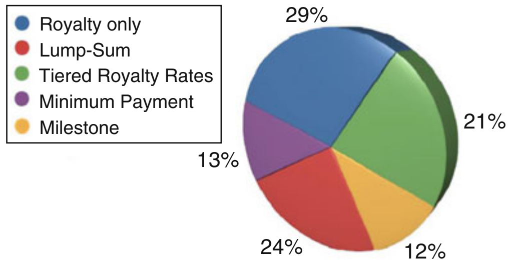
The focus on transparent prices and coordination makes the emphasis on factors important for increasing dynamic market efficiency. Since the *contract* used to trade and the *mechanism designs* (rules) are key factors in obtaining market efficiency (or contributing to market failure), these will be discussed first. In this case, a more subtle aspect is also how the patent system itself is important, how the rights are *construed* and *granted*, and how the *validity* of patents is realized. One could say that the contract between the patent holder and the state is *incomplete* upon grant. See (Hart 1988), others on incomplete contracts. The *intermediaries*' role (traders) in creating the dynamics is also discussed briefly.

A Linear Contract

To capture the dual values of the patent, the blocking value and the investment value, I propose using a *linear contract*. (There is a rich literature on linear contracts. Basically these contracts are contingency contracts on, for example, revenues.) There are two reasons for the choice of linear contract. Firstly, the linear contract is a common contract that is used in today's *personal* exchange. It is difficult to get access to pricing information on patent contracts but one source of data on patent licensing contracts informs that 50 % of contracts are linear, i.e., there is some fix component such as a lump sum payment combined with a royalty component on revenues in unit or dollar sales (Royalty Patents Inc, in Washington DC). See Table 1. This suggests that in half of the cases, there is an incentive to give a fixed payment upfront and in others, not. There appears however always to be a royalty. They are only in 50 % conditional on "signing" for the royalty part sometimes conditional (milestone). In other words, risk sharing is always present but risk transfer only in 50 % of the cases and then sometimes conditional (milestone). The typical transition from personal to impersonal markets often follows, when it comes to the contract, the contract already used in the personal

From Personal to Impersonal Exchange in Ideas, Table 1 Types of payments in patent agreements

Royalty only	50%
Royalty only	29%
Tiered royalty rates	21%
Fix payment and Royalty	50%
Milestone Payment	12%
Lump sum payment	24%
Minimum Payment	13%

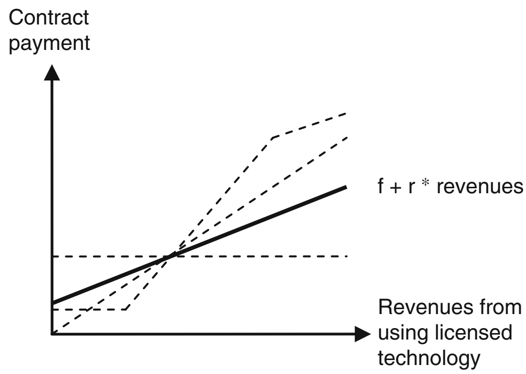


exchange. The NY stock market is an example here and commodities markets. However, there is at some point an agreement, or standardization, upon what kind of contracts that can be traded. This agreement is an important factor in creating efficiency and transparency.

The Linear Contract and Risk Sharing

Typical linear contracts studied in the literature have followed similar functional characteristics with input from fields other than patents. These contracts allow for a royalty to kick in at a certain level (minimum volume), tiered (different royalty rates given the usage/volume), flat fee, flat royalty, or a strict linear combination (minimum payment). See Fig. 3. It is the simple linear contract that is chosen in this study to capture both a fix (minimum) and a (constant) royalty payment.

With reference to Arrow (1962), a fix-price market is used to *transfer* the risk and separate derivate markets, one for each state of nature, are used to *share* the risks (Arrow-Debreu securities). The linear contract *combines*, in one contract, what the functioning of a fix-price transfer market and derivate markets for each and every state of nature do to achieve optimal allocation of risk sharing *and* risk bearing in the economic system. In the proposed study, risk transfer and risk sharing are thus negotiated in the same contract, reducing the number of markets needed to one.



From Personal to Impersonal Exchange in Ideas, Fig. 3 Different types of linear contracts

A Linear Contract Mechanisms

Mechanisms to trade such a linear contract are in the beginning of development. Similar contracts appeared at the heart of "the marginal cost controversy" where Coase (1946) suggested that an optimal system of prices may not be a single price per unit but instead a multi-part system of pricing. This approach goes hand in hand with the observations and discussion regarding an optimal pricing system for technical ideas based on the patent system.

Conclusions and Future Directions

The transition of exchange in technical ideas has come far in the first 500 years and attained an important role in coordinating firms, universities, and inventors in their pursuit of technical solutions for increased productivity. The impact of the patent system is now approaching the doorstep – it seems – of organized exchange in ideas. Advances in mechanism and contract design may be what are needed to make such organized markets efficient enough as a system of pricing for technical ideas.

Cross-References

▶ Academic Entrepreneur, Academic Entrepreneurship
▶ Academic Entrepreneurship
▶ Business Climate and Entrepreneurialism
▶ Business Incubator
▶ Business Start-Up: From Emergence to Development
▶ Church and Entrepreneurship
▶ Co-conception and Entrepreneurial Strategies
▶ Cognition of Creativity
▶ Collaborative Innovation and Open Innovation
▶ Corporate Entrepreneurship
▶ Creative Collaboration
▶ Creative Destruction
▶ Creative Knowledge Environments
▶ Creative Management
▶ Creativity Across Cultures
▶ Creativity and Church
▶ Creativity and Innovation: What Is the Difference?
▶ Decrease in Creativity
▶ Entrepreneurship and Business Growth
▶ Entrepreneurship and financial markets
▶ Entrepreneurship and Small Business Agility
▶ Entrepreneurship in Creative Economy
▶ Entrepreneurship Policy
▶ Innovation and Entrepreneurship
▶ Innovation Policies (vis-à-vis Practice and Theory)
▶ Innovation Policy Learning
▶ Innovation Systems and Entrepreneurship
▶ Joseph A. Schumpeter and Innovation
▶ Knowledge Capital and Small Businesses
▶ Knowledge Creation and Entrepreneurship
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index
▶ Nature of Creativity
▶ Patents and Entrepreneurship
▶ Research on Creativity
▶ Risk, Uncertainty, and Business Creation
▶ Role of Intuition in Creativity
▶ Schumpeterian Entrepreneur
▶ Science of Creativity
▶ Scientific Creativity as Combinatorial Process
▶ University Research and Innovation
▶ Venture Capital and Small Business

References

Arrow JK. Economic welfare and the allocation of resources for invention. Santa Monica: The Rand Corporation; 1962.
Arrow KJ. Uncertainty and the economics of medical care. Am Econ Rev. 1963;53:941–73.
Arrow KJ. Aspects of the theory of risk-bearing. Helsinki: Yrjö Jahnssonin Säätiö; 1965.
Barzel Y. Knight's "moral hazard" theory of organization. Econ Inq. 1986;25:119–20.
Baumol WJ. The free-market innovation machine: analyzing the growth miracle of capitalism. Princeton: Princeton University Press; 2002.
Coase RH. The nature of the firm. Economica. 1937;4:386–405.
Coase RH. The marginal cost controversy. London School of Economics and Political Science; 1946.
Coase RH. The problem of social cost. J Law Econ. 1960;3:1–44.
Crouch DD (2008) The rising size and complexity of the patent documentm, research paper, University of Missouri School of Law.
Gambardella A, Al E. The value of European patents evidence from a survey of european inventors. Final report of the patval eu project, contract HPV2-CT-2001-00013, January 2005.
Hart OD. Incomplete contracts and the theory of the firm. J Law Econ Organ. 1988;4:119–39.
Hurwicz L. The design of mechanisms for resource allocation. Am Econ Rev. 1973;63:1–30.
Kahneman D, Tversky A. Prospect theory: an analysis of decision under risk. Econometrica. 1979;47:263–92.
Kamien MI, Tauman Y. Fees versus royalties and the private value of a patent. Q J Econ. 1986;101:471–92.
Katz ML, Shapiro C. How to license a patent. Princeton: Woodrow Wilson School, Princeton University; 1984.
Kaufer E. The economics of the patent system. New York: Harwood Academic; 1989.

Klee MM, Fairfield CT. Where did the US patent laws come from?
Knight FH. Risk, uncertainty and profit. New York: AM Kelley; 1921.
Krugman P. A "technology gap" model of international trade. Macmillan; 1985.
Krugman P. Endogenous innovation, international trade and growth. 1990.
Lamoreaux NR, Sokoloff KL. Inventive activity and the market for technology in the United States, 1840–1920. NBER; 1999.
Lamoreaux NR, Sokoloff KL. Market trade in patents and the rise of a class of specialized inventors in the 19th-century United States. Am Econ Rev. 2001;91:39–44.
Leroy SF, Singell LDJR. Knight on risk and uncertainty. J Polit Econ. 1987;95:394–406.
Nordhaus W. Invention, growth and welfare. Cambridge, MA: MIT Press; 1969.
Nordhaus WD. The optimum life of a patent: reply. Am Econ Rev. 1972;62:428–31.
North D. Structure and change in economic history. New York: Norton; 1981.
Plant A. The economic theory concerning patents for inventions. Economica. 1934;1:30–51.
Popper KR. The logic of scientific discovery. London: Hutchinson; 1959.
Schumpeter JA. The fundamental phenomenon of economic development. Schumpeter, the theory of economic development. 1934. p. 57–94.
Schumpeter JA. Capitalism, socialism and democracy. New York/London: Harper & Brothers; 1942.
Smith VL. An experimental study of competitive market behavior. J Polit Econ. 1962;70:322–3.
Smith VL. Optimal insurance coverage. J Polit Econ. 1968;76:68–77.
Smith VL. An empirical study of decentralized institutions of monopoly restraint. In: Essays in contemporary fields of economics. West Lafayette: Purdue University; 1981.
Smith VL. Microeconomic systems as an experimental science. Am Econ Rev. 1982;72:923–55.
Ullberg E, Rodriguez E, Stormby N. Risk management – from portfolio strategy to value creating system strategy. Geneva Pap Risk Insur Issues Pract. 2002;27:467–76.
Ullberg E. Trade in ideas – performance and behavioral properties of markets in patents. 1st ed. New York: Springer; 2011.
Vickrey W. Auctions and bidding games. In: Recent advances in game theory. Princeton University Press, Princeton; 1962.

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Game Theory

▶ Game Theory and Innovation Analysis

Game Theory and Innovation Analysis

Igor N. Dubina
Economic Information Systems, Altai State University, Barnaul, Russia

Synonyms

Game theory; Innovation; R&D

Definition

Game theory is a mathematical approach to the modeling of strategic interaction among independent agents that recently become one of the most powerful analytical tools in economics, especially in microeconomics and industrial organization. In particular, game theory, among other applications, offers a way to formulate predictions, delivers prescriptions and recommendations for decision makers, and helps to develop and implement efficient strategies.

The Levels of Game-Theoretic Analysis of Innovation

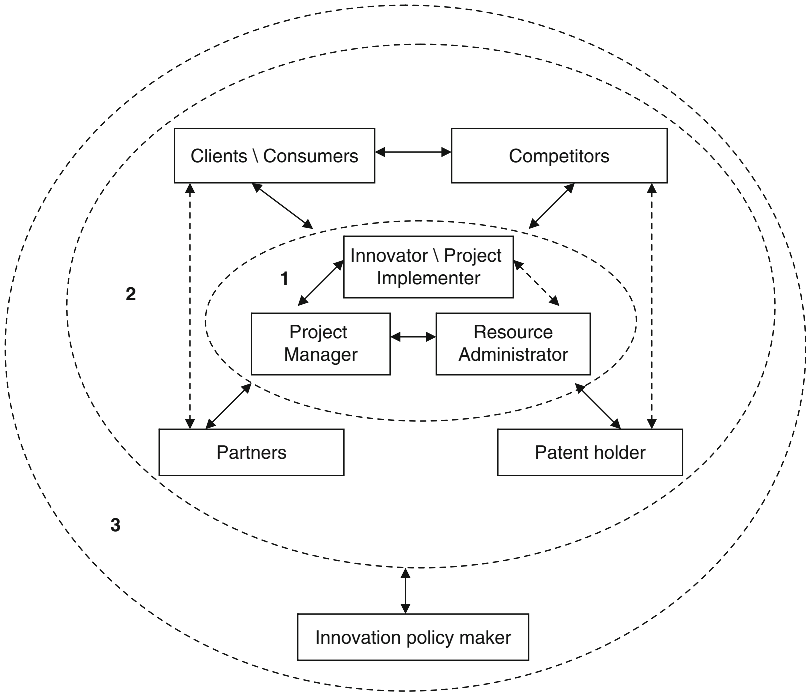
The main directions of game-theoretic analysis of innovation can be divided into three levels of innovation interactions or three types of innovation games:

1. Intraorganizational game, which is played within a firm; in this game, main players are an innovator (idea generator, project initiator or implementer, etc.), a project manager, and/or resource administrator.
2. Interorganizational game, where the main players are a firm, its competitors, its partners (e.g., venture inventors, distributors, suppliers, outsourcing allies, research centers), clients (customers), and sometimes a patent or other intellectual property holder.
3. Metaorganizational game, where the main players are a social planner (innovation policy maker, government, a social or government institution, e.g., a research foundation) and an aggregate innovative entrepreneur. The structure of all levels and their relations are depicted in Fig. 1.

The main objective of analysis on the intraorganizational level is:

1. To find and substantiate optimal variants of organizational and economic interaction of innovation process participants (inventor, innovation entrepreneur, project manager, investor, project implementers, etc.)

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
DOI 10.1007/978-1-4614-3858-8,



Game Theory and Innovation Analysis, Fig. 1 Innovation game levels: (*1*) intraorganizational game, (*2*) interorganizational game, (*3*) metaorganizational game (Source: The author's own conceptualization)

2. To secure a high level of creative activity of idea generators and project implementers
3. To effectively stimulate knowledge sharing in the firm

The existing literature mostly concentrates on the interorganizational and metaorganizational levels. On the level of interorganizational interaction, game theory models help to define optimal competition and cooperation strategies, in particular, to determine optimal R&D expenditure, optimal mechanism of financial relationships for innovation participants (royalty, fixed payment, innovation project profit or revenue sharing amount, etc.), the best time to introduce a new product into a market (time to launch innovation), to develop the most profitable licensing agreement, to select the right project or make a right choice of investment alternatives or innovation strategy, etc.

On the macrolevel, innovation games describe the interaction between an innovator and a social planner of innovation policy (e.g., government). The main questions are the following: What is the optimal configuration of intellectual property rights (IPR) policy? What are the welfare implications of licensing? Which industry and market structure provides the highest incentive to innovate? Game-theoretic approach helps to construct the optimal government policy with respect to innovation activity, to maximize the capitalized value of net social surplus, to enhance technological innovation and international competitiveness, etc.

It is important to note that a model initially developed for innovation analysis on one level can be often adapted to the analysis on another level (model transfer). For example, an intraorganizational knowledge sharing agent-based model can be also adapted for the analysis of interorganizational interactions in an innovation consortium.

The reviewed literature concentrates mostly on noncooperative games; however, cooperative game models are also used, mostly to solve the problem of optimal sharing of innovation project outcomes among the member of innovation

Game Theory and Innovation Analysis, Table 1 Analyzed problems and modeling techniques for different types of interaction games

Level of interaction	Modeled problems	Types of model
Intraorganizational	Team building in R&D	A static game of 2 or *n* players
	Stimulation of innovative activity	Dynamic 2-player games
	Knowledge sharing in an innovative firm	A static 2-player game
Interorganizational	The choice of an R&D strategy (R&D expenditure, product differentiation, etc.)	A Stackelberg game of *n* players
	The choice of an innovation strategy (independent, initiative, cooperative, etc.)	A differential game of *n* players
	The choice of optimal parameters of a licensing contract	A 2-player game
	The interrelation of a patent holder and innovative firms	A dynamic noncooperative game
	Patent race	A cooperative game
	The cooperation of R&D consortium partners	An asymmetric game of 2 players
		A static or iterated "prisoner's dilemma" game
Metaorganizational	Optimal innovation policy and government interventions in R&D	A Stackelberg game of *n* players
		A dynamic game of *n* players
		A cooperative game

Source: The author's own conceptualization

alliances. In most cases, the specificity of innovation process is often "hidden" in a model. It is typically assumed that an innovation process results in low-cost or quality improvement technology. Hence, researchers often go from latent and nonmeasurable variables (e.g., R&D effort) to some aggregate variables (e.g., R&D costs depending on R&D effort).

A survey by Baniak and Dubina (2012) demonstrates a clear tendency of stable and rapid growth of a number of publications on game theory applications to innovation analysis during the last 3 decades. The summary of the innovation problems modeled with game theory and model types used is given in the Table 1.

Conclusion and Future Directions

Game theory models sometimes result in conclusions contrary to intuition and common sense, but these conclusions, as numerous computer and laboratory experiments and real practice demonstrate, are often more useful and applicable than intuitive decisions and common sense. A wide spectrum of successfully analyzed and solved problems as well as the powerful logical and mathematical methodology of game theory give an idea that the game-theoretic approach will take an important role in innovation research during the next decade.

References

Baniak A, Dubina I. Innovation analysis and game theory: A review. Innovation: Management, Policy & Practice. 2012;14(2):178–191.

Gazelle

► Startup

Gender

► Diversity and Entrepreneurship

Gender and Innovation

Malin Lindberg[1] and Helene Schiffbaenker[2]
[1]Department of Business Administration, Technology and Social Sciences, Luleå University of Technology, Luleå, Sweden
[2]JOANNEUM RESEARCH, Vienna, Austria

Synonyms

Creativity; Men; Norms; Women

Introduction

This entry describes, defines, synthesizes, and reviews the topic of gender and innovation, which is an emerging field of research evoked by the need for more inclusive innovation policies, innovation networks, and innovation processes.

Over the last two decades, innovation has become an increasingly common subject of political action and scientific studies in Europe and worldwide. This interest emanates from the widespread understanding that development and dissemination of innovations transforms the economy to become more dynamic and knowledge-based. This vision permeates OECDs innovation strategy as well as the new European Union strategy *Europe 2020* and its flagship initiative *Innovation Union*. Simultaneously, the need for more inclusive and creative policies, processes, and networks of innovation has been articulated by gender scientists and gender equality officials (Schiebinger 2008; Fürst Hörte 2009; Danilda and Granat Thorslund 2011; Schraudner 2010). This need is motivated by the fact that most Western policies and research studies on innovation have prioritized a narrow range of actors, areas, and innovations at the expense of other creative and innovative spheres (cf. Blake and Hanson 2005; Pettersson 2007; Lindberg 2010, 2011). Innovation is an area that traditionally has been characterized "either by gender-blindness or male dominance" (Ranga and Etzkowitz 2010, p. 1). Nevertheless, gender analyses have a "potential to enhance human knowledge and technical systems by opening them to new perspectives, new questions and new missions" (Schiebinger 2008, p. 4). In this entry, the prevalent research of gender and innovation will be summarized and reviewed in order to clarify the scope and effects of this dawning field of research.

The entry starts with introducing two theoretical concepts intended to clarify the relation between gender and innovation: doing gender and gender mainstreaming. This is followed by a review of existing research on gender and innovation, which is synthesized in the light of the two theoretical concepts presented at the start. Finally, conclusions are drawn, and future directions in research on gender and innovation are distinguished.

Concept No. 1: Doing Gender

In order to understand how gender is relevant to the field of innovation, the theoretical concept of doing gender will here be highlighted. This concept provides a framework for understanding how gender can be analyzed in policies and organizations. Doing gender constitutes nowadays one of the main approaches employed in contemporary gender research (Gunnarsson et al. 2003). According to the doing gender approach, gender is not a given natural dimension but is constructed in social interactions, and by this, existing gender differences can be analyzed and changed. Gender is then regarded as an ongoing activity and interaction performed among and between women and men in organizations and society (West and Zimmermann 1987). Everyday practices and activities are thereby related to an institutional and structural level. Gender is consequently related to innovation by policies, processes, and networks of innovation being characterized by gendered practices and frameworks at individual, relational, structural, and symbolical level. By viewing gender as an accomplishment, as in the doing gender approach, the attention is shifted "from individuals to interactional and institutional arenas, thus opening up opportunities for change" (Danilda and Granat Thorslund 2011, p. 51).

One of the classic contributions of gender research relies on the principles of doing gender as it exposes how gender often is done in ways that create dichotomies, for example, between men and women or between femininity and masculinity (Hirdman 1990). This leads not only to segregation – for example, on the labor market – but also to hierarchies where areas associated to men and masculinity often are ascribed higher value – for example, by higher wages, faster careers, and political prioritization (Gunnarsson et al. 2003; Lindberg 2010; Schiffbänker 2011). This implies an uneven distribution of power and resources between women and men. Gender is consequently related to innovation by the uneven distribution of power, resources, and status between women and men, as well as between services and manufacturing industries, in policies, processes, and networks of innovation (Pettersson 2007; Lindberg 2010; Danilda and Granat Thorslund 2011).

Contextual variations are an important part of doing gender, distinguishing how gender is done in different ways in different times and places. The focus on everyday practices underlines the possibility of doing things differently (Gunnarsson et al. 2003). According to the doing gender approach, it is not compulsory that the doing of gender ends up in segregating and hierarchical patterns. Quite the opposite, since it – at the individual level – is possible to act in ways that break this trend, opening up – at the structural level – for more dynamic and nuanced perceptions of the world. Such acts can be interpreted as a way of "undoing gender" (Wetterer 1999). Concerning the relation between gender and innovation, such a change in the doing of gender could imply a different pattern of prioritization, esteeming actors, industries as innovations not by their gendered nature but by their potential to evoke creativity and societal development (Andersson et al. 2009; Lindberg 2010; Danilda and Granat Thorslund 2011). However, it is not always easy to bring about change since the dominating structures can be tenacious, reacting with resistance when challenged. The resistance reveals that there is power relations involved, requiring negotiations about "what men and women are allowed to do, how they are allowed to behave and how men and women are to be ranked and valued" (Kvande 2003, pp. 37–38).

Concept No. 2: Gender Mainstreaming

In order to understand how gender is relevant to the field of innovation, this entry will now be continued by highlighting the concept of "gender mainstreaming." It was introduced at the end of last century after the United Nations Fourth World Conference on Women in Beijing 1995 to involve broader areas of policies and actors into gender equality targets. Gender mainstreaming is primarily used as an overarching strategy of gender equality efforts in policies and organizations. As a strategy, it implies that gender equality is to be addressed in all policy and organizational areas as well as in all phases of decision making and implementation (Rees 2005). In research, gender mainstreaming is analyzed theoretically due to its varying content and effects. Walby (2005) and Squires (2005) have launched two alternative ways of classifying efforts to mainstream gender in policies and organizations, which both cast a light on the relation between gender and innovation.

There are many ways of defining gender mainstreaming and many ways of implementing it in practice (Walby 2005). One definition is provided by Rees (2005, p. 560), stating that gender mainstreaming is "the promotion of gender equality through its systematic integration into all systems and structures, into all policies, processes and procedures, into the organization and its culture, into ways of seeing and doing." Another definition is maintained by True and Mintrom (2001, p. 28), proposing that gender mainstreaming is to be understood as "efforts to scrutinize and reinvent processes of policy formation and implementation across all issue areas to address and rectify persistent and emerging disparities between men and women."

Walby (2005, pp. 323–324) highlights two general ways in which gender can be mainstreamed.

Firstly, there is a strategy of integrationism that promotes gender mainstreaming as “a way of more effectively achieving existing policy goals” and thus fails to challenge prevalent policy paradigms. Secondly, there is strategy of agenda setting that implies “the transformation and reorientation of existing policy paradigms, changing decision-making processes, prioritizing gender equality objectives, and rethinking policy ends.” In this context, the term transformation is to be understood as “neither the assimilation of women into men’s ways, nor the maintenance of a dualism between women and men, but rather something new, a positive form of melding.” As Walby notes, while the strategy of agenda setting means that gender mainstreaming is less likely to be rejected in mainstream policy making and organizations, it is more likely to have only a limited impact on segregating and hierarchical gender relations.

Squires (2005, pp. 368–371) suggests a different way of categorizing efforts to mainstream gender in policies and organizations. She discerns three types of strategies: inclusion, reversal, and displacement. She connects the strategy of inclusion to a liberal type of feminism, seeking gender neutrality and conceiving people as autonomous. What is mainstreamed in this category is primarily formal equality of opportunities, realized by bureaucratic policy processes. The strategy of reversal is associated to the stream of radical feminism, seeking recognition for a specifically female gendered identity and explicitly talking of women as a given category. Mainstreaming is here seen as a way to include women’s voices. Squires links the strategy of displacement to a postmodern type of feminism, using gender as a verb instead of as a noun. It is problematized how discourses ascribe gender to people, attributes, and activities. Gender mainstreaming is then equivalent to norm diffusion, acknowledging a broad spectrum of identities, experiences, and visions.

Walby and Squires thus identify a range of manners in which gender can be mainstreamed in policies and organizations. These manners do not necessarily have to be seen as alternatives to each other. Squires underlines that the three strategies she discerns are to be regarded as complementary rather than competing or incompatible. Ultimately, she concludes that gender mainstreaming is most likely to be truly transformative when all three strategies are implemented side by side. In theoretical studies of gender mainstreaming – as well as in practical efforts to mainstream gender in policies – it is however important to distinguish which strategy that is being employed. This is since the different types differ in their effects on gendered structures in policies and organizations. These differing effects are relevant not least when relating gender to innovation, since policies, processes, and networks of innovation are gendered in different ways. This will be exemplified in the last section of this entry.

Gender Research on Innovation

Having set the scene by introducing the gender theoretical concepts of doing gender and gender mainstreaming, this section summarizes and reviews prevalent gender research on innovation.

Gender has been advocated as a relevant aspect in relation to innovation within a number of research fields, for example, feminist science and technology studies, political science, history of science, business economics, and human geography (c.f. Hacker 1989; Blake and Hanson 2005; Papouschek et al. 2006; Pettersson 2007; Schiebinger 2008; Ranga and Etzkowitz 2010; Schraudner 2010; Danilda and Granat Thorslund 2011; Ekman et al. 2011). There, it has been highlighted how the dominating image of innovation and innovators builds on stereotypical notions of gender, promoting men and masculinity as the norm. According to Nyberg (2009), this gender imbalance leaves innovative opportunities unexploited, thus hampering political prospects of continuous economic growth. In order to make better use of these innovative opportunities, Ghaye and Gunnarsson (2009) suggest the creation of “cultures of appreciation,” improving innovation within organizations. Such cultures effectively address gender issues since the positive and creative sides of the organization and the employees are accentuated, reaching beyond hampering gender stereotypes. Schiebinger and Schraudner (2011, p. 154) mention the innovation potential of "gendered innovations" which are defined as "the process that integrates sex and gender analysis into all phases of basic and applied research to assure excellence and quality in outcomes."

Existing gender stereotypes in policies, processes, and networks of innovation can be challenged by acknowledging that innovative activities occur also "in economic sectors and by actors that are typically ignored or undervalued by current research and by policy" (Blake and Hanson 2005, p. 681). Integrating other innovative employment fields like services and creative industries – both in the private and public sectors – widens the understanding of innovation and acknowledges the contribution by women-dominated professions (Nählinder 2005, 2010; Papouschek et al. 2006; Pettersson 2007; Schiffbänker 2008; Lindberg 2010; Ranga and Etzkowitz 2010). This can be reinforced by acknowledging the importance of the nonprofit sector for innovation beside the public, private, and academic ones, implying an expansion of the Triple Helix model of innovation networks into a Quadruple Helix model (Carayannis and Campbell 2010; Lindberg et al. 2012). A democratization of innovation can thus take place "through extending the circle of actors who take part in the process," which also increases the likelihood of evoking "responsible innovations" (Gustavsen 2011, pp. 4–5). Thereto, a broader view on innovation has been suggested, embracing not only technological/manufacturing innovations but also social and organizational innovations (Blake and Hanson 2005). Consumers are thereto claimed to be interested in products that "break with traditional gender stereotypes" (Danilda and Granat Thorslund 2011, p. 55). In these ways, gender aspects are increasingly acknowledged in studies of knowledge production and innovation (Schiebinger 2008; Ranga and Etzkowitz 2010).

Some of the gender research performed on innovation has specifically focused innovation policies, since they affect the availability of financial resources for initiating innovation networks and innovation processes. Sweden is predominant in the pioneering work performed on gender in innovation policies, but some studies have also been carried out in Norway, UK, and USA. Some of the Swedish research studies include Pettersson (2007), Fürst Hörte (2009), Andersson et al. (2009), Lindberg (2010), and Danilda and Granat Thorslund (2011). The studies in Britain and the United States have been performed by, for example, Rees (2000) and Blake and Hanson (2005), and in Norway by, for example, Foss and Henry (2010) and Kvidal and Ljunggren (2010). The conclusions uniting these studies of the gendered nature of innovation policies are threefold:

1. Public investments in innovation networks primarily prioritize men, male-dominated networks, and male-dominated sectors of the economy.
2. Public promotion of innovation is hampered by gendered stereotypes, ignoring the innovation potential among certain actors, industries, and innovations.
3. Public programs usually describe innovations and innovation networks with reference to mechanical machines and technical products rather than human relationships and services, which can be interpreted as masculine traits.

Fürst Hörte (2009) discerns two levels of gender aspects in innovation policy: gendered structures in innovation policy programs and gendered structures within the innovation networks being promoted by such programs. Pettersson (2007) clarifies that gendered divisions in innovation policies are seldom elaborated in national policy programs. Pettersson and Saarinen (2005) state the same for the innovation networks being promoted by such programs. In order to address both these levels, a double strategy has been suggested, promoting gender mainstreaming in already prioritized innovation networks at the same time as promoting innovation networks within industries employing most women (Fürst Hörte 2009; Lindberg 2010; Danilda and Granat Thorslund 2011). Within innovation networks, nonnormative thinking might strengthen weak links innovation milieus by allowing them to reach beyond gendered stereotypes. Normative thinking is thus regarded as an obstacle to innovative thinking, since gender diversity is claimed to improve creativity and decision making (Andersson et al. 2009; Ghaye and Gunnarsson 2009; Danilda and Granat Thorslund 2011).

Within innovation policy programs, the importance of broadening the spectrum of actors, areas, and innovations being prioritized has been emphasized (Rees 2000; Blake and Hanson 2005; Pettersson 2007; Lindberg 2010). This suggestion is motivated by a survey of prioritization within innovation policies and regional growth policies of different innovation networks in Sweden 2002–2010 (Lindberg 2011). The results exposed that in 80% of the cases, manufacturing industries and new technologies (e.g., ICT, biotech, fiber optics) industries were prioritized, both of them representing men-dominated industries. In a fifth of the cases, services and creative industries were prioritized, representing industries employing most women. This pattern of prioritization creates a segregation and hierarchy between men and women in relation to innovation since these two groups are being unequally involved in policy programs promoting innovation due to a difference in the estimation of their importance for innovation.

Broadening the spectrum of actors, areas, and innovations being prioritized in innovation policies to a less gender segregating pattern would mean to include services and creative industries to a greater extent than today. This would increase the inclusion of women in innovation policies and ascribe women and men equal importance for innovation, thus making the segregation and hierarchy between these two groups less distinct (Pettersson 2007; Lindberg 2010). An increased emphasis upon services and creative industries in innovation policies is in line with predominant policy efforts to transform Western societies and economies to become more knowledge-based (cf. Rees 2000). Pioneering research studies expose, however, that these industries entail a complicated reconciliation of working time and free time (Papouschek et al. 2006; Schiffbänker 2008). People in these industries suffer from long working hours, work extending to evenings and weekends, difficulties with planning ahead, dependency on commissioners, and economical risks. This means that the diminishing gender segregation and hierarchy attained by including services and creative industries in innovation policies might be counterpoised by the poor working conditions in these industries, making it hard to maintain a bearable work-life balance. It is thereby not guaranteed that “broadly framed networks [. . .] necessarily produce responsible innovation” (Gustavsen 2011, p. 5).

In order to challenge and change prevalent gendered structures in innovation policies and practices, suggested measures have to be able to reach beyond the distinction between “men” and “women” and provide the grounds for an equal estimation of different groups of industries, irrespective of their gender distribution (Lindberg 2010, 2011). Gender mainstreaming in innovation policies and practices requires a transformed perspective on economic development and innovation and increased reflection on which actors are seen as assets and what sectors of the economy are seen as “strong” or useful in innovation policies and innovation networks (Pettersson 2007). Such a transformed perspective harmonizes with Rees’ (2005) definition of gender mainstreaming, stating that a gender perspective is to be integrated into ways of seeing and doing, into systems and structures, into all policies, processes and procedures, and into the organization and its culture. It is also supported by Schiebinger’s (2008, p. 4) definition of gendered innovations as “transformations in the personnel, cultures, and content of science and engineering brought about by efforts to remove gender bias from these fields.” Such transformations seem to be supported by the overall trend in innovation theory and practice, pinpointed by Ranga and Etzkowitz (2010, p. 3):

> Innovation theory and practice is in the midst of a shift in focus from product and process innovation, primarily in the private sector, to innovation in services that are located in the public as well as the private sector. This transition has profound consequences for the visibility of the gender dimension in innovation.

Synthesizing Gender and Innovation

This section synthesizes the review of existing research on gender and innovation using the two theoretical concepts of doing gender and gender mainstreaming.

The ongoing construction of gender, pinpointed by the concept of doing gender, is detectable in innovation policies, processes, and networks (cf. West and Zimmermann 1987; Gunnarsson et al. 2003). In the promotion and practices of innovation policies and networks, gender is done when certain actors, sectors, and innovations are distinguished in a manner that is congruent with the sex-segregated labor market, thus reinforcing the gendered pattern of keeping women and men apart. On the symbolical level, gender is done when differing value is ascribed to the distinguished actors and sectors in relation to innovation and economic growth, thus reinforcing hierarchical gender relations (cf. Blake and Hanson 2005; Pettersson 2007; Lindberg 2010).

Efforts to integrate gender in innovation policies, processes, and networks are reflected in the concept of gender mainstreaming (cf. Rees 2005; Squires 2005; Walby 2005). One of the mainstreaming strategies – integrationism – is visible in the attempts to relate gender and innovation by assuming that there is a potential for gender equality to contribute to increased economic growth. As a strategy of integrationism, this kind of relation does not challenge existing policy paradigms and thus has limited likeliness to change masculine norms in innovation policies and practices. However, its coherence with all-embracing policy goals, such as economic growth, increases its likeliness to be accepted by policy makers and brought into the policy agenda (cf. Walby 2005). Similarly, the attempts to relate gender and innovation by securing equal access for women and men to apply for funding of innovation networks and innovation processes – thus using the strategy of inclusion – are more likely to be integrated in the policy agenda since they "only" demand formalized rights to gender equal influence and benefit from regional policy programs and projects. They do not promote a gender perspective on the goals of innovation policies, nor do they challenge the segregating notions of "women" and "men" as unified – but separate – groups (cf. Squires 2005).

In contrast, the attempts to relate gender and innovation by highlighting the contribution made by women in services and creative industries – thus using the strategies of agenda setting and reversal – do challenge existing policy paradigms by reorienting existing policy goals, for example, by highlighting alternative ways to achieve innovation and societal development. They thus challenge masculine norms in innovation policies and practices. At the same time, they lower their likeliness to be accepted on the policy agenda. They recognize the importance of including a multitude of experiences and perspectives in policies, processes, and networks of innovation. But they also tend to reinforce those very dualistic notions of gender that constitute the base of segregating and hierarchical gender orders. The attempts to relate gender and innovation by questioning the differing estimation of women and men – and of services and manufacturing industries – in relation to innovation reflect the strategy of displacement. Such attempts assume that there are so many individual variations within each of these categories that it is more fruitful to analyze how gender is "done" in each situation where women and men are ascribed different attributes, competences, and interests, thus limiting people's prospects to contribute to creativity and innovation (cf. Squires 2005; Walby 2005).

In relation to the classifications of gender mainstreaming, the doing gender approach seems to share more features with the strategy of agenda setting than the strategy of integrationism (cf. Walby 2005). This is since the first-mentioned strategy tends to bridge dualistic gender constructions and challenge their static appearance in a way that accords with the understanding of gender as continuously constructed as advocated in doing gender. Those links between gender and innovation that embrace the strategy of integrationism are hence more likely to challenge and change prevailing gendered norms in policies, processes, and networks of innovation. The deconstructive stance of the strategy of displacement is similar to the understanding of gender as continuously constructed and thus possible to change, as proclaimed in the doing gender approach (cf. Squires 2005). The links between gender and innovation that cohere with this strategy are thus more likely to evoke less segregating and hierarchical gender relations in innovation policies, processes, and networks than the ones accepting the dominant gendered norms of innovation. As Squires emphasizes, however, are the different strategies of gender mainstreaming not to be regarded as mutually exclusive. Instead, they are most likely to be truly transformative when implemented side by side.

Conclusion and Future Directions

The review of prevalent research on gender research and innovation reveals four explanations of the relevance of gendered structures on innovation policies, processes, and networks. These four explanations are the following:

- The potential for gender equality to contribute to innovation and growth
- Differing estimation of women and men – and of services and manufacturing industries – in relation to innovation
- The contribution to innovation by services and creative industries
- Unequal access to funding of innovation networks and innovation processes

Each of these explanations relies on specific strategies of gender mainstreaming, evoking different kinds of changes in gendered structures of innovation policies, processes, and networks. The main conclusion to be drawn is that their understanding of gender as continuously constructed varies as well as their potential to challenge masculine norms – differences that might be overcome in policy and practice by combining available strategies. It still remains to be scrutinized, though, to what extent each of the four explanations actually manages to change segregating and hierarchical notions of gender in practice. This calls for further empirical studies of innovation policies, processes, and networks, tracking the long-term effects of gender equality interventions. It also remains to be scrutinized whether recently established policies, processes, and networks promoting innovation in services and creative industries are more capable of changing segregating and hierarchical notions of gender than those focusing manufacturing and hi-tech industries.

Cross-References

- ▶ Clusters
- ▶ Creative Knowledge Environments
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Democratic Innovation
- ▶ Female Entrepreneurship
- ▶ Healthcare and Innovation
- ▶ Innovation and Entrepreneurship
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Network and Entrepreneurship
- ▶ Quadruple Helix
- ▶ Social Innovation
- ▶ Triple Helics

References

Andersson S, Amundsotter E, Svensson M, Däldehög A-S. Middle managers as change agents – action oriented gender research. Hudiksvall: Fiber Optic Valley; 2009.

Blake MK, Hanson S. Rethinking innovation: context and gender. Environ Plan A. 2005;37:681–701.

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a transdisciplinary analysis of sustainable development and social ecology. Int J Soc Ecol Sustain Dev. 2010;1(1):41–69.

Danilda I, Granat Thorslund J, editors. Innovation and gender. Stockholm: Vinnova; 2011. VI 2011:03.

Ekman M, Gustavsen B, Asheim BT, Pålshaugen O, editors. Learning regional innovation – Scandinavian models. Houndmills, Basingstoke: Palgrave Macmillan; 2011.

Foss L, Henry C. Gender and innovation: exploring the hegemonic voice. Paper presented at the conference gender, work and organisation in Keele, UK, 21–23 June 2010

Fürst Hörte G. Behovet av genusperspektiv – om innovation, hållbar tillväxt och jämställdhet: utvärdering (The need for a gender perspective – on innovation, sustainable growth and gender equality). Stockholm: Vinnova; 2009. VR 2009:16.

Ghaye T, Gunnarsson E. Creating cultures of appreciation: organisational innovation through employee well-being. In: Döös M, Wilhelmson L, editors. Organising work for innovation and growth. Stockholm: Vinnova; 2009.

Gunnarsson E, Andersson S, Vänja Rosell A, Lehto A, Salminen-Karlsson M, editors. Where have all the structures gone? Doing gender in organisations,

examples from Finland, Norway and Sweden. Stockholm: Stockholm University; 2003.
Gustavsen B. Innovation, participation and ‘constructivist society’. In: Ekman M, Gustavsen B, Asheim BT, Pålshaugen O, editors. Learning regional innovation – scandinavian models. Houndmills, Basingstoke: Palgrave Macmillan; 2011.
Hacker S. Pleasure, power and technology. London: Unwin Hyman; 1989.
Hirdman Y. The gender system. Theoretical reflections on the social subordination of women. English series. Report no. 40 (1990)
Kvande E. Doing gender in organisations – theoretical possibilities and limitations. In: Gunnarsson E et al., editors. Where have all the structures gone? Doing gender in organisations, examples from Finland, Norway and Sweden. Stockholm: Stockholm University; 2003.
Kvidal T, Ljunggren E. Implementing’a gender perspective’ in an innovation program: more innovation or ambivalence and uncertainty?. Paper presented at the conference gender, work and organisation in Keele, UK, 21–23 June 2010.
Lindberg M. Genusgränser i Sveriges innovationspolitik – en fråga om prioritering (Gender borders in Sweden’s innovation policy – a matter of priority). In: Freidenvall L, Rönnbäck J, editors. Bortom Rösträtten (beyond universal suffrage). Södertörn: Södertörns högskola; 2011.
Lindberg M. Samverkansnätverk för innovation – en interaktiv och genusvetenskaplig utmaning av innovationspolitik och innovationsforskning (Joint action for innovation – a participative and gender scientific challenge of innovation policy and innovation research). Doctoral thesis. Luleå: Luleå University of Technology; 2010
Lindberg M, Danilda I, Torstensson BM. Women Resource Centres – creative knowledge environments of quadruple helix. J Knowl Econ. 2012;3(1):36–52.
Nählinder J. Innovation and employment in services: the case of knowledge intensive business services in Sweden. Doctoral thesis. Linköping: Linköping University, 2005.
Nählinder J. Where are all the female innovators? Nurses as innovators in a public sector innovation project. J Technol Manag Innov. 2010;5(1):13–29.
Nyberg A-C. Making ideas matter – gender, technology and women’s invention. Doctoral thesis. Luleå: Luleå University of Technology, 2009
Papouschek U, Schiffbänker H, Reidl S. Zur Gestaltung des Verhältnisses von Erwerbsarbeit und Privatleben in den Creative Industries. Oesterreichische Zeitschrift für Soziologie. 2006;4:80–93.
Pettersson K. Men and male as the norm? A gender perspective on innovation policies in Denmark, Finland and Sweden. Stockholm: Nordregio; 2007.
Pettersson K, Saarinen Y. Entreprenörer, motorer och andra hjältar – manlig norm i svensk klusterpolitik (Entrepreneurs, motors and other heroes – male norm in Swedish cluster policy). Nordisk Samhällsgeografisk Tidskrift. 2005;(39):44–68.
Ranga M, Etzkowitz H. Athena in the world of techne: the gender dimension of technology, innovation and entrepreneurship. J Technol Manag Innov. 2010;5(1):1–12.
Rees T. The learning region? Integrating gender equality into regional economic development. Policy Politics. 2000;28(2):179–91.
Rees T. Reflections on the uneven development of gender mainstreaming in Europe. Int Fem J Politics. 2005;7(4):555–74.
Schiebinger L, editor. Gendered innovations in science and engineering. Stanford: Stanford University Press; 2008.
Schiebinger L, Schraudner M. Interdisciplinary approaches to achieving gendered innovations in science, medicine, and engineering. Interdiscip Sci Rev. 2011;36(2): 154–67.
Schiffbänker H. Karrieren in der industriellen Forschung: zwischen subjektiven Orientierungen und institutionellen Barrieren (Careers in industrial research: between subjective orientations and institutional barriers), Doctoral thesis. Vienna 2011.
Schiffbänker H. Kreative Karrieren: (Fast) alles ist möglich, nix ist fix. In: Eichmann H, Schiffbänker H, editors. Nachhaltige Arbeit in der Wiener Kreativwirtschaft. Vienna: LIT 2008. p. 95–116.
Schraudner M. Gender and innovation: Fraunhofer’s “discover gender” research findings. In: Spitzley A, Ohlhausen P, Spath D, editors. The innovation potential of diversity – practical examples for the innovation management. Karlsruhe: Fraunhofer-Institut für System- und Innovationsforschung ISI; 2010. p. 169–82.
Squires J. Is mainstreaming transformative? Theorizing mainstream in the context of diversity and deliberation. Soc Politics. 2005;12(3):366–88.
True J, Mintrom M. Transnational networks and policy diffusion: the case of gender mainstreaming. Int Stud Q. 2001;45(1):27–57.
Walby S. Gender mainstreaming: productive tensions in theory and practice. Soc Politics. 2005;12(3):321–43.
West C, Zimmermann DH. Doing gender. Gend Soc. 1987;1:125–51.
Wetterer A. Ausschließende Einschließung – marginalisierende Integration. Geschlechterkonstruktionen in Professionalisierungsprozessen. In: Neusel A, Wetterer A, editors. Vielfältige Verschiedenheiten. Geschlechterverhältnisse in Studium, Hochschule und Beruf. New York: Frankfurt a. M.; 1999. p. 223–53.

Generative Algorithms

► State Space Paradox of Computational Research in Creativity

Genius

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Synonyms

Brilliance; Superachiever; Superior creative power; Superior intellectual power

Definition

A genius is a person top-valued by the society for the uniquely expressed highly innovative vision of the world.

Introduction

A popular online encyclopedia directly states at the beginning of the article on genius, "There is no scientifically precise definition of genius, and indeed the question of whether the notion itself has any real meaning is a subject of current debate" (Genius, Wikipedia, retrieved Dec. 23, 2011).

The mission of this article is to prove the opposite: to provide a scientific definition of genius and to prove that the phenomenon of genius exists and is worth researching.

The issue of genius is extremely complex. It involves biological, psychological, and social aspects of human beings whose achievements are considered to be extraordinary. Since the phenomenon of genius falls under the jurisdiction of many sciences, the approaches differ dramatically, the opinions on the issue are contradictory, and the myths are abundant. The fact that may strike an independent observer most is that there is no special science studying genius.

This situation may be called the genius paradox. Geniuses like Aristotle, Giordano Bruno, Galileo, Copernicus, Isaac Newton, Louis Pasteur, Albert Einstein, and Madam Curie created the scientific basis for modern civilization. Many of them are credited with establishing new sciences: Euclid – Geometry, Claude Bernard – physiology, N. Zhukovsky – aerodynamics, and Gregor Mendel – genetics (with the theory of inherited features). As a top achievement, Hermann von Helmholtz is sometimes called the "father of three sciences." However, those who made all those scientific discoveries and created all sciences have not been studied scientifically. It looks like a proverbial situation "shoemaker without the shoes" reached the level of genius because geniuses that created all sciences have not created the science of genius itself. Therefore, to resolve the genius paradox, geniusology, a science of genius, was offered. Geniusology was first mentioned at the Teachers' Conference in Singapore in 2003 and first published in 2004 (Aleinikov 2004). Some elements of geniusology, like the new definition of genius, megacreativity, and genius classification, appeared earlier (Aleinikov 2002a, b).

Traditional and Modern Views on Genius

There are thousands of books and articles on intelligence and creativity as well as hundreds of definitions of genius. Since the most popular definitions call genius "a super intellectual power" or "extraordinary creative power," many researchers study psychosocial background, developmental, cognitive, educational, and other aspects of a genius to figure out how a person may have achieved the top level of creativity or intelligence.

Meanwhile, the term "genius" became very popular and overused. For example, after the introduction and popularization of IQ tests, some applied the term "genius" to those who scored high on the tests. However, Dr. Abbie F. Salny, supervisory psychologist, American Mensa, clarified the confusion by answering the question, "Are there really any true geniuses?":

> Genius may be in the eye of the beholder. Furthermore, a true genius may not score particularly well on a standard group IQ test. We know a Nobel Prize winner who never scored at Mensa level on a school IQ test… And really, those who are

what we may call a genius don't need a score to prove it. (Salny 2009, Retrieved from http://permianbasin.us.mensa.org/resources/questionofgenius.html Dec.23, 2011)

In reality, the IQ tests show that individuals who score high have wide knowledge and are able to solve intellectual puzzles (problems). However, it is only the real life that can show how impressive their achievements would be in order to be considered geniuses.

The same may be stated about the Torrance Tests of Creative Thinking (Torrance 1974). They measure creative abilities (some score lower, some higher), but whether these abilities will be used to get the top achievements to be recognized as geniuses is up to the person and society he or she lives in.

Another example of the term "genius" being extremely popular and attractive is the creation of the MacArthur Fellowship, nicknamed "genius award." It is given by the John D. and Catherine T. MacArthur Foundation each year to 20–40 Americans showing "exceptional merit and promise for continued and enhanced creative work." This award actually is a genius way to support potential geniuses, who, as Oscar Wilde states, "are born, not paid," and whose work is often "nothing for use or profit" (Schopenhauer).

Traditionally, the phenomenon of genius is defined through:

- Hard work – "Genius is one percent inspiration and ninety-nine percent perspiration" (T. Edison). H.W. Austin echoes Edison by saying, "Genius, the power which dazzles human eyes, is oft but perseverance in disguise."
- Intellect – Genius is a superior intellectual power, and people with a high IQ are geniuses (as in Stillson 1998).
- Creativity – Genius is a superior creative power (Gelb 1998; Michalko 1998; Simonton 1999; Sobel 1996; Thorpe 2000).
- Some dominant feature (imagination or sensitivity) – "The source of genius is imagination alone, the refinement of the senses that sees what others do not see, or sees them differently" (Eugène Delacroix).
- Some unusual ability – "Genius is an ability to see through to the essential" (unknown author). "To see things in the seed – that is genius" (Lao-tzu).
- Power of talent – "Talents are buffaloes, and the most powerful of them are geniuses" (Jules Renard).
- Originality – "The principal mark of a genius is not perfection but originality, the opening of new frontiers" (Arthur Koestler).
- Error, mistake, and incident – "It [genius] is personality with a penny's worth of talent. Error which chances to rise above the commonplace" (Pablo Picasso).
- Madness or mental disease – Mad genius controversy (Durrenberger 1999).

Many of the studies of genius are individual-centered, while in reality, the concept of genius is both social and individual in nature. A simple mental experiment makes it obvious. Even in the case of the most well-known definition stating that genius is extraordinary intellectual power, there is no such thing as an extraordinary intellectual power individual who grows up in isolation and lives alone somewhere on a desert island. In such a hypothetical case, first of all, there would be no learning from the society, no language, and no societal problems to solve; second, there is no comparison against the other minds in the field for measuring social achievements; and third, there is no social recognition... and consequently there is no genius. From this point of view, genius is a social status (name, concept) *given* by the grateful society as an "award" to some individuals with outstanding contributions to humanity.

In some works on genius, authors choose to take one fate, one individual, and research one life while trying to reveal the genius behind (Gleick 1993; Seifer 1998). Then there are those who compare a few geniuses in hope to deduce a list of common features (Gardner 1993) and those who research larger groups (Bloom 2002). Many authors attribute genius to a divine intervention (see William Crashaw's idea in the list of quotes below). Some try Darwinian (scientific) approach to creativity and genius (Simonton 1999).

The path to establishing a new science repeats itself in many domains. As in many other fields, literature comes first. Numerous literary biographies of geniuses provide metaphoric, poetic, and picturesque descriptions that depict the sociocultural background of the phenomenon. Then some well-established branches of science research separate aspects of genius that form a kind of a transition from mythology to science with its precise terms, abstract notions, and repeatable and testable objective data. Finally, the need for generalizing the research data on genius becomes obvious, and consequently, there appears a separate science with a multidisciplinary approach to coordinate and organize these findings. This science, geniusology, has its own objective and its own research methodologies to discover the regularities and laws of genius development.

In the history of science, when a new science appears, it unites the efforts of an individual researcher and research groups which contribute to a common goal – an adequate reflection of the phenomenon.

To follow this path of the development, it would be correct to start with mythology.

Myths of Genius

The issue of genius is surrounded by a number of myths that feed public imagination. Some of the most popular myths are summarized below:

Geniuses Are Born

When people say that geniuses are born, not made, they mean that the main contributor to genius is genetics. Inherited features do matter, but without proper upbringing and education, even the best genetic material is doomed. "Genius without education is like silver in the mine" (Benjamin Franklin). On the other hand, even the best training and education would not make a genetic imbecile a genius. The approach is not "nature or nurture," as some people tend to state it, but "nature and nurture." Only a combination of both produces proper results.

Genius Must Be Visible in Childhood

This myth comes from the confusion of prodigy and genius. It is prodigy that is visible in childhood. Only 5 % of prodigies show up on the genius level – the others burn out and end up in oblivion. On the other hand, many of the recognized geniuses were considered dumb in childhood. Einstein, for example, who was a dyslexic, began to speak at about three and needed tutoring in school. Another example, little Pablo Picasso survived elementary school only by having his father sit in the classroom (to protect him from ridicule).

Genius Is Talented in Everything (Gifted)

The idea that geniuses are well rounded and talented in everything is very popular. Otto Weininger calls it "universality" (see quotes below). This myth is only partially true. There are geniuses in history, like Leonardo da Vinci, Johann Wolfgang von Goethe, and Mikhail Lomonosov, who were talented in everything; however, there were also hundreds of recognized geniuses who were not that gifted but exhibited brilliance only in one field.

Genius Is Accidental

This point of view is supported by serendipity – the science of accidental discoveries. The discovery of x-rays by Röntgen is one of the classical examples. History states he "accidentally" noticed some shimmering lights in the darkness of the room when an electrical discharge was passed through the cathode tubes blocked by cardboard that should prevent light from escaping. He called the unknown rays "x-rays." Another famous example of "serendipity" is Henri Becquerel's discovery of radioactivity. There was no sunshine needed for his experiments for several days; so he put the uranium compound crystals away to the drawer on the photo paper. Then "accidentally" or in impatience he developed films and found white spot in the form of the crystal on the film. He correctly concluded that uranium compound crystal even without being exposed to sunlight emits some rays that penetrate the light resistant paper. This is how radioactivity has been discovered. These discoveries may seem accidental, but both Röntgen and Becquerel were researchers, and had complex equipment in their labs, and experimented with cathode tubes and uranium ore... If not them, then earlier or later somebody else would have had such an "accident."

Geniuses Are Mad

The myth about geniuses being mad is supported by literature and movie industry. For instance, the movie *A Beautiful Mind* dramatized the genius/madness relationship of the Nobel Laureate John Nash. Some people state it less offensively: a genius and an insane person are two points of a cut-and-open circle. Some authors show that highly creative people have a larger chance of being mentally ill. Others disagree. Genius, however, is more visible and attractive to media, while thousands and millions of mentally ill people stay in mental clinics, kept away from the public and publicity. In any case, the issue is so attractive that the first in the world *Encyclopedia of Creativity* – an outstanding collection of research in itself – does not have an article on genius but offers an article on genius/madness controversy (Durrenberger 1999).

On the other hand, since genius is always far ahead of the society he or she lives in, the society is often merciless and does a lot to make this genius seem mad (see the citation by Jonathan Swift, Oliver Wendell Holmes, and Heinrich Heine below). Moreover, some societies are mad. Take, for example, the Nazi Germany from where Einstein and other scientists had to run away. The answer to the question, "Who is crazier?": Einstein poking his tongue out (very popular photo) or the society that burns books in the streets and Jews in the concentration camps, is obvious.

Modern Views on Genius (Highlights)

Media Approach

Contemporary media is glorifying genius on the one hand and making fun of it on the other, but the fact is – media is attracted to genius. Some popular magazines dedicate entire issues to genius. There are articles, books, and Web sites on genius. The issue of genius continues to attract the public. The case of Grigory Perelman, who solved the Poincaré conjecture, was named "a mathematical genius" but refused to receive the Fields Medal and $1,000,000 prize, is but one of the recent examples.

Genius Quotes

Some quotes about genius (retrieved from http://www.theabsolute.net/minefield/genqtpg.html) to reflect the common knowledge include:

- Geniuses are like thunderstorms. They go against the wind, terrify people, cleanse the air. (Kierkegaard)
- A genius is one who can do anything except make a living. (Joey Adams)
- Genius is born, not paid. (Oscar Wilde)
- Genius is not so much about new ideas as it is about clarity of ideas. Two people can have the same idea yet it will be genius in the one and mediocrity in the other. (Kevin Solway)
- Genius is the ability to act rightly without precedent – the power to do the right thing the first time. (Elbert Hubbard)
- Intellectuals solve problems; geniuses prevent them. (Albert Einstein)
- Philosophy becomes poetry and science imagination, in the enthusiasm of genius. (Disraeli)
- Neither a lofty degree of intelligence nor imagination nor both together go to the making of genius. Love, love, love, that is the soul of genius. (Wolfgang A. Mozart)
- The first and last thing required of genius is the love of truth. (Johann Wolfgang Von Goethe)
- Genius does what it must, and Talent does what it can. (Owen Meredith Earl of Lytton)
- Andy Warhol is the only genius with an IQ of 60. (Gore Vidal)
- Oh! how near are genius and madness! Men imprison them and chain them, or raise statues to them. (Denis Diderot)
- Genius. . .is the capacity to see ten things where the ordinary man sees one. (Ezra Pound)
- The principal mark of a genius is not perfection but originality, the opening of new frontiers. (Arthur Koestler)
- When a true genius appears in this world, you may know him by this sign that the dunces are all in confederacy against him. (Jonathan Swift)
- Thousands of geniuses live and die undiscovered – either by themselves or by others. (Mark Twain)
- The world is always ready to receive talent with open arms. Very often it does not know what to do with genius. (Oliver Wendell Holmes)

- Genius is the ability to reduce the complicated to the simple. (C. W. Ceran)
- Genius without education is like silver in the mine. (Benjamin Franklin)
- Everyone is a genius at least once a year; a real genius has his original ideas closer together. (G. C. Lichtenberg)
- When human power becomes so great and original that we can account for it only as a kind of divine imagination, we call it genius. (William Crashaw)
- Everyone is born with genius, but most people only keep it a few minutes. (Edgard Varese)
- Every man is a potential genius until he does something. (Sir Herbert Beerbohm)
- Universality is the distinguishing mark of genius. There is no such thing as a special genius, a genius for mathematics, or for music, or even for chess, but only a universal genius. The genius is a man who knows everything without having learned it. (Otto Weininger)
- Society is a republic. When an individual endeavors to lift himself above his fellows, he is dragged down by the mass, either by means of ridicule or of calumny. No one shall be more virtuous or more intellectually gifted than others. Whoever, by the irresistible force of genius, rises above the common herd is certain to be ostracized by society, which will pursue him with such merciless derision and detraction that at last he will be compelled to retreat into the solitude of his thoughts. (Heinrich Heine)
- It is the genius in reality and not the other who is the creator of history, for it is only the genius who is outside and unconditioned by history. The great man has a history, the emperor is only a part of history. The great man transcends time; time creates and time destroys the emperor. (Otto Weininger)
- Genius is its own reward; . . .The work of genius may be music, philosophy, painting, or poetry; it is nothing for use or profit. To be useless and unprofitable is one of the characteristics of genius; it is their patent of nobility. (Schopenhauer)

In the research on genius, a genius should be clearly differentiated from:

- A hero (one time act – usually a bravery act, often known to one country, like war or revolution heroes, but sometimes to the whole world, like Yury Gagarin – the first cosmonaut, astronaut)
- A celebrity (known to the people of the same generation but may be forgotten as time passes and culture forges ahead)
- A talent (bright, sparkling individuality, easy to learn, easy to produce but lacking originality, persistence, or dedication for high-level innovation)
- A national leader (political figures – well known to the public but just in line with other leaders. And leaders come and go. . .)

Genius is none of these with the exception of very innovative political leaders whose achievements are extremely valued by the society, like Peter the Great. Often, a genius may be unknown during one's lifetime but will be known in centuries to follow. Geniuses stay forever; see the profound thought of Otto Weininger in the quotes, "The great man transcends time; time creates and time destroys the emperor."

Origins and History of the Concept Development

Historically, the word *genius* can be traced back to Latin. In ancient Rome, a genius was understood as a deity or spirit that watches over each person from birth. At that time, it was customary to glorify the genius of the emperor, the genius of commanders, as well as on the lower level, to propitiate the spirits, like the genius of the location, house, and even gates for protection. This genius spirit was associated with wit, talent, some prophetic skills, and even generative powers. Etymologically, the Latin word *genius* came from the root *gignere* – beget, produce. The common root *gen* – produce – is now seen in the words *gen*eration, *gen*esis, *gen*etics, etc. The first usage of the word *genius* in the contemporary meaning "person of natural intelligence or talent" is recorded in the seventeenth century. The path of the meaning change from god-genius to human-genius resembles the path the word *creator* and its derivatives went through (see the definition entry on "▶ Creativity" in this Encyclopedia).

Research of Genius

Modern research on genius ranges from measuring the weight of Einstein's brain (after he died in 1955) to psychological research on genius/madness connection (see, e.g., http://www.scienceagogo.com/news/20020422222106data_trunc_sys.shtml Dec. 22, 2011).

Dean Keith Simonton, for example, developed the chance-configuration theory to analyze the scientific genius by using characteristics such as exceptional productivity, lifestyle, motivation, age and achievements, family background, education, and role models. Convinced that creativity can be understood best as a Darwinian process of variation and selection, he also made it clear that genius belongs to the level of metasciences, like philosophy, sociology, and psychology of science (Simonton 1999).

The research on genius, however, is contradictory, and some researchers openly express their frustration with the situation:

> After hours of research, days of discussion, interviews of few and surveys of many, our attempts at discovering the exact definition and cause of "genius" have been almost futile. There are no two sources that will give the same definition of genius, and in talking to several experts in the field of psychology, nobody could come to a consensus on what made a genius a genius (Arielle Olicker at http://www.sciencenet.emory.edu/mismeasure/genius/conclusion.html).

Similar to the research situation with the definition of creativity (Aleinikov 2000), there are four ways to deal with this multiplicity:

- To select one definition.
- To accept multiplicity.
- To consider all of the definitions, including the future ones, as being a reflection on the complexity of the phenomenon.
- To offer a universal (scientific) definition that would simplify the issue to its essence.

"Genius is the ability to reduce the complicated to the simple. (C. W. Ceran). "Genius is the ability to see through to the essential" (unknown author).

Many researchers choose the first option and use the selected definition as a working definition. Dr. E. Paul Torrance, "the creativity man," preferred the second option. While commenting on the situation with thousands of creativity definitions described in the book *MegaCreator: From Creativity to Mega-, Giga-, and InfiCreativity* (Aleinikov 1999b), he said, "Definitions will continue endlessly, but people will learn not to be disturbed by it and continue finding out more about creativity" (Torrance 2002).

Geniusology, the science of genius, employs the last two options on the list. First of all, it accepts all available definitions as a prescientific stage of studying a genius, and second, it offers a scientific definition.

Scientific View on Genius: Geniusology – The Science of Genius

Geniusology, a new science of genius, was first mentioned in 2003 (in Singapore) and then officially published in the USA in 2004 (Aleinikov 2004).

The results of research in science are represented by classifications. Objects and processes fall into some well-defined and logically differentiated categories. Classifications make reality much simpler. For example, the periodic table of elements (Mendeleev) introduced order into the large number of chemical substances. The genius idea that allowed Mendeleev to create such a classification was to use the atomic weight of chemical elements for this purpose.

First of all, the science of genius can employ the classifications of geniuses available in literature and in reality. Then geniusology can create an ideal (deductive logic) classification that includes all available and yet undiscovered types of geniuses, that is, a matrix with possible fill-ins.

Real-life classifications (prescientific) are often a conglomerate of empirical observations and theoretical explanations. Traditionally, they form a necessary foundation for large-scale generalizations. Below are all available classifications:

Since geniuses are human, and humans have to work for a living, the most obvious category of classification can start with the occupation:

- Science genius (like Isaac Newton and Albert Einstein)
- Technology genius (like Thomas Edison)
- Composing genius (like Wolfgang Amadeus Mozart and Ludwig van Beethoven)
- Medical genius (like Hippocrates)
- Teaching genius (like Maria Montessori)
- Business genius (like Henry Ford and Bill Gates)
- Military genius (like Alexander the Great)
- Organizational genius (like Napoleon: contrary to the popular opinion, he was not a military genius – he lost a number of wars and battles, but when defeated, he could come back to Paris and organize another army for another campaign within months)
- Artistic genius (like Pablo Picasso, Vincent van Gogh, etc.)
- Performing genius (like Charlie Chaplin, Nicolo Paganini, etc.)

This classification is naturally unlimited – new professions or fields appear and will arise. Athletes may say, "Why is there no athletic genius (like Hercules, Mohamed Ali, Michael Jordan, and Pele)?" Cooks may say, "Why not a cooking genius?" By the way, it was Abraham Maslow who said that a first-rate soup is more creative than a second-rate painting.

The next classification category is the degree of propagation of self-expression:

- Sleeping genius (never awake, passive, not applied) versus active
- Hidden genius (actively creating, but never seen, like Copernicus who allowed to publish his work only after his death) versus open
- Open genius (discovered, often suffering, like Galileo)
- Accidental genius (serendipity genius) – onetime event, momentous genius, like Joseph Rouget de Lisle, the composer of the Marseillaise (French national anthem), who, according to Stephan Zweig, never meant it to be an anthem and was even fighting against his song usage. . .but later buried near Napoleon
- True genius (longtime performing genius, like Mozart, Beethoven, Titian)

Finally, the next obvious category of classification is the degree of recognition:

- Unrecognized genius (0, zero recognition) like in the case of Gregor Mendel for 50 years before he was discovered and many others who have NOT been discovered yet.
- Recognized genius (from 1 to about 1,000,000) – already called a genius but still in the stage of recognition. Sometimes, the Nobel Prize winners make their top discoveries in young age but get the prize recognition for their contribution much, much later.
- Megarecognized (true) genius (over a million of citations, mentioning the name in prolonged time (centuries) and space (over the country borders)).

These empirical classifications of genius lead to a theoretically sound scientific classification of geniuses. One of them is built on the scientific model of genius in general (universal four-sided model of language, language awareness, speech, and heuristic act). Another one is based on the matrix of physical reality offered by Bartini and the scientific discoveries called the laws of conservation (Aleinikov 2005).

Scientific Model and Definition of Genius

Genius, in the traditional understanding (in the majority of cases, as it was mentioned above), is the peak of intellectual achievement or creative expression in some field (medium) for which the person is "awarded" this title by society.

In all definitions above, there is one element missing: the reflection system, the language, or the sign. The thing is that the achievement of a genius should be expressed in some semiotic system – the system of signs – and then published, exhibited, and publicized. Whether it is a formula, a theory, a discovery, a melody, a painting, a sculpture, or a pedagogical approach, it must be expressed in a system of signs. With this element added, the genius situation becomes a particular case in the universal state of order depicted by the universal model of sign, language, language awareness, speech, and heuristic act, first developed for creative linguistics (see "▶ Creative Linguistics" and Aleinikov 1988). This is a four-sided model in three dimensions. When a symbolic system is added to the equation, it allows people to visualize the genius activity of producing *newness* and transferring this *newness* to the society (see "▶ Novology" in this Encyclopedia).

Here is how the universal model of sign, language, speech act, and heuristic act looks:

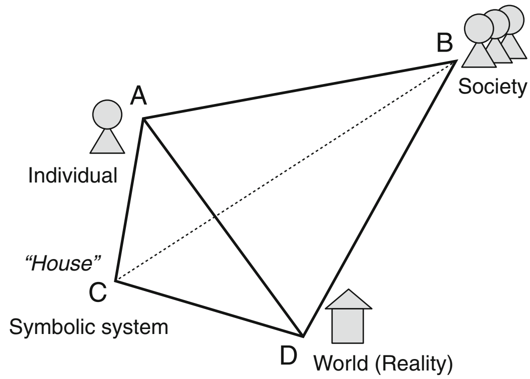
In general, as Fig. 1 shows, an individual (A) is the person who creates a vision of the world (D), expresses it in symbols of the system (C), and sends it to the society (B). Society is understood as any person, or persons, speaking the same language or using the same semiotic system. The message (AB) is received by the society (B), evaluated, and appreciated or not appreciated. The size and the depth of the message can be easily reflected by the size and the depth of the model. That is why some messages would be ordinary (low creative) and quickly forgotten, while the others – deep and original (highly creative) – would be remembered (= valued) for centuries.

In the particular case of a genius, the message (AB) is so uniquely expressed in a symbolic system (C) and reflects such a highly innovative vision of the world (D) that it is top-valued by the society (B) – that is why this individual (A) is named a genius.

Therefore, the model of genius must include four absolutely necessary elements – elements that are generic (universal for all):

- Individual (to learn, to comprehend social problems, to act)
- Society (to teach individual first and to evaluate the contributions later)
- Symbolic system (to express the vision – language, mathematics language, visual arts language, musical language, etc.)
- World (to be reflected by individual)

In addition to the universal (generic) elements of the situation, the description of a genius includes some more elements that characterize individuals that are specifically genius and not referring to all people. These specific elements



Genius, Fig. 1 Universal model of sign, language, language awareness, speech, and heuristic act

are "top-valued" by the society, "uniquely expressed," and of "highly innovative vision."

Therefore, a scientific definition of genius reads as follows: **a genius is a person (A) top-valued by the society (B) for the uniquely expressed highly innovative vision (C) of the world (D).**

Note that this definition does not mention creativity or intellect (to avoid controversy) but mentions checkable and repeatable elements, like symbolic expression, level of innovation, and top societal evaluations. This definition is also domain-free because it can be used for science, for technology, for arts, for education, etc. It fits all of the domains.

A properly built scientific definition should include only necessary and sufficient elements. The necessity is usually tested by mentally omitting one element and checking whether the concept still stands. The sufficiency is checked by applying the definition to real examples and checking whether all elements of the definition **together** are sufficient to cover life examples, where nothing else is needed.

Checking the primary elements of the definition for necessity:

- No person (individual) – no genius: neither machines (objects) nor groups of people are called geniuses.
- No society – no genius: there is no social evaluation at all, so there is no top evaluation.
- No uniquely expressed highly innovative vision – no genius: non-expressed originality cannot

be seen, read, heard, and consequently evaluated.

- No world behind the uniquely expressed highly innovative vision (empty, meaningless) – no genius: a nonmeaningful expression like accidental set of symbols, crazy and stupid combinations, etc., do not count for genius.

Checking the secondary elements (dependent on the primary) for necessity:

- B_1 "top-valued" – genius is the highest verbal award for a human being from the society. So it is not just "highly valued" (prize, fellowship, or medal) or "valued" – it is top-valued. There is no higher evaluation in the society than the rank of a genius. Rich and famous may be forgotten, geniuses are forever. No wonder, there are so many self-proclaimed geniuses and so much media noise about geniuses. For the definition check: no "top-valued" – no genius.
- C_1 "uniquely expressed" – articles, books, paintings, sculptures, movies, etc., all are unique expressions – no compilation and no plagiarism accepted. No unique expression – no genius.
- C_2 "highly innovative vision" – level of innovation matters: world-level innovation, versus country-level innovation, city-level innovation, and plant-, school-, company-, street-, family-level innovation. No world-level innovation (highly innovative vision) – no genius.

So, both the primary elements and the secondary elements are necessary.

Checking the terms for sufficiency:

Here are some examples from science, technology, and arts domains to test for sufficiency:

- Isaac Newton (A) in simple formulas (C_1) expressed his unique vision (C) of the world's mechanics (D), which saved the society (B) huge amount of resources that could have been wasted without calculations. For this highly innovative vision (C_2) of the world, he is considered a genius; mechanics is now called Newtonian physics, and there is a unit named Newton in honor of his name (B_1).
- Albert Einstein (A) uniquely (C_1) expressed his highly innovative vision (C_2) of the world (D) in the theory of relativity (C) that advanced the science of astronomy and led to many other discoveries, as well as the introduction of a new cosmological constant, for which the grateful society (B) top-valued (B_1) his contributions and considers him a genius.
- Thomas Edison (A) in over 1,000 patents (C) uniquely expressed (C_1) his highly innovative vision (C_2) of the technology world (D), which advanced social development immensely for which the grateful society (B) calls him a technological genius (B_1).
- Wolfgang A. Mozart (A) in numerous music compositions (C) uniquely expressed (C_1) his highly innovative vision (C_2) of the world sound harmony (D) that opened a new era in classical music, for which he is highly honored (B_1) by society (B), and his music can be heard everywhere.
- William Shakespeare (A) in unique poetic forms (C_1) expressed (C) his highly innovative vision (C_2) of the world of human feelings (D) for which he is top-honored (B_1) by the grateful society (B). By the way, out of 17,000 words that he used in his poetry 1,700 were new words! A very high level of innovation!
- Van Gogh (A) in uniquely thick strokes and basic color paints (C_1) expressed (C) his highly innovative vision (C_2) of the visual world (D) thus contributing to the creation of the new style of arts – impressionism. For this world-level innovation in the field of visual arts, he is top-valued (B_1) by the society (B). As an example, one of his simplest paintings – "Chair" – was once auctioned for $37,000,000.
- Andy Warhol (A) in uniquely multiplied sameness of the screen printed images of popular personalities and artifacts (C_1) expressed (C) his highly innovative vision (C_2) of the modern repetitious and full of advertising world (D), thus founding a new style of fine arts – Pop Art, for which the society (B) calls him a genius (B_1).
- Charlie Chaplin (A) in his uniquely entertaining manner (C_1) expressed (C) his highly innovative vision (C_2) of the "little-guy-in-the-big-city" world (D) for which the grateful (laughing to tears) society (B) calls him the genius of silent film (B_1).

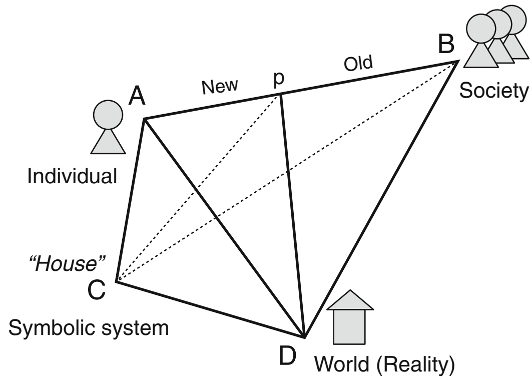
First of all, notice how the pattern repeats itself in the explanations above. It is exactly what science is: it provides testable and repeatable knowledge. Second, note how the scientific definition cuts off:

- Computer poetry and music (no A, individual).
- Self-proclaimed geniuses, as well as lower-level producers, who write, exhibit, perform, etc., but are not innovative enough and, therefore, not top-valued (no B, society; no B_1, recognition).
- Intellectuals or IQ test high-scored individuals that do not develop new vision and do not express it in writing and publishing, painting and exhibiting, dancing, singing, reciting, performing, etc. They may be lazy, too shy, and so on – reasons do not matter. Since there is no production expressed in symbols, no unique expression, no highly innovative vision, there is no basis for rewards (no C_1, unique expression; no C_2, highly innovative vision).
- Senseless, meaningless production in writing or performing – like “monkey typing” or mentally sick doodling that has no reflection of the world (no D, real world).

On the basis of such a universal model and definition, it is easy “to see” the essence of the genius and to visualize the genius situation. A genius is certainly not just the high IQ which is often simply knowledge of already known facts and patterns – far from something really new. These are not “new frontiers” (see the quote of Arthur Koestler). What new frontiers could be found in the book of puzzles or tests already created by somebody? The test taker merely follows the test creator and hundreds of those who took the test before in order to check its validity.

This graphic model (ABCD) also allows researchers to visualize the most important aspect for the explanation of the genius activity. It is the differentiation plane that cuts the old and the new in the message. This is how the cutting plane (CDp) looks in general:

It can be explained as illustrated by Fig. 2: any statement (report, article, book, research, painting, music show, theatrical performance, etc.) consists of the old (BCDp) and the new (ACDp)



Genius, Fig. 2 The new/old plane in the model

parts. In the case of genius, this new part (what genius has discovered and now communicates to the society) is much larger than the old part (what society already knows).

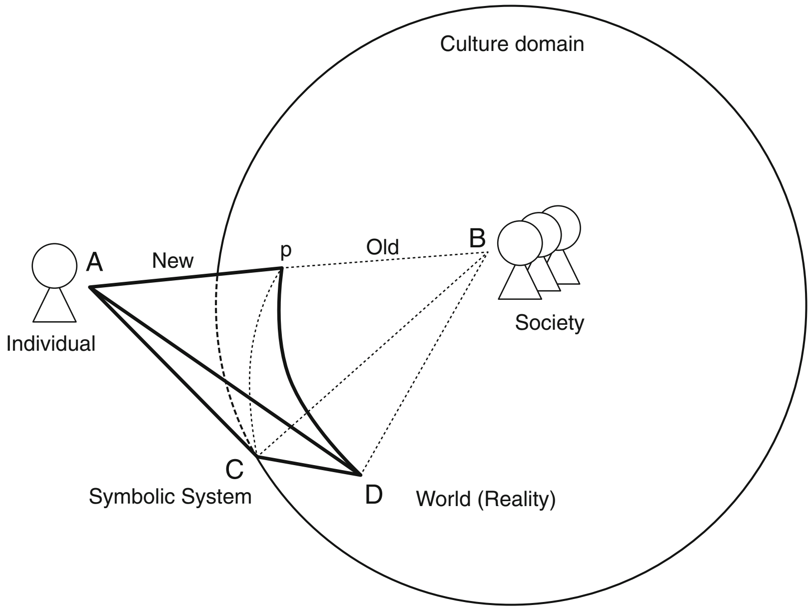
This is what the model of interaction in general looks like:

As Fig. 3 suggests, an individual (A) creates a new vision of the world (D), expresses it in the language (C) also known to the society (B), and sends a message (AB) consisting of known volume (pBCD) and also new volume (pACD). This is the modification of the figure published first in the article titled “Humane Creativity” (Aleinikov 1999a) to show how creative acts expand the society’s culture domain.

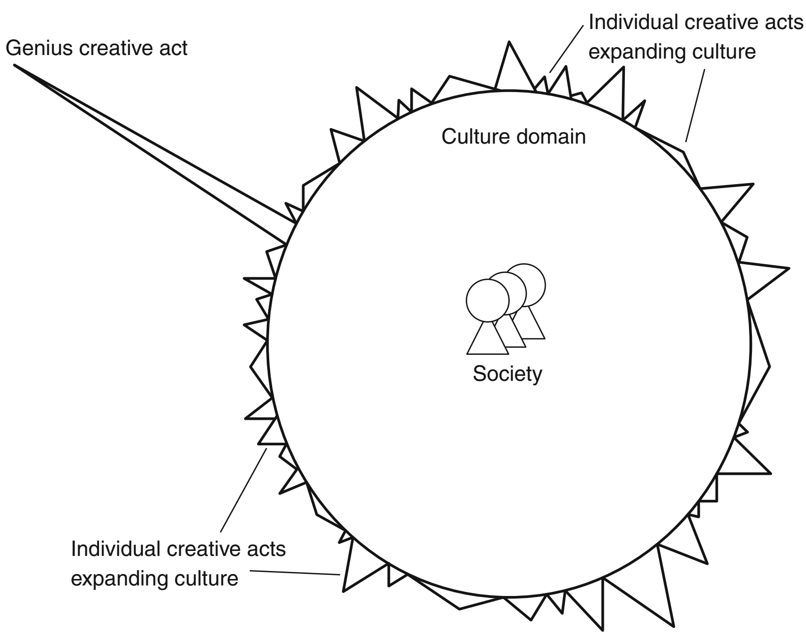
Now, applying it to the issue of genius, this is what the graph would look like.

As Fig. 4. illustrates, genius often makes a needle-shape shot into the future, and it takes several followers (disciples), then hundreds of researchers, and finally, thousands of commentators to explain the genius creative act, thus stretching the social culture (common knowledge, traditions, rituals) to the height of the genius ideas. Christianity and other religions are a great example.

This model also explains why the society does not understand genius and descends to ridicule (see above what Heinrich Heine, Mark Twain, and Oliver Wendell Holmes said). The needle-shaped long shot looks like having no or little foundation in the culture domain. It is often seen as “crazy,” it terrifies people as a statement or vision lacking “foundation” (see the quote by Kierkegaard).



Genius, Fig. 3 Model of creative act expanding culture



Genius, Fig. 4 Genius creative act expanding culture

Certainly, if genius is 50–200 years ahead of the society, it would take society 50–200 years of development to catch up with the genius. Only then, the society will appreciate the intellectual or creative power of the person and call this person a genius.

This model also shows that a genius is the fastest culture expander. A genius either produces ten/hundred times more (i.e., faster) than a talented person or is the first to arrive at a discovery (a highly innovative vision of the world). This is the essence of a genius and another short definition: **genius is the fastest culture expander!**

Speaking about speed, preliminary research shows that geniuses produce about 10 times more new ideas than talented people and about 100–1,000 times more than ordinary people. Geniuses produce so many new ideas that it dazzles the bystanders (see the quote of Ezra Pound above).

To measure the genius ideation productivity, in addition to Torrance's measuring of creative abilities (Torrance 1974), and Kirton's creative style measurement (Kirton 1994), geniusology introduced the ideation efficiency measurement and a new measurement unit (1 idea per second = 1 Alein). Consequently, there would appear new concepts of decacreativity (x10), hectocreativity (x100), kilocreativity (x1000), megacreativity (x1,000,000), and gigacreativity (x1,000,000,000) as the numerically defined concepts for measuring the efficiency of creative output (Aleinikov 1999b, 2002a).

In addition to the first (scientific) and second (graph-based) definition, geniusology offers a "genius-type" definition of genius. It was developed in one of genius thinking classes during the so-called genius definition exercise, where participants were allowed to use only two words for a definition. Such a two-word definition of a genius is **megarecognized megainnovator**. As in the case of megacreativity (Aleinikov 2002a), the words are spelled together. Only the Microsoft editing program and human editors prefer the spelling in four words. Even in four words, it is probably the shortest definition of a genius: **mega recognized mega innovator**.

Since genius is "the ability to reduce the complicated to the simple" (C. W. Ceran) and genius is "not so much about new ideas as it is about clarity of ideas" (Kevin Solway), geniusology, the science of genius, offers a simple, short as a formula and numerically precise "genius-type" definition: **genius is a mega recognized mega innovator.**

Note: In more traditional (less precise) words, it might be "a super recognized super innovator." The term *mega*, however, is preferable because it means "million" in science (megawatt, megahertz), while the word *super* does not have any mathematical equivalent.

A genius, therefore, according to this "genius-type" definition, has two sides united in one:

- Social recognition (over a million references, quotations, records in time and in space, i.e., over the centuries and over the country borders).
- The activity that caused (earned) this recognition – the activity of innovation that either includes over a million innovative acts or involves one or several acts that led to a million of innovative acts after its discovery. A good example of the latter is the discovery of x-ray (Roentgen) that spread to medicine, technology, geology, astronomy, and many other fields.

Finally, from the societal point of view, **genius is a social phenomenon of highly appreciated (valued) individual greatness**. Genius is just a social verbal award for individual's outstanding contributions for the benefit of society.

In general, in order to be accepted as a scientific definition, a definition should withstand counterexamples (mental experiments). For example, somebody states that "genius is a superior intellectual power." Then finding a genius (the person extremely famous for one's innovation) but not having a superior intellectual power would be considered a counterexample. For instance, Gore Vidal calls Andy Warhol, one of the founding figures of Pop Art, "**a genius** with the IQ of a **moron**." So the definition with "superior intellectual power" does not work for all geniuses. If there is at least one counterexample, the definition is not true.

Note that the definitions, offered by geniusology, withstand such a counterexample. Andy Warhol is certainly:

- A person top-valued by the society for the uniquely expressed highly innovative vision of the world
- A mega recognized mega innovator
- The fastest culture expander

The fact is that his influence spread over all medium from fine arts to TV and film industry, from literature to theater, and then to philosophy.

It was even called the Andy Warhol "empire," and some people rightfully doubt it could be done by a person with low IQ. Much closer to truth is the hypothesis that it was his play – the desire to be controversial, careless, and mysterious which attracted more viewers to the art, as was in the Salvador Dali's case as well.

Practical Applications of Geniusology

In Science

Studying geniuses and using genius methods of thinking brings outstanding results. As a case in point, studying the methods of Robert Oros di Bartini (Soviet air designer and physicist), the group of researchers from Monterey and Santa Cruz in California:

- Developed a new – mathematically simple and physically sound – vision of the world
- Introduced five new sciences and three new fields of research
- Discovered 11 new laws of conservation (for comparison: Isaac Newton discovered one, Johann Kepler – two)
- Offered 12 new measurement units for new physical reality (Aleinikov and Smarsh 2011).

In Education

The new scientific model of genius allowed educators to determine precise steps in developing genius habits, skills, knowledge, creativity, and innovation patterns both for children and adults. Genius Education Methodology (GEM) began its practice in 1995 with the opening of School of Genius in Montgomery, Alabama, and quickly spread around the world (Germany, India, Russia, Singapore, South Africa, Pakistan, Thailand, and the USA). GEM showed outstanding results in elementary, middle, and high schools, colleges, and universities, in teachers' and principals' education (for more details see "► Creative Pedagogy").

First of all, in its philosophy, GEM considers that there is a genius in every child and adult. It looks for what Plato seriously calls "peculiar bent of the genius" in each (echoed in the speech of Singapore's Minister for Education, Wong 2001) and many other authors mention with irony (see Mark Twain, G. C. Lichtenberg, Edgard Varese, and Sir Herbert Beerbohm in quotes).

Then GEM defines five steps to the genius level and develops specific methodologies to maintain the interest of the learner until it becomes internal motivation and makes the person being educated an idealearner (genius learner), who learns by oneself – no other motivators (exams, tests, grades, diplomas, awards) needed. Just as Schopenhauer stated, "Genius is its own reward." Learning genius thinking methods makes children so interested in studying that it changes their lives.

Some examples of teaching the genius thinking methods to children:

- Thirteen worst sixth graders of the school, selected by teachers out of 1,200 students as "doomed to fail," after a 3-day intervention, pass all the exams (math, science, english, and mother tongue) and proceed to the next level of academic education. This is 100 % success (Jiemin Primary School, Singapore).
- One of these pupils, an 11-year-old boy, invented a new skateboard by using a genius thinking method (creative activity), entered it in a contest in Japan (innovation activity), won the contest, traveled to Japan to participate in the ceremony, received $1,500 as winning prize, and gave his father $500 for "being a good father."
- A 12-year-old girl from Felton, California, who studied Bartini's methods, discovered two new laws of conservation and used one of them to solve the Great NASA Gravity Mystery ("Pioneer 10, 11 Anomaly"). For details see http://globalscience.ru/article/read/212/ and http://globalscience.ru/article/read/321/).

The main achievement of GEM, however, is that teachers after this pedagogical intervention see their students and their own professional duties in a totally different way. For saving geniuses in children and adults on four continents, media labeled Genius Education Methodology (GEM) "the GEM of education."

For comparison, there are other approaches to genius education and training. Genrikh Altshuller, for example, teaches the genius life strategies as chess game strategies (weak move, better move, the best move), and a person can follow these strategies to win the game of life and after life (Altshuller and Vertkin 1994).

China Daily reports that several "genius training camps" have been established in major cities across China, with one in Beijing (retrieved from http://www.chinadaily.com.cn/china/2006-05/19/content_594875.htm). The approach, however, is the "genius = high IQ" approach.

Conclusion and Future Directions

Genius is an extremely complex subject to study, and therefore, a separate science, geniusology, is evolving to study it. The science of genius is created with the purpose of understanding what genius is and how it is affected and reflected at all levels, ranging from the physical to the societal. Its mission is to research genius lives, genius learning, genius thinking, genius solutions, genius ideas, genius imagination, genius character, genius feelings, genius habits, genius skills, genius upbringing, genius environment, genius growth and decline, etc. Every aspect of genius and every bit of knowledge about genius is extending human understanding of genius, thus increasing the probability of improving the humanity scientific, technological, educational, and social achievements. Geniusology is being built around one object to study, which unifies research efforts, but it also incorporates diverse, multidisciplinary approaches [see "▶ Transdisciplinary Research (Transdisciplinarity)"] to be developed by academics, scholars, and researchers from all disciplines. Geniusology embraces cognitive, computational, mathematical, and educational approaches. The first geniusology results include both theoretical and practical achievements, such as a new vision of the genius world, new definitions of genius, new model of genius, new measurements, new measurement unit, and finally Genius Education Methodology that applies the research results to the educational practice. The inclusion of the educational aspect ensures that geniusology does not become a pure science: it needs testing and retesting in education; it needs educational and industrial applications to save geniuses, to develop geniuses, and to model geniuses.

Geniusology, as a new science with its "love" (Wolfgang A. Mozart) for genius and "love of truth" (Johann Wolfgang Von Goethe) about genius, is a vast field of research that is open to thousands of researchers. It opens new horizons or "new frontiers" (Arthur Koestler) for discoveries (see "▶ Invention Versus Discovery"). It embraces all previous empirical findings, all the data gathered by researchers, and builds new theories. Just as "philosophy becomes poetry" (Disraeli), the poetry becomes philosophy, and a set of definitions randomly taken from the list is used for illustration of the new science. Geniusology analyzes all types of reasoning: analogy reasoning and mathematical reasoning. It must research all types of logic: formal, modal, dialectical, deontic, and even "iron" logic; all types of problem-solving: trial and error, lay and scientific problem-solving, creative problem-solving, innovative problem-solving, etc. Geniusology creates a passionate tribute to the genius of creation, genius of arts, genius of education, and certainly genius of science!

In the future, geniusology must unite the studies of intelligence and multiple intelligences with studies on creativity (see "▶ Science of Creativity") and innovation (social newness) because genius is the combination of the top intelligence, top creativity, and top social orientation. Geniusology must study the strategies of genius thinking and the strategies of genius living, the strategies of genius solutions of the open-ended and ambiguous problems. Geniusology must investigate creative methodologies and innovative leaps, motivational, emotional, and social contexts of genius lives, as well as sociocultural, economic, political, historical, and environmental factors, causing genius and developing the genius. Geniusology must study cross-cultural (see "▶ Creativity Across Cultures") and intracultural genius. It must develop measurements of genius activities, abilities, and even products. It must find out the roots of greatness and eminence, giftedness and talent in all spheres of human life from arts and science to politics and war.

Geniusology achievements can result in new learning technologies, including intelligent tutoring systems, new visualization tools, computer-supported collaborative environments, new digital libraries, and real-time assessment tools. Obviously, there is place for mathematical, statistical, and computational modeling that will help to develop new tools and technology to support the science of genius. Countries that begin to apply the science of genius and its innovative methodologies can achieve a breakthrough in development in 10–20 years when children who went through GEM grow into genius thinkers, make their genius discoveries, patent and implement their inventions, and create their masterpieces in arts.

Cross-References

▶ Creative Linguistics
▶ Creative Pedagogy
▶ Creativity Definitions, Approaches
▶ Invention Versus Discovery
▶ Inventive Problem Solving (TRIZ), Theory
▶ Novology
▶ Science of Creativity
▶ Transdisciplinary Research (Transdisciplinarity)

References

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, USSR Academy of Sciences; 1988. p. 77–89. russ. Креативная лингвистика (обоснование, проблемы и перспективы). Языковое сознание: стереотипы и творчество.

Aleinikov AG. Humane creativity. In: Runco M, Pritzker S, editors. Encyclopedia of creativity, vol. 1. San Diego: Academic; 1999a. p. 837–44.

Aleinikov AG. Megacreator: from creativity to mega-, giga-, and infi-creativity. Montgomery: MIMII; 1999b.

Aleinikov AG. Mega creativity: five steps to thinking like a genius. Cincinnati: Walking Sticks; 2002a.

Aleinikov AG, editor. The future of creativity. Bensenville: Scholastic Testing Service; 2002b.

Aleinikov AG. Geniusology, the science of genius: theoretical foundations, problems, and perspectives. Proceedings of the Academy of Creativity and Innovation, Allied Academies, Vol. 1, Number 2, p. 3, Maui, Hawaii; 2004.

Aleinikov AG. Geniusology: scientific classification of genius. Proceedings of the Academy of Creativity and Innovation, Allied Academies, Vol. 2, Number 1, p. 11, Memphis, TN; 2005.

Aleinikov A, Kackmeister S, Koenig R. Creating creativity: 101 definitions (what Webster never told you). Midland: Alden B Dow Creativity Center; 2000.

Aleinikov A, Smarsh D. 11 New laws of conservation: expanding physics horizons for strategic management. Proceedings of the allied academies' internet conference, Vol. 13, p. 132, Candler, NC; 2011.

Altshuller GS, Vertkin IM. How to become a genius: the life strategy of a creative person. Minsk: Belorussia; 1994. russ. Альтшуллер ГС, Верткин ИМ. Как стать гением: Жизненная стратегия творческой личности. — Минск: Беларусь, 1994.

Bloom H. Genius: a mosaic of one hundred exemplary creative minds. New York: Warner Books; 2002.

Durrenberger SD. Mad genius controversy. In: Runco M, Pritzker S, editors. The encyclopedia of creativity, vol. 2. San Diego: Academic; 1999. p. 169–77.

Gardner H. Creating minds: an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi. New York: BasicBooks; 1993.

Gelb MJ. How to think like Leonardo da Vinci: seven steps to genius every day. New York: Delacorte Press; 1998.

Gleick J. Genius: the life and science of Richard Feynman. New York: Vintage Books; 1993.

Kirton M, editor. Adaptors and innovators. Styles of creativity and problem solving (revised). New York: Routledge; 1994.

Michalko M. Cracking creativity: the secrets of creative genius. Berkeley: Ten Speed Press; 1998.

Olicker A. Conclusion. Genius research, Retrieved July 25, 2003, from http://www.sciencenet.emory.edu/mismeasure/genius/conclusion.html)

Salny AF. The question of "Genius." A report from the Supervisory Psychologist, American Mensa, 2009. (Retrieved from http://permianbasin.us.mensa.org/resources/questionofgenius.html December 25, 2011).

Seifer MJ. Wizard: the life and times of Nikola Tesla: biography of a genius. New York: Citadel Press Book; 1998.

Simonton DK. Origins of genius: Darwinian perspectives of creativity. Oxford: Oxford University Press; 1999.

Sobel D. Longitude: the true story of a lone genius who solved the greatest scientific problem of his time. New York: Penguin; 1996.

Stillson A. The Mensa genius a-b-c quiz book. New York: Perseus; 1998.

Thorpe S. How to think like Einstein: simple ways to break the rules and discover your hidden genius. Naperville: Sourcebooks Trade; 2000.
Torrance EP. Future needs for creativity research, training, and programs. In Aleinikov AG, editor. The Future of Creativity. Bensenville: Scholastic Testing services, Inc.; 2002, p. 1–10.
Torrance EP. Torrance tests of creative thinking. Bensenville: Scholastic Testing Services; 1974.
Wong A. Speech presented at the opening of the Ednoland. Nurture the genius in your pre-schooler, Seminar & Exhibition, Singapore; 2001.

Genotype

► State Space Paradox of Computational Research in Creativity

Geometrical Design

► Innovations in Geometry

Global Innovation Ecosystems

► Epidemiology of Innovation: Concepts and Constructs

Global Language

► Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Global University System

► Global University System in World Society

Global University System in World Society

Thomas Pfeffer
Department for Migration and Globalization, Danube University Krems, Krems, Austria
Institute for Science Communication and Higher Education Research, Klagenfurt University, Vienna, Austria

Synonyms

Global university system; World society

Key Concepts and Definition of Terms

World Society

From the perspective of modern systems theory in the tradition of Niklas Luhmann, *world society is a global social system that comprises all communications and actions* and makes them mutually accessible. There exists no social entity outside world society, and only events and actors which are processed in communication can be part of society. Without being established in communication, society cannot deal with them.

All other social systems can be regarded as internal structures of world society, which are also composed of communications and actions. The main *types of social systems are society* itself (segmentally differentiated in function systems), *organizations and interaction systems*. Social systems of different types are not mutually exclusive but rather overlap (or interpenetrate) each other.

Function Systems

Functional differentiation can be seen as the dominant structural principle of world society. While premodern societies were societally stratified (dominated by one vertical hierarchy that claimed validity for all social spheres), modern society (understood as one world society) is internally segmented in a growing plurality of thematically specialized function systems. *Function systems are thematic specifications of communication* like politics, the economy, law, religion, art, sports, the health system, the mass media, science, and education. A societal function system emerges when it succeeds in establishing a unique (functionally specialized) communicative domain, which clearly distinguishes itself from other domains.

To distinguish itself from its environment, each function system uses its own, unique symbolic generalizations as *success media and binary codes for processing its operations*. For example, the political system uses the medium of power and operates in the code of powerful/subject to power, the economic system deals with the medium of money and operates along the binary distinction of paying/not paying, and the legal system communicates in the medium of law and uses the code legal/not legal. Media and binary codes increase the probability of otherwise improbable communication (e.g., the exchange of money against goods) and allow for subsequent communication of the same type (e.g., using received money for further purchases). The binary code makes it possible to identify communications of the same type. By linking them, operational closure and the self-production of a function system can take place. Each of the success media and respective binary code only has validity within the thematic domain of its function system.

Two crucial consequences follow from this concept. First, *the arrangement of function systems in world society is segmental*. They exist in parallel to each other in a nonhierarchic order. Interdependencies between function systems may exist, but no function system can subordinate or substitute the operations of another one. Second, the *thematic focus of each function system is* per se *a universal one* which cannot be reduced to a local or regional context. Globalization is not only driven by the political and/or the economic system but also by the emergence and expansion of all other function systems as well, which all claim worldwide relevance for their thematic specialization.

While function systems constitute thematically specialized communicative domains of global reach, they cannot interact with other systems in their environment. They observe their environment for events which can be dealt with in their respective code. But this is only internal communication within the function system. To communicate with other social systems, function systems depend on organizations (Luhmann 1997: 843).

Organizations

Organizations are another crucial structural component of world society. The emergence of formal organizations is closely related to the genesis of function systems (Stichweh 2007: 137). One can speak of a coevolution of both types of social system. Functional differentiation is a prerequisite for the emergence of organizations, while organizations simultaneously promote the expansion and the unfolding of the internal complexity of function systems.

Organizations distinguish themselves from their environment via the *principle of membership*, which is tied on conditions and regulated formally. Membership allows organizations to define their boundaries to the outside as well as behavioral expectations toward their members inside. *Decisions*, which can be attributed to their members or to the organization as such, are the *core operations of organizations*. The recursive connection of its own decisions leads to operational closure of the organization. This operational closure of the organization is the prerequisite for its informational openness. Only on the basis of its own decisions, an organization can observe its environment and communicate externally (Luhmann 1997: 835ff).

The formal organization represents a principle, which is orthogonal to functional differentiation (Stichweh 2011: 5). Organizations can (and have to) switch between different functional domains. However, they also tend to focus on the binary code of respectively selected function systems. This leads to the emergence of specialized types of organizations, for example, to companies and banks in the economic system or to courts and prisons in the legal system.

Nation States

After WW II, a major structural change in the political system of the world society came to completion. The formerly stratified structure of colonial states and large empires, which subordinated local regimes as provinces or colonies in their respective sphere of political control, was substituted by a *segmented structure of formally equal nation states* (Stichweh 2010: 299), a development that led to the establishment of more than 130 new nation states since 1945 (Meyer et al. 1997: 158).

Nation states are territorially bound. Since they are political organizations, their primary function is to generate collectively binding decisions for their members by which they facilitate the *inclusion of their members in the global political system*. Modern states can also be regarded as welfare states insofar as they *moderate the inclusion in other function systems* (e.g., the economic, the legal or the health system, the education or the science system). However, nation states cannot politically control these function systems. Rather they have to focus on providing access opportunities to autonomously operating function systems, for example, by providing pools of candidates for inclusion into the respective thematic domains (Stichweh 2010: 305).

Universities

In mediaeval times, the university emerged as a place to accumulate societally relevant knowledge, knowledge that could claim universal relevance. The most important knowledge domains were law, medicine, and theology, supplemented by various types of arts (e.g., grammar, rhetoric, arithmetic) (Stichweh 2006: 33f). Since this time, the main function of universities has been to *provide (higher) education*. Following Kade (2005: 19f), one can claim that universities (in their role as entities of the education system) use two related success media, *knowledge and certificates*, in conjunction with their respective binary codes knowing/not knowing and passed/not passed.

In the eighteenth century, the amount of socially available knowledge started a huge expansion, a process that also led to the differentiation of scientific disciplines and disrupted the former hierarchy between knowledge domains. Research as a systematic activity to generate new knowledge became a professional activity. Universities became the main *places where research is performed and the validity of knowledge is certified*. In their role as entities of the research system, universities use two other success media, truth and (scholarly) publications in conjunction with their respective codes true/not true and published/not published. Scholarly publications rather than classic texts became the content of higher education; the systematic and never ending test of its validity (true/not true) rather than the mere reproduction of knowledge became a crucial principle to gain insight during the educational process.

Combining these considerations, one can say that universities produce and reproduce themselves by three types of communication: *“the communication of knowledge, called ‘teaching’* [or better: ‘education’]*; the communication of problems and questions of ignorance, called ‘research’; and the communication of decisions on teaching* [education] *and research, called ‘the organization of a university’”* (Baecker 2010: 358).

Political actors may set political limits to these activities and try to influence the organizational structure of universities, and economic actors may offer incentives for universities to focus their activities on certain topics. Both may link specific utilitarian expectations with their engagement. And (especially American) universities have proven to be responsive to their poly-contextual environments. But external interventions and utilitarian expectations cannot determine the way in which a university operates internally, which is the communication in the codes of the education and the research system and the communication in its own decisions as an organization. In this *“focus of trusteeship”* in the development of secular knowledge and learning, the university is *“perhaps the most important structural component of modern societies that had no direct counterpart in earlier types of society”* (Parsons 1961: 261).

The Global University System

The global university system is not a function system in the sense described above. Rather it is an *interorganizational system that is based on* *relationships of observation*, interaction, cooperation, and competition between organizations (Stichweh 2009: 2).

While in the past, the development of universities largely depended on the development of their respective national university systems, which only occasionally learned from each other, mainly from the perceived centers of the global university system, the situation is fundamentally changing since the midst of the twentieth century, especially since the 1960s. *International governmental organizations*, like the OECD (e.g., "Education at a Glance"), UNESCO (e.g., the ISCED-classification), or the World Bank, started to gather data on education and research to *systematically compare and to offer advice to national systems*.

Based on these data, one can, for example, observe an increase of the participation rate in higher education between 1900 and 2000 from less than 1% to about 20% of the age cohort worldwide. Enrolment ratios continue to climb rapidly; in some industrialized countries, they are well beyond 50% already (Schofer and Meyer 2005). Especially since the 1960s, exponential growth took off on a global scale. This *growth in enrolment ratios is accompanied by a rapid proliferation of universities and the differentiation of types of higher education institutions*. The International Association of Universities (IAU) currently lists more than 17,500 institutions worldwide, a number that is growing constantly.

The emergence of *higher education research as a distinct research field* also can roughly be dated in this time. Authors like Joseph Ben-David (1977) or Burton Clark (1983) started to systematically *compare selected national systems* mainly from European and North American origin. More recent research also compares *clusters of national systems*. For example, Pechar and Andres (2011) analyze different types of welfare regimes and their impact on higher education: conservative regimes (in Continental European countries) combining medium public expenditures on higher education with low/no tuition fees, social democratic regimes (in Scandinavian countries) combining high public expenditures with no tuition fees, and liberal regimes (in Anglo-Saxon countries) combining medium/high public expenditures with high tuition fees. Similarly, Marginson (2011) identifies a "Confucian model" (in Southeast Asian countries), which combines low, but focused public expenditures with high tuition fees. These are important differences in the global university system.

An even more interesting phenomenon is the emergence of *regional, transnational forms of coordination between national systems*. The most prominent example is the Bologna process, which is establishing the European Area of Higher Education (EAHE) via the introduction of a joint academic degree structure, of the European Credit Transfer System as a joint measure to weight and transfer course certificates, and of joint standards and guidelines for quality assurance in higher education. The Latin American and Caribbean Area for Higher (ENLACES) seems to aim in a similar direction, but is less developed yet. More advanced seems to be the emergence of *regional qualifications frameworks*, which foster transnational comparisons and the transfer of degrees, for example, the European Qualifications Framework (EQF), the Southern African Development Community Qualifications Framework, or the Southeast Asian Nations Framework Arrangement.

Having been squeezed between the academic profession and the state, the traditional university (especially in Europe) had much resemblance with both an assembly of a guild and a subunit of the state bureaucracy but often lacked a strong organizational identity of its own. Its members tended to have stronger loyalty to their respective disciplinary communities and to the state administration than to their home institution, which left the internal organization of the university fragmented in small fiefdoms, a situation that led to the description of the university as a loosely coupled system. External relations were often maintained as personal relations of individual professors. This situation has been changing in recent decades since *universities are increasingly turning into organizational actors*. Krücken and Meier (2006) identified four related elements, which characterize this transformation: the trend toward accountability and external quality assurance (which addresses the university as an autonomous organization), the definition of organizational goals (which requires internal coordination of expectations), the emergence of formal structures (which represent a growing variety of administrative and supportive instead of traditional academic tasks), and the raise of the management profession (which specializes in performing these organizational task).

This emerging organizational actorhood is a prerequisite for universities to develop *organizational relationships*, for example, for the exchange of larger amounts of staff and students, for the cooperation in joint research projects, or for the provision of joint study programs. It also offers universities the possibility to create and join *organizational associations* based on criteria of location (e.g., European University Association), disciplinary specialization (e.g., Association to Advance Collegiate Schools of Business, World Veterinary Association), or status consideration (e.g., League of European Research Universities). These organizations of organizations serve as exclusive clubs, which promote joint interests but also develop expectations and set standards for the behavior of their members, similarly to what scientific associations did for individual academic members.

Another phenomenon that addresses individual universities and fosters their observation, comparison, and competition is the *emergence of national and global rankings of universities*. At a national level, the first rankings based on reputational methodology have been established in the USA a few decades ago and can currently be found in more than 40 countries. At a global level, university rankings only exist since the turn of the century. Their most prominent examples are the Shanghai ranking and the Times Higher Education Supplement ranking. Even if the methodologies of these rankings are still contested, but their results have gained tremendous attention and huge influence on the self-perception and the decision making of universities. While in the past, institutional comparisons were rather restricted to a regional space (and universities were often content to blend in into their regional contexts), national league tables and global rankings *expand the cognitive spaces for comparisons* (and encourage competition among universities to improve or defend their status). Remarkably, global rankings also seem to steer the competition between national systems by offering indicators to measure progress of their developments. One of the results is the aspiration of several national governments to heavily invest in selected institutions to push them into the perceived league of *world-class universities*, even if the rationale behind these plans in some cases seems to be one of national pride and of politically profitable ambition rather than of sorrow economic calculation (Wildavsky 2010: Chap. 4). For some countries, this also means a step toward more stratification and a departure from prior attempts to create homogenously composed national university systems.

Mobility of staff and students always has been an important characteristic of universities. In this sense, they always have been international organizations even if this mobility has often been a random or at least unsystematic effect. Becoming more entrepreneurial, the *search for talents and for revenues on international and global markets* becomes a strategic endeavor for universities, even if they remain territorially located organizations. However, this peculiarity of universities is beginning to change as well. In difference to economic multinationals, which have a long tradition in establishing subsidiaries in other countries, universities have started to experiment with *offshore branch campuses* only in the 1990s. In the meantime, 162 branch campuses have been established, predominantly in the Middle East and in Southeast Asia (Wildavsky 2010: Chap. 2).

Digital media contribute to many of these developments and lead to the *virtualization of universities*. In their aim to establish presence in the World Wide Web, universities create self-descriptions of increasing complexity and post them on their home pages or portals. These self-descriptions, but also centralized enterprise systems for accounting, reporting, and documentation, foster the integration of universities as organizations and their addressability for external communication. Computerized or at least computer-aided forms of research become widespread in all disciplines, but additionally, digital media change the ways in which research is organized, communicated, and published. Similarly, digital media change the production, distribution, and accessibility of learning materials, which has consequences on the production structure of higher education. Given the ubiquitous availability of content, assessment of self-directed learning will become a more important part of education than the mere distribution of knowledge. And, if higher education is about the alphabetization at an academic level (i.e., educating students in the ability to read and to write scholarly texts), it becomes a new task for universities to foster literacy in selecting, analyzing and understanding digital forms of academic knowledge resources and databases, and in producing academic publications in new digital formats and genres (Pfeffer 2012).

Theoretical Background and Open-Ended Issues

World society is a distinct layer of reference, the starting point of macro-sociological analysis, not its empirical result (Hasse and Krücken 2005: 187). There are not too many theoretical concepts available that deal with the analysis of world society. Maybe the most prominent alternative to modern systems theory is the strain of neo-institutionalism that has been developed by John Meyer and the so-called Stanford School, which also conceives the nation state as an organizational phenomenon within world society. In this concept, world society comes to existence through global processes of modernization which spread "world cultural models" or "taken-for-granted scripts." The worldwide dissemination of these rationalistic models or scripts shapes organizational forms and assumptions on which activities have to be done. This neo-institutional approach has also led to an impressive body of empirical research. The studies on the proliferation of the modern nation state and on the exponential growth of participation in higher education are important examples, which have been mentioned above already.

However, given its specific interest in the proliferation of world cultural models or global scripts, this approach focuses on the observation of processes of standardization, on significant similarities, and on trends toward isomorphism. In difference to that, systems theory is more interested to observe the evolving complexity and differentiation of world society. It is therefore better equipped to deal with phenomena of innovation at the level of society, which mainly take place when new functions emerge and new organizational forms are developed.

Implications for Theory, Policy, and Practice

Theories of the world society in general and the concept of the global university system in particular can help to avoid methodological nationalism, the tendency to take the nation state as the main source, the dominant actor, and the sole end of innovation, and social developments, especially when it comes to universities. This does not mean that the global level is the only relevant for further considerations, which substitutes all other structures. Rather, these concepts help to observe the increasing complexity in the environment of universities, the multiplicity of contexts to refer to and the increasing variety of organizational actors to deal with.

From a theoretical perspective, it seems crucial to conceptualize and analyze phenomena like international organizations, regional (transnational) organizations, and organizations of organizations in the global university system without following merely political or economic considerations. From a political perspective, nation states should depart from ideas of unilateral control of their universities, or of nationally closed higher education and research markets, which requires new, innovative concepts of higher education and research policies. From the practical perspective of the individual university, it seems reasonable to acknowledge the limitations (and benefits) of any given local or national environment. But simultaneously, every university should use the expanding cognitive space of the global university system to search for the most appropriate peer organizations to compare with, to compete with, and to cooperate with. The better a university is in positioning itself within the global university system, the lesser it will be passive object of external influences.

Conclusions and Future Directions

While in the midst of the twentieth century, the global university system could adequately be described as a system of national university system, the situation is heavily changing since the 1960s. All over the world, participation rates in higher education grow exponentially, the organizational types of higher education institutions diversify, and their overall number continues to expand. In many countries, universities have started to break loose from rigid administrative control by their national governments and are increasingly developing organizational identities and actorhood. Additionally, new organizational actors of various types gain importance.

To observe further innovations in the global university system, a wide range of questions emerges:

- What are the most important *international organizations* for the global university system (in addition to OECD, UNESCO, the World Bank, etc.)? How can they be compared and analyzed in their influence on the global university system?
- What are the most significant examples of *regional (transnational) coordination between national systems*? Can similar coordination mechanisms be found within large national systems (e.g., USA, China)? Will they lead to a polycentric structure in the global university system or should a center-periphery structure rather be expected?
- Where can examples for *organizational associations* be found in the global university system and in how far do they foster a differentiation of organizational types?
- In comparison to global rankings, would *network analysis*, for example, based on bibliometric indices, data on research collaborations, and student exchange programs provide alternative pictures of the relevance and connectedness of individual institutions in the global university system?
- In how far does the emergence of international and global markets for higher education and research change the balance between public and private contributions? What could be defined as *public goods in the global university system* and how could they be provided?
- *How comprehensive or specialized* should individual universities and national university systems become in positioning themselves within the global university system?

At the moment, research on the global university system still is rather scarce. To answer some of these questions will change this.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Creativity and Systems Thinking
- ▶ Higher Education and Innovation
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Quality Assurance and Quality Enhancement in Higher Education and Innovation
- ▶ Social Innovation
- ▶ Social Networks and Entrepreneurship
- ▶ Techno-Globalization and Innovation
- ▶ University Research and Innovation

References

Baecker D. A systems primer on universities. Soz Syst Z für soziol Theo. 2010;16(2):356–67.

Ben-David J. Centers of learning. Britain, France, Germany, United States. New York: McGraw Hill; 1977.

Clark BR. The higher education system: academic organization in cross-national perspective. Berkeley: Universty of California Press; 1983.

Hasse R, Krücken G. Der Stellenwert von Organisationen in Theorien der Weltgesellschaft. Eine kritische Weiterentwicklung systemtheoretischer und neo-institutionalistischer Forschungsperspektiven. *Zeitschrift für Soziologie* 2005; (Sonderheft "Weltgesellschaft"): 186–204.

Kade J. Wissen und Zertifikate. Erwachsenenbildung/Weiterbildung als Wissenskommunikation. Z für Pädagogik. 2005;51(4):498–512.

Krücken G, Meier F. Turning the university into an organizational actor. In: Drori GS, Meyer JW, Hwang K, editors. Globalization and organization. World society and organizational change. Oxford: Oxford University Press; 2006. p. 241–57.

Luhmann N. Die Gesellschaft der Gesellschaft, vol. 1–2. Frankfurt am Main: Suhrkamp; 1997.
Marginson S. Higher education in East Asia and Singapore: rise of the Confucian Model. High Educ. 2011;51(5): 587–611.
Meyer JW, Boli J, Thomas GM, Ramirez FO. World Society and the Nation State. Am J Sociol. 1997;103:144–81.
Parsons T Differentiation and variation in social structures. Introduction. In: Parsons T, Shils E, Naegele KD, Pitts JR, editors. Theories of society. Foundations of modern sociological theory (Vols. 1–2, Vol. Volume 1). New York: Free Press of Clencoe; 1961. pp. 237–64.
Pechar H, Andres L. Higher-education policies and welfare regimes. International comparative perspectives. High Educ Policy. 2011;24:25–52.
Pfeffer T. Virtualization of universities. Digital media and the organization of higher education institutions, Innovation, technology, and knowledge management. New York: Springer; 2012. http://dx.doi.org/10.1007/978-1-4614-2065-1.
Schofer E, Meyer JW. The worldwide expansion of higher education in the twentieth century. Am Sociol Rev. 2005;70:898–920.
Stichweh R. Die Universität in der Wissensgesellschaft: Wissensbegriffe und Umweltbeziehungen der modernen Universität. Soz Syst. 2006;12:33–53.
Stichweh R. The eigenstructures of world society and the regional cultures of the world. In: Rossi I, editor. Frontiers of globalization research. Theoretical and methodological approaches. New York: Springer; 2007. p. 133–50.
Stichweh R. Funktionale Differenzierung der Weltgesellschaft. In: Albert G, Sigmund S, editors. Soziologische Theorie kontrovers, Sonderheft 50/2010 der Kölner Zeitschrift für Soziologie und Sozialpsychologie. Wiesbaden: VS Verlag für Sozialwissenschaften; 2010. p. 299–306.
Stichweh R (2011). Functional differentiation as a test case. On the comparison of systems theory and neoinstitutionalism. Presented at the workshop isomorphism and differentiation. From globalization(s) to world society, 2001 July 8–9; Hamburger Institut für Sozialforschung, 2011.
Stichweh R. Die Universität in der Weltgesellschaft. Presented at the "Dies Academicus" of Luzern University, 1. 2009 Oct; Luzern; 2009.
Wildavsky B. The great brain race. How global universities are reshaping the world. Princeton/Oxford: Princeton University Press; 2010.

Globalization and Entrepreneurship

► Entrepreneurship in International Context

Governance

► Innovation Policies (vis-à-vis Practice and Theory)

Government Commands

► Planned Economy and Entrepreneurial Function

Graphic

► Speaking Pictures: Innovation in Fine Arts

Great Groups

► Creative Collaboration

Green Belts

► Six Sigma

Green Business and Entrepreneurship

Abdelillah Hamdouch[1] and Marc-Hubert Depret[2]
[1]Planning Department, Polytechnic School, University of Tours, Tours, Cedex 3, France
[2]University of Poitiers, IRIAF, CRIEF, Niort, France

Synonyms

Cleantech; Environmental innovations; Green economy; Green growth; Renewable energy; Sustainable development

Introduction

The last few years have seen the emergence and gradual development of a number of innovative environmental products, services, and technologies, hence the rapid growth of a tangible "green" business/economy which is developing today all around the world and which is becoming increasingly organized through the formation of coalitions/clusters/networks of "green entrepreneurs."

However, green entrepreneurship remains understudied in the literature. Therefore, the contours of the phenomenon are rather fuzzy. At the same time, green entrepreneurs are still facing substantial economic and noneconomic barriers that hamper their development.

Environmental Innovations and "Green Business": A Great Potential Entrepreneurship Opportunity

Broadly speaking, environmental innovations can be defined as new or modified processes, techniques, practices, systems, and products to avoid or reduce environmental harms. When widening the scope, it comprises all the activities related to the environment, all sectors of cleantech (fuel cells, new materials, energy efficiency, etc.) and renewable energies (agro-fuels, solar and wind energy, biomass, etc.), and all the activities designated as being "low carbon."

For many experts, the challenging issues related to sustainable development (SD), to the preservation of the environment, and to the attenuation of climate change effects give rise to a continuous stream of significant innovations that may even constitute a "new techno-industrial paradigm." For the entrepreneurs (and investors), green business is therefore a great opportunity of profit in many sectors. Indeed, various converging trends provide clear evidence that "green markets" are now substantial and grow rapidly.

This structural momentum – that President Obama has designated as being a "Sputnik moment" in his 2011 *State of the Union* address – reflects a change in the way different stakeholders perceive environmental issues in four key areas (Hamdouch and Depret 2010). Firstly, the environment has become a global and long-term challenge. Secondly, the deterioration of the environment can no longer be solely attributed to industrial production processes, and consumption patterns now feature prominently in the equation. Thirdly, the limited, corrective, and local management of ecological and climatic degradation is gradually being replaced by the conviction that protecting actively the environment is not necessarily harming growth, job creation, and competitiveness. Fourthly and lastly, decision-makers have understood that a sustainable innovation policy is likely to promote radical environmental innovations with the ability to set in motion the cumulative and long-term development of competitive green sectors at a global and continental level.

The global turnover generated by the market of post-carbon and environmental goods and services exceeds $5,000 billion (BERR 2009). This estimation is recouped by various other indicators or concrete evolutions observable in several specific areas (environmental technologies, environmental goods and services, clean technologies or energies, renewable, etc.). Indeed, most available studies emphasize the fact that green markets are now reaching a "critical mass," display high growth rates, and should continue to develop in the next future, particularly in renewable energies and energy efficiency.

At the corporate level, a growing number of companies are now adopting a "corporate social responsibility" (CSR) and sustainable development (SD) approach in their organizational and strategic orientations and are also investing and diversifying more and more in green activities. At the same time, following the Kyoto Protocol ratification, R&D expenditures, as well as the number of patents and of commercialized innovations in the environmental field has literally boomed. Lastly, there is now a move toward the formation of networks and clusters focusing on activities, research, and innovation in these environmental fields (Depret and Hamdouch 2012).

This fast-growing trend is also observable in the world of finance where both the number and the size of merger and acquisition deals have substantially risen in the recent period. Equally, some key actors in the financial field (venture capital companies, ethical funds, and several pension and investment funds) are more and more attracted in investing in the environmental business. Finally, one should notice the recent fast development of emission or pollution bonds and carbon fund markets within the key financial places.

At the institutional level, the context for the development of the green business is also increasingly becoming more favorable thanks to various factors, especially the works of the IPCC, the "TEEB report," and the "Stern report"; the increase and volatility of raw materials and energy prices; the installation of the Obama Administration in the United States; the financial, economic, and social consequences following the subprime crisis; etc. Equally, and in relation with the factors noted above, the "new green economy" ambition is now provoking a growing commitment in many countries and regions of the public authorities but also of the civil society. This commitment stems partly from an emergent and consolidating change in mentalities and behavior of consumers/citizens but also from the conviction that recovery from the crisis requires a more sustainable economic growth pattern. By a matter of fact, this new "ecological awareness" translates very concretely in the privileged role given to the "green growth" theme in public policies, as asserted by the new institutional, fiscal, and social policy orientations which aim at creating favorable conditions for the economic development/consolidation of green industries (Hamdouch and Depret 2010).

Missing Green Entrepreneurs in the Economic and Managerial Literature

For all the reasons examined above, green markets appear today as a great strategic opportunity for many entrepreneurs who see in them the chance to win the new global competitive race based on SD, CSR, and green growth approaches.

It may then appear surprising that this entrepreneurship phenomenon around environmental activities has barely been addressed in the economic and managerial literature on entrepreneurship and clustering that has proliferated in recent years (see this volume). Even worse, there are hardly any publications, case studies, or best practices released by academics, journalists, or experts on "green entrepreneurs" though some of such entrepreneurship dynamics is a truly visible phenomenon today in many countries (see Cooney 2008; Isaksson 2009; Warren 2009; Horwitch and Mulloth 2010; Koester 2010; Wüstenhagen and Wuebker 2011).

Green Entrepreneurship: A Reality, But a Contrasted Phenomenon

The contours of the green entrepreneurship phenomenon remain rather fuzzy, notably because green entrepreneurship displays differentiated realities depending on the countries or sectors considered (Hamdouch and Depret 2010; Depret and Hamdouch 2012).

Still, several statistical data and stylized facts are available which attest of the reality and ongoing dynamism of green entrepreneurship in the key developed and emerging countries.

From an economic point of view, the markets of "post-carbon and environmental goods and services are concentrated around only few key Developed Countries and Emergent 'players'" (BERR 2009).

Indeed, most leading green clusters are located in these countries (Depret and Hamdouch 2012). This is a core factor for spurring green entrepreneurship as innovation clusters and networks facilitate greatly the creation of start-ups through the provision of human resources (especially managerial skills) and the funding needed in the accomplishment of entrepreneurial projects (see entry "▶ Clusters" in this volume).

By a matter of fact, the green entrepreneurship phenomenon relies heavily on the growing support of funding and investment institutions that are attracted by the economic potential of innovating projects in the environmental field. Investments in cleantech have increased rapidly during the last few years (see UNEP and Bloomberg New Energy Finance 2011).

From a technological point of view, about three quarters of financial investments in renewables are devoted to wind energy and take the form of asset finance of utility-scale projects due to the very high cost induced by this king of energy generation. Indeed, venture capital (VC) and private equity (PE) firms invest very few in wind energy. Rather, they invest in solar energy or, to a lesser extent, in biofuels, particularly because they consider that the chance is higher for a new entrant to take competitive advantage in the latter than in the former sectors.

From a geographical point of view, financial investments attracted by China, India, and Brazil were as important as those attracted by the USA and Europe taken together. Developing countries are today far more important than developed countries on public market investments and in asset finance for utility-scale projects. However, VC and PE investments in cleantech are clearly concentrated in North America, while Europe and South America lag behind and Asia is nearly absent regarding these sources of funding.

In Search of Specific Green Entrepreneurship Policies

The main green clusters are located precisely in those countries and regions where the public authorities (national, regional, or local) adopt an active environment and innovation policies (Hamdouch and Depret 2010). Indeed, depending on their geographical location, green entrepreneurs benefit from a contrasted specific green entrepreneurship (national) institutional context with its strengths and weaknesses.

However, and paradoxically, including in the main countries engaged in green growth strategies, "green entrepreneurship policies" are practically nonexistent. For the most, the policies dedicated to the "green business" are not specifically oriented toward green entrepreneurs. At best, these policies target small and medium enterprises that are innovating in green sectors and offer to them support via financial, fiscal, or regulatory mechanisms that have been used for other high-tech sectors (IT, biotechnology, etc.): "loan guarantee programs" (which back private loans to promising companies with new technologies); regional clusters technical and financial assistance (by facilitating access to angel investments and VC) to entrepreneurs and early stage companies; business plan contests (prize awarded to winning competitors to help them finance their project); subsidies, grants, and tax exemptions; public-private partnerships for R&D; etc. At worse, the policies engaged support as much – if not more – the "Greening Goliaths" (large companies or incumbents) as "Emerging Davids" or new entrants (Hockerts and Wüstenhagen 2010).

Green Entrepreneurship and the Development and Diffusion of the Green Business: A Hurdle Race

The development of green technologies is constrained by a series of both economic/financial and non-strictly economic (mainly psychological and institutional) inhibiting factors and obstacles (Depret and Hamdouch 2012).

The Economic/Financial Constraints and Barriers are Clearly the Most Important Green Entrepreneurs Must Deal with

Firstly, green technologies often depend upon the availability or constitution of a critical mass of knowledge, (multidisciplinary) competences, and (human and managerial) resources that are complex, cumulative, and, for the most, still embryonic or difficult to access. This is notably the case for human capabilities as green jobs require new "blocks of competence" for the integration of the environmental dimension in work attitudes and professional behavior. From this point of view, considerable efforts must be devoted for the mobilization and training of the manpower, for the acquisition of new knowledge and know-how, and for informing employees about new green technologies and services and their market potential. Equally important here is the need for a close coordination among a great

Green Business and Entrepreneurship, Table 1 Technology risk/capital intensity green projects funding matrix

		Technological risk	
		Low	High
Capital intensity of project	High	**Project finance/existing firms**	**Hard to fund ("valley of death")**
		E.g.: wind farms, utility-scale solar, "first-gen" biofuel refineries, fabs for solar cells using, established technologies	*E.g.: first commercial plants for unproven solar cell technologies, advanced biofuel refineries, offshore wind farms, carbon sequestration*
	Low	**Bank debt/existing firms**	**Venture capital**
		E.g.: wind and solar components of proven technologies, internal combustion engines, insulation/building material, energy efficiency services	*E.g.: energy efficiency software, lighting, electric drive trains, fuel cells/power storage, wind and solar components of unproven technologies*

Source: Authors, adapted from Ghosh and Nanda (2011, pp. 8–9)

number of heterogeneous and geographically dispersed actors. This coordination often goes through the formation of interest coalitions, vertical and horizontal partnerships, interorganizational networks as well as social and political networks, clusters, etc. (see above).

Secondly, green business implies huge R&D, production, and commercialization costs, notably in energy sectors. Indeed, investing in greentech is usually more costly than investing in polluting technologies because "green entrepreneurs" must face the problem of "double (environmental and technological) externality" that environmental innovations bear. Following this, the financial uncertainties that usually characterize investments in the green business can be high enough to discourage risk bearing by private or even public investors. This is particularly the case for emerging green technologies that require costly research infrastructures and huge basic research efforts that both can hardly be engaged by the private sector. Also, given the challenges characterizing the ongoing and future environmental and climatic issues, the (very) long-time scale underlying the required investments is obviously beyond the financial short-medium constraining time horizon that most private investors and entrepreneurs must usually face. Moreover, as financial markets are both incomplete (future generations do not contribute to the funding of current investments; the market does not allow an efficient inter-temporal allocation of risk bearing) and imperfect (risk aversion and excessive cautious attitude of investors and savers, lack of fair valorization of natural resources and pollution costs, risks related to spillovers appropriation, incomplete information, etc.), long-term and risky projects can hardly find their required financing.

Thirdly, green entrepreneurs need to get access to differentiated sources of funding depending on the evolution stage of their project: public subsidies, seed capital, public equity, and VC for the first stages of the project and savings and banking resources during the further development of the project. Moreover, depending on the type of project they undertake, the risk is high for green entrepreneurs to get trapped within a technological, commercial, or managerial "valley of death" at one moment or another of their evolution (see Table 1). One key obstacle here that green entrepreneurs (especially those involved in radical innovation fields) must face relates to the structural weakness of VC and PE investments. Indeed, less than 4% of total financial investment comes from VC and PE. The explanation for this situation is threefold. First of all, venture capitalists are rather cautious regarding green sectors, which they still consider as being too new and risky. The very emergent character of some green technologies, the uncertainties surrounding the relevant business models to be implemented, and the difficulty to exit from a still too narrow market are the main reasons for such reluctant attitude of VC and PE investors. This explains, in turn, why the supply of VC and

PE funding for clean energy is concentrated among few key players (Ghosh and Nanda 2011). At the same time, it is perhaps not surprising that some of the biggest VC/PE deals in renewable energy were made by companies supported by government loan guarantees (UNEP and Bloomberg New Energy Finance 2011). Equally important as an explanation is the fact that VC and PE are primarily invested in early stage projects, which are less capital intensive than more mature (and highly capital consuming) projects (Ghosh and Nanda 2011). Finally, as some of the most massive environmental technologies (wind turbines, utility-scale solar infrastructures, energy efficiency technologies, etc.) are supported by incremental rather than radical innovations and are also run by large companies, their funding rely more on project finance resources, bank loans, and stock markets than on VC or PE investments. Moreover, VC investments "have begun to move away from radical technologies related to energy production and are increasingly focused on energy efficiency, software, energy-storage and transportation" (Ghosh and Nanda 2011, p. 2).

Fourthly, green entrepreneurs are confronted with important risks (scientific or technological, economic, and legal) that render their financial prospects even more problematic. These risks are susceptible to generate sunk costs (related to the infrastructure, the maintenance of equipment, the training of workers, etc.) that may prove to be significant. This is particularly the case in certain industries (automobiles, energy, building materials, etc.) where several alternative (and noncompatible) green technologies are competing within a standardization process. In this context, there is a risk that "the winner takes it all" and/or important switching costs arise for those trapped in "loosing" technological choices. Equally, learning and experience effects, network effects, and other kinds of "increasing returns to adoption" can deter the entry of pioneer entrepreneurs in green markets, especially those which are either emerging ones or hardly "contestable" by newcomers.

For all these reasons, the transitory intervention of public actors (whatever their nature and forms of intervention) along with the risks taken by the entrepreneurs is often indispensable for the emergence and development of a viable green business. Specifically, only the State is able to mitigate market uncertainties, both through the pooling of the diversifiable risks and by directly taking in charge the consequences of the extreme and nondiversifiable risks. Besides, the State should also create a "favorable environment" for long-term investors.

However, public funding is not a panacea because it also creates at least three additional sources of uncertainty for the entrepreneurs or investors. The first one relates to the possible capture by a small number of powerful/better informed "players" (large companies or lobbies) of a large portion of the public funds offered. The second source of uncertainty is the creation, through the public intervention, of "bubbles" around green technologies or market niches that may ultimately prove to be economic or technological "deadlocks." Finally, unless the public policies devoted to the development of green markets and technologies are clear, credible, and coherent over time in their deployment, it is likely that the public intervention results in a failure.

Psychological and Institutional Obstacles also Play an Inhibiting Role, Though not as Visible as Economic and Financial Barriers

The first difficulty comes from the fact that the transition toward a green or carbon-free economy generates different forms of inertia and resistance (stemming from the sectors that should bear the costs for this transition and from their lobbies) that can slow/block the development of green markets and, as a consequence, discourage green entrepreneurship.

Secondly, purchasing behavior of key clients (households, companies, local public authorities, etc.) for green technologies/products/services can hardly been anticipated *ex ante*. This is the case on the one hand because this behavior depends on the evolution of the preferences of the actors (sensitivity to the economic environment, quality of the available information, "fashion" and "bandwagon" effects, influence of eco-labels, etc.).

These preferences cannot be easily quantified and are traditionally rather conservative and routine-based. On the other hand, clients' price sensitivity and their consent to pay for green products depend greatly on the changes affecting relative prices, which themselves are influenced by many exogenous factors: increase in the prices of key natural resources and energy sources; economic life duration of technical equipment; level of eco-taxes, nature of environmental regulations, and importance of public subsidies in favor of environmental R&D efforts; degree of standardization and substitutability of the alternative green technologies/products/services that are available; intensity of learning effects and their impact on costs/prices reduction over time; etc. As a consequence, there still are many uncertainties regarding the growth rhythm, the robustness, and the solvability of the demand for green products, even if the trend is positively oriented.

Thirdly, green entrepreneurs often face technical or institutional problems relatively hard to be overcome. This is the case when some key infrastructures or technical networks (energy, transports, etc.) are weak or even lacking. There is also a difficulty related to the scarcity of some natural resources or raw materials that are indispensable for certain green technologies. This scarcity is problematic not only because it increases the price for such resources but also because it confers a monopoly power to those actors (notably, certain large companies and countries) that own, preempt, or produce them (Depret and Hamdouch 2012). Finally, extra-economic barriers relate frequently to administrative or bureaucratic rules and behavior, especially when these are connected to political/strategic reasons (national security, sovereignty, geostrategic bargaining power…). Equally important is the absence or weakness of adapted regulations and financial public support to green entrepreneurship and business development.

Conclusion and Future Directions

As it stands today, green entrepreneurship becomes more and more a visible phenomenon though its very industrial bases and development patterns remain unclear. In particular, the economic, political, competitive, and psychological context which conditions this development is as uncertain as contrasted from one country to another. To be sure, whatever the place, green entrepreneurs need "green (new) business models," "green (academic or technical) education and training, "green customers/citizens," "green investors," and "green governments" and "green entrepreneurship policies."

At the same time, one can wonder if green entrepreneurship should be envisaged and analyzed as a specific phenomenon or if it relies on the more standard factors that support innovative entrepreneurship generally speaking, whatever the business sector or innovation field considered. More precisely, are risks borne by green entrepreneurs higher than for other kind of entrepreneurs? Does green innovation emergence and dissemination depend on the same support mechanisms (clustering and networking dynamics, partnerships with large companies, etc.) than innovation in general?

Finally, the emphasis put today on greentech is probably excessive as it is likely that green services, the emergence of new amenities, and the search for solutions toward better quality of life may well also constitute significant opportunities for green entrepreneurs.

These issues are still under question and require further theoretical and empirical investigation, both on the motivations and strategies underlying entrepreneurial behavior in green sectors and on the territorial-institutional specific settings that favor at best green entrepreneurship at the geographical level.

Cross-References

- ▶ Clusters
- ▶ Entrepreneurship
- ▶ Entrepreneurship Policy
- ▶ Innovation
- ▶ Networks
- ▶ Sustainable Development
- ▶ Technology

References

BERR Department for Business Enterprise & Regulatory Reform. Low carbon and environmental goods and services: an industry analysis. Winsford Cheshire: John Sharp: Innovas Solutions Ltd; 2009.

Cooney S. Build a green small business: profitable ways to become an ecopreneur. New York: McGraw-Hill; 2008.

Depret M-H, Hamdouch A. Clean technologies and perspectives of the "green economy" in emergent and developing countries: foundations, opportunities and constraints (forthcoming). In: Laperche B, Levratto N, Uzunidis D, editors. Innovation, growth and sustainable development: the new eco-tech paradigm. Cheltenham: Edward Elgar; 2012.

Ghosh S, Nanda R. Venture Capital investment in the clean energy sector. Harvard Business School Working paper, 11–020; 2011.

Hamdouch A, Depret M-H. Policy integration strategy and the development of the "green economy": foundations and implementation patterns. J Environ Plan Manag. 2010;53(4):473–90.

Hockerts K, Wüstenhagen R. Greening goliaths versus emerging davids: theorizing about the role of incumbents and New entrants in sustainable entrepreneurship. J Bus Ventur. 2010;25:481–92.

Horwitch M, Mulloth B. The interlinking of entrepreneurs, grassroots movements, public policy and hubs of innovation: the rise of cleantech in New York city. J High Technol Manag Res. 2010;21(1): 23–30.

Isaksson A. Cleantech entrepreneurs: attributes, intentions and performance. Front Entrep Res. 2009; 29(5):19.

Koester E. Green entrepreneur handbook: the guide to building and growing a green and clean business. New York: CRC Press; 2010.

UNEP, Bloomberg New Energy Finance, Global trends in sustainable energy investment 2011: analysis of trends and issues in the financing of renewable energy. Frankfurt: UNEP Collaborating Centre for Climate & Sustainable Energy Finance Frankfurt School of Finance & Management; 2011.

Warren L. Sustainable innovation and entrepreneurship. Int J Entrep Behav Res. 2009;15(3):315–6.

Wüstenhagen R, Wuebker R. Handbook of research on energy entrepreneurship. London: Edward Elgar; 2011.

Green Economy

▶ Green Business and Entrepreneurship

Green Enterprising and Green Entrepreneurs

Aljona Sandgren
School of Business, Åbo Akademi University, Turku/Åbo, Finland
Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden

To have innovative ideas is not enough; one needs to bring innovations to society. Entrepreneurs are the necessary link in bringing new ideas to the market and society (Audretsch 2007). Green enterprising is a relatively new concept which needs to be further developed, denoting a bottom-up approach to solutions to environmental challenges, broader than cleantech as it is not just about technology. There is a general need for rethinking our understanding of entrepreneurship and entrepreneurs, our present practices and processes, applying new social science perspectives. Meaning and understanding, how you think about phenomena, is important as this influences our actions. The aim of this entry is to offer an analysis of entrepreneurship in general and green entrepreneurship in particular, based on a literature review supported by results from case studies of entrepreneurs, focused on environmental solutions, in Sweden and Russia. What are the main drivers of green entrepreneurs? What is the importance of cultural, historical, social, and economic factors? Results from this study, including theoretical reflections, will be used here as illustrative examples of green enterprising.

Entrepreneurship today became a banner word, seen often both in developed and developing countries as a solution to many societal and economic problems. The meaning of this term however, varies as there are many different interpretations and understandings. Mainstream definitions have their roots in the ideas of classical and neoclassical economists', who, according to Schumpeter (1954) and Blaug (2000), fail to distinguish the role of entrepreneurs from the capitalist, the owner of capital or manager with an emphasis on profit maximizing. Entrepreneur is often identified narrowly as the rational calculating man, homo *oeconomicus* who acts according to preferences, based on the rationality of his/her choice.

During recent years there are attempts to broaden the view of entrepreneurship, and new terms arise such as *cultural* (Wickham 1998), *social/public* (Steyaert and Hjorth 2006; Nicholls 2006; Bjerke et al. 2007; Gawell et al. 2009), *academic* (Etzkowitz and Leydesdorff 2001; Shane 2004), *green* (Isaak 1998; Schaper 2005, 2010), or entrepreneurship for sustainable development. The main driver for *social/cultural* entrepreneurship, for example, as Kirby (2003) argues is not wealth creation or business capability but creativity, the enrichment of life, by challenging convention and by opening up ways of thinking and behaving that previously did not exist.

Referring to social and/or public entrepreneurship, researchers emphasize that entrepreneurship belongs to society and not just the economy: The focus is on citizens not merely consumers. Social entrepreneurship, as mentioned above, is about making a difference, solving a problem, and the willingness to bring change into society. In connection to social entrepreneurship, it would be important to mention another significant feature of entrepreneurship pointed out by some researchers such as *organizing* (Bjerke et al. 2007). *Organizing*, creating organizations for the realization of visions, ideas, and opportunities, characterizes entrepreneurship as a form of interhuman creativity. This means that it is not only about creating new products or services but also about forming associations, communities, and commitments to activities in the public arena. It is necessary to keep in mind, however, that such interhuman activity is rooted in its own cultural context – habits, traditions, and attitudes.

Green Entrepreneurship/Enterprising

Among researchers focusing on green entrepreneurship theory there exists a clear distinction between *commercial* and *social* entrepreneurs, for example, commercial and social ecopreneurs (Pastakia 1998), green and green–green (ideal type) (Schaper 2005). According to the researchers, *commercial ecopreneurs* are those who seek to maximize personal (organizational) gains by identifying green business opportunities. Social ecopreneurs are those who seek to promote eco-friendly products/technologies either through market or nonmarket routes. However, based on the discussion in this entry and the broader understanding of the nature of entrepreneurship, the division between *commercial and noncommercial entrepreneur* seems problematic.

The definition suggested here is: *Green enterprising* is based on bottom-up approaches, challenge driven rather than market or technology driven. It is about the process of creating and acting, finding and implementing innovations and/or solutions to environmental challenges, new creative combinations of phenomena which could be old or recently invented, learned/developed.

The meaning of *green* in this context is "the coherent pursuit of social and environmental aims while being sustainable, not damaging to the environment or preventing environmental damage" (GEF 2011). It is a mindset and an intention, or it is an existentialist commitment as suggested by Isaak (1998).

The word *enterprising* here was chosen (1) partly because of the rather confusing connotations linked to the narrow understanding of the word entrepreneurship, (2) partly because it is a verb form, highlighting the ongoing activity or process, and (3) it includes many varieties of social endeavors not easily classified as entrepreneurial activity.

In order to understand the nature of entrepreneurship and green entrepreneurship in particular, the author of this entry prefers to take as the point of departure Schumpeter's (1911) definition, which is nonmainstream, with its emphasis on breakthrough innovation and which allows us to consider entrepreneurs as change agents in society. As Michael Schaper (2005) underlines, economies – and societies, for that matter – do not change simply because of inevitable sets of circumstances or trends; they can only transmute when there are people who individually set new directions, suggest new ways of doing, and then successfully become role models. In line with the ideas of Schumpeter and Schaper, entrepreneurs are such individuals. It is important to notice that entrepreneurs are to be found not only within SMEs but also within large enterprises, as so-called intrapreneurs, according to Pinchot (1985), and within the public or not for profit sector – as mentioned above.

The term *green enterprising* functions as an umbrella concept, including all aspects and activities of contemporary entrepreneurs, people with proactive attitude to life and challenges, acting with passion for the better of others and self to a certain degree, are involved in different kind of economic activities such as searching funds, investments, and project financing. Enterprising here is about entrepreneurship in a broader understanding which will be developed below.

Greening of business is a term for making an enterprise greener, decreasing harmful environmental impact (not just paying lip service to environmental concerns in society, by superficial means, so-called greenwashing).

Green enterprising is broader than cleantech, seen as an investment category (or sometimes, as in EU, overlapping with environmental technology, ETAP 2004). Green enterprising includes technology, products, services, practices and processes, new solutions or combinations, sometimes a system of solutions. The underlying idea could appear simple but none the less prove to be smart (as crayfish used for cleaning water, Vodokanal, Russia).

Green entrepreneurship could materialize for many reasons and be:

- *Driven by intention*, challenge or problem based, emanating from environmental and social concerns. In the interview cases, Swedish SME's Solvatten and Scarab, both focused on innovative solutions, based on research, for providing clean water in developing countries, the guiding motivation being a concern with poverty and disease in developing country contexts.
- *Based on an innovative idea* (invention or process): Swedish Biofuels has developed, through advanced research, an alternative fuel made from biomass, which could, in part, substitute fossil fuels in jet engines.
- *Based on solution*: In this case, there is a new solution for financing and ownership of alternative power. O2 Vindel, a Swedish wind power company, develops, runs, and sells wind power. Many of the plants are owned by smaller private companies or by Swedish municipalities. Ecoprom, based in Russia, servicing companies in the field of water supply, sewage, and ecology, and organizing solutions in disaster areas, based on biotechnology.
- *By chance or by seeing a green opportunity*: The Russian company Promelektronica was originally developing advanced navigation equipment for ships, filling a gap after the dissolution of the Soviet Union. They also, including monitoring the quality of the marine environment, developed computer-based antennas and aerials, meteorological support and parameters of the marine environment or subsystem. Mobile monitoring devices now developed can provide automatic reporting about water quality.
- *Greening of business*: The Research and Production Enterprise n.a. Komsomolskaya Pravda is a research based company in Russia focused on energy savings and recycling of plastics. Also, they are now treating their own waste water and are not polluting anymore. They have developed a scientific production and an association for recycling. They produce light diodes and power efficient lighting fittings. Plastic materials and products, made from recycled materials, are provided for other companies. Some new products are based on super high molecular polyurethane research together with information technology in cooperation with universities.

Motivation and Intentions

Analyzing the difference between entrepreneurs in general and green or social entrepreneurs in particular, the argument here is that motivation and intentionality are the significant distinguishing features. The intentions and goals of entrepreneurs, their consciousness, and their values based on moral principles (Bromme 2011) play a crucial role for the direction of their entrepreneurial activity.

There is a common view in Western societies, however, that market is the main driving force behind social and green entrepreneurship. Government's role is to regulate opportunities for market and quasi-market solutions to be used by the self-driven, energetic, and calculating individual. USA has a developed system of supporting entrepreneurs by different structures, incentive system, a network of venture capitalists, and business angels. During the annual Swedish–US entrepreneurial forum, aiming at generating economic opportunities for green entrepreneurship in Sweden and the United States (ESBRI 2011), a question was raised: How entrepreneurship could be promoted in Sweden?

In countries such as Sweden or France, with traditions of large enterprises and strong government, people are more likely to choose the security of working within established enterprises, having regular income rather than living under great uncertainty as entrepreneurs do. It is not the case in Russia, however, where entrepreneurship is a way of survival (Sandgren 2004).

Passion or Interest?

Understanding the sources of human motivation behind green entrepreneurship can be helpful in answering the above mentioned question. Is it really the market which drives people in their actions? Roger Scruton (2012) argues, however, that market solutions subsume human motivation under the model of cost and benefit by seeing rationality in instrumental terms. According to him our moral motive is bound up with our sense of who we are. It is intrinsic, and not instrumental values are behind our moral motives. This argument is fully supported by the interviewed entrepreneurs and green entrepreneurs in particular: *I am a person driven by personal interest and involvement. I must be able to be that in everything...I want to contribute something in the wider context (LM)*. . .*I wanted to make a difference, to solve a problem: I wanted to do something for the environment* . . .*Saw the problem: polluted water. Wanted to help women (PW) I have always been engaged in social problems, since 1968, poverty and environmental problems, developing countries (ASä).*

Passion/love, an idea or vision is what drives entrepreneurs and not possible future profits as expressed in interviews: . . .*without passion you cannot stand all failures and rejections..You burn for an idea and spread your passion to others* (from an interview, PW, 2011). The reason behind is as interviewees say: *It takes a long time before you can make any profit/get results* (*ASä*, 2011). Therefore, the idea behind enterprising should be strong enough to keep entrepreneurs going all the way, despite failures and often a long time, toward success. It takes at least 2 or 3 years before one can get positive results, and it often demands a lot of efforts and extra working hours.

The dichotomy between passion and interest was discussed by Albert O. Hirschman already in 1977, as pointed out by Hjorth and Johannisson (1997) noticed that passion was separated and replaced by interest in the development of capitalist society, which needed control over citizens. Passion with its roots in spontaneity intuition and chaos rather than order is not easy to control. Interest (mostly materialistic wealth) in opposite can be steered and regulated by law, rules, and structures. Therefore, the emphasis has been on the calculating rational man, *homo oeconomicus*, and not on the passionate one. This separation of passion from interest, however, is problematic, as could be concluded from the interviews and stories told by entrepreneurs, who build their businesses and create possible profits on the basis of their passions.

Being Proactive

There are debates in media and research about what role individuals can and should play in solving the societal/environmental problems. Is it the responsibility of the government to act for the better of its citizens, leaving to individuals the more passive duty of not to harm as some researchers suggest (Bromme 2011, forthcoming)? The argument here, however, is that proactive attitudes and a bottom-up approach to solving societal/environmental problems are significant characteristics of the entrepreneurs and in particular, social and green entrepreneurs. Proactive behavior or *doing the thing* (*I am a doer*, LM, 2011) also means that you are not waiting for somebody to take care of your problems and that you are willing to make a difference yourself, that is, meaning here that individuals matter.

This raises another dilemma, can such entrepreneurs be considered as activists, as some researchers suggest? If activism is defined broadly, many social and green entrepreneurs could be considered as activists to a certain degree, but it would be going too far to identify them as activists fully. Entrepreneurship is not just an idealistic action, even pursuing idealistic goals; it always includes some kind of economic activity. This issue, problematizing the possibility of combining material gains for oneself with altruism toward others, again leads to the issue of separation of passion from interest. To conclude, there is a gray zone, making it difficult to decide whether our actions should be considered idealistic or entrepreneurial (even in its broader meaning). This is one of the reasons for the preference here for the term *green enterprising*, with its broader more inclusive connotation.

As discussed above, entrepreneurs act according to their own ideas, values, and moral principles, not waiting for the market or government to take the initiative. This is of course not to say that government policies or support structures do not play a significant role; entrepreneurs need support and encouragement in different forms, first of all, financing in different forms, as investments and grants, or crowd funding as a possible alternative, as well as tax incentives and regulatory infrastructure, as mentioned by the interviewees in Sweden and in Russia.

Entrepreneurship: A Liberating Force?

> Entrepreneurship is about freedom and the possibility to influence and steer your own time (LM)

Another motivation mentioned by the interviewees is freedom. Being able to raise money for *what you want to do*, becoming self-reliant, makes entrepreneurship, to a certain degree, a liberating force. As interviewees confirmed, they choose to become entrepreneurs because they wanted to be in charge *of their own time and to work on their own terms*, even though it could mean more work and less security as well as no guarantee for success. Uncertainty and risk is the price they pay for such freedom. Risk here, however, should be seen from a broader perspective as ownership is not a necessary characteristic of entrepreneurs, according to Schumpeter, but instead in relation to one's own reputation in case of failure, etc. Attitudes in society which allow for failure are important for entrepreneurship to develop, as you learn from your mistakes. In some countries/cultures, however, such as in Sweden, failure is not easily accepted by the society, which influences entrepreneurship negatively, because of the tendency not to trust an entrepreneur who has once failed in business.

Emphasizing the importance of freedom and autonomy for entrepreneurs, it should be made clear that this does not always make entrepreneurs comfortable to work with. They could cause turmoil in organizations, especially large hierarchical establishments with strong emphasis on control.

Entrepreneurs as Contrarians

> ..The driving force or motivation is the ability to think in new ways and go against the current. (LM)

Entrepreneurs in large organizations/corporations – so-called intrapreneurs – could be compared to rebels, following the ideas of Pinchot (1985), who "ask for forgiveness rather than for permission." Intrapreneurs often work "underground," developing the ideas they believe in, which could be different from the official ones. They may work alone or in a smaller group of people whom they trust.

Intrapreneurs do not easily accept the status quo of things in the organization, and their ideas may lead to change in the organization where they work. Being able to go the alternative way requires, as mentioned, a strong sense of autonomy and courage. *Contrarians*, as Edward C. Johnson, owner of Fidelity Investments (1996), calls them, oppose orthodox thinking, and according to him, this is the company's key to success. Through freedom to try new ideas, learning from mistakes, the company builds on its successes. In any case, it is a great challenge for leadership and management to consider such contrarians as assets in the organization, providing them with an allowing and encouraging atmosphere or giving them a *space for play*, as Hjorth (2006) argues. Intrapreneurs need a space where they can try out their new or crazy, at least in the eyes of others, ideas for finding new creative solutions. Otherwise there is a risk of losing such people or their commitment.

In this context it is important to point out the difference between management and entrepreneurship as representing two different rationalities (Hjorth and Johannisson 1997; Sandgren 2012). Management and managerialism as an ideology is striving for control and order which is contradictory to some distinguishing features of entrepreneurship and entrepreneurs, mentioned above, such as the strong sense of autonomy and passion as their primary motivation.

Another significant factor is the breakthrough nature of innovations, which presupposes critical thinking, questioning of norms and established orders, searching for alternative ways and solutions, could be regarded as troublesome by managers. It is important, however, to understand this mentioned above difference in rationalities in order to balance power and control and the independent and passionate nature of entrepreneurs in the organization.

Entrepreneur: An Artist?

> I am an artist . . .being an artist helps me in finding solutions (PW)

Creativity is indeed an important component of entrepreneurial activity, as confirmed in the literature and by the interviewees. However, this is not always understood by researchers who view entrepreneurship from the narrow perspective of being primarily a process of moneymaking or as a management activity. As confirmed by one of our interviewed green entrepreneurs, *creativity is needed – not only in terms of the original idea but also in the implementation of the solution – to see the whole picture, the business solution.* In the era of the knowledge society, creativity and innovation is becoming even more crucial for societal and economic development. Creativity in relation to entrepreneurship and innovation, however, is not always a pleasing activity as pointed out by Alf Rehn (2010) in his book *Dangerous Ideas*. Creativity could be of a rebellious character; by challenging norms, being provocative and even uncomfortable for others, as mentioned above, in this way leading to breakthrough innovations.

Fostering creativity was an important component of their upbringing and early development, as confirmed both by the Swedish and Russian entrepreneurs, with an allowing atmosphere at home and/or being involved in different creative activities outside home. However, not many had entrepreneurs as parents, or role models in this sense, which contradicts some common hypotheses. This is not to diminish the inspirational value of role models and good examples. In this context, it could be added that all the interviewed green entrepreneurs mentioned a love of nature, learned in childhood. This was the basis of their values, motivation, and actions later in life, which confirms the argument above that entrepreneurs act according to their intrinsic values.

Concluding Remarks

To summarize the analysis of interviews on motivation behind entrepreneurship in general and green entrepreneurship in particular, the ambition here is not to give the complete picture of all possible characteristics of entrepreneurship; the aim is rather to help in our understanding that entrepreneurship is a complex, broad, and holistic concept which is made up of many different features, sometimes presupposing each other or interdependent. As confirmed by the interviewees, passion and moral principles, which are rooted in our sense of who we are, are the main motivation of green entrepreneurs (as well as entrepreneurs in general) in particular and not interest (profit). Another distinguishing feature is the proactive attitude and bottom-up approach to solutions. Striving for self-reliance as a necessary condition for freedom and autonomy is important for many entrepreneurs. Breakthrough nature of innovations presupposes the ability of critical thinking and a rebellious nature of creativity. On the basis of these characteristics, it is possible to claim that the general understanding of entrepreneurship is becoming broader as economic/materialistic goals are combined with more altruistic (humanistic, idealistic) ones, and in many cases there is no clear division between for profit or not for profit entrepreneurial activities, as also found in our case studies.

How we define social phenomena is crucial for our understanding and actions. In our view, green enterprising is a useful and broad concept, embracing a variety of entrepreneurial activity including social and public actions. In this way, passion and interest are no longer separated. Individuals matter in this bottom-up, proactive approach to tackling environmental challenges, which implies that individual initiative is important along with the government action.

References

Audretsch DB. The Entrepreneruial Society. Oxford New York: Oxford University Press; 2007.

Bjerke B, Hjorth D, Larsson H, Asplund C-J. Publikt Entreprenörskap. Det marginella görs centralt. Malmö: Folkbildningsföreningen; 2007 (Public Entrepreneurship) (in Swedish).

Blaug M. Entrepreneurship before and after Schumpeter. In: Swedberg R, editor. Entrepreneurship, the social science view. Oxford/New York: Oxford University Press; 2000. p. 76–89.

Bromme J. Notes from SCAS (Swedish Collegium for Advanced Study) seminar on Climate Matters, Uppsala University, 22 Sept 2011.

Bromme J. Climate matters: ethics in a warming world, (forthcoming).

ESBRI. Entrepreneurship and Small Business Research Institute, Stockholm, 2011. www.esbri.se.

ETAP. 2011 Environmental technologies action plan, communications, 2004. http://ec.europa.eu/environmnet/etap

Etzkowitz H, Leydesdorff L, editors. Universities and Global Knowledge Economy. A Triple Helix of University-Industry-Government Relations. London, New York: Continuum, Science, Technology and the International Political Economy Series; 2001.

Gawell M, Johannisson B, Lundqvist M. Entrepreneurship in the name of society. Stockholm: KK Foundation; 2009.

GEF. Green entrepreneurship forums, Green entrepreneurship. An introduction, 2011. http://www.generation-europe.eu/forum

Hjorth D. Entrepreneurialism and managerialism. In: Keynote address presented at the Rethinking Entrepreneurialism in the University Context Conference, St. Petersburg organised by Stockholm University with funding from the Swedish Institute, 2006.

Hjorth D, Johannisson B. The ugly duckling of organizing – on entrepreneurialism and managerialism, 1997. Retrieved from www.sbaer.uca.edu/research/icsb/1997/pdf/44pdf/

Hirschman AO. The passions and the interests: political arguments for capitalism before its triumph. Princeton: Princeton University Press; 1977.

Isaak R. Green logic: ecopreneurship, theory and ethics. Sheffield: Greenleaf; 1998.

Johnson EC. Adventures of a contrarian. In: Managing innovation, Daedalus, Journal of the American Academy of Arts and Sciences. Cambridge: Spring, 1996; 125(2):167–82.

Kirby DA. Entrepreneurship. Berkshire: Mc-Graw-Hill Education Heynemann; 2003.

Nicholls A, editor. Social entrepreneurship. New models of sustainable social change. Oxford: Oxford University Press; 2006.

Pastakia A. Grass-roots ecopreneurs: change agents for a sustainable society. J Org Change Manag. 1998; 11(2):157–73.

Pinchot G. Intrapreneuring: why you don't have to leave the corporation to become an entrepreneur. New York: Harper & Row Publishers; 1985.

Rehn A. Farliga Ideér. När det opassande tänkandet är din värdefullaste resurs. (Dangerous Ideas), Stockholm: Bookhouse (in Swedish), 2010.

Sandgren A. Managerialism and entrepreneurialism in universities-is there space for creativity? In: enlightenment, creativity, and education-polities, politics, performance. Rotterdam: SENSE Publishers; 2012.

Sandgren A. Are Russian universities becoming entrepreneurial? In: Shattock M, Knjazev E, Pelikhov N, Sandgren A, Toivonen N, editors. Entrepreneurialism and the transformation of Russia universities. Paris: IIEP, UNESCO; 2004. p. 57–76.

Schaper M, editor. Making ecopreneurs: developing sustainable entrepreneurship. Farnham: Ashgate Publishing; 2005.

Schaper M. Making Entrepreneurs. Developing Sustainable Business, second edition. Farnham, Surrey, UK: Gower Publishing; 2010.

Schumpeter JA. The theory of economic development. London: Oxford University Press; 1911/1980.

Schumpeter JA. History of economic analysis. New York: Oxford University Press; 1954/1994.
Scruton R. Green philosophy. How to think seriously about the planet. London: Atlantic Books; 2012.
Shane SA. Academic Entrepreneurship: University Spinoffs and Wealth Creation. Cheltenhamn, UK: Edward Elgar Publishing; 2004.
Steyaert C, Hjorth D, editors. Entrepreneurship as social change. Cheltenhamn: Edward Elgar; 2006.
Wickham PA. Strategic entrepreneurship: a decision-making approach to new venture creation and management. London: Pitman Publishing; 1998.

Green Growth

▶ Green Business and Entrepreneurship

Group Creativity

▶ Creative Collaboration

Group Musical Creativity

▶ Creativity in Music Teaching and Learning

Growth

▶ Business Start-Up: From Emergence to Development
▶ Networking Entrepreneurship
▶ Open Innovation and Entrepreneurship

Growth and Development

▶ Joseph A. Schumpeter and Innovation

Guided Creative Idea

▶ Scientific Inventive Thinking Skills in Children

Guided Evolution

▶ Directed Evolution® Technology

Gut Feelings

▶ Role of Intuition in Creativity

H

Health of Entrepreneurs

Olivier Torrès
University of Montpellier South of France, Montpellier, France

Stating the Existence of a Blind Spot

The French economy has very few statistics regarding occupational health in SMEs, particularly with regard to the employer. This fact, however, is not specific to France. At the current time, it seems that there is very little work and very few statistics from abroad either on this theme. There is thus an almost universal lack of information. Occupational health appears to have been pushed away from the entrepreneurial realm.

Nevertheless, one of the founding works on occupational medicine, written by Ramazzini in the 1700s, is entitled the "Traité de la maladie des artisans" (Treaty on the illnesses of craftsmen) (De Morbis Artificum Diatriba). Its aim, wrote Ramazzini, was to understand through observation why certain trade associations seemed preserved from certain dangers, such as the plague, for example, when others presented on the contrary much stronger prevalence. As man spent more time working than doing anything else, the conditions in which he did it, as well as the fact of handling certain harmful or healthy substances inherent to his business, were able to explain his health. Occupational medicine was born.

The most notable and most decisive progress with regard to occupational health came undoubtedly from Louis René Villermé who, in the nineteenth century, was interested in the work conditions of the working class in a context of increasing industrialization. His major work, the *Tableau de l'état physique et moral des ouvriers employés dans les manufactures de coton, de lain et de soie* (Table of the physical and moral state of the workers employed in cotton, wool and silk factories), which was first published in 1840, was the origin of a law limiting child labor in factories. The role played by Villermé and the rise of industrial hygienism explain why occupational medicine focused on the effects of mass industrialization on health at work.

Occupational medicine probably has a more social mission than other medical disciplines: its genesis in the nineteenth century and its extensions in the twentieth century have, over time, defined an implicit social purpose, to defend the weakest (the work of women and children) and especially the underprivileged classes. In such a context, the working class becomes central, and "workerism" still remains strongly anchored in the writings of contemporary occupational doctors. René Barthe, who was the inspiration for the law of July 28, 1942 in the Vichy regime which established occupational medicine as an obligation and was the author of the first "Que Sais-Je," on occupational medicine, in 1944, declared "Let us be the good 'housekeepers' of our factories, as our farmers are the good

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"housekeepers" of our land. This essay aims to present this new culture, which is a permanent effort for a better life for our working class world" (Barthe 1944, p. 9). The question of workers' health remained for a long time and is, even today, a profound identity marker for occupational medicine. It is moreover in the bastions of industry that developed the first initiatives for a chair of occupational medicine, such as in Lyon in 1930 or in Lille in 1935, in the heart of the mining cottages of the mining industry in the North. Today, there is still a strong tradition for occupational medicine in Lille.

In France, occupational medicine has been highly structured since the law of 1946 (Desoille 1958). It focuses almost exclusively on the occupational health of employees. Barthe considered that a "definition of Occupational Medicine is easy to find if we restrict ourselves to its general principle: it is a Social science directed toward the protection of employees in their very place of work" (Barthe 1944, p. 6). This focus on employees only has had two consequences.

On one hand, occupational medicine has allowed numerous forms of social progress to develop and analysis of employees has been perfected with subtle subcategorizations: workers are divided into qualified and unqualified. Similarly, statistics make a distinction, with good reason, between executives and senior executives. On the other hand, the disadvantage is that the self-employed are totally excluded from the tables and any data calculated on such matters. Only directors with employee status are covered by occupational medicine, although only 170,000 companies have such directors and are a tiny minority with regard to the 2,411 million nonwage earners counted by INSEE (National Institute for Statistics and Economic Studies) in France in 2008.

For this reason, as soon as it is a question of nonwage earning independent workers, there are less statistics, and those that are there are more vague because they are very heterogeneous. Sometimes storekeepers and craftsmen are included. Sometimes there are the liberal professions, as if master bakers or stonemasons can be compared with professionals such as attorneys and lawyers! Where are the business managers, who are neither craftsmen, nor storekeepers, and even less liberal professions? How do we make a distinction between the leaders of very small firms, small firms, and medium-sized companies?

Do the statistics for occupational health take into account managerial contingencies, in particular those related to the size of workforce? Experts were skeptical at first, but no longer have such doubts today. The concept of SME, taken in its full complexity, is not a relevant category for the medical sciences. Nevertheless, independents work in conditions with many particularities.

Although health is an essential topic, the health of business managers is an unrecognized aspect. Nevertheless, the health-capital of the director, whether he is a craftsman or a storekeeper, is probably the first immaterial asset in the company because dependence on the director is all the greater if the company is small, and this is precisely the main feature of small shops and the craft industry (Mouzaoui and Horty 2007). Henri Fayol, in his *Administration Industrielle et Générale* makes health and physical strength the first cardinal value of the business manager. "The qualities and desirable knowledge for all CEO are as follows:

1. Health and physical strength
2. Intelligence and intellectual strength
3. Moral qualities: well-thought out, firm desires, and perseverance; activity, energy and, if necessary, audacity; the courage of responsibilities; a feeling of duty; and a concern for general interests
4. Good general knowledge
5. Administrative capacities
6. General notions of all the main functions
7. The widest possible range of skills in the particular profession that is characteristic of the company"

The director's health is often synonymous with the good health of the company, whereas on the contrary, a health problem can bring down the whole company (Chao et al. 2007; Massey et al. 2004).

Fayol adds that "the absence of health can cancel out all other qualities together"

(Fayol 2005, p. 84). It is enough to think of the devastating effects which a health problem can have on small-sized companies, as Chao et al. (2007) do with AIDS to show the value of cross-referencing medical sciences and entrepreneurship sciences. All these considerations plead in favor of a study of the health-capital of directors, in the style of what Bournois and Roussillon (2007) did in the context of the directors of large groups, but instead adapting it to the specificities of SMEs (small- and medium-sized enterprises).

The objective of this contribution is to draw up a corpus of hypotheses on the occupational health of entrepreneurs. Then, it presents the fundamental equation for entrepreneurial health. What researchers know about the working environment of entrepreneurs pushes them to believe that their working system is pathogenic (work overload, stress, uncertainty, loneliness…). But, in reference to the works on "salutogenesis" (Bruchon-Schweitzer 2002) which can be traced back to the middle of the 1990s in the field of health psychology, this entry will show that these negative effects are probably compensated for (in whole or in part?) by a system of beliefs which can be beneficial for health. The key question is to know in which direction the scales are tipped.

Given what is at stake, studying the beliefs, attitudes, and behaviors of entrepreneurs with regard to physical and mental health is a surprisingly virgin field of research (Kaneko et al. 2011). The results of such research could be very interesting. The initiative behind the AMAROK observatory, the first observatory for entrepreneurial health, is part of this perspective. Certain aspects of this observatory are presented in the conclusion.

The Failings of Health Statistics for Entrepreneurs

"Self-employed" is a banner label for all independent workers with no employer, employers themselves, and home helps. In 2008, they represented 9 % of the active population in France. The lowest percentage (5 %) is found in the Paris area, while Languedoc-Roussillon has the highest, with 13.5 %. To answer the question of the health of this population, the observer is obliged to notice that the existing statistics are profoundly insufficient, both at the quantitative and qualitative levels. The first notable fact is the almost total absence of data on the health of SME directors. It is true that SMEs are not regarded as a relevant dimension for studies on health.

Among the most commonly selected variables, there is a high frequency of age; gender; average revenue; socioprofessional categories; level of study; and, to a lesser extent, place of residence and marital status. It is thus very difficult to obtain statistics which are dedicated exclusively to SMEs.

It is, however, possible to obtain some statistics which get closer to the world of SMEs, even if they do not exhaust the subject: it is the statistics which are interested in the social and occupational group of craftsmen and storekeepers. Even if these statistics are invaluable when it comes to tackling the problem of the health of directors of SME, they are nevertheless presented under a common category of extremely heterogeneous situations. These statistics often group together the category of storekeepers with that of craftsmen. However, the trade and craft industries have notable differences with regard to the relationship to work and know-how and trade union representativeness (Medef/CGPME for the trade vs. UPA (Professional Union of Craftsmen) for craftsmen).

Similarly, craftsmen develop the use of manual work much more than in trade, and manual work often involves a more intense use of the body, which can result in specific pathologies. Shopkeepers and craftsmen are thus two similar fields of activity as they are often keen to preserve their independence but which nevertheless have differences. These differences, in terms of health, deserve greater differentiation.

But the worst is that sometimes studies are based on figures which mix craftsmen, tradesmen, and liberal professions. Although the liberal professions are also concerned by independence, as evidenced by the professional orders which govern them, they have very considerable differences with craftsmen and tradesmen. For example, the "level of study" variable is generally high in liberal professions and much lower among craftsmen and tradesmen. Yet, it has been proven that this variable has an impact on health (Bruchon-Schweitzer 2002). Another variable that has an incidence on health is the capacity for organization of liberal professions when in work collectives.

Lawyers, chartered accountants, medical specialists, solicitors, land surveyors, and receivers work much less on their own than previously. Increasingly, they group together as partners, which greatly facilitates the pooling of means (secretarial department, office) and resources (clientele, network), as well as making possible a better management of absences, particularly in case of illness or vacation time. In addition, the feeling of loneliness is reduced, and certain works have shown that loneliness has a pathogenic impact on health (Bruchon-Schweitzer 2002). Storekeepers and craftsmen, on the other hand, are often very much alone in their jobs, and this can be an almost insoluble problem when they fall ill or wish to take time off.

Another point which deserves to be underlined is the total ignorance of the size of the staff for which storekeepers and craftsmen are responsible. Although most storekeepers or craftsmen work alone, sometimes with the assistance of their spouses or children (what statistics refer to as family help), many businesses have employees, sometimes several dozen. This gives these storekeepers/craftsmen the role of an employer business manager. But the statistics never provide information regarding the size of the company of which the storekeeper or craftsman is the director. In other words, the size of the staff is never indicated, and it is a shame, as it is a situation which strengthens the impression that the statistics for health in the work place are not interested in SMEs.

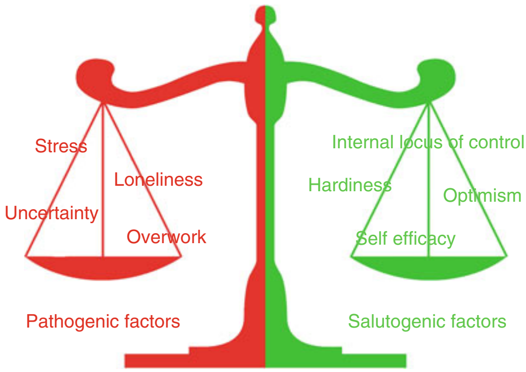
In spite of all these limitations associated with the heterogeneity of the craftsmen and storekeepers socioprofessional category and the even greater heterogeneity of the craftsmen, storekeepers, and liberal professions category, we can, by cross-referencing the few statistics available, nevertheless obtain a body of evidence which converges on the same observation: craftsmen and storekeepers sometimes have a state of health more like that of workers than that of senior executives.

The Entrepreneurial Health Equation: Pathogenic Factors Versus Salutogenic Factors

The health of entrepreneurs is subject to permanent conflict between pathogenic factors, which have a negative impact on health, and salutogenic factors, which are beneficial. The equation for entrepreneurial health is thus:

On the one hand, although occupational doctors have long been aware that overwork, stress, uncertainty, and solitude are long-term pathogens for employees (Leclerc et al. 2008; Niewiadomski and Aïach 2008), they have never wondered what effect these factors have on employers. But how is it not possible to see just how much entrepreneurs often accumulate these four factors? Many works have been published on overwork and the resulting increase in stress (Buttner 1992; Akande 1994; Mcdowell-Larsen 2007; Ahmad and Salim 2009) among company owners, who often work more than 60 h a week (Boyd and Gumpert 1983; Roussillon and Duval-Hamel 2006). Uncertainty is also one of the fundamental elements of the entrepreneur, one of whose characteristics is that he has variable income, unlike the regular monthly salary paid to employees. In certain sectors, the order book does not go further than a few months in advance, sometimes just a few weeks in times of crisis. The director must deal with this uncertainty on a permanent basis. Finally, Gumpert and Boyd (1984) have insisted heavily on the isolation, or even solitude, of directors, to the extent that the use of entrepreneurial networks, or associations of peers, is often salutary. Such isolation makes the director fragile, and when difficult decisions – such as redundancy – have to be made, directors are often filled with doubt and remorse (Torrès 2009).

On the other hand, health psychologists (Bruchon-Schweitzer 2002; Fischer and Dodeler 2009) are aware that the internality of the locus of control, endurance (hardiness), self-efficacy, and optimism are all salutogenic… even though they have never noticed that they are simply entrepreneurial attitudes and beliefs! Once again, how is it possible to not notice that these are characteristics that are often associated with entrepreneurs? Although empirical studies hoping to validate the



Health of Entrepreneurs, Fig. 1 The entrepreneurial health equation (Source: Torrès 2012)

locus of control theory have never been able to establish even a modest correlation between this psychological characteristic and entrepreneurs, it nevertheless remains positive (Janssen and Surlemont 2009, p. 41). Verstraete (1999, p. 165) also evokes the importance of the internality of the locus of control in entrepreneurial behavior. Finally, Filion (1997), by identifying the works from what is known as the "school of characteristics," showed that optimism and perseverance are psychological traits common to entrepreneurs. The same can be said for self-efficacy (Bradley and Roberts 2004). Entrepreneurship, is it good for health (Volery and Pullich 2010)? (Fig. 1)

Hence, this fundamental equation for entrepreneurial health: on the one hand, we accept the work of occupational medicine is interesting; there is a system of constraints to which a large number of directors are subject and which seems to be pathogenic. And, on the other, recent works from the field of health psychology, which show that the entrepreneurial attitude and belief system is in fact salutogenic. The question this raises is thus how do we know when the scales are going to tip one way or another?

Conclusion and Future Directions

It was in the aim of resolving this entrepreneurial health equation that the initiative of creating the AMAROK observatory is appeared, the first such structure for the health of SME owners. AMAROK is an Inuit name that means wolf. It refers to a legend, the moral of which is that a society must protect those who support it.

AMAROK is an observatory with a scientific and experimental vocation, the aim of which is to study the beliefs, attitudes, and behaviors of SME owners, craftsmen, and tradesmen with regard to their physical and mental health. Based on the theories governing the specificity of SMEs, this observatory also aims to devise and propose practical actions in the field both in terms of prevention and cure. The priority population is that of SME owners and craftsmen.

The objective of this observatory is to combine medical and entrepreneurship sciences. The AMAROK project is complex and requires a multidisciplinary approach. The scientific skills mobilized involve occupational medicine and public health, entrepreneurship and management, health and workplace psychology, as well as the economy and geography of health. However, this observatory remains anchored primarily in management science because the ultimate purpose is to improve SME management.

By combining the two sides of the employers' health equation (i.e., the pathogenic and salutogenic aspects), AMAROK hopes to attain an ambitious goal: ideally, AMAROK would like to produce the first medium-term statistics on the health of employers. The issues at stake are perfectly matched to this ambition.

- Either AMAROK discovers that the owners of SMEs, craftsmen, and tradesmen put their health in danger without their knowledge and brings to light a public health scandal
- Or, on the contrary, AMAROK will discover that entrepreneurship is beneficial for health. In the latter case, AMAROK will have one of the best arguments for promoting human-sized enterprises and craft industries: SMEs are good for your health!

In the medium term, the aim of AMAROK is to create one of the first epidemiological records of a cohort of SME managers. The stakes are high because the sums involved are substantial and the commitment must be long term (one to several decades) (Bousquet; Dreyfus Daures, Demoly, 2004). It is important to know that there is no such register anywhere in the world.

Cross-References

- ► Entrepreneur
- ► Entrepreneurial Capability and Leadership
- ► Entrepreneurship and Social Inclusion
- ► Individual determinants of Entrepreneurship

References

Ahmad SZ, Salim FAA. Sources of stress and the coping mechanism for Malaysian entrepreneurs. Afr J Bus Manag. 2009;3(6):311–6.

Akande A. Coping with entrepreneurial stress: evidence from Nigeria. J Small Bus Manag. 1994;32:83–7.

Barthe R. La médecine du travail. Presses Universitaires de France, Paris, Coll. Que sais-je?, 1944, n°166, 128p.

Bournois F, Roussillon S. Les dirigeants et leur capital santé. dans de Bournois F, Duval-Hamel J, Scaringella JL, Roussillon, S sous la dir. Comités exécutifs : Voyage au cœur de la dirigeance. Editions Eyrolles; 2007. pp. 206–211, 862 p.

Boyd DP, Gumpert DE. Coping with entrepreneurial stress. Harv Bus Rev. 1983;61:44–64.

Bradley DE, Roberts JA. Self-employment and job satisfaction: investigating the role of self-efficacy. J Small Bus Manag. 2004;42(1):37–58.

Bruchon-Schweitzer M. Psychologie de la santé – Modèles, concepts et méthodes. Paris: Editions Dunod; 2002. 440 p.

Buttner HE. Entrepreneurial stress: Is it hazardous to your health? J Manag Issues. 1992;4(2):223–40.

Chao LW, Pauly MV, Szrek H, Sousa PH, Bundred F, Cross C, Gow J. Poor health kills small business: illness and microenterprises in South Africa. Health Aff. 2007;26:474–82.

Desoille H. La médecine du travail, première édition. Paris: Presses Universitaires de France; 1958. 128 p

Fayol H. Administration industrielle et générale. Paris, Editions Dunod, première édition 1916, 2005. 133p.

Filion LJ. Le champ de l'entrepreneuriat: historique, évolution, tendances. Rev Int PME. 1997;10(2):129–72.

Fischer GN, Dodeler V. Psychologie de la santé et environnement – facteurs de risque et prévention. Editions Dunod, Coll. Topos; 2009. 150 p.

Gumpert DE, Boyd DP. The loneliness of the small-business owner. November–December: Harvard Business Review; 1984. p. 18–24.

Janssen F, Surlemont B. L'entrepreneur : ses caractéristiques et ses motivations. dans Janssen F, sous la dir, Entreprendre – une introduction à l'entrepreneuriat. Bruxelles: Editions De Boeck; 2009. pp. 33–48, 343 p.

Kaneko S, Ogyu H, Torrès O, Kamei K. Mental Health of managers of small and medium enterprises as seen from the viewpoint of risk management. J Disaster Res. 2011;6(2):204–11.

Leclerc A, Kaminski M, Lang T. Inégaux face à la santé – du constat à l'action. Paris: La Découverte; 2008. 298 p.

Massey C, Harris C, Lewis K. Death, divorce and disease: personal life event and the business life-cycle. In: European Council for small business, RENT XVIII conference, Copenhagen, 2004.

Mcdowell-Larsen S. L'effet néfaste du stress sur les dirigeants. dans de Bournois F, Duval-Hamel J, Scaringella JL, Roussillon S, sous la dir. Comités exécutifs : Voyage au cœur de la dirigeance. Editions Eyrolles; 2007. pp. 185–190, 862 p.

Mouzaoui H, L'Horty Y. Quels emplois pour les PME? Étude sur les PME et l'emploi en France, Regards sur les PME, Paris, OSEO, 2007: n°15, 194p.

Niewiadomski C, Aïach P(coordonné par). Lutter contre les inégalités sociales de santé – politiques publiques et pratiques professionnelles. Presses de l'EHESP, Coll. Recherche Santé Social; 2008. 286 p.

Roussillon S, Duval-Hamel J. Le stress des dirigeants : mythe, compétence clé, risque pour l'entreprise?. Cahier de recherche EM. LYON Business School 2006; 2006/03: 30.

Torrès O. L'inaudible et inavouable souffrance patronale : le cas du licenciement en PME. dans de Lecointre G, sous la dir. Le grand livre de l'économie PME. Galino Editeur; 2009. 639 p.

Torrès O (ed). La santé du dirigeant – de la souffrance patronale à l'entrepreneuriat salutaire, Bruxelles: Editions De Boeck, 2012, 217p.

Verstraete T. Entrepreneuriat, connaître l'entrepreneur, comprendre ses actes. Paris: Editions L'Harmattan; 1999. 207 p.

Volery T, Pullich J. Healthy entrepreneurs for healthy businesses: an exploratory study of the perception of health and well-being by entrepreneurs. N Z J Empl Relat. 2010;35(1):4–16.

Healthcare and Innovation

Piera Morlacchi
Department of Business and Management, School of Business Management and Economics (BMEc), University of Sussex, Falmer, East Sussex, UK

Synonyms

Medical innovation

Innovation is viewed as fundamental in healthcare, leading to advances in medicine, and individual and public health but also to economic growth and generation of wealth. When people think about innovations in healthcare, they normally focus on technological innovations such as drugs, devices, and diagnostics that have advanced medical practice and the treatment of diseases. This leaves a gap and, therefore, a need to further define and explain the nature of "healthcare systems," "healthcare innovations," and "healthcare innovation process."

Health, Healthcare, and Healthcare Systems

Health has been defined by the World Health Organization (WHO) as "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO 1946), and healthcare is about the prevention, treatment, management of diseases and illness, and the preservation of health and well-being through the services delivered by healthcare providers. These healthcare providers include medical and allied health practitioners and professionals such as physicians, nurses, medical technicians, therapists, pharmacists, nutritionists, paramedics, complementary and alternative therapists, and community health workers.

Healthcare or healthcare system is the organization of the healthcare services to meet the needs of a target population. There is a wide variety of healthcare systems around the world which are characterized for instance by different levels of access, funding, and structure of provision of healthcare services. The main actors which are common to many healthcare systems are hospitals and other medical facilities (e.g., primary care centers, clinics, and other specialized medical facilities such as IVF clinics), universities and research institutes, industrial firms and their suppliers (e.g., pharmaceutical companies but also specialized suppliers of electronic components for medical devices and of reagents and animal models for scientific laboratories), governments and public agencies (e.g., National Institute of Health (NIH) in the USA), regulators (e.g., Food and Drug Administration (FDA) in the USA and the National Institute of Clinical Excellence (NICE) in the UK), payers (e.g., third-party payers in USA like Medicare and Medicaid), professional bodies and societies, medical charities, patient associations, the media, and the public at large. Most people have direct experience of part of the healthcare system constituted by the providers and facilities involved in the delivery of healthcare (e.g., physicians, nurses, and hospitals), whereas other parts of the system such as the healthcare industry (e.g., medical device sector) and the medical research community (e.g., research centers and academic institutions) are less visible.

Healthcare is important also in economic and financial terms in many countries around the world. With its subsystems such as healthcare delivery and healthcare industry, it is one of the largest and fast-growing industries in developed countries and consumes high rate of gross domestic product (GDP) also in developing countries.

Healthcare Innovation

In order to understand healthcare innovation, it is useful to start with what is known about innovation more in general. Innovation refers at the same time to something new (e.g., a product, process, or an idea) and to the act or process of innovating, which is coming up with an innovation. Other terms used to indicate the innovation process or parts of it are technological change, technological progress, technological evolution, and technological development. Innovations can be classified according to "types" (e.g., new product, new methods of production, new ways to organize business) and to how radical they are compared to what is already in use (e.g., radical vs. incremental innovations). Among other findings, studies of innovation have pointed out for instance that although an important distinction is normally made between "invention," "innovation," and "diffusion" – where invention is the first occurrence of an idea, while innovation refers to the first attempt to use out an idea and diffusion to the spread of it in practice – those are stages of a continuous process. A "linear model of the innovation process" sees it as constituted by a sequence of activities that goes from basic research through applied research, targeted development, manufacturing and marketing, until adoption (or diffusion), and use. A more simplified version is a two-step model that distinguishes only between development and diffusion. The linear model of innovation assumes that either scientific research and technological development ("technology push" model) or market demand ("demand pull") are the main drivers of innovation. Although the linear model has been shown inadequate to represent what happens in empirical terms where feedback mechanisms and loops among different stages can be observed, this simplified view of the innovation process remains widely held in the public at large and in some parts of the medical community. A more productive approach to understand innovation is to unpack different stages of the process such as development and diffusion and the feedback mechanisms and loops among them.

From studies of innovation in different domains, it became clear that the organization for innovation and innovation processes can have varying configurations in different contexts and evolve over time. It follows that general findings and theories about innovation need to be validated in specific contexts. This is the case for innovation in the context of healthcare where innovations and the processes that lead to their development and use have some specific characteristics. The popular image of healthcare or medical innovation is the one in which a group of biomedical scientists in a research laboratory come up with an idea that moves in a linear manner from the bench to the bedside. However, innovation studies have shown that this linear conceptualization of medical innovation is misleading. Important issues are related to the nature of healthcare innovations, their development, diffusion in healthcare organizations, and regulation of the overall innovation process.

The Nature of Healthcare Innovations

When people think about innovations in healthcare, they normally focus on technological innovations such as drugs, devices, and diagnostic that have advanced medical practice and the treatment of diseases such as antibiotics, pacemakers, and ultrasound. Other health innovations such as clinical procedures (e.g., minimally invasive cardiac surgery), organizational innovations (e.g., intensive care units or ICUs), and infrastructural innovations (e.g., such as information and communication technologies such as computer-based hospital information systems) have less visibility and have been less studied.

The Development of Healthcare Innovations

Although healthcare innovations and the dynamics of their innovation processes are quite diverse, studies have focused on the study of technological development in medicine and in particular drugs. General findings on technological development in medicine are the importance of the interaction between developers, clinicians, and regulators; the feedback mechanisms between different steps of the development process and between the development and use (including diffusion); and the importance attributed to randomized clinical trials to provide evidence of efficacy for new treatments.

Pharmaceutical innovation is useful to illustrate some of these findings in the context of the development of new drugs. Research on pharmaceutical innovation has highlighted that it is science-based or depending on advances in life sciences (e.g., molecular biology), lengthy and expensive, and uncertain. The process of drug discovery has become increasingly complex and sophisticated. It was based on random screening of compounds to find new drugs until 1940s, later on began a transition to a more "guided" process or "drug development by design" drawing heavily on advances in molecular biochemistry, pharmacology, and enzymology until 1970s, and more recently on tools of genetic engineering. After a new drug has been identified, it goes through a development process that includes preclinical research (e.g., animal testing), clinical trials (i.e., testing in humans), and in some cases regulatory approval. Clinical trials are a set of procedures used to collect data on safety (e.g., adverse drug reactions and adverse effects of other treatments) and efficacy of new drugs, used both in the process of development and regulatory approval of new drugs and other therapeutic interventions. It can take between 10 and 20 years between the start of the process of discovery and when a new drug reaches the patients for normal clinical use, and many new drugs considered promising in drug discovery fail to do so. The development of a drug does not end necessarily with the adoption in clinical practice because new indications for existing drugs can be found (e.g., use of beta-blockers in the treatment of heart disease) or better compounds can be developed from learning by using in the treatment of patients. Close relationships among industry, academia, and government have been always crucial to drug discovery and development, because basic biomedical and clinical knowledge created in university and public funded settings are exploited in industrial laboratories, which also conducted basic research and drug discovery. However, over time, the division of labor between actors involved in the process has changed leading the industry to focus their investments more on final stages of drug development and testing and to leave the initial and more uncertain stages to academia and publicly funded research institutions.

Although the development of other medical technologies like devices and diagnostics are less studied than drugs, some general findings like the importance of the interaction between developers, clinicians, and regulators or casted difference of industry, academia, and government, and the importance and role of research, regulation, and uncertainty also stand in these contexts, but some differences can be noticed. For instance, the process of development of new devices and diagnostics is in many cases shorter than drugs, even when regulatory approval is necessary before introducing a product on the market (e.g., hip replacements). Moreover, although also a large proportion of the market in the medical device and diagnostic sectors are concentrated in the hands of a few multinational firms, differently from the pharmaceutical sector (also including the biotechnology side of it), they are populated by large number of small firms that contribute to innovation dynamics.

The Diffusion of Health Innovations in Healthcare Organizations

Research on the diffusion of medical innovations focuses on explaining why and how an innovation spread and got adopted in clinical practice or generally used. Studies on the diffusion of innovations in healthcare organizations pointed out the following factors: the nature of the innovation itself in terms of, for instance, complexity of use, relative advantage to existing technologies, and possibility to try and observe the innovation; the adoption and implementation processes also in terms of communication and influencing process (e.g., existence of innovation champions and lead users); and the organizational context and its immediate environment (e.g., reimbursement mechanisms that shape financial incentives for the purchasers such as hospital administrators to adopt new innovations, but also reputational effects brought by the adoption of new technologies).

The Regulation of Healthcare Innovation

In many countries, healthcare and healthcare practices are highly regulated (e.g., standardization of medical practice through guidelines which are issued by professional bodies with the aim of guiding decisions and criteria regarding diagnosis, management, and treatment in specific areas of healthcare). This extends also to healthcare innovation, where both innovations and the process that leads to their development and use are regulated. Healthcare innovations such as drugs and devices are reviewed and evaluated by appointed bodies in each country (e.g., in the USA is the Food and Drug Administration (FDA)) on the basis of data on safety and efficiency collected in some cases through clinical trials before they are introduced in clinical practice and released on the market. The level of scrutiny depends on the level of risks attributed to different products, and in some cases, the monitoring of their performances continues also after they have been introduced in the market (e.g., risky new devices such as pacemakers and heart valves are evaluated before their introduction on the market but also after they are introduced in clinical practice through the compulsory reporting of adverse events and malfunctioning, and defective products can be ordered to be recalled).

The Nature and Direction of the Healthcare Innovation Process

The Nature of the Healthcare Innovation Process

Although the nature of innovation process in healthcare can be characterized as dynamic and systemic, a linear view of the medical innovation process still prevails. The assumption of the linear model is that scientific knowledge developed through basic scientific research and engineering knowledge developed in the biomedical field or through technology transfer from other fields (such as in the case of laser and ultrasound) are driving innovation in healthcare. However, the linear conceptualization assumes first of all that it is possible to make a clear distinction between research and development on one hand and adoption and use on the other, whereas in many cases, like medical devices but also therapeutic drugs, the development does not end with the adoption of an innovation, but there are incremental changes. Moreover, the development occurs not only in industrial R&D laboratories but also in the context of clinical practice. This is the case for laser that was introduced for the ophthalmologic and dermatological purposes, but new indications of use were discovered in clinical practice such as in oncology, thoracic surgery, gynecology, and other specialties. An alternative conceptualization to the linear model is a dynamic (or more evolutionary) model where there are feedback mechanisms in the process between the phases of adoption and use and applied research and development, i.e., after the introduction of the first-generation innovation in clinical practice through learning by using important information about improvements can be generated and embodied in new generations of the innovation.

The interactive and distributed nature across time and space and across areas of medical practice and institutions of healthcare innovation process can be labeled as "systemic." It follows that approaches that study the systemic nature of the healthcare innovation process focus on the components of the system or actors and their interactions in specific contexts. The difference among some approaches is in the way in which they determine the boundaries of the systems: national and regional approaches focus on geopolitical boundaries and sectoral or technology approaches identify actors that operate in the same product market.

The Role of Users and Other Actors

The development and use of new medical innovations is also shaped by the demand for these innovations, which is traditionally related to the needs and preferences of users like physicians and the end customers, i.e., the patients. Physicians are users of medical technologies, but they play an important role also in their development, establishing a close interaction with manufacturers. The supply and demand of healthcare innovations has complex dynamics that go beyond the interaction between developers and users. In recent years, the innovation process in healthcare came to be more and more significantly influenced by other groups of actors such as hospital administrators, payers, and regulators but also patients and their families, patient (advocacy) groups, and the media. However, there is still a limited understanding of how the interaction of supply and demand influences the aim, direction, and rate of innovation in healthcare.

The Direction of Healthcare Innovation

In recent years, the biomedical perspective of health has been challenged by evidence that the steady reduction in mortality and increased longevity in many developed countries in the last century was mainly due to improved sanitation and nutrition and general improvements of living standards and not to advances in medicine. Furthermore, healthcare and medicine are becoming more and more driven by science, technology, and industry on a global scale. Finally, the current trend of healthcare expenditures is unsustainable, both in developed and in developing countries.

This problematic situation has triggered different reactions. One of these is the rise of the complementary and alternative medicine (CAM) movement, where patients turn to health practices other than Western medicine (e.g., acupuncture, chiropractic, Ayurveda, etc.) to deal with illness and well-being. Currently, there is also an intense scrutiny of pharmaceutical industry by part of the biomedical community, the media, and the public at large of the pharmaceutical industry, previously considered unquestionable and viewed as the producer of life-saving products. Pharmaceutical productivity has declined and new drugs are difficult to come by, and the costs of developing them increased together with the total R&D expenditures. Moreover, there are still unmet medical needs and health inequalities, especially in areas such as infectious diseases where drugs are available but not affordable for many in developing countries. Finally, the discussions about the role of public and private sectors in healthcare are leading to examples of social experimentation (e.g., public-private partnerships) and measures of cost savings and efficiency making it difficult to see how they can solve fundamental issues in healthcare affected by the need of dealing with chronic diseases in an aging population and the costs of high-technology medicine.

Studies of Healthcare Innovation: Unpacking the Economic, Social, Political, and Ethical Aspects

The study of healthcare innovation is characterized by multiple approaches and areas of interest that is undertaken in many separate academic fields. Traditionally, approaches such as economics of innovation, health economics, and innovation management have focused on the economic, financial, and managerial aspects of innovation. Science and technology studies that have focused on health and medicine have taken more sociological and historical approaches to study the development and use of medical innovations, focusing on the controversial and negotiated aspects of them such as in the case of allocation of resources between basic scientific research on finding cure for diseases and public health measures for prevention or ethical issues on emergent and promising but risky new technologies like xenotransplantation (i.e., the use of animal organs in humans) or stem cells. Another field involved in the study of healthcare innovation is medical sociology where a more critical approach is taken for instance to explore "biomedicalization" or how healthcare and medicine have become increasingly driven by science, technology, and industry on a global scale, leading to unpack and study in depth several processes such as the increasingly scientific and technological nature of medicine, the transformation on how biomedical knowledge is produced, distributed, and consumed, and the political economy of biomedicine (Clarke et al. 2003). An evaluation of healthcare innovations that aims to be comprehensive and multidimensional is a challenging undertaking. The multidisciplinary field of health technology assessment (HTA) examines beyond costs, efficacy, and safety the social, political, and ethical aspects of the development, diffusion, and use of health technologies. The ethical aspects of healthcare innovation like organ donation, healthcare rationing, and questions related to emergent technologies in biology and medicine stem cells, genomics, and human enhancement are also studied in the field of bioethics.

Conclusions and Future Directions

The debate about high-tech medicine and its impact on the raising of costs of healthcare pointed out that the fundamental problem in today's healthcare systems is the weak correlation between the types of innovations generated by the innovation process driven by the medical research community and industry and the needs of healthcare delivery. However, solutions on how to close the gap between medical research and healthcare delivery or how to innovate the healthcare innovation process are hard to come by. Disruptive healthcare innovations that are at the same time affordable to all should be the priority for theory, policy, and practice.

Cross-References

▶ Invention Versus Discovery
▶ National Innovation Systems (NIS)
▶ Nonlinear Innovation
▶ Patterns of Technological Evolution
▶ Product Innovation, Process Innovation

References

Blume SS. The significance of technological change in medicine: An introduction. *Res Policy*. 1985;14: 173–177

Callahan D. Taming the beloved beast. How medical technology costs are destroying our health care system. Princeton: Princeton University Press; 2009.

Clarke AE, Shim JK, Mamo L, Fosket JR, Fishman JR. Biomedicalization: technoscientific transformations of health, illness, and U.S. biomedicine. *Am Social Rev*. 2003;68(2):161–94.

Gelijns AC, Rosenberg N, Moskowitz AJ. Capturing the unexpected benefits of medical research. N Engl J Med. 1998;339:693–8.

Greenhalgh T, Robert G, Macfarlaine F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and recommendations. Milbank Q. 2004;82(4):581–629.

Lehoux P. The problem of health technology. Policy implications for modern health care systems. New York: Routledge; 2006.

Morlacchi P, Nelson RN. How medical practice evolves: learning to treat failing hearts with an implantable device. Res Policy. 2011;40(4):511–25.

Roberts EB, Levy RI, Finkelstein SN, Moskowitz J, Sondik EJ, editors. Biomedical innovation. Boston: MIT Press; 1981.

WHO (1946) Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19–22 June, 1946; signed on 22 July 1946 by the representatives of 61 States (Official Records of the World Health Organization, no. 2, p. 100) and entered into force on 7 April 1948

Heroic Entrepreneur, Theories

Sophie Boutillier[1,2] and Dimitri Uzunidis[1,3]
[1]Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France
[3]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Business; Individual initiative; Industrial activity; Industrialization; Risk

The economic theory of the entrepreneur is defined in the analysis of R. Cantillon at the beginning of the eighteenth century, who draws a distinction between those who are a "known quantity" and those who are an "unknown quantity," the entrepreneur belonging in the second category. That is effectively how the framework of the entrepreneur is constructed. The entrepreneur is the economic agent who supports risk emanating from the erratic functioning of the market. However, Cantillon distinguishes neither risk nor uncertainty. About a century later, J-B Say defined the entrepreneur as the intermediary between the savant who produces knowledge and the worker who applies it to industry. In this way, Say introduces a nodal element in the definition of the entrepreneur: innovation. Schumpeter too joins the original diptych. He, along with Cantillon and Say, constitutes the founding fathers of the theory of the entrepreneur. Both Schumpeter and Say, as distinct from Cantillon, put the accent on the introduction of novelty (and thus innovation) into the economy.

The object of this entry, then, is to revisit the work of those economists who since Cantillon have placed the entrepreneur at the heart of the analysis of capitalism. In this context, the marginalist theory initiated by Léon Walras stands out because, although well-founded on the base of liberal market economics, it notably promotes the hypothesis of market transparency and thus the *absence* of uncertainty.

Economic agents, who are considered as rational beings (perhaps better expressed as beings whom there is no reason *not* to consider as rational), take decisions (e.g., an entrepreneur who takes a decision to invest, based on a rational cost/benefit analysis, is being assumed that he has available to him all information necessary for such analysis) At almost the same moment in 2011, the Austrian economist Carl Menger (1840–1921) places himself also in the marginalist paradigm without, however, signing up to the same definition of rationality. For Menger, the rationality of economic agents is limited. Going on from this Austrian "current," the economic analysis of the entrepreneur has been able to develop fruitfully over the course of the twentieth century. Joseph A. Schumpeter, R. Coase, F. von Hayek,

L. von Mises, I. Kirzner, and others would seek to replace the uncertainty and risk at the heart of their economic model by giving space to the emerging concept of the entrepreneur.

The heroic entrepreneur is the one who formed the link between the preindustrial period (around the end of the eighteenth century) and the industrial maturity of the start of the twentieth century. He built a new economic and productive logic on the ruins of the feudal system.

The general idea advanced by R. Cantillon or J-B Say is that the weight of the market economy rests on the entrepreneur, while the greater part of the population (including the country's leaders) seems to ignore or pretend to ignore him. From another angle, en economist such as Karl Marx highlights the nodal role (albeit temporary) of the *bourgeoisie* which contributes through its entrepreneurial dynamism to increasing the speed of technical progress. But that argument shifts all the risk on to the weakest segment, the proletariat. Marx, like Schumpeter, is an economist of transition who concentrates on the procedures of the passage from the capitalism of the heroic entrepreneurs toward socialized entrepreneurs. Following on, Walras reinvents a liberal model (the theory of pure and perfect competition) where uncertainty and risk have been ousted. And by the same token the entrepreneur. Walras succeeds, almost in spite of himself, in demonstrating up to what point the entrepreneurial function is intimately linked with the uncertainty/risk diptych.

The Economic Thought of the Entrepreneur During the First Industrial Revolution

Richard Cantillon: "People of Unpredictable Worth"

Close to being a physiocrat, Richard Cantillon (1697–1755) was also a critic. However, if he shares an important aspect of physiocratic analysis, he privileges the virtues of free exchange. In this context, the entrepreneur occupies an important place. The entrepreneur assumes the role of the managed order of the mercantilists. He takes on, too, the role of the prince, great organizer of the mercantilist order. Cantillon in fact distinguishes two types of economic agent, those of predictable worth, and those of unpredictable worth. He classifies the entrepreneur in the second category. The entrepreneur takes risks in committing himself firmly, without guarantee as to the solvency of his client or his backers. Without fortune of his own, thanks to his projects, the entrepreneur manages to bring progress to the economy, but society does not trust him and rejects him.

Cantillon was himself an entrepreneur, even a kind of adventurer. He associated himself with John Law and died in obscure circumstances (probably by assassination). But if the economy is the science of business, as Schumpeter held, Cantillon was most certainly a great economist, since he accumulated a sizeable fortune, precisely thanks to his capacity to take risks in his affairs just as in life. His main work "Essay on the Nature of Commerce in General" was only published in 1755, several years after his death. In this work, the entrepreneur embodies what would later become the "invisible hand" of Adam Smith in the form of "catalyst of production and exchange."

Cantillon did not have primacy in this idea. He was preceded in his task by other distinguished authors. In 1675, Jacques Savary published "The Perfect Merchant" a veritable best seller on the right of merchants. But this work appears to be rather a code of business practice than a manual of political economy. It was Cantillon who gave a new dimension to the entrepreneur by conceptualizing his behavior. He distinguishes two types of economy, a centralized economy (symbolized by a great managed domain along feudal lines) and the managed economy. In the first system, wealth is concentrated in the hands of landowners; under the "new" system, it is the entrepreneurs who concentrate the wealth. The task of the entrepreneur is to identify demand and to manage production so as to satisfy it. He takes risks and scouts out the way ahead to find potentially profitable activities. The entrepreneur is present both in production (farming, manufacturing, and the provision of services) and in exchange (wholesaling and retailing). The first are the productive entrepreneurs and bring together a wide range of professions, bookmakers, carpenters, doctors, lawyers – even beggars and thieves. On the other hand, he accords only little importance to manufacturers, with the exception of cloth makers – doubtless because, in the seventeenth century, this represented a fairly well-developed industrial activity.

Adam Smith: The Invisible Hand Masks the Entrepreneur

Smith (1723–1790), contrary to Cantillon, was not an entrepreneur but an academic. He travelled widely in Europe and sympathized with the philosophers of the Enlightenment. However, he expressed little interest in the entrepreneur as such (such doers of projects inspired little confidence in him). His underlying sentiment was that only the market is capable of bringing wealth and prosperity, without overshadowing the state, as a reducer of uncertainty, and whose role is to create an environment propitious to the development of business. His analysis is contained in the famous concept of the "invisible hand" according to which the sum of individual interests is equal to the general interest.

In the whirlwind of business, enterprises are created and developed. The same applies to the ownership of capital. Smith interested himself in the development of limited companies. The separation between management and ownership seemed to him likely in the longer term to damage individual initiative. The shareholder has no particular interest in the future or the enterprise apart from the dividends which he may be able to withdraw as net company worth progresses. Companies having shares are by their nature less efficient than companies managed directly by their owners, since the interests of the shareholders are not necessarily the best interests of the company. This tends not to be the case for the shareholder who thinks strategically in terms of accumulating or trading blocks of shares. As in Schumpeter nearly two centuries later, capitalism seems to lose its soul in socializing itself.

Jean-Baptiste Say or the Profession of the Entrepreneur

Jean-Baptiste Say (1767–1823), in the image of Cantillon, accords a central role to the entrepreneur. In his time, he was the best known of all French economists. He obtained the first chair in economics at the Collège de France and at the National Conservatory des Arts et Métiers and was a minister of finance during the first empire. One of his brothers founded the sugar refiners Say, which in 1973 became Béghin-Say. He was also a journalist. Adapting the ideas of Adam Smith, which he attempted to popularize in France, in 1803, he published his Treatise on Political Economy, where he identified the advantages of free enterprise and the market. This treatise was poorly received by the government of the day. He was unable either to publish a second edition or to carry on the profession of journalist. He became an entrepreneur, creating a business in cotton which had all the hallmarks of modernity for the times. The business prospered rapidly.

Undoubtedly benefitting from his theoretical certainties and his entrepreneurial experiences, Say defined the "profession of the entrepreneur" according to the following criteria:

1. The entrepreneur acts for his own account. But entrepreneur and chief executive are not entirely synonymous. The entrepreneur does not necessarily have recourse to the labor input of others. He sets up his business mainly through a desire for independence.
2. He can carry on different professions – clock maker, farmer, dyer, etc. It is in innovating that he becomes an entrepreneur because he is an intermediary between the worker carrying out his tasks and the original work of the scientist. Say thus distinguishes three kinds of "industrial operations," "scientific research," "its application by the entrepreneur," and "its execution by the worker." This art of "application," which forms an essential part of production, is the occupation of a class of men that we call entrepreneurs of industry (Say, cited by Boutillier and Uzunidis 1995, p. 17). In this sense, his work is productive in the same way as that of the scientist or the worker.
3. He is the principal agent of production. The other operations are of course necessary for the creation of products, but it is the entrepreneur who gets the process under way,

who gives it a vital impulsion, and who recovers the value at the end of the process (Say, cited by Boutillier and Uzunidis 1995, p. 18).

4. Production is the application of science or of "notions." This application concerns the whole of the "needs of man." In order to satisfy these needs, the entrepreneur must prove he possesses a "certain intellectual combination." It is a question of appreciating not only the physical needs of man, but also his "moral constitution" (his customs and habits, his tastes, the degree of civilization he has attained, the religion he professes). The entrepreneur must be endowed by providence with a certain "capacity of judgment." It is he who judges the needs of his fellow men and above all the means of satisfying them and who formulates the end according to the means available to him. The union of these qualities in a single individual is uncommon because "this type of work demands moral qualities which are rarely found in a single person" Say (cited by Boutillier and Uzunidis 1995, p. 18).
5. The entrepreneur organizes and plans production and bears all the contingent risks. This is in sharp contrast to those secondary agents he employs: "a clerk or a worker receives his salary or other remuneration whether the enterprise is in profit or loss" (cited by Boutillier and Uzunidis 1995, p. 18).
6. The profits are thus not the "fruits of despoliation" because their achievement depends on a great number of uncertain factors which the entrepreneur cannot control. He must be ready to bear all the consequences of bankruptcy should it occur.
7. The entrepreneur combines the "natural productive services," such as those of work and capital and must be aware of the state of the market. His head is accustomed to an ongoing series of calculations so that he can "compare the costs of production with the value of the product when it is put on sale." Say, just as later Schumpeter, puts the accent on the entrepreneur's capacity for innovation. In order to surmount the multiple obstacles raised before him, there is no way he can accommodate routine. He must ceaselessly invent, that is to say, to have "the talent to imagine all at once the best targets for speculation and the best means of attaining them."

The Entrepreneur in the Neoclassical Theory

Léon Walras and Carl Menger: The Diverging Marginalists

At the end of the nineteenth century, the neoclassical economists recentered their work on the founding principles of Adam Smith (competition and private property) and forged a series of scientific investigatory tools. The enterprise disappeared and became a combination of factors of production, in other terms, a function of production. This concept of the function of production forms an abstraction as much of the enterprise as of an organization composed of a varying number of individuals and which obeys a grouping of functional rules laid down by the entrepreneur as decider. The model of pure and perfect completion evacuates the uncertainty and the risk. In this conceptual setting, the entrepreneur in fact disappears – not on account of the bureaucratization of productive activities (cf. development of managerial capital) but because the risk (and consequently the profits) disappears. In the neoclassical theory such as formulated by Léon Walras (1834–1910), the entrepreneur is a sort of intermediary between the markets (factors of production, of goods etc.) who bends without resisting to the will of the market through the price mechanism. Among numerous criticisms levied at the Walras model that of Joan Robinson is entirely pertinent, not to say debunking, since she affirms that the pure and perfect competition model can only function efficiently within a planned economy, in other words, in the absence of uncertainty and risk. We can add to the rout of Walras that the pure and perfect competition model is not a representation of economic reality but a kind of deal which the real economy endeavors to approach.

A paradox? Walras has not constructed a clear theory of the entrepreneur, even though the thinking behind it is based on free enterprise. The entrepreneur is an economic agent just like the worker or the consumer. The Walrasian entrepreneur, in contrast to the descriptions given by Cantillon or Say, is not an exceptional individual. Nor is he distinguished by exceptional faculties. In the Walrasian theory, the theory of the entrepreneur, that of the firm and of production, is superimposed on one another. The entrepreneur can be perceived as a function of production in the same way as the firm, a kind of black box whose workings remain unknown. Walras also affirms that the function of the entrepreneur corresponds to a service given free of charge.

In lesson n°19 of "Elements of Pure Economy," whose first edition dates from 1874, Walras (1988) describes the entrepreneur as a personality (he can be either an individual or a firm) who purchases raw materials from other entrepreneurs, then rents a parcel of land from a landowner, pays a wage for the personal services of his workers, pays interest on capital to his backer(s), and finally, heaving applied productive processes to the raw materials, sells for his own account the products obtained. The entrepreneur has thus for his task, with regard to the present definition, to combine these different resources. Walras pursues his definition and specifies that there exist different types of entrepreneurs, in agriculture, industry, and commerce. Whatever the sector of activity where he operates, the entrepreneur makes a profit if he sells his products or goods at a price higher than the costs of production.

Explaining innovation or economic crises did not fall within Walras' ambitions. Is it perhaps for this reason that he casts aside the entrepreneur in imagining a world without either uncertainty or risk?

Carl Menger: The Limited Rationality of the Entrepreneur

Although generally associated with the works of Walras as cofounder (with S. Jevons) of marginalism, Carl Menger (1840–1921) built a different theoretical framework, since he placed the accent on uncertainty which influences, and is influenced by, the rationality of economic agents. His economic analysis (contrary to that of Walras) tends to retrace the evolving dynamics of capitalism by putting the accent not on situations in balance but on imbalance. The essential cause of progress resides in the growth of knowledge. But where does such growth originate? And what are the economic agents that mobilize it? The answer is relatively contrasted. The process which leads economic agents to take decisions is relatively more complex than that imagined by Walras, in the first place, because the information available to the economic agents is not only objective but also a great deal more diffuse. This knowledge is capable of being mobilized into action, that is to say, across the interactions of individual behavior patterns. In his way, and well before the birth of theories on social networks, Menger puts the accent on the formation of networks of social relations which play a nodal role in the formation of business opportunities.

Thus, Menger puts the accent on the process of apprenticeship during which the agents acquire knowledge. Such knowledge is in some degree discovered by particular economic agents. But Menger also puts the accent on the acquisition of knowledge linked directly to the activities in which the economic agents are engaged. Throughout the acquisition of knowledge the economic agents create, without the intention of so doing, institutions which permit them to reduce uncertainty. Such social institutions are the spontaneous result of the interactions of individual behavior, interactions which permit in particular the mobilization and the spread of tacit knowledge. The discovery of this tacit knowledge stems from a limited number of individuals showing innovative behavior. These individuals are in some way "agents of clairvoyance."

These agents do not possess in themselves a maximizing behavior. They pursue objectives of their own in a context of uncertainty and consequently are susceptible to error. No two individuals have the same vision of the world, for each individual has his own such vision. One can speak in this sense of limited responsibility, even though this concept correctly stated only goes back to the end of the 1940s under the pen of H. Simon. The Mengerian entrepreneur acts in a context of uncertainty. He has no objective vision of the economic situation into which he is plunged. His vision is subjective because it depends on the position he occupies in the market but equally on his own identity. Each economic agent is unique and marked by his own characteristic traits.

Alfred Marshal: Managers and Entrepreneurs

Alfred Marshall (1842–1924) was Professor of Economics at the prestigious Cambridge University. Among his various students was the (later) illustrious J. M. Keynes. Keynes, like his teacher, never ceased to rework the neoclassical model. He is highly critical in his *principles of political economy* with regard to the world of business, for the modern economy "provides new temptations for dishonest conduct in business. The progress of science has permitted the discovery of new ways of giving things an appearance other than reality .... The producer is now far removed from the final consumer, and his misdemeanors do not receive the severe and prompt punishment which falls on the head of a person obliged to live and die in the village where he was born."

For the term "competition," he substitutes the expressions "freedom of industry or work" or "economic freedom" and emphasizes that nearly all the inventions without number which have been given to us by the power of nature have been the products of independent workers. From the primitive society to which he often refers, Marshall shows that the economy has progressed and that the division of labor has become considerably more complex. In this context, the entrepreneur has secured for himself an important place. The localization of industry and the appearance of the system of capitalist entrepreneurs were parallel phenomena due to the same general causes, and each one helped the progress of the other. "Economic freedom" led to the triumph of "the men most capable of founding a business, and organizing and managing it." This is without calling to mind the "most clairvoyant" (economic) agents of Menger.

The appearance of the entrepreneur predates capitalism. In the proto-industrial system, the entrepreneur reigned over what is now called working from home, "a system of small tradespeople managed by the workers themselves ...." Then came the system of large firms, where the entrepreneur specializes in one function of management and organization of the firm. These upheavals, which put an end to the customs which had become "too late to train oneself and too blind to act only when the time to act is already past," call out to "the men of energy", ready for anything, counting only on themselves, and "considering their success as being due to their own energy." The spirit of enterprise which inhabits these men is what distinguishes the modern economy from the primitive economy.

The entrepreneur is nonetheless an unloved creature. His fortune is often suspect in the eyes of the common man, despite which the profits he earns are no more than the just remuneration for his labor. The entrepreneur is an entrepreneur because he manages "to do noble and difficult things simply because they are noble and difficult" (Marshall 1919, vol. 2, p. 391). Despite this, the evident hostility of society adds a bitter pill to the actions of the entrepreneur!

In *industry and trade* (1919), Marshall interests himself in economic history from the angle of concentration of capital. He distinguishes several types of firms typical of different stages of economic history. The typical firm takes on at least two different forms: the individual firm, embodied by the entrepreneur, owner of the capital, and then the limited liability company, embodied by the manager (the shareholder plays a relatively minor role). During the preindustrial period, entrepreneurs were the businessmen who purchased goods in a particular locality and resold them in another. Such traders all through the Middle Ages ran great risks, and international trade offered wide possibilities for economic initiative and perspicacious foresight. From the industrial revolution onwards, the industrial entrepreneur occupied a central position. He had to be able to estimate with precision the required investment and recruit the necessary labor. From the end of the nineteenth century, the socialization of capital divided the function of the entrepreneur between on the one hand the manager and on the other hand the shareholders. The manager took charge of the strategic direction of the business, but he is a salaried member of staff, and thus takes none of the risks inherent in management. In the case of failure he risks, according to Marshall, simply put, his reputation and his employment. The shareholders, in contrast, bear the risks but delegate nearly all their functions as owners of the business to the managers.

Thus the entrepreneur and the manager divide the market between them. The first survives thanks to his dynamism and his capacity for innovation. The second relies on the solidity of a large organization which shields him from the dangers of uncertainty. Certainly, he is lacking in energy and initiative relative to that deployed by the entrepreneur, nevertheless the important financial means at his disposal allow him to put to use the entrepreneur's new ideas. The role of each one is clearly different. The entrepreneur is not obliged to justify the decisions he takes. This is the reverse of the case of the manager who must obtain the approval of his board of directors and possibly the whole body of shareholders meeting in assembly. Marshall puts the accent on the charisma of the entrepreneur which allows him to motivate his personnel. The vitality of the small firm is closely linked to the qualities of its owner, more diligent, more assiduous in watching over the business, and more intimately connected with a multitude of details.

In a larger organization, on the other hand, the working ambiance is far more codified, even coasting along as the result of bureaucratic habits such as to impede any initiative which might disturb it. The main fault of large firms lies in their excessively centralized administration. To the extent that this risks imposing higher costs on smaller firms, the entrepreneur gives way to the manager. Large firms dominate numerous markets by reason of the superiority of mass production methods. However, certain sectors of production, or certain steps in the production process, are less expensive to carry out on a small scale, thus a division of labor exists between large and small firms. Furthermore, if the entrepreneur does not disappear, his independence is clipped because his order book depends on the activities of large firms. The state has to accompany this evolution of the productive system, by putting in place legal mechanisms to guarantee the contribution of each shareholder. Its role is to maintain confidence, by guaranteeing the stability and harmony of the working of the market thanks to public services rendered by the police, the justice system, and the construction and maintenance of infrastructures.

Two worlds coexist for Marshall, that of the small, innovatory firm (which by definition is exposed to uncertainty and risk) and where the entrepreneur has a key role, and the large firm, having a share capital, and which rests on a bureaucratic organization and mass production. The large firm has the capacity by virtue of its size to control the market (it plays an important role in the fixing of prices at high levels). The small firm (just like the artisanal proto-industrial business) is close to the consumer and knows his or her needs, in contrast to large industrial groups. Inevitably its situation is more precarious.

The Economists of Transition

We have grouped together three economists, Marx, Schumpeter, and Coase, under the title "economists of transition." There is no question here of evoking the progress of mechanisms of the planned market in the direction of capitalism, or the reverse, but rather of studying the mechanisms involved in the transition of the heroic entrepreneur to the socialized entrepreneur. What are the spurs to growth in the size of firms? What becomes of the entrepreneur in an economy dominated by large firms? Finally, if a certain trend in the concentration of capital has been in progress since the beginning of the twentieth century, is this process in fact unacceptable?

Karl Marx: Entrepreneurs or Capitalists

Karl Marx (1818–1883) is not a theoretician of the entrepreneur; however, an in-depth reading of his works is rich in information as to the role and the place of this figure in the dynamics of capitalism. Marx (2004), though, rarely employs the term "entrepreneur," preferring the word "capitalist." The latter is frequently qualified as "fanatical agent of accumulation" who "forces men without mercy or truce to produce for the sake of producing. . ..” “Accumulate, accumulate! That is the law and the prophets”. One could equally well replace “accumulate” with “innovate.” The propos of Marx are not necessarily distorted. Nor does he abandon the term of entrepreneur, to which he always attributes a place and a precise role in the dynamic of accumulation. According Marx, the movement of social accumulation thus presents, on the one hand, a growing concentration in the hands of private entrepreneurs of the reproductive elements of richness, and on the other hand, the dispersal and multiplication of points of accumulation and of relative concentration, which repel reach other from their own particular orbits.

The capitalist entrepreneur is caught up in a kind of endless spiral. His capacity for initiative (of action) is limited by the coercive law of the market. He is, besides, alienated from the worker he exploits. In the *Communist Party Manifesto* Marx and Engels (2005) qualify the bourgeoisie as the agent without will of his own and with no resistance to the forces of industry.

Even though Marx may have qualified capitalism as revolutionary on the technological level, he failed to establish an explicit relation between innovation and the entrepreneur. Invention had become “a branch of business” and the application of science to immediate production determines inventions at the same time that it solicits them.

Marx concentrates his analysis on the general dynamic of the accumulation process. Capitalism is caught up in a kind of dynamic which overtakes it, but which, it also seeks to master. Competition is tough. Uncertainty is high. The sharks eat the minnows. Business must either expand or disappear. The competition which is the quintessence of capitalism adapts itself. Large firms emerge (performers on an international scale) which seek to control more and more tightly the uncertainty proper to the functioning of the market. Productive activity becomes more and more socialized. Capitalism changes its nature. Marx leans on the theory of the end of history (which Schumpeter also takes up), where he evokes the possibility of a new form of organization of the economy where the market and private property have disappeared. The state would then take over the management of things. In the absence of the market, uncertainty and risk are also eliminated, and consequently, the entrepreneur can force open the market with no resistance. However, the entrepreneur is not perceived by Marx as an autonomous economic agent, master of his own decision-making. Capitalism, founded on the principles of competition, and consequently on risk, evolves progressively towards a managed economic system, where risk and uncertainty have all but disappeared in the same way as all the other economic principles attached to capitalism, whether it be the market, prices, or currency.

Joseph A. Schumpeter: The Metaphor of Capitalism

At the beginning of the twentieth century, J.A. Schumpeter (1883–1950) developed his theory to compensate for the gaps in the Walrasian model (which despite this he admired), and which had proved incapable of providing explanations for technical progress, growth, or even economic crises. Against this, the Schumpeterian entrepreneur introduced the idea of movement (1980, 2010). Schumpeter defined the entrepreneur as the economic agent who innovates. But this is an irrational agent in the Walrasian sense of the term. His behavior is not guided by any economic calculations. In the image of what was the very existence of Cantillon, the Schumpeterian entrepreneur is a player. He assumes in his basic conditions both success and failure at the same time.

The entrepreneur is the motor of “creative destruction.” According to Schumpeter, capitalism, let us repeat, constitutes by its nature a type or a method of economic transformation and not only is it never stationary, but it could never become so. Then, he explains that the fundamental impulsion which starts off and maintains the capitalist machine owes its being to new products of consumption, new methods of production and transportation, new markets, and new types of industrial organization – all the elements created by capitalist initiative. He calls this evolutionary process unique to capitalism the process of creative destruction. This process of Creative Destruction constitutes the basic element of capitalism: it is this element that in the last analysis comprises capitalism and any capitalist firm must, with good grace or otherwise, adapt to it.

The motivation of the Schumpeterian entrepreneur resides in the challenge, change, and the game. His aim is to go against the established economic order. The entrepreneur is thus instrumentalized in order to explain the dynamics of capitalism or "economic evolution." The most important idea that we retain is that of innovation by opportunism. Innovation is not limited for Schumpeter to the creation of new products or the introduction of machinery into the workshops. Innovation is, roughly speaking, that which allows the entrepreneur to grow his business and his dominant position on the market. Additionally, even if the entrepreneur is not entirely certain of the effect of his discoveries, the latter can become, in the case of success, a means of conferring on him provisionally, (through its effects on competition) a monopoly position. By the power of innovation, the entrepreneur goes beyond the limits of his own market; he establishes his own rules, so as to master the uncertainty otherwise inherent in the functioning of the market. Human motivations are never strictly individual but always form part of a social and historical reality. In other words, the entrepreneur invests in such or such a sector of activity because it is the state of the economy, of society, science, or technology which permits him to do so, while bringing solutions to the problems posed. The Schumpeterian entrepreneur is the economic agent who introduces "new combinations of factors of production" which provide by the same token opportunities for investment. Such factors manifest themselves in multiple forms: the making of new products, transferring of production methods from one branch to another, opening up of new sales outlets, development of new sources of raw materials or of semimanufactures, and achievement of new market powers (e.g., a monopoly). These new combinations appear very close to the practices denounced by Marshall, according to whom businessmen hold up the progress of science in order to put a new appearance on things in an artificial way.

The characteristics of the Schumpeterian entrepreneur are the following:

1. His independence is limited by the effects of competition and consequently by uncertainty.
2. The execution of new combinations is "difficult and only accessible to people having the quality of strong determination." Only a few people "have the aptitudes needed to be able to take charge in such a situation."
3. Being an entrepreneur does not always signify "having lasting relations with a particular business." One is not an entrepreneur for life. The entrepreneur is only an entrepreneur when he puts into practice new combinations of production factors. Such a situation is by definition unstable because, by virtue of the dynamic of creative destruction, other entrepreneurs can be led to innovate, and this process is ongoing. Whence comes a virtually permanent situation of uncertainty in which the function of the entrepreneur is embedded.
4. Being an entrepreneur is not to be summed up by combining the factors of production, an activity which (maybe paradoxically) becomes routine. But only the entrepreneur can bring to bear new combinations of production factors. Managing the daily business of production is part of routine. This is not the function of the entrepreneur. Our eyes, someone is in principle not an entrepreneur unless he carries out new combinations; furthermore, he loses his character (as entrepreneur) if he continues to carry on the existing business without breaking out of the already established procedures.
5. The entrepreneur links the world of technology with that of the economy in introducing his new combinations of production factors. Achievement of this objective carries risk. That is why it interests the entrepreneur.
6. The quest for profit is secondary, although that does not mean to say it is neglected by the entrepreneur. He is a kind of gambler for whom the joy of creating carries him forward on the wave of research intrinsic to the gain. But, if profit merely crowns the success of new combinations of production methods, it is the expression of the value of the entrepreneur's

contribution to production, just like the salary is to the worker.

7. The Schumpeterian entrepreneur is a clever calculator because he is able better than others to predict the course of demand, which gives him a degree of power to channel the uncertainties he faces.
8. The Schumpeterian entrepreneur has charisma and authority. The importance of authority cannot be absent; it is often a question of surmounting local resistance, of winning relationships, and being able to support heavy challenges.
9. But the term "leader" does not turn the entrepreneur into the equivalent of a military chieftain. The entrepreneur does not distinguish himself by specific qualities. The task of the leader is very special: he who can master it has no need of specific connections, nor any particular intelligence, nor to be interesting or cultivated, nor to occupy in any sense a "higher ground"; he may even appear ridiculous in social situations where due to his success he may find himself. By his very essence, but also by his history (the two do not necessarily coincide) he is, away from his office, typically seen as a *parvenu*; he is without tradition, what is more he is often uncertain of himself, he appears anxious, in short he is everything but a leader. He is the revolutionary of the economy – and the involuntary pioneer of social and political revolution. His own colleagues disown him whenever they manage to steal a march on him, so effectively that he runs the risk occasionally of being excluded from the ranks of established industrialists.

A number of economists have attempted to search in the economy for the true Schumpeterian entrepreneur. But the entrepreneur described by Schumpeter lacks consistency. One cannot find an individual who embodies the stipulated qualities in a durable way. For example, Henry Ford only became an entrepreneur when he created the "model T"? For Schumpeter, being an entrepreneur is not a profession and certainly not a lasting state of affairs. Did not J.K. Galbraith try to affirm this when he wrote that one may compare the existence of the great entrepreneur to the male *aspis meblifera* which accomplishes the act of procreation at the price of his own existence?

The condition of the entrepreneur is therefore not a permanent state. Anyone is in principle only an entrepreneur if he puts into practice new combinations – and thus he loses this quality if he continues thereafter to manage the business according to existing principles – consequently, it is comparatively rare to see someone remain an entrepreneur on top form for decades; whereas, the businessman who has never been an entrepreneur, to however modest a degree, is a far more common species. The existence of the entrepreneur is consequently a precarious and uncertain one. But, that is not only on account of the place and the role attributed to him in a capitalist economy; it lies in economic theory so far as it exists. The entrepreneur, and most particularly the Schumpeterian entrepreneur, incorporates a dynamic disembodied from capitalism.

The general definition which Schumpeter gives to innovation suffices largely to explain profit as an exceptional and temporary source of revenue which rewards the entrepreneur, that is to say, the economic actor who has taken the risk of breaking the monotony of the Walrasian equilibrium, a situation where profit is nil.

The link between "innovation," "entrepreneur," and "economic growth" is brought about by the concept of the arrival of a group of entrepreneurs in a strategic market. This phenomenon is for Schumpeter the start of a long cycle of expansion. These pioneering entrepreneurs play an essential role because they "suppress the obstacles confronting others not only in the branch of production where they feature, but also, conforming to the usual nature of obstacles, they suppress them ipso facto in other branches of production. The example works by itself; many gains made within a particular branch serve other branches as well, as is the case for the opening of a market, an abstraction stemming from circumstances seemingly of secondary importance which soon appear: increase of prices etc.... This is how the action of the first leaders exceeds the immediate sphere of their influence, and the whole group of entrepreneurs increase business still further than would otherwise be the case. Thus the national economy is affected faster and more completely than would normally be thought in the process of reorganization; this constitutes the period of lift-off."

R. Coase: Alternatives to the Market

Coase (1910–) does not go along with the same theoretical current as Marx and Schumpeter. He asks neither the question of the disappearance of the entrepreneur nor that of capitalism; the theoretical model which he constructs belongs rather to the set of problems of transition such as we have posed in the above arguments. Coase even imagines an extreme situation where the market becomes confused with one sole and single firm, a situation of absolute monopoly, where uncertainty has disappeared and there the firm in question has complete freedom to fix prices. But this situation only corresponds to an academic case study set by Coase. He does not envisage it as a situation likely to arise. Coase distances himself from the neoclassical definition of the firm; he conceives the firm not as an instrument of production, but an as organization. It is not a question in the Coase analysis of the size of the enterprise (by what criteria in any case should this be defined? By the number of employees? By the amount of capital employed?). But the firm is conceived as an organizational form standing as an alternative to the market. Two alternatives can be offered: either the entrepreneur is himself responsible for production or else he delegates this task to other firms by means of subcontracting. In this case, the activity of production takes the form first and foremost of a contractual relationship. Coase thus plays in a dialectic fashion on a particular relationship between the firm and the market. The setting up of a firm encompasses within itself the functions of the market, at the same time, endogenizing the uncertainty proper to the functioning of the market itself.

The Coase analysis constitutes an important theoretical advance for the neoclassical theory because it leads towards legitimizing the existence of the firm in the eyes of those fervent liberal economists who are partisans of the market. But, the Coase analysis also brings to bear a pertinent explanation as to the size of firms (which distinguishes itself from basic analyses of pure and perfect competition, in the first place that of the atomicity of the market). The size of a firm grows when additional transactions (which may be exchanges coordinated by the market, that is to say by the price mechanism) are organized by the entrepreneur. The size of the firm shrinks when the entrepreneur abstains from such transactions. It is then possible to deal scientifically with the question of the size of firms.

The advantages of internal coordination do not lead towards the universal firm because the creation of a firm also implies costs to be set principally against the decreasing yields of management. For Coase, there exists an optimum sharing of coordination between the firm and the market which allows determination of the size of the firm thanks to reasoning at the margin. A firm grows when additional transactions (which might be exchanges in the context of the price mechanism) are organized by the entrepreneur, and it diminishes when the entrepreneur fails to pursue such transactions.

Coase (1937) resumes his argument by setting out three situations in which a firm might assume a growth trend, which would allow it by the same token to take on the functions of the market, and consequently to channel the uncertainty inherent in the working of the market:

1. If the number of transactions increases, while the costs of the organization and their elasticity remain weak.
2. Still within the hypothesis of an increase in the number of transactions, if the entrepreneur is unlikely to commit errors and the rate of errors decreases.
3. When the offer price of production factors falls (or increases only slightly) the size of the firm can increase to a significant extent.

However, to the extent that the size of the firm increases the organizational costs, losses due to errors can increase. But, these organizational costs can be reduced thanks to technical innovation. Coase gives the examples of the telephone and the telegraph, as innovations reducing organizational costs.

Following on from the contribution of Coase, Williamson (1986) brought together the contributions of two other economists, North and Akerlof. The contribution of the first resides in the existence of institutions, while that of Akerlof resides in the asymmetry of the information existing between sellers and buyers, which leads the first to keep their best products to themselves and to select inferior goods to sell. The institutional environment determines the rules of the game so far as concerns the methods of governance. The firm and the market are, for Williamson, the two institutions of the economy. However Williamson's contribution includes other aspects: the use of concealed information is also an important aspect of the economic game which goes beyond the Walrasian hypothesis of the maximization of profits; Williamson considers that economic agents act by opportunism which he defines as being the will of individuals to act in their own interests by voluntarily pursuing the deceit of others. In these conditions, uncertainty results not only from the opacity implicit in the behavior of some economic actors, but also from the deliberate will of certain economic agents to develop concealed strategies. These strategies have precisely as their aim the attempted channeling of the uncertainty inherent in the functioning of the market. Under these conditions, what is the fate of the limited rationality sketched out by Menger? Williamson postulates implicitly that economic actors seek to combat uncertainty by creating their own sources of information, which by virtue of their strength in the market-place impose themselves in the face of other protagonists.

We are thus placed in the following situation: either the firm (which is essentially according to Coase a collective object, centralized and planned) or the market which responds to a spontaneous order and a decentralized decision process. The firm (contrary to what Coase affirms) does not present itself as a tangible, material reality.

It seems to grow or to regress according to the progression of an environment which is itself shifting, and which changes in accordance with movements in prices. In these conditions, growth in the size of firms is seen as a means of counteracting the uncertainty inherent in the working of the market whilst itself forming part of the market mechanism. Thus, the Coase analysis tends to show in an implicit way that firms, whatever their size, are capable of adaptation. During the 1970s Williamson (1965, 1985) followed in the same direction in stressing that the costs of transaction, as put in evidence by Coase, are linked principally to the degree of complexity and uncertainty in the economic environment. Of course, demonstrably the hypothesis of market transparency rejects uncertainty.

Conclusions and Future Readings

Inserted into the market economy (by reason of its uncertainties) the entrepreneur is by definition a risk-taker. The entrepreneurial function is closely linked to the risk taken in a situation of doubt or uncertainty. It is in seeking to avoid or reduce risks that the entrepreneur plays his role of innovating. Innovation thus acts as a relative reducer of uncertainty because it endows the entrepreneur with a temporary power of monopoly; by his innovation, the entrepreneur contributes to the transformation of the market. But, in this permanent movement of uncertainty there can be no final result in the permanently enveloping mist of the business world. Now, it is precisely by means of these keywords that the function of the entrepreneur has been progressively and more precisely defined ever since the eighteenth century, at the dawn of industrialization (cf. Cantillon). Ever since then, the theory of the entrepreneur has been enriched, but the duo uncertainty/risk still remains at its base.

As an agent for change, the entrepreneur is singled out by his capacity to take risks, and forms part of the "people of uncertain worth." Even the term entrepreneur lends itself to confusion as it designates from the outset a character undoubtedly real in economic life, despite economists frequently using the term as a metaphor. The paradox of the theory "of the entrepreneur resides in the very term of entrepreneur which designates a kind of economic actor who can without difficulty be identified as such in the real economy (e.g., head of a business), but from another perspective, this is not the position that economists adopt, whatever their position may actually be. In fact, the entrepreneur does become a metaphor, that of movement or progress in a capitalist economy.

The entrepreneur, from Cantillon to Coase, materializes the movement of the economy, in its dynamic, growth, or in a recession the contrary. He is identified with risk taking since in a context of uncertainty he detects investment opportunities by anticipating the needs of consumers. By innovating, that is to say, by launching a new product or service on the market, he creates a pocket of uncertainty both for his own business and for others because he is incapable of anticipating the reaction of consumers. Will they accept or avoid the novelty?

Cross-References

▶ Business Cycles
▶ Creative Destruction
▶ Entrepreneur
▶ Entrepreneur: Etymological Bases
▶ Schumpeterian Entrepreneur

References

Boutillier S, Uzunidis D. L'entrepreneur. Une analyse socio-économique. Paris: Economica; 1995.
Coase R. The nature of the firm. Economica. 1937;4(16):386–405.
Marx K. Capital, critique of political economy. London: Penguin Classics; 2004, first edition 1867.
Marx K, Engels F. Communist manifesto; 2005. 1st ed. London: Public Domain Books; 1848.
Marshall A, Industry and trade; 1919. http://socserv2.socsci.mcmaster.ca/econ/ugcm/3ll3/marshall/Industry%26Trade.pdf
Schumpeter JA. Theory of economic development. An inquiry into profits, capital, credit, interest and business cycles. 1st ed. New Brunswick: Transaction Publishers; 1980; 1942.
Schumpeter JA. Capitalism, socialism and demcracy; 2010. London: Routledge, first edition 1942.
Walras L. Eléments d'économie pure ou théorie de la richesse sociale. Paris: Economica; 1988, first edition of 1874.
Williamson OE. A Dynamic Theory of Interfirm Behavior. The Quarterly Journal of Economics. 1965;79:579–607.
Williamson OE. The Economic institutions of capitalism: firms, markets and relational contracting. New York: The Free Press; 1985.
Williamson OE. Economic organization: firms, markets and policy control. Brighton: Wheatsheaf Books; 1986.

Heuristics

▶ Strategic Thinking and Creative Invention

Higher Education and Innovation

Elke Park
Institute for Science Communication and Higher Education Research (WIHO), University of Klagenfurt, Vienna, Austria

Synonyms

Disruptive innovation in higher education; Higher education institutions; Teaching and research/teaching-research nexus; Tertiary education; University (research university); University governance

Introduction

The two main functions or contributions by higher education institutions to innovation processes in today's knowledge society are **teaching** and **research.** On the one hand, universities and other higher education institutions (HEI) fulfill the task of educating and training a skilled workforce capable of dealing with the – increasingly complex – demands of the knowledge economy and the labor market; on the other, they act as central institutions in the creation of new, original insights and ideas, and among other players, they still play a fundamental role in the production of knowledge (see also contributions on *University Research and Innovation*; *Mode 1, Mode 2 and Innovation*; *Mode 3*). HEI thus occupy a central position in innovation processes and societal and economic development, in fact, higher education has been considered "a cornerstone of the global knowledge society" (UNESCO et al. 2009).

Whereas traditionally universities or HEI where shielded from market pressures, operating in a protected realm believed to be most conducive to scientific inquiry and the production of scientific knowledge, a process of organizational change has affected institutions of higher learning and research which increasingly opened universities up to market forces. It has been argued that a marketization or quasi-marketization (Musselin 2010) of higher education has occurred. This process is also related to the transition from elite to mass higher education starting in the 1960s as the organizational setup of elite higher education began to prove increasingly insufficient in accommodating mass access to tertiary education. Today, teaching and research are considered valuable "products" of HE, providing the basis for sustainable economic growth as "science and technology are seen as the main source of **competitive advantage** on the national and regional level" (Carayannis and Campbell 2012, 2). Restructuring processes within higher education also aim at "unlocking and capturing the **pecuniary benefits** of the science enterprise" (ibid.). Thus, market mechanisms of supply and demand and, more generally, capitalist modes of production, for example, specialization or differentiation processes, aspects of "mass production," competition, and the ultimate rule for cost efficiency increasingly apply in and shape higher education.

The Teaching-Research Nexus

Teaching and research – at universities, these two functions or outputs of higher education were linked in a special way since the inception of the modern research university in the early 1900s. The specific connection between teaching and research has been the characteristic of the Western research university ever since, and to many it still represents the ideal of what it is that higher education does. However, over the last 30 years, a rupture of the teaching-research nexus took place, a separation of tasks based on an increasing differentiation of or within HE institutions. Schimank and Winnes (2000) speak of pre-Humboldtian systems where teaching and research are institutionally separated (as in France) or post-Humboldtian systems where teaching and research take place at the same institution but are funded separately and carried out by different staff (as in the UK). Still, the most prominent and influential model based on a unity of teaching and research within one institution and in the person of the professor was the Humboldtian model which originated in Germany in the early 1900s and heavily influenced the US-American system (especially on the graduate level). The unity between teaching and research was first proclaimed and instituted by Wilhelm von Humboldt, and it represents a special way of producing, expanding or advancing, and disseminating new knowledge. What happens at a (research) university, how does the process of knowledge production ideally works at these institutions? According to the very influential Humboldtian ideal a professor shares his or her knowledge and research interest and the questions and problems he is working on with his students in the setting of a seminar or discussion round (later, labs), and he or she involves them in his or her research and in turn receives input, critique, feedback, and new ideas by his students who are supposed to grow themselves in the process both as independent thinkers and as experts in the field. Also, students are not merely "taught" – teaching as a mere appropriation of content is, in Humboldt's view, the task of secondary education – they are expected to engage independently on (research) questions and problems provided by their professor or mentor who acts as their supervisor, not their teacher (see Humboldt 1993, 191). Ideally, the most talented students would be selected to remain and progress on to an eventual career in academe or research. This is, simply put, the basic functioning of the modern research university, the teaching-research nexus in practice. In short, it is learning (research) by doing (research). However, finding or securing a place and making it to this elite circle of students engaging in discussions with the most eminent experts of their field, was limited to a small elite of the population that underwent severe – and highly socially predetermined – selection processes before entering tertiary education.

The Massification of Higher Education

With the onset of massification of higher education in the 1960s and 1970s, political leaders increasingly recognized that economic growth could only be sustained through an increase in the qualification of the workforce (see Fischer 1974, 591 in Preglau 1986, 194), and massive spending in secondary and higher education followed. Vice versa, a growing middle class recognized – and realized – the potential for social mobility through (higher) education. General demographic changes (population increase, with the baby-boomers entering higher education in the 1960s) further contributed to the phenomenon of rapidly rising student numbers. The 1960s are thus considered the "take-off phase" of mass (higher) education (Preglau 1986, 202). Accordingly, student enrollment grew at a rapid pace, and the quantitative increase in student numbers over the last 50 years is rather impressive: Since 1960, student enrollment in the USA more than quintupled (a 560 % increase, compared to a 72 % population increase); in Germany, more than six times as many students were enrolled at universities in 2009 compared to 1960 (a rough 640 % increase); at Austrian universities an almost eightfold student increase occurred since that time (790 %) (Data for the USA: Schuster and Finkelstein 2006, US Bureau of the Census; for Germany: Statistisches Jahrbuch der BRD; Statistisches Jahrbuch der DDR; for Austria: Hochschulbericht 1969; uni:data, www.bmwf.gv.at). Further, these numbers pale in comparison to Asian tigers such as China and Korea which show even higher growth rates (see Brandenburg and Zhu 2007 for a discussion of enrollment numbers in China, for example, accepted students after entrance exam in 1976: 270,000, in 2007: 5.67 million).

Martin Trow (1973, 7) has identified three phases in the evolution of higher education: an elite system (participation less than 15 % of the age group), mass higher education (participation between 15 % and 50 %), and universal higher education (participation more than 50 %). Today, some countries (Korea, Canada, and Japan) already exhibit universal participation rates, while most OECD members currently show tertiary attainment rates at around 40 % (OECD 2011, 40).

Differentiation of Higher Education Institutions

Under the circumstances of mass or universal higher education, the above-mentioned special institutional setup and focus of research universities following the Humboldtian model became problematic. Policy makers, expert organizations, and higher education researchers alike increasingly insisted on the necessity of a differentiation and diversification of HEI by also including and fostering other HE institutions focused more on teaching and knowledge proliferation as well as training in practically oriented skills: Guri-Rosenblit et al. (2007, 1, also quoted in Meek and Davies 2009) summarize the two main arguments advocating increased institutional diversity in higher education:

> First, most experts agreed that it is impossible to teach all of the large numbers of students in research universities which are extremely expensive to sponsor. Therefore, it seemed obvious that other types of higher education institutions geared mainly for teaching and professional training are appropriate for absorbing the growing numbers of students (Clark 1983; Trow 1973, 2000). Second, a growth of diversity of backgrounds, talents and motives of job expectations among the rising number of students should be accommodated by heterogeneous higher education providers.

Again, with participation rates of over 40 % in many, if not most, industrialized countries, policy makers were confronted with the following problems: (a) if providing – expensive – research-oriented training for more than half of the population or age group is financially viable; (b) if the "production" of a research-oriented workforce makes sense in regard to the demands of the labor market; and ultimately (c) if research training is in fact what most people aspire to or expect from their education, if it fits their needs and capabilities and corresponds with participants' own goals. It is often claimed that more practice and learning-oriented programs better serve the needs of the workforce and the labor market. On the other hand, in defense of the research university, it can be argued that the cognitive abilities developed in research-focused training, namely, independent, critical thinking, and the ability to extract relevance out of a vast knowledge base, are exactly the qualifications needed in today's ever more complex labor market (see also Huber 2004).

A recent OECD report further underlines the importance of a diversified range of institutions in a HE system. First, highlighting again the argument for cost efficiency, Lynn Meek states that while "recognizing the importance of both research and research-intensive universities to the development of knowledge economies it needs to be recognized that no nation can afford to fund all of its universities at a level commensurate with world-class research universities" (Meek and Davies 2009, 64). She goes on to say that the quality or success of a higher education system is based not so much on the number of "world class" research universities but instead relies on a balanced "world-class system" of higher education with highly differentiated institutions answering to a multitude of demands: "There is evidence to suggest that world-class systems of higher education are differentiated systems. These are systems that address the increasing needs of society and the diversity of student backgrounds that result from massification" (ibid.).

Accordingly, a variety of institutions emerged in the field of tertiary education over the last 50 years, and the numbers of institutions focusing on teaching and knowledge proliferation in more applied, practical fields increased rapidly: polytechnics (UK), universities of applied sciences (Germany, Austria, Switzerland), or community colleges in the USA. The latter saw especially high enrolment growth rates over the last 30 years (currently 44 % of undergraduates are enrolled at community colleges) with peaking growth rates during the economic crisis of the late 2000s (see Fry 2009).

On the other hand, especially in systems where diversification is not – or only slowly – taking place vertically between institutions, an internal horizontal differentiation within institutions can be observed (see Chiang 2012, 140; also Guri-Rosenblit et al. 2007; Clark 1997). On the European continent, a shift of research-based teaching (i.e., the teaching-research nexus) to the higher levels within an institution (to the graduate level or doctoral education) is currently taking place. It can be argued that due to the growing complexity and specialization of the knowledge base which has to be appropriated and taught in the first place on the undergraduate level (and can no longer be provided by secondary education alone, as Humboldt envisaged it) research-based training in its original sense makes most sense on the graduate level. Clark 199, 246 states that "the trend from elite to mass to universal higher education brings enormous growth in the teaching of beginning and intermediate students who ostensibly must master codified elementary materials before they can go forward to advanced work." Experts agree that a strong research focus on the undergraduate level would have adverse effects on learning as it leads to a "patchy coverage" of the curriculum (Trowler and Wareham 2007: 3–5. quoted in Meek and Davies 2009, 70ff). Thus, truly research-based training is more and more reserved to the graduate level. What occurs on the undergraduate level is teaching. This clearly noticeable shift is much deplored especially in the German-speaking countries (see also Clark 1997, 247) where a tendency to increasingly turn university education on the undergraduate level into school instruction ("Verschulung") oriented toward a fast appropriation of content in the curriculum met with strong protests and was criticized as the beginning of the end of the Humboldtian ideal of the university. This was also related to changes brought about by the so-called Bologna process and the harmonization of European degrees introducing the three-tier structure of bachelor-master-PhD. In the Anglo-American area, especially in the US where the

Humboldtian model (i.e., seminars) was emulated originally more on the graduate level, the undergraduate level traditionally had a broader focus aimed at providing a general education (Clark 1997, 248) and was less targeted on research training in one specific discipline. Research orientation there traditionally took place in graduate schools.

Equity and Access to Higher Education

The teaching-research nexus and the traditional Humboldtian research university which provided the prominent model for HEI over much of the last two centuries is under siege. Due to the massification of higher education and the concurrent attempts to accommodate rising student numbers at a low cost, a clearly visible differentiation is taking place. Research-based teaching is either shifting to the top levels within an institution or to top-level research universities within a HE system. Will this result in a new elitist function of the research university with only a select few progressing on to the top tier of university education (this time ideally based on merit and accomplishment not on social status, however, the line is thin here)? Will research-based training as a consequence only take place in a small elite sector and will this most expensive form of training be reserved again to a minority? Finally, will it lead to the resurrection of new (old) elites with socially or financially disadvantaged groups receiving their training in lower-ranking, more practically oriented, and cheaper colleges or online classes? Indeed, recent studies begin to show that, as a result of differentiation processes, socially disadvantaged groups tend toward nonresearch-oriented forms of higher education – such as UAS in Germany – while more privileged groups opt for an education at research universities (see, for example, Lörz 2012).

In highly differentiated systems such as the USA or the UK, it is certainly positive that cheaper forms of instruction provide access to those parts of the population that formerly did not participate in higher education – which is why US president Obama referred to community colleges as the "unsung heroes" of the American education system, because they – in principle – provide open access with at least theoretical possibility to move up to higher, even the highest-ranked institutions if qualified. However, institutional stratification as a result of massification is considered highly problematic on the European continent. There, especially in the German-speaking area, the free and open access to the best possible (research-based) education for all is considered a societal accomplishment (and a human right) and a powerful social and political achievement and agenda which is not easily abandoned or given up in favor of more hierarchical structures. Providing research-based training to all students is a mission laid down in most institutional charters of German-speaking comprehensive research universities, a claim that is becoming increasingly harder to fulfill for all students on all levels. Access to these institutions – some of them the top universities of the respective countries – is, with few exceptions, open to all high school graduates with little or no tuition fees. It must be noted that the open access policy in these countries originated from a tradition where only a very small elite was able to complete secondary education and thus obtained the right to enter university. As a sign of the ongoing persistence of these traditions, the tertiary attainment rates in countries with full open access policies to research universities are still notably lower than the OECD average (see Pechar 2010). Today these systems struggle with severe financial difficulties possibly to the detriment of both teaching and research at these institutions. European comprehensive "mass research universities" face a dilemma as they try to accommodate both being a top-rated research university based on the Humboldtian model and providing (research-based) training to comparatively very high numbers of students while at the same time confronted with shrinking government funding: These universities, often being left to deal with this problem autonomously, struggle in trying to make the impossible possible.

Research and Institutional Prestige

Ironically, an increased focus on research in recent years has partly counteracted the development toward institutional differentiation and the rupture of the teaching-research nexus. Research output denotes status in academe; it is one of the main pillars of institutional reputation, and thus the basis for success in the HE marketplace by attracting more or better students and/or increased funding (see Luhmann 1970). This development was in large parts also fostered by popular university rankings which exhibit and promote a strong focus on research performance. Thus, many institutions tried to follow and emulate the model of the research university, for example, Universities of Applied Sciences in Germany are trying to raise their status by incorporating scientific practice into their profile, mission, and activities; they try to improve their standing by focusing more strongly on research either by increasing the publication output of faculty or by incorporating more "scientific" methods and standards in teaching. A strong focus on research has partly also had detrimental effects on the quality of teaching within research universities. Teaching was neglected as it did not count as strongly in performance evaluations; however, there are signs and initiatives which begin to reward excellence in teaching more strongly. Still, most institutions orient themselves toward the ideal of top research institutions in order to gain visibility on rankings and institutional prestige to attract students and/or funding.

"Disruptive Innovation" and the Challenge or Opportunity of Online Learning

A strong proponent for increased differentiation between institutions and a separation of the teaching-research nexus is Hayden Christensen, Harvard business scholar and cofounder of the concept of "disruptive innovation." He argues that "the historical strategy of trying to be great at everything and mimic institutions such as Harvard is not a viable strategy going forward" and favors an increased focus on "institutions focused solely on knowledge proliferation": Advocating a clear separation of teaching and research between institutions and limiting research-based learning to a smaller number of institutions, he claims in the pronounced jargon of business economics (teaching and research are considered two different "business models") that

> [Research] institutions of higher education remain vital – indeed those that focus on research as well as those that train people for the academy will still be critically important for the country's future. Most of America's elite colleges and universities will continue to fulfill this job. But we should no longer force those institutions that are focused on teaching and learning to compete on the same metrics and play by the same rules. Pushing these institutions to adopt a mission of knowledge creation has created institutions that have two conflated value propositions and business models – and added significant overhead costs. We need institutions focused solely on knowledge proliferation – and need to regard those that do a good job on this dimension as being of high quality at what they were meant to do. (Christensen et al. 2011, 5)

In this context, the business scholar applies his concept of "disruptive innovation" to higher education. According to Christensen, disruptive innovation occurs when a formerly sidelined or "low-end" product enters or "disrupts" a domain (or market) that was formerly only accessible or reserved to a limited few because its products and services were complicated, expensive, and inaccessible, to allow a **whole new population of consumers** access to a product or service (e.g., the personal computer vs. the mainframe computer, mobile phones vs. fixed lines, and US community colleges vs. 4-year colleges (see Christensen et al. 2011, 2 for a detailed definition). In higher education – a domain which could certainly also be considered as historically only accessible to consumers with a lot of money or a lot of skill – Christensen sees the use of new media and online learning as the product or element resulting in a process of "disruptive innovation" as it offers cheaper and easier to use products that can serve new audiences. Computer-based online education and the use of new technologies in (higher) education has been a frequently debated topic for almost two decades now with little concrete or visible changes taking place so far; however, this could be about to change: Christensen states that, today, growth rates in online learning are increasing rapidly, and he estimates that, while roughly 10 % of students in 2003 took at least one online course, the fraction grew to 25 % in 2008 and was nearly 30 % in the fall of 2009. He projects it will be

50 % in 2014 (Christensen et al. 2011, 3). The use of computer-based online learning would certainly cut costs – and make education more affordable thus providing a financially viable transition from elite to mass education. According to Christensen, a diversification of tasks and purposes (community colleges vs. elite research-oriented universities) would also lead to the inclusion and participation of students who were formerly not able to attend higher education institutions ("and if a postsecondary education is fundamentally affordable – meaning lower in cost, not just price – this will also answer the question of how to extend access by enabling students to afford a higher education," ibid., 9).

Increased access via new technologies is certainly a good thing, both economically and personally, however, while the use of online-based learning could provide cheaper access to higher education, the question remains if institutional differentiation as outlined by Christensen would result in a new institutionalization of elites and an increased social segregation whereby lower social status groups attend cheap online programs or community colleges and elites afford top research universities (see above). It is argued here that the most fascinating, possibly revolutionary and truly disruptive aspect of online-based learning technologies and the use of social media in higher education is not the emergence and use of "cheaper, nonresearch-based schools for the masses" but possibly – as an increasingly less utopian vision – the free or remarkably cheaper access to knowledge on the undergraduate level at all HEI, including top-tier research universities. Already, Princeton and other top-tier US research universities are beginning to offer so-called "massively open online courses" (MOOC) whereby thousands of students from all around the world participate in online classes linked by social media, thus, also providing for the possibility of interaction (see Kolowich 2012). Knowledge, even at the highest possible level and at the highest quality, is free (freely accessible). This could indeed be considered a fundamentally disruptive innovative process, seriously undermining the cost-efficiency argument that guided policies and strategies in higher education in recent years and troubled (European) HE systems still maintaining full open access to top research universities. While private universities in the USA do not yet foresee accreditation mechanisms (Princeton so far declines offering certifications for free online courses), others, especially state-run institutions show a certain willingness to issue certifications. This development could provide state-funded universities with a possibility of maintaining open access while – to an extent – disregarding or alleviating cost-efficiency considerations and at the same time providing education for all that in terms of quality does not necessarily have to be inferior to classroom instruction. In fact, it most likely surpasses overcrowded classrooms with little to no personal contact to a professor as it often is the case at mass research universities today. The free access to knowledge through the internet for those who are motivated, interested, and capable of learning is actually the most fascinating aspect of "disruptive" new developments in higher education. It could contribute to fundamental changes in higher education by challenging the driving argument for cost efficiency which implies that research-based training for all is too expensive. A "seminar" supervised by a professor, guided by his research questions – the Humboldtian model – could in theory also be possible for hundreds of thousands of students, although practically the system works better on the undergraduate level or in the humanities where lab equipment is not necessary even on the graduate level. MOOC do not necessarily have to be limited to the mere proliferation of knowledge, in the sense of passive appropriation of content which already increasingly takes place on the undergraduate level in open access universities today, but would allow for interaction and participation, for questions and new ideas, and for the assignment of tasks – in short, for research-based teaching in the Humboldtian sense. In fact, the teaching-research nexus could be maintained rather than disrupted through the use of new online technologies. Obviously, practical problems, for example, how to effectively tutor and grade tens of thousands of students present themselves. Suggested solutions include peer tutoring by students or the use of artificial intelligence in evaluating and sorting students' contributions (see further Kolowich 2012). Also, ideally, research output could be enhanced by increasing the brain-pool working on and discussing a problem in new online fora. Through online learning, a truly disruptive innovation could lead to the replacement of more traditional forms of higher education, and by entering elite institutions, it could have an equalizing effect where cost – at least on the undergraduate level – no longer matters. It is argued that higher education, however, "has yet to experience the kind of disruption and subsequent gains in productivity realized by other knowledge-based industries" (http://icw.uschamber.com/publication/college-20-transforming-higher-education-through-greater-innovation-smarter-regulation).

On the Marketization and Commodification of Higher Education

"Cost efficiency, productivity gains, and new 'business models' offering products and services at a lower price" judging by the terminology used in policy making and research higher education has turned into a market or quasi-market and, to a certain extent, market-like structures of supply and demand have taken over the sector. Knowledge and educated human "resources" have become a direly needed and valuable good, a tradable commodity; in fact, a nation's competitiveness and ultimately its economic stability strongly depend on the output of HEI. It is argued here that massification – triggered by the insight that education is "good" to attain, both on the individual/personal level to promote life chances and on the system or state level to promote productivity and thus revenue – has currently resulted in a marketization or "capitalization" of higher education or, rather, an approximation toward capitalist modes of production in higher education.

It was shown above that the onset of massification of higher education in the 1960s was accompanied by a massive increase of state funding. Following the enormous expansion of the postsecondary education sector, this generous funding level could not be sustained, and since the 1980s the (public) funding level for universities has relatively decreased leading some to speak of an ongoing "fiscal crisis" for universities (Ordorika 2006: 2–3, quoted in Meek and Davies 2009, 46). Universities and other HEI are increasingly forced to act in a market-like environment competing for scarce resources faced with societal pressures for more direct "return on investment." Not only has the funding level relatively decreased, the formerly untargeted distribution of funds to universities has given way to conditional funding based on tangible and measurable performance and output. Institutions are held more directly accountable for the effective and efficient use of public funds, and they have to show – tangible – results to justify public investment. Why this "withdrawal of the state" expressed most notably in the reduction of public resources or the "reduction of trust" by society (Ordorika 2006, 2 and 10 quoted in Meek and Davies 2009, 44) at a point when the significance and increased importance HEI play in the societal innovation and production process should have become most obvious? First, it could be argued that, with participation rates of over 40 % untargeted resources growing equally in proportion to student numbers and allocated mostly to – expensive – research universities could simply no longer be sustained at the same level as in an elite sector (and it must be noted again that historically the state only sponsored a very small elite and its access to higher education): It was increasingly recognized that "nations will attempt to structure their higher education systems in order to produce the highest educated population at the lowest possible cost" (Meek and Davies 2009, 64). Clark 1997, 247 argues that "governments increasingly indicate that they are not prepared to pay the unit costs of mass higher education at the level of elite education. [...They] also make clear that they are not willing to pay throughout a national system for the increasingly high costs of research and research-based teaching and learning." Thus, vertical differentiation between institutions was enhanced. Second, the role of the state vis-à-vis its agencies has changed dramatically over the last 30 years: governments were apparently no longer willing or able to maintain direct control either due to an increased complexity which can simply no longer be steered centrally or because of an underlying belief that a sector of this importance could best be "regulated" by (partly) opening it up to market or market-like forces and by introducing managerial concepts such as efficiency, performance, and accountability in the steering process. This neoliberal agenda which has pervaded political systems and their subunits also strongly affected HE systems. Ironically, but not surprisingly, it is the success, importance and size of the sector from a former elite sector to an almost all encompassing one that contributed to its marketization as the outputs of HE turned into central "products" of the knowledge economy. One author argues, "Once they have conceded that knowledge is a commodity to be traded, universities become subject . . . to the full and ruthless protocols of the market" (Bertelsen 2002, 1 quoted in Meek and Davies 2009, 53).

Changes in University Governance

In Europe, the concept of new public management (NPM) which originated in the 1980s in the UK drastically altered the relation between the state and its agencies, among them higher education institutions and universities. The basic idea behind the concept is a more market-oriented approach to public management and administration by emulating practices derived from private enterprise in the public sphere (Park 2012b), with the aim of achieving (cost-) efficient results and to enhance the "productivity" of the respective sector. European universities – such as other publicly funded bodies – have been radically transformed in line with the demands of this central new approach to public management. According to Ferlie et al. (2008) NPM-inspired reforms in higher education are characterized by an increased level of competition and financial pressures, a stronger vertical differentiation between institutions, a heavier emphasis on performance, and the introduction of nonacademic executive leadership as well as a top-down management style. De Boer et al. (2007) further establish five relevant dimensions of NPM in the governance of HE. On the basis of these criteria, the authors formulate a hypothetical "NPM standard" which would ideally be set to: (1) state regulation = low, (2) academic self-governance = low, (3) external guidance = medium to high, (4) managerial governance = high, and (5) competition = very high. Their so-called governance equalizer, an analytical tool comprised of these five dimensions, enables them to measure the extent of NPM policy in the various national higher education systems. The UK currently still represents the European system closest to this hypothetical NPM standard, whereas in other European HE systems, only certain aspects of the NPM scheme were implemented, with each country showing a specific combination or focus (see Park 2012b). In the course of NPM-inspired reforms, a decoupling from state authority and the direct control of the state took place in several countries. In the Netherlands and Austria, for example, universities were turned from state agencies into autonomous entities under public law competing for funding and students; they are thus no longer directly responsible to the state or the ministry in their internal steering processes. Control is exerted indirectly through ex-post-evaluation and performance measurement to justify the spending of public funds and at the same time to create competition for public funding among institutions (the most notable example would be the rigorous RAE in the UK). Institutional autonomy is also counterbalanced by an increased influence of various external stakeholders ("stakeholder guidance"), such as governing boards composed also of members of private industry, and the state has become merely one stakeholder.

Further, as a result, the internal organization and governance mechanisms at universities underwent unprecedented transformation processes in the last decades. One of the most drastic effects as a corollary of NPM-inspired reforms on universities has been the curtailing of academic self-governance. Whereas traditionally the academic profession – or the so-called academic oligarchy (Clark 1983) referring to the full professoriate, not all university employees – had a strong influence on the internal governance of their institution ("republic of scholars"); the steering of universities is now increasingly turned over to professional executive university managers who are expected to guide the institution effectively through an ever more competitive HE landscape. The degree and importance of collective decision making and academic self-governance by scholars has been a longstanding characteristic of the Western university. For centuries, professors represented in collegial bodies such as the academic senate and other committees decided collectively upon most internal and academic matters in often cumbersome and slow procedures – a decision-making process possibly unfit for flexible, quick reaction to market pressures. Thus, in many countries following the NPM paradigm, nonacademic and more top-down leadership structures were established which challenged the once "donnish dominion" of scholars over their institution (Halsey 1992). Strategic decisions are now increasingly taken by management (the president, vice-chancellor, or in the rectorate), whereas formerly the rector was considered a *primus inter pares* simply voicing the decisions the collegiate arrived at communally. In some countries, the once powerful senate has been reduced to dealing with purely academic matters, such as the development of curricula (see also Park 2012b). The university as an independent and self-governing entity shielded from outside pressures is turning into a more corporate entity following organizational models derived by private enterprise.

This shift toward more entrepreneurial notions of the university as an organization is also reflected in changes of employment contracts and employment relations. The marketization and "capitalization" of HEI also had drastic effects on the academic profession, and in the last decade a trend toward more flexible work contracts and increasingly insecure employment situations at universities emerged as management is aiming to maintain institutional flexibility. Academic tenure, generally understood as permanent employment until retirement with a high degree of dismissal protection for professors, was once considered the "cornerstone" or the "sacred cow" of the academy. Also, academic self-governance relied to a large degree on the power and privileges of full professors. It can be argued that currently an "erosion of tenure" (Park 2012a) is taking place referring both to the shrinking numbers of tenured positions within universities and the diminishing strength or degree of employment protection tenure offers. The "rise of the part-time profession" (UNESCO et al. 2009) and the increase in off-track appointments have recently been regarded as the most important development and prominent "threat" to the "full professor." The American Federation of Teachers states: "In recent years, the most notable – and potentially the most destructive – trend in higher education has been a significant shift away from employing tenured and tenure-track faculty members in favour of employing full-time non tenure-track faculty members, part-time/adjunct faculty members and graduate employees" (AFT, American Academic 2009, 3). Schuster/Finkelstein (2006) even speak of an "appointment revolution," and they demonstrate that the proportion of full-time faculty who were in fixed-term contracts (non tenure eligible) was barely perceptible in the 1960s but has risen to over a quarter of the full-time faculty over the last 30 years. Finkelstein (2007, 149) shows that 58,6 % of new hires in 2003 were nontenured, off-track positions. The full-time professoriate is in retreat and a recent UNESCO report concludes pessimistically: "The professoriate faces significant difficulties everywhere [. . .and] the decline of a real full-time professoriate is undermining high-quality higher education." (UNESCO et al. 2009, 89f., see also Park 2012a).

Conclusions and Future Directions

It was argued here that the massification of HE and the problems associated with effectively financing growing student numbers and accommodating various differing needs both on the personal as well as on the system level resulted in an increased differentiation of HE institutions. The (Humboldtian) research university based on a unity of teaching and research no longer serves as the sole model for higher education institutions; in fact, the teaching-research nexus is only upheld in an increasingly smaller segment of the higher education sector, possibly leading to a renewed elite function of the research university. Systems where the research university still serves as the prominent model are currently encountering severe financial difficulties. Further, changes in higher education policies over the last 30 years were fueled by an underlying belief in the regulatory forces of the market and ultimately answer to the argument for cost efficiency. On the organizational level, the question arises if the university is turning into a business organization like any other, a knowledge producing and/or disseminating firm with private-sector employment regulations and increasingly less staff participation in the decision-making process. A firm competing for funding and students, trying to prevail in a competitive market setting relying on effective strategic management to find their market "niche" – be it world-class research on the one hand or affordable quality education on the other.

In relating the above to the discourse on innovation, innovation is conceptualized here as constant renewal or change, as a process of "creative destruction" in the Schumpeterian sense, continuously bringing about new and "better" or more efficient ways of doing things. It is also an essentially capitalist notion or endeavor, as constant innovation and improvement leading to growth is at the core of capitalist modes of production. In the words of Josef Schumpeter: "This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in" (Schumpeter 1950, 83). It is based on the underlying assumption of getting more or qualitatively better output with less effort thus "incessantly revolutioniz[ing] the economic structure *from within*, incessantly destroying the old one, incessantly creating a new one" (ibid.). This was already stated by Marx who claimed that "the bourgeoisie cannot exist without constantly revolutionizing the instruments of production, and thereby the relations of production, and with them the whole relations of society" (1848).

Leaving normative assessments aside, besides unleashing an enormous creative potential and power, capitalist modes of production can also have an equalizing effect, as (certain) hierarchies stand in the way of and hinder optimal output (they are simply not as efficient) as is evident in the transition from feudal to modern structures. The development from craft shop to factory is often quoted as an essential innovative step. Interestingly, governance changes at (European) universities over the last 30 years make for an impressive example for a similar transition. Humboldtian research universities were transformed from self-governing organizations resembling a feudal guild structure of ordinary professors or chair holders who ruled their institution as members of a privileged "estate" to a more capitalist notion of the university with strong leadership and nonacademic management vis-a-vis employed staff or knowledge workers. Also, under the conditions of mass higher education, the master/apprentice relationship between professor and student can no longer be upheld. The personal "craft-shop style" formation of the Humboldtian model possible in times of elite higher education is increasingly impossible to sustain unless extreme costs are incurred.

It remains up for debate if specialization/differentiation and NPM-inspired practices and policies in higher education can be termed as "social innovation" (in the sense of finding new and better or more efficient ways to distribute funds, or the search for creating more efficient or beneficial regulatory frameworks, for example), a "societal innovation" or merely an "organizational innovation process" (aiming toward more cost-efficient results under the conditions of mass production). What seems clear, however, is that innovation and thus capitalist modes of production itself have taken hold of an age-old bastion of social organization – next to the catholic church, the university is considered one of the oldest surviving institutions of the Western hemisphere (Stichweh). Innovation enters the system itself, and it is undergoing a process of change or renewal based on considerations of cost efficiency. Constant innovative effort and improvement are at the heart of the capitalist enterprise; in higher education, this translates to how to make education and knowledge production more or most efficient, how to educate the largest amount of people with the least amount of cost, or how to organize and foster scientific research most optimally in order to guarantee economic advantage.

However, and most importantly, it was argued here that currently a change or "revolution" in the means of production in the higher education sector is on the verge of taking place: Innovation as creative destruction has brought about a change in the way teaching and research are carried out by introducing new, computer-based modes of (higher) learning. It is important to note that this change was initiated by technological advances and innovation not by social innovation per se which seems to follow and again appears derived. As a – utopian, but increasingly visible – outlook and conclusion to this segment, the special creative destruction processes inherent in capitalist modes of production highlighted by both Schumpeter and Marx could – through new modes of production, that is, social media and computer-based technologies – initiate a truly disruptive innovation process in higher education fundamentally challenging the argument for cost efficiency currently plaguing systems maintaining full open access policies (and thus – paradoxically – challenging the capitalist paradigm based on cost efficiency itself). Innovation could contribute to turning higher education and especially research universities into an easily affordable and accessible and at the same time extremely valuable product open to all.

Cross-References

▶ Creative Destruction
▶ Global University System in World Society
▶ Mode 1, Mode 2, and Innovation
▶ Mode 3
▶ Social Innovation
▶ University Research and Innovation

References

American Federation of Teachers. American academic. The state of the higher education workforce 1997–2007, Washington; 2009. http://www.aft.org/pdfs/highered/aa_highedworkforce0209.pdf. Accessed 21 Jan 2013.

Bertelsen E. Degrees 'R' us – the marketisation of the university. Academics Association, South Africa: University of Cape Town; 2002. Retrieved 21 January 2013 from http://firgoa.usc.es/drupal/node/3675

Brandenburg U, Zhu J. Higher education in China in the light of massification and demographic change. Lessons to be learned for Germany. Gütersloh; 2007. CHE Arbeitspapier Nr. 97.

Carayannis EG, Campbell DFJ. Mode 3 Knowledge Production in Quadruple Helix Innovation Systems, SpringerBriefs in Business 7; 2012.

Chiang K-H. Research and teaching revisited: a pre-Humboldtian or post-Humboldtian phenomenon? The cases of France and the UKejed_1513 139..152. Eur J Educ. 2012;47(1):139–52.

Christensen CM, Horn MB, Caldera L, Soares L. Disrupting College. How disruptive innovation can deliver quality and affordability to postsecondary education. http://www.americanprogress.org/issues/2011/02/pdf/disrupting_college.pdf (2011). Accessed 14 June 2012.

Clark B. The higher education system: academic organization in cross-national perspective. Berkeley: University of California Press; 1983.

Clark B. The modern integration of research activities with teaching and learning. J high educ. 1997;68:241–55.

De Boer H, Enders J, Schimank U. On the way towards new public management? The governance of university systems in England, the Netherlands, Austria, and Germany. In: Jansen D, editor. New forms of governance in research organizations. Dordrecht: Springer; 2007. p. 137–52.

Ferlie E, Musselin C, Andresani G. The steering of higher education systems: a public management perspective. High Educ. 2008;56(3):325–48.

Finkelstein M. The new look of academic careers in the United States. In: Kogan M, Teichler U, editors. Key challenges to the academic profession (UNESCO forum on HE, research and knowledge/INCHER). Paris/Kassel: Jenior; 2007. p. 145–58.

Fischer-Kowalski M. Zur Entwicklung von Universität und Gesellschaft in Österreich. In: Fischer H, editor. Das politische System Österreichs. Wien: Europa; 1974.

Fry R. College enrollment hits all-time high, fueled by Community college surge. Report available online at http://www.pewsocialtrends.org/files/2010/10/college-enrollment.pdf Pew Research Center; 2009.

Guri-Rosenblit S, Sebkova H, Teichler U. Massification and diversity of higher education systems: interplay of complex dimensions. Paper presented at the regional seminar "Globalizing Knowledge: European and North American Regions and Policies Addressing the Priority Issues of Other UNESCO Regions"; March 5–6; Paris: UNESCO Forum on higher education, Research and Knowledge. http://unesdoc.unesco.org/images/0015/001578/157816e.pdfQuotes in Meek OECD; 2007.

Halsey AH. Decline of donnish dominion. The British academic professions in the twentieth century. Oxford: Clarendon; 1992.

Hochschulbericht. Austrian Federal Ministry for Science and Research; 1969. Available online at www.bmwf.gv.at.
Huber L. Forschendes Lernen. 10 Thesen zum Verhältnis von Forschung und Lehre aus der Perspektive des Studiums, in: die hochschule 2/2004, 29–45; 2004.
Kolowich S. Elite universities' online play. Inside higher Ed (18 April 2012). http://www.insidehighered.com/news/2012/04/18/princeton-penn-and-michigan-join-mooc-party (2012). Accessed 20 Aug 2012.
Lörz M. Differenzierung des Hochschulsystems und soziale Ungleichheit: Führt der Ausbau der beruflichen Bildungswege zur Inklusion oder Exklusion bildungsferner Schichten? (HIS-Institut für Hochschulforschung), Paper presented at the 7th Annual Meeting of the Association for Higher Education Research (Deutsche Gesellschaft für Hochschulforschung) May 9–11 2012; Vienna; 2012.
Luhmann N. Selbststeuerung der Wissenschaft. In: Luhmann N, editor. Soziologische Aufklärung 1. Aufsätze zur Theorie sozialer Systeme. Opladen: WDV; 2005/1970. p. 291–316.
Meek VL, Davies D. Policy dynamics in higher education and research: concepts and observations. In: Meek VL, Teichler U, Kearney M-L, editors. Higher education, research and innovation: changing dynamics. Report on the UNESCO forum on higher education, research and knowledge 2001–2009. Kassel: International Centre for higher education Research Kassel (INCHER-Kassel); 2009. p. 41–82.
Musselin C. Universities and pricing on higher education markets. In: Mattheou D, editor. Changing educational landscapes. educational policies, schooling systems and higher education – a comparative perspective. Dordrecht: Springer; 2010.
OECD. Education at a glance. Paris: OECD Indicators; (2011). Available online at http://www.oecd.org/dataoecd/61/2/48631582.pdf. Retrieved 14 June 2012.
Ordorika I. Commitment to society: contemporary challenges for public research universities. Paris: UNESCO Forum on higher education, Research and Knowledge; 2006. Available online at http://portal.unesco.org/education/en/files/51618/11634242365Ordorika-EN.pdf/Ordorika-EN.pdf, Accessed June 14, 2012.
Park E. The transformation of the academic profession: the erosion of tenure and the (e)state of the Professoriate. In: Vukasović M, Maassen P, et al., editors. Effects of higher education reforms: change dynamics. Rotterdam: Sense Publishers; 2012a. p. 219–38.
Park E. From academic self-governance to executive university management – Institutional governance in the view of academics in Europe. In: Teichler U, editor. The academic profession in Europe: responses to societal challenges, The changing academy – the changing academic profession in international comparative perspective, vol. II. Heidelberg: Springer; 2012b.
Pechar H. Die ständische Versäulung des österteichischen Bildungssystems. In: Josef Broukal & Erwin Niederwieser (Hg.), Bildung in der Krise. Warum wir uns Nichtstun nicht leisten können. Wien: Kremayr & Scheriau; 2010. S. 27–38.
Preglau-Hämmerle S. Die politische und soziale Funktion derr österreichischen Universität. Innsbruck: Inn; 1986.
Schimank U, Winnes M. Beyond humboldt? The relationship between teaching and research in European university systems. Sci Public Policy. 2000;27:397–408.
Schumpeter JA. Capitalism, socialism and democracy. 3rd ed. New York: Harper and Row; 1950.
Schuster J, Finkelstein M. The American faculty: the restructuring of academic work and careers. Baltimore: The Johns Hopkins University Press; 2006.
Trow M. Problems in the transition from elite to mass higher education. Berkeley: Carnegie Commission on higher Education; 1973.
Trow M. From mass higher education to universal access: the American advantage. Research and occasional paper series. UC Berkeley: Center for Studies in Higher Education; 2000.
Trowler P, Wareham T. Reconceptualising the 'Teaching-Research Nexus'. Enhancing the teaching-research Nexus. http://www.lancs.ac.uk/fass/projects/nexus/outputs.htm. quotes in meek, 70ff; 2007. Retrieved Dec 15 2007.
UNESCO, Altbach PG, Reisberg L, Rumbley LE. Trends in Global higher education:Tracking an academic revolution executive summary a report prepared for the UNESCO 2009 World Conference on higher education, http://www.unesco.org/tools/fileretrieve/2844977e.pdf; (2009).
von Humboldt W. Königsberger Schulplan. In: Flitner A, Giel K, editors. Wilhelm von Humboldt. Stuttgart: Schriften; 1993. p. 198–200.

Higher Education Institutions

► Higher Education and Innovation

Higher Order Learning

► Epidemiology of Innovation: Concepts and Constructs

Higher-Order Thinking

► Dialogical Critical Thinking in Children, Developmental Process

Highly-Leveraged Transaction (HLT)

▶ Entrepreneurship and Financial Markets

Homophily

▶ Networks and Scientific Innovation

Hospice

▶ Palliative Care and Hospice - Innovation at End of Life

How does Material Culture Extend the Mind?

Johan De Smedt[1,2] and Helen De Cruz[3,4]
[1]Department of Philosophy & Ethics, Ghent University, Ghent, Belgium
[2]Uehiro Centre for Practical Ethics, University of Oxford, Oxford, UK
[3]Somerville College, University of Oxford, Oxford, UK
[4]Centre for Logic and Analytical Philosophy, Katholieke Universiteit Leuven, Leuven, Belgium

Synonyms

Cognitive integration; Cognitive scaffolding; Epistemic engineering; Extended cognition; Extended mind; Extended mind thesis

Material Culture and the Brain

Humans rely extensively on material culture when they are thinking, including when they are involved in reasoning tasks that require creative solutions. Examples are measuring devices like compasses and barometers; external memory aids like calendars, books, and maps; calculating instruments like abaci and slide rules; and highly specialized tools like imaging software. Even a brief look around one's desk suffices to indicate that humans are surrounded by artifacts that are specifically designed to perform a variety of cognitive tasks. Why do humans rely so extensively on external tools? What are the kinds of cognitive tasks that material culture helps them to accomplish? How are they instrumental in helping them complete such tasks? This entry of the extended cognition literature will look at these questions in more detail and pay special attention to their relevance to creativity, starting out by considering different ways in which material culture enhances cognition and then briefly reviewing three models of extended cognition. This entry ends by outlining practical applications of the extended cognition literature for innovators.

Extended Cognition: Key Concepts

Epistemic Actions

Kirsh and Maglio (1994) draw a useful distinction between *epistemic* and *pragmatic actions*. Like pragmatic actions, epistemic actions involve some physical manipulation of the external world, for example, a Scrabble player who rearranges tiles on her tray, an engineer who draws a diagram, or a carpenter who makes a pencil mark on a piece of wood to indicate where sawing has to take place. The chief difference between pragmatic and epistemic actions is that the main aim of pragmatic actions is to bring about changes in the world, for example, driving from home to work, whereas epistemic actions are mainly performed in order to aid and enhance cognitive processes, for example, driving around in order to explore the neighborhood one just moved into. Although epistemic actions are primarily aimed at acquiring information and improving cognitive performance, they have pragmatic consequences as well. Drawing a map does not physically alter the environment, but makes it easier to navigate – one does not have to level the terrain or fell trees to get a comprehensive overview. Carpenters who stick to the dictum that one should measure twice and saw once avoid wasting material.

Epistemic actions are often performed in the context of creative problem solving. “Creative problem solving” refers to forms of problem solving that involve the generation of solutions that go beyond established action patterns, or that combine existing ideas in new ways, for example, by applying an approach used in one domain to a different domain. Performing epistemic actions helps one to test run novel combinations of ideas and behavior patterns in a virtual manner, avoiding the costs of real-world trial and error. Epistemic actions are therefore vital to creativity. Examples include an engineer who tinkers with a prototype in order to test the effects of varying parameters to her design and a composer who tests the effects of different harmonic structures in a novel composition by trying them out on the piano.

Epistemic Tool Use

Many animals rely on epistemic actions. Ants make pheromone trails to find their way back from a food source to the nest; birds and other territorial animals frequently inspect their territory to check for intruders. However, tool use specifically aimed at gaining knowledge – known as *epistemic tool use* or *epistemic engineering* – remains rare in the animal kingdom. No animal has ever been observed to make tools (i.e., intentionally modify objects) primarily for cognitive functions. Humans, by contrast, make use of a myriad of artifacts that are specifically designed to help them fulfill epistemic actions. Early examples of epistemic tool use include a 30,000-year-old lunar calendar from Abri Blanchard (French Pyrenees), which not only kept track of the phases of the moon but also of its actual position upon its ascent in the spring sky, and a notched bone from Ishango (Congo) dated to about 25,000 BP, which has notches grouped in numerically interesting ways, for example, prime numbers (De Smedt and De Cruz 2011). These examples predate the earliest emergence of writing by over 20,000 years.

Epistemic tool use is not only ancient but also cross-culturally ubiquitous. Even people with a relatively sparse material culture rely on epistemic engineering. For example, traditionally, Australian aboriginals (who lived a nomadic lifestyle that precludes hoarding large amounts of material culture) used message sticks to relay coded information to distant groups; bark paintings, which captured features of the landscape, like water sources and mountains; and cave paintings, which remarkably preserved biological knowledge of species that have gone extinct for thousands of years, such as fruit bats and giant marsupials (De Smedt and De Cruz 2011). Epistemic tool use is a human universal and has been so for thousands of years. The next sections will review some of the ways in which epistemic tools help humans to perform disparate cognitive tasks, with a focus on creativity.

Lightening Cognitive Load

Perhaps the best-known function of epistemic tools is to extend and supplement human biological memory. Keeping the diverse elements of a complex task in memory is cognitively demanding, and there is always a good chance that some elements get misrepresented, overlooked, or forgotten. By externally representing elements of a task, the mind is relieved from having to represent them internally and can focus better on creative aspects of the enterprise.

Even for those cognitive tasks that can be held in biological memory, it makes sense to use external representations that simplify them. For example, while many people would be able to mentally calculate 231×43, a pocket calculator is faster and less error prone. Drawing up to-do lists, subdivided in urgent, less urgent, and contingent tasks, relieves a person’s memory from keeping in mind what to do next and reduces the chance of overlooking pressing assignments. Interestingly, external representations can differ in the way they lighten cognitive load, as Zhang and Norman (1995) showed in their comparison of different numerical notation systems. They found that nonpositional systems like Roman numerals are more challenging to calculate with than positional systems, in particular, because the former offer fewer opportunities to perform some parts of the calculation externally, while the latter allow, for example, for carrying numbers. By contrast, nonpositional systems provide straightforward, visual representations of quantity that positional systems lack. For example, one can see at a glance that XXXIII is larger than XII, whereas a user of Arabic numerals needs to retrieve the values of 1, 2, and 3 from memory to assess whether 33 is larger than 12.

Improving Conceptual Stability

Creativity involves a complex manipulation of conceptual structures. These need to be represented in such a way that some parts of the representation can be altered (e.g., combining new ideas with old ones) while at the same time keeping other parts unaltered. For instance, the available physical space where an architectural solution needs to be implemented typically remains unchanged regardless of the solution that carries the day. Hutchins (2005) notes that the complexity of creative tasks can be greatly increased if the stability of the representation is improved. One obvious way to increase conceptual stability is to simply carry out creative solutions in the real world instead of representing them mentally. Painters, for example, often test different compositional ideas on their canvas by lightly outlining them (as x-rays of historical paintings indicate), or even by altering their design while the painting progresses (the older layers with earlier solutions, the so-called *pentimenti*, are sometimes still partly visible). This allows them to accurately assess the effects of compositional alterations. Also, they typically do not mix colors mentally, but directly test different color combinations on their palette. When reasoning about features of the environment, it is often cumbersome and suboptimal to make an internal, mental representation of them. When testing compositional ideas in the mind, it is difficult to keep some elements unchanged while altering others. By using the external representation as its own best model, a designer can directly interact with it, making her thinking easier, faster, and more reliable. Because they do not involve internal reconstruction, such real-world interactions with the environment are less liable to error.

Making Hidden or Nonobvious Properties More Explicit

Although the world is often its own best model (Brooks 1991), it is not always possible to rely on direct interactions with the world to solve creative problems (e.g., in architectural or airplane design). Moreover, making a new external representation of some features of the world sometimes reveals properties that were hitherto hidden or nonobvious. Kirsh (2010) provides the example of visual designers, who shift between scale models, pen-and-paper diagrams, computer-generated fly-throughs, and various other media. By making multiple representations, they discover structural properties that were previously undetected. A 3D model allows engineers to approach the design from different angles. By observing it from unusual viewpoints, they can see structural relations and detect violations of constraints that would not be detected otherwise. Scale models have the advantage that their relations logically and physically are independent from the designer. Unlike a mental representation, an actual physical model needs to be self-consistent. It can be examined and manipulated independently of the designer's prior ideas and allows for discussion, since its structural elements are there for all to see. Pen-and-paper diagrams do not allow for such rich and detailed inferences (especially not the multiple angles), but allow one to keep a sense of the big picture, the basic ideas underlying the design. Fly-throughs, on the other hand, can give one a phenomenological impression of what the design would look and feel like once executed.

Providing a Handle on Concepts That Are Difficult to Grasp

Not all ideas are equally easy to comprehend and handle. Cognitive anthropologists have examined how the structure of the human mind influences the way we acquire and transmit ideas. Consider a child who learns that a platypus is an animal. From this information alone, she can rely on a rich body of knowledge she already possesses: she can infer that platypuses need food and drink, can reproduce, will die, and so on. The concept platypus is thus a relatively easy concept to learn.

One cannot rely on this earlier-stored tacit knowledge for all concepts. Few people have a good grasp of quantum mechanics or relativity theory, because both run counter to our commonsense conception of physics. Even a concept like heliocentrism is difficult to represent, as is clear in people's inability to solve problems such as why there are different seasons. Most laypeople think it is because the Earth is closer to the Sun in summer than in winter, but realize this cannot be correct, since this does not explain why seasons differ between geographical locations. External representations, such as a model of the solar system that clearly indicates the eccentricity of the Earth's orbit, can facilitate this. Without external representations, some solutions to cognitive problems are almost literally unthinkable. For example, mathematical solutions like algebraic rules to solve second- and higher-degree equations would be impossible without some way of representing these problems externally, either through symbols, as in western mathematics since the sixteenth century, or diagrams, as in ancient Greek and medieval Islamic mathematics.

Costs of Epistemic Tool Use

Epistemic tool use clearly provides many cognitive benefits, but may also carry cognitive costs. In a world where large chunks of information can be stored and transmitted with high accuracy, thanks to its external storage and where diverse channels can be used to transmit these, people can have too much information pushed at them, resulting in a cognitive overload as irrelevant data do not get filtered out. This problem, however, is not so much caused by the amount of information but, rather, by lack of control over it. Employees who return to work from an extended holiday are typically confronted with a large pile of paper mail and dossiers, an overflow of unanswered e-mails, and recordings of missed phone calls. All this information must at least be sifted through in order to decide whether and how to respond, causing stress and anxiety.

Potential cognitive costs not only present themselves for information that is provided but also for information one can freely retrieve. Take the so-called Google effect on memory. In a series of experiments, Sparrow et al. (2011) presented participants with a large set of trivia they had to type on a computer. Half of the participants were told they could use the computer to retrieve facts later on; the others were told the computer would erase the typed information. Participants who thought that they could not rely on the typed notes showed a superior recall. Those who were deceived into expecting they could use the typed notes recalled the information poorly. In a variation on this experiment, Sparrow et al. (2011) let students type information in several folders on a computer. Again, the subjects who were led to believe that they could retrieve the data later on were less good at recalling the facts they stored. Strikingly, they were better at remembering where it was stored than at recalling the information itself. The widespread use of search engines and digital storage thus alters the way human natural memory functions: people shift from recall of facts to recall of where these facts are stored. This in itself may not be a problem, but it can become a problem if information becomes temporarily unavailable, or gets accidentally destroyed (e.g., hard drive failure). As the authors were finishing this entry (January 19, 2012), there was a blackout of Wikipedia, causing disruption and frustration among students and redaction rooms worldwide.

Theoretical Background and Open-Ended Issues

Material culture plays an indispensable role in human reasoning processes. There are several theoretical models to describe how material culture accomplishes this: internalism, active externalism, and cognitive integration.

Internalism

Internalism is the standard view in cognitive science. It maintains that although epistemic actions play an important role in improving our cognitive capacities, they are not genuinely part of cognitive processes. Internalists think that cognitive processes are as a matter of fact purely intracranial, that is, they only take place inside the skull. An analogy with pragmatic tool use, offered by Adams and Aizawa (2001), illustrates this. A person who uses lopping shears to cut thick branches is accomplishing something he would not be able to do with his bare hands, but this does not imply that the muscular processes within his hands and arms actually extend into the shears. Similarly, although microscopes and diagrams are involved in our epistemic actions, this does not imply that one should attribute cognitive agency to these objects. Some authors writing in the field of extended cognition (e.g., Menary 2007) have criticized internalism because it places severe constraints on what counts as cognitive. Obviously, creative reasoning also relies on internal cognitive processes, such as when one makes a chain of associative thought or when ideas one has previously been "brooding on" combine to yield a sudden insight. However, as outlined in section "Extended Cognition: Key Concepts", without external media, creative solutions would be highly constrained, not only in their complexity (purely internal mental representations are hard to stably keep in memory), but also in their kind (some creative solutions are literally unthinkable without external representations). Hence, internalism does not seem to be a fruitful theoretical model to explain what goes on in creative reasoning.

Active Externalism

Active externalists think of cognition as a coupled process, where internal cognitive operations causally interact with epistemic actions. For example, multiplying two numbers using pen and paper consists of internal cognitive processes (e.g., mental arithmetic) coupled with external cognitive processes (e.g., carrying numbers, writing down results). A possible worry is that by granting cognitive status to epistemic actions, one might overextend cognition to every object that is somehow causally involved in cognitive processes. Do a pencil and notepad become part of cognition because these objects were used in a cognitive task? To adjudicate which instances of epistemic tool use are cognitive, Clark and Chalmers (1998) propose the parity principle. Roughly, this holds that if one characterizes a process that takes place in the brain as cognitive, one also ought to characterize a structurally similar process that takes place outside of the brain as cognitive. Take an Alzheimer's patient who relies on a notebook to keep track of facts and appointments: if one is happy to concede that the neurologically normal person is informed by her (internally stored) beliefs about facts and appointments, one should, according to Clark and Chalmers (1998), also regard the externally stored information in the notebook of the Alzheimer's patient as beliefs and thus treat his use of the notebook as cognitive.

Cognitive Integration

Although the parity principle may be useful to overcome some traditional ways of thinking about cognition, it is quite limited when it comes to describing what actually goes on when one is engaged in epistemic tool use. Indeed, in many cases, thinking with the help of external media is radically different from thinking in a purely internal way. An engineer who engages in real-world interaction with a model or pen-and-paper diagram is thinking in a very different way compared to one who ponders about his design using mental representations only. The real-world interactions allow for more consideration of details and can bring to light properties that remain undetected when engaged in internalized cognition. Thus, some authors (e.g., Menary 2007) have argued that the parity principle may not be a good starting point for thinking about extended cognition. Cognition should not be limited to those instances of intracranial processing and external actions that happen to be isomorphic to them, but rather, cognition should be conceived of as an integration of internal and external processes. This involves a causal, dynamic interaction between both types of processes, where the practices of manipulating external objects can lead to structural changes in the way internal cognitive processes take place. The Google effect on human memory, where an increased reliance on the Internet and other external sources has altered internal memory processes, provides a good example of such integration.

Practical Applicability of Extended Cognition Research for Creativity and Innovation

This entry of the extended cognition literature indicates that humans rely on material culture to perform a variety of epistemic actions. These are not merely duplicates of internal cognitive processes but are often structurally very different. Although the extended cognition literature is at present mostly concerned with describing how material culture enhances human cognition, one can draw some practical conclusions for its role in human creativity and innovation. As reviewed here, epistemic actions provide a handle for ideas that are difficult to keep in mind; they allow one to detect properties that are not obvious and improve conceptual stability. Given that different external representations facilitate diverse solutions, creative workers frequently use disparate media to work on the same problem. The chance that an undetected problem or unconceived solution becomes apparent increases as one uses different ways to externalize the problem one is working on. However, engaging in epistemic actions does present a cost in terms of time, energy, and resources. Using a new software program can provide benefits, but requires an initial learning period before these become apparent. Developing external representations (e.g., scale models) requires time, money, and energy. Individual reasoners will therefore have to make trade-offs between what they are willing to invest in the development of external representations that aid their cognitive processes (e.g., make a computerized fly-through or a scale model) and the expected payoffs of this in facilitating or promoting creative solutions.

Since humans have access to a variety of epistemic tools to an unprecedented extent, innovators will need to consider carefully when deciding which tools they will use. For tasks that require creative solutions, it seems important to choose external media that:

- Help to lighten cognitive load, so that more attention and cognitive resources can be devoted to envisaging new solutions
- Enhance conceptual stability, which allows one to consider more complex problems and to develop more true-to-life solutions
- Bring to the fore features that were previously undetected, increasing the pool of possible creative solutions
- Allow to represent ideas that are hard to conceive internally, expanding the range of novel ideas that can be applied in problem solving

Conclusions and Future Directions

The role of material culture in human reasoning, especially in tasks that involve novel, creative solutions, is substantial and unavoidable. Coming up with creative solutions would not only be more cumbersome and labor-intensive – without epistemic tools, some solutions would just be unthinkable. Recognizing the importance of epistemic tool use for creativity highlights the importance of choosing good external representations. Sometimes, the world is its own best model, but in many cases, innovators need to develop new external representations to solve creative problems. By choosing the right epistemic tools, one can facilitate creative discovery to a considerable extent.

The cognitive study of the use of material culture can benefit significantly from a closer look at real-world examples, and this is an important direction where future research can be carried out. Until now, a large part of this literature has been concerned with in vitro psychological studies that take place in the laboratory, where the available epistemic resources are highly restricted (e.g., Kirsh and Maglio 1994; Sparrow et al. 2011). Next to this, mostly theoretical and philosophical considerations play a role (e.g., Clark and Chalmers 1998). Examining the actual practice of creative individuals like engineers or architects at work in R&D departments or design studios can bring to light *what* informs the choices made by creative individuals about *which* epistemic tools they will use. Such in vivo psychological studies have up to now mainly been conducted in science labs and military settings (see, for instance, the work of Bruno Latour, Kevin Dunbar, and Edwin Hutchins).

Studies like these can shed light on what drives real-world creative work and the role of epistemic tools therein, for instance, trade-offs between time and money constraints and the advantages of epistemic engineering.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Cognition of Creativity
▶ In Search of Cognitive Foundations of Creativity
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Research on Creativity

References

Adams F, Aizawa K. The bounds of cognition. Philos Psychol. 2001;14(1):43–64.

Brooks R. Intelligence without representation. Artif Intell. 1991;47(1–3):139–59.

Clark A, Chalmers D. The extended mind. Analysis. 1998;58(1):7–19.

De Smedt J, De Cruz H. The role of material culture in human time representation: calendrical systems as extensions of mental time travel. Adapt Behav. 2011;19(1):63–76.

Hutchins E. Material anchors for conceptual blends. J Pragmat. 2005;37(10):1555–77.

Kirsh D. Thinking with external representations. AI Soc. 2010;25:441–54.

Kirsh D, Maglio P. On distinguishing epistemic from pragmatic action. Cognit Sci. 1994;18(4):513–49.

Menary R. Cognitive integration: attacking the bounds of cognition. Basingstoke: Palgrave; 2007.

Sparrow B, Liu J, Wegner DM. Google effects on memory: cognitive consequences of having information at our fingertips. Science. 2011;333(6043):776–8.

Zhang J, Norman DA. A representational analysis of numeration systems. Cognition. 1995;57(3):271–95.

Hub

▶ Clusters, Networks, and Entrepreneurship

Human Inequality

▶ Political Leadership and Innovation

Human-Computer Interaction

▶ Interaction, Simulation, and Invention

Hyperkinesis

▶ Attention-Deficit/Hyperactivity Disorder and Creativity

Hyperkinetic Disorders

▶ Attention-Deficit/Hyperactivity Disorder and Creativity

Hypothetical Thinking

▶ Imagination

I

Idea Generation

► Brainstorming and Invention
► Product Development, Business Concept, and Entrepreneurship

Idea Leadership

► Creative Leadership

Ideal Leadership

► Creative Leadership

Idea-Marathon System (IMS)

Takeo Higuchi
Idea-Marathon Institute (IMS Institute)/
University of Electro-Communications,
Tokyo, Japan

Synonyms

Brain-writing; Continuity; Self-Brainstorming

What is Idea-Marathon System?

Idea-Marathon System, so-called IMS, is a philosophical approach of creativity, to build up a habit of daily thinking and immediate writing in one's notebook along with a consecutive number to each idea. IMS was created by Takeo Higuchi in 1984. Higuchi has been writing these days 50 ideas everyday, often with drawings in his 408 notebooks as of Oct, 2012, accumulating more than 360,000 ideas in his notebooks.

Principles of Idea-Marathon

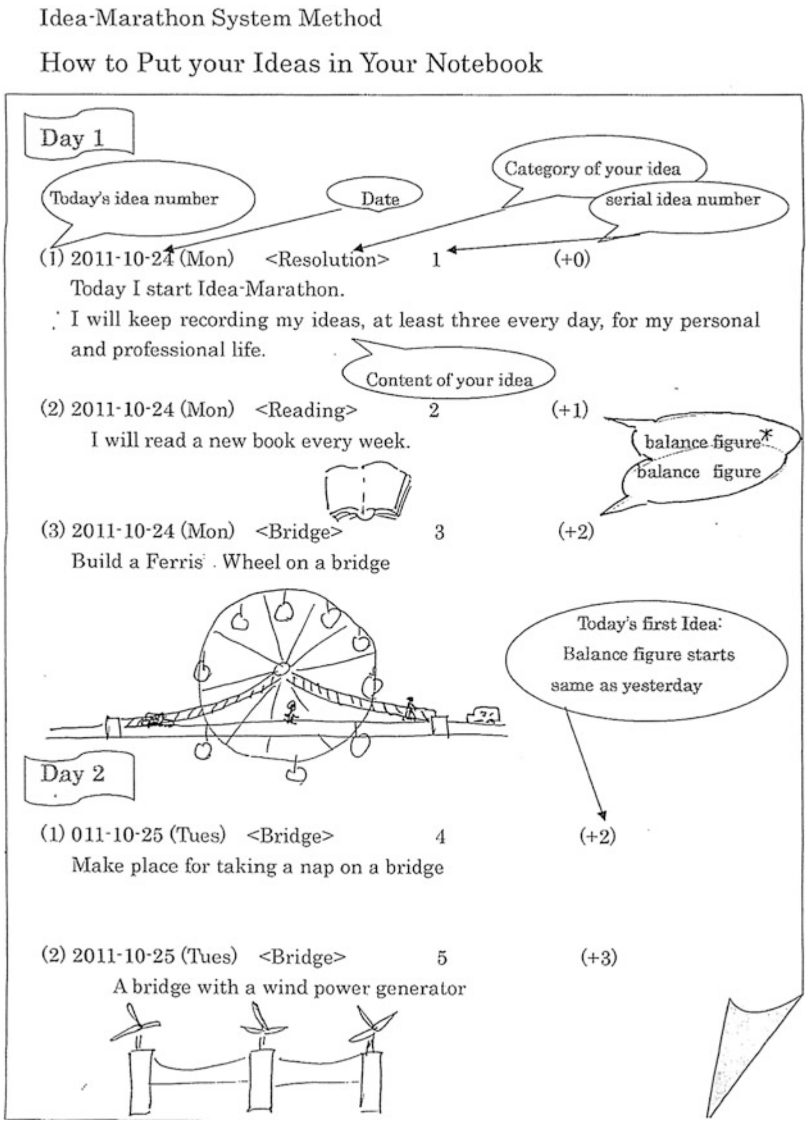
1. Keep using notebooks of the same kind.
2. Generate new ideas everyday to write in the notebook chronologically with idea numbers.
3. Draw pictures for your ideas as often as possible.
4. Talk to your neighbors.
5. Review your ideas.
6. Implement the best ideas out of stock.

Unique points of Idea-Marathon (IMS) are that it is done DAILY so that IMS will become a habit for at least 3 months.

What to Record Idea in IMS

In Idea-Marathon, there are no limits for idea creation. We often can get interesting ideas for

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
DOI 10.1007/978-1-4614-3858-8,



Idea-Marathon System (IMS), Fig. 1 Balance Figure

our work and specialty when we are thinking about something other than our work and specialty.

We can write ideas of hardware and software, better solution, improvement, concepts, project ideas, long range plan, dreams, doubt, checking points, good own jokes, sketches, poems, essay's title, novel's scenario, etc., almost everything out of our brain. Each idea will be written in the notebook like the following example (Fig. 1):

Your balance figure remains even (+0) when you keep writing one idea every day. And if you put forward more than one idea in a day your balance figure will be +1 or more.

IMS Effectiveness for University Students

Empirical quantitative analysis of Idea-Marathon was done by T. Kawaji, M. Higa, and Y. Nakaji of Otsuki City College in 2011. As the result, IMS practice for 3 months showed significant effect in Fluency of Ideas and

Originality of ideas while not effect in Flexibility (Kawaji et al. 2011).

Accumulation Effect or Progressive Stock of Ideas in Notebooks

If one keeps Idea-Marathon with the average of two ideas per day, after only 1 year, one has a stock of 730 ideas in notebooks, 2 years – 1,460 ideas, 10 years – 6,300 ideas. In case any ideas written in notebooks, our brain keeps vague but widely scattered image-like memory of ideas inside brain. Therefore, if we keep a large quantity of our ideas in our notebooks, it starts to resonate with our brain. Our brain is getting faster and stronger in creative power and reaction with the back-ground stock of ideas written in notebooks. One's creative confidence will also be increased accordingly.

References

Kawaji T, Higa M, Nakaji Y. Effect of Creativity in Idea-Marathon System. (in Japanese). The 33rd conference of Japan Creativity Society; 2011.

Ideas and Ideation

Mark A. Runco and Garrett Jaeger
University of Georgia, Athens, GA, USA

Synonyms

Brainstorming; Divergent thinking; Flexibility; Fluency; Originality

Introduction

Ideas are meaningful units of thought. In fact, they represent the most useful unit of thought. There is no way to pinpoint some of the dimensions of ideas since they vary so much (e.g., your idea of "a good time" is probably more complex than your idea of "your favorite color"), but this is in fact part of their utility. They can be defined such that the variation and flexibility are retained. Ideas are smaller than concepts, which are also varied but cover entire categories of thought (e.g., "funny movies"). Ideas can be quite precise. They are the smallest meaningful unit of thought.

Ideas often make themselves known to the individual (in consciousness) in a verbal form, but it would be a huge mistake to see them as always verbal. Ideas occur in all modalities and perhaps in all domains (e.g., music, mathematics). It is typical to think about ideas in some verbal form, but that is just because it is most common to represent thinking with words. The same tendency is apparent in the research on ideas: it is easiest to study words when they are represented in words. Yet ideas need not be verbal. And an important part of the ideational process is in fact preverbal. This is when thoughts (and perhaps emotions) coalesce into meaning.

Ideas play an important role in creativity and innovation. Simply put, most creative breakthroughs, inventions, innovations, and original contributions of any sort begin with an idea. The more significant the creative or innovative product, the more likely it is that other things (revision, communication, judgment, evaluation) are required after the initial idea, but still, the process begins with an idea. That is why there are programs to stimulate ideation (e.g., brainstorming) and several tests of ideation (divergent thinking tests, such as the *Torrance Tests of Creative Thinking* or the *Runco Creativity Assessment Battery*) and why there is a long history of interest in ideas and ideation (Runco 1991, 2008, 2012).

The History and Philosophy of Ideas

The interest in ideas and ideation goes back millennia. PLATO discussed ideas in his *Republic*. There he used the allegory of a cave, with shadows seen by the cave dwellers merely representations of deeper forms. These forms, then, cast shadows which in turn conjure ideas.

John Locke, seventeenth-century author of *An Essay Concerning Human Understanding*, was also explicit about ideation and the concern for ideas. He discussed them as part of his epistemology, the key idea being that we are not born with ideas preformed. Each of us is a tabula rasa, or blank slate, and knowledge and ideas are acquired from experience. Locke suggested that simple ideas are reactions to sensory information and interaction with the environment. These can grow into complex ideas when they are combined and sometimes when divided.

Other philosophical treatises have developed theories of ideas (e.g., David Hume, William James, Alexander Bain), but it has not been only the philosophers who, throughout history, have pondered the origin of ideas. There is, for instance, a long-standing interest in, and debates about, ideas and ideation in the field of jurisprudence. Much of this focused on criteria and methods for recognizing original ideas as part of intellectual property and protection.

Several aspects of ideas seem to have remained constant through history. Ideas are usually associated with knowledge, for example, or are involved with the ontology of knowledge. PLATO suggested that knowing ideas is impossible, yet the observable world (the allegorical shadow) is a mimesis, a parallel of the form (the object which casts the shadow). The association of knowledge and ideas is currently a matter of debate. Many in the cognitive sciences see knowledge as static and dependent on experience. (Personal or reflective experience may be all that is involved; it is not necessarily experience with the objective world.) Ideas may be independent of experience or, more likely, personal constructions that may or may not be the result of thinking about experience. In the terminology of the cognitive sciences, some intellectual processes are top-down and being with thinking, while others are bottom-up and reactions to experience and sensory information. Often these work together; our thoughts draw from interactions with the natural environment but also draw from our imagination and inferences. Ideas, in this light, may result from an interplay of top-down and bottom-up processes. They are not, however, solely dependent on knowledge. Again drawing from the cognitive sciences, the information we hold in long-term memory is often factual and just information, sans personal input and interpretation. This kind of information is not ideational. Admittedly, the process leading up to the formation of an idea (or construction of an interpretation, for that matter) is not well understood. Headway has been made since new brain imaging technologies have been brought to bear. fMRI research, for example, shows that insights may occur as the individual works with factual knowledge, but eventually switches (due to "decisions" of the prefrontal lobes) to a broader activation of knowledge (in the right hemisphere) such that new options can be found.

Another interesting example from the history of ideas and ideation involved Alfred Binet, author of the first test of mental ability. (The procedure for standardizing that led to the IQ was after Binet's work. Binet recognized that ideas are related to fantasy while perception contributes to the experience of reality. Since perception is closely tied with the physiological contributions of our sensory systems, ideas allow transcendence of physical and temporal laws held by common perceptions. Furthermore, when ideas and perception align, they aid in adaptation to our physical surroundings. The external validity provided by our environment allows substitution of ideas for sensation and provides a coupling that appears as perception. Both ideas and perceptions occupy space in our personal realities.

As an aside, Binet's work exemplifies early empirical research on the topic of ideas. He is famous for his work on the psychometrics of IQ, but when he was working, there were fewer distinctions among modes of thought than there are today. Just as Binet did not have the concept of an IQ at his disposal, so too did he lack (as did all of the behavioral sciences) the distinction between *convergent* and *divergent thinking*. Yet Binet's first test of mental abilities actually contained tasks that required the examinee to draw from long-term knowledge as well as tasks that allowed the examinee to product multiple ideas. You might even consider this a kind of historical preverbal process, at least in that Binet was testing both convergent and divergent thinking even though he did not have the labels for them. Those labels were not suggested for another 50 years. Applying this analogy of preverbal processes a bit further to the history of ideas and to Alfred Binet, it is interesting to see how the lack of the distinction (and labels) for convergent and divergent thinking constrained Binet's thinking about possible modes of thought. This is certainly how it works on a personal level (and perhaps on a historical level as well): once you have the labels and concepts about a subject, you can delve into it, but without the labels and concepts, you can't think much about it at all.

Original Ideas and Divergent Thinking

There is a large literature on divergent thinking that has direct implications for our understanding of ideas and ideation. Indeed, this area of research has no doubt contributed more than any other to such understanding. It is a fairly rigorous area of research, spanning just over 50 years, with innovations in both the tasks designed to elicit ideation and the analytic approaches applied to the resulting ideation. J. P. Guilford is usually credited with initiating this line of research in the late 1940s. He developed a structure of intellect model which ostensibly covered all modes of thought. Just before his death, Guilford (1988) claimed that he had identified 180 distinct modes! Many of them reflected what he called convergent thinking. This is usually used when an individual encounters a task or problem for which there is one correct or conventional answer. If asked to name the largest ocean on Earth, for example, there is one correct answer. Divergent thinking, on the other hand, is used when the task at hand is ill-defined and open-ended. The individual can product many ideas. He or she can in fact think in different directions and, as a result, find original ideas (rather than just the correct ones elicited by convergent thinking tasks).

The technology of divergent thinking defines several kinds of ideation. There is, for example, *ideational fluency*. This is simply the productivity of an individual and operationalized as the number of ideas generated to any one task. Ideational originality is operationalized as the number of unique or novel ideas (usually statistically determined). Ideational flexibility is operationalized in terms of the number of conceptual categories in an individual's output. If asked to name bodies of water on Earth and the person responds with "Atlantic Ocean, Pacific Ocean, Lake Erie, the Mississippi River, and my bird bath," he or she will probably receive a flexibility score of four (one for oceans, one for lakes, one for rivers, and one for baths). Ideational flexibility is very important in that it is indicative of a kind of adaptability. Flexible individuals can cope with changes or surprises much better than an inflexible, or rigid, person. Originality, on the other hand, is indicative of creative potential. Indeed, originality is necessary (but not sufficient) for creative thinking. Fluency is actually predictive of both originality and flexibility. It does not replace them, but it is likely that a fluent individual will be original and flexible – likely, but not absolutely certain. Of course someone can have one idea, but it is an incredibly original one!

In 1962 Mednick published the very influential paper, "The Associative Basis of Creative Thought." This described how new ideas are found and had implications for a theory of how fluency is related to originality. Mednick's (1962; Mednick and Mednick 1967) theory received partial support. His idea of remote associates, for example, usually holds up. In particular, when faced with an opportunity to produce various ideas, the first things most people think of are conventional and obvious. Only after they are depleted do most people turn to more original ideas. Note the implication that time may be needed to find original (and therefore creative) ideas. Mednick's own Remote Associates Test has not fared as well. It presents three concepts to an individual (e.g., Meadow: Mowing: Hay::), and the respondent must think of a third concept that is connected to them (Grass). The problem with the RAT is that it tends to be verbally biased: people with good verbal skills usually do well and people with poor verbal skills do not. Still, Mednick was able to infer that ideas are often associated by acoustics (they sound alike), by functionality, or experientially.

Various technologies are now available to mimic associative tendencies (e.g., the Semantic Web). One kind of software uses an algorithm in assignment semantic proximity to a pair of words. These powerful computations of semantic similarity power a bulk of our Internet search engines and often allow the individual at the keyboard to find what he or she is looking for, despite inaccurate queues. Given the ubiquity of these technologies and their apparent context validity, the psychometric potential of semantic analysis will increase in relevance as associative theories of ideation evolve.

Other assessments have been developed, in addition to tests of divergent thinking and the *Remote Associates Test*. The *Runco Ideational Behavior Scale*, for example, is a self-report that asks the respondent how often they have produced certain kinds of ideas and in what settings. Some measures examine ideational skill, but instead of looking to the productivity or originality of ideas, they look at evaluative tendencies. The rationale for these tasks is that the production of ideas is only one of several important skills involved in creativity and innovation. Not only is it important to produce good ideas, it is also important to be able to judge ideas, to evaluate them, and to know when you have in fact found ideas with potential. Such evaluative skills are moderately, but not overwhelmingly, correlated with divergent thinking and the production of ideas. It is as if producing ideas gives individuals experience at judging ideas (the more you produce, the more experience you will have examining them), but there are people who are good at one or the other (divergent thinking or idea evaluation).

Conclusions and Future Directions

Ideas are a part of intellectual property, innovation, everyday creativity, and world-changing insights. They are a part of every day. They are not easy to define in any way that implies universality, but to do so would probably mean that the result is artificial and not indicative of spontaneous ideation. Still, ideas are as operational as, say, "bits" of information (not a binary digit "bit" used in computer code, but a "bit" used in the cognitive sciences to describe units of information processed in short-term working memory). Bits also vary from person to person and must be defined on a level that allows such variation. The technology of divergent thinking indicates that ideas are defined in a fashion that allows scientific study. There is a huge literature on divergent thinking, and much of it is experimental or quasi-experimental and moderate in internal validity.

Numerous innovations have taken place in the research on ideas and ideation. The literature summarized herein has identified the best tasks and assessments for particular populations, for example, and research has demonstrated that familiar tasks elicit a large number of fairly unoriginal ideas (probably because the person can draw from experience), while unfamiliar tasks are better for eliciting original ideas. Several new indices of divergent thinking (e.g., transformational power, appropriateness) are being used in ongoing research, and associations between ideation and intrinsic motivation, attitude, and values are being examined, often with cutting-edge statistical methods. Future directions include a study of the interstices of thought – what happens between ideas? – and their neurological basis. Given the value of ideas for various kinds of thinking, including creativity and innovation, no doubt these areas will soon receive the attention they deserve. Ideas about them are already being offered in various theoretical discussions.

Cross-References

▶ Brainstorming
▶ Divergent Thinking
▶ Idea-Marathon System (IMS)

References

Binet A, Simon T. The development of intelligence in children. Annee Psychol. 1905;11:163–91.

Guilford JP. Some changes in the structure-of-intellect model. Educ Psychol Meas. 1988;48(1):1–4.

Locke J. An essay concerning human understanding. New York: Dover; 1959. (Original work published in 1690)

Mednick SA. The associative basis of the creative process. Psychol Rev. 1962;69:220–32.

Mednick SA, Mednick MT. Examiner's manual: remote associates test. Boston: Houghton Mifflin; 1967.

Plato. The Republic (trans: Grube GMA, Reeve CDC). In: Cooper JM, Hutchinson DS, editors. Plato: complete works. Indianapolis: Hackett; 1997. pp. 971–1223. (Original work published in 380 B.C.)

Plucker JA, Runco MA, Lim W. Predicting ideational behavior from divergent thinking and discretionary time on task. Creativity Res J. 2006;18:55–63.

Runco MA, editor. Divergent thinking. Norwood: Ablex Publishing Corporation; 1991.

Runco MA. Commentary: divergent thinking is not synonymous with creativity. Psychol Aesthet Creativity Arts. 2008;2(2):93–6.

Runco MA, editor. Divergent thinking and creative potential, vol. 2. Cresskill: Hampton Press; 2012.

Ideation

▶ Divergent Thinking

Identifying and Assessing Creativity

Robina Shaheen
The Open University, Milton, Keynes, UK

This chapter discusses the methods for identifying and assessing children's creativity and outlines the various behaviors found in the classroom as well as reported findings from existing creativity research on the most and least valued student traits by teachers. This is followed by a section on assessing creativity and includes the need for creativity assessment, as outlined in the educational policy documents of various countries as well as general literature, and the various assessment instruments which are in use. Following this are the findings from a large-scale mixed-methods study, conducted in Pakistan, which looks at the teachers' views on ways to assess primary school children's creativity as well as policy provisions for this and primary school children's performance on the Torrance Tests of Creative Thinking (TTCT).

Identifying Creativity

Some of the behaviors which are said to be found in the classroom when children are being creative include those outlined by the UK government, as part of the initiative to promote creativity in schools. These include:

Questioning and challenging: ask "why?" "how?" and "what if?"; ask unusual questions; respond to ideas, questions, tasks, or problems in a surprising way; challenge conventions and their own and others' assumptions; and think independently.

Making connections and seeing relationships: recognize the significance of their knowledge and previous experience; use analogies and metaphors; generalize from information and experience, searching for trends and patterns; reinterpret and apply their learning in new contexts; and communicate their ideas in novel or unexpected ways.

Identifying and Assessing Creativity, Table 1 Most valued pupil characteristics from the ideal pupil checklist

Fryer and Collings (1991), $N = 1{,}028$	Sen and Sharma (2004)	Torrance's experts in Sen and Sharma (2004)	Stoycheva (1996)
Considerate (45)	Doing work on time, healthy, sincere	Courageous in conviction	Sincere
Socially well adjusted (29)	Courteous, competitive	Curious	Curious
Self-confident (26)	Self-confident, neat, and orderly	Independent in thinking	Thorough
Independent in thinking (23)	Courageous in conviction, desirous of excelling		Healthy
			Persistent
		Independent in judgment	Sense of beauty
Curious (20)	Affectionate, industrious	Willing to take risks	Sense of humor
		Intuitiveness	
		Becomes preoccupied with tasks	Independent thinking
	Curious, independent in thinking, refined, free of coarseness	Persistent	
	Physically strong, socially well adjusted	Unwilling to accept things on mere say	
	Remembering well, versatile	Visionary	
	Altruistic, energetic, determined, persistent		
	Popular, well liked		

Source: Fryer and Collings (1991), Sen and Sharma (2004), and Stoycheva (1996)

***Envisaging what might be*:** imagine, seeing things in the mind's eye; see possibilities, problems, and challenges; ask "what if?"; visualize alternatives; and look at and think about things differently and from different points of view.

***Exploring ideas, keeping options open*:** play with ideas; experiment, try alternatives and fresh approaches; respond intuitively and trust their intuition; anticipate and overcome difficulties, following an idea through; and keep an open mind, adapting and modifying their ideas to achieve creative results.

***Reflecting critically on ideas, actions, and outcomes*:** review progress; ask, "is this a good...?" and "is this what is needed?"; invite feedback and incorporate this as needed; put forward constructive comments, ideas, explanations, and ways of doing things; and make perceptive observations about originality and value (QCDA 2009, p. 1).

Studies into teacher views about creativity have shown that certain student characteristics are more valued than others. Some of these studies used the Torrance's Ideal Pupil Checklist which contains over 60 characteristics (also refer to ► Creative Behaviors and ► Creativity Across Cultures). The most valued characteristics across studies are shown in Table 1.

There is a difference in the most valued traits of students in that independence of thinking is among the top in the Torrance's experts rating and Fryer, but it is not in Sen and Sharma (India) or Stoycheva (Bulgaria). Many of the most valued traits in the Sen and Sharma's study are different to the other studies.

The top-rated least valued trait by Torrance's experts is "conformity"; however, although this is also in the Sen and Sharma's list, it is not among the highest rated (refer to Table 2). Obedience is another trait which is among the least valued in studies other than Sen and Sharma's, which shows that there are differences in teacher views across countries. Other creative behaviors outlined using different instruments include:

- Has interesting, uncommon ideas
- Shows great curiosity and interest in things others are not interested in

Identifying and Assessing Creativity, Table 2 Least valued pupil characteristics from the Ideal Pupil Checklist

Fryer and Collings (1991), $N = 1{,}028$	Sen and Sharma (2004)	Torrance's experts given in Sen and Sharma (2004)	Stoycheva (1996)
Negativistic (62)	Fearful, apprehensive	Conformity	Bashful
Haughty and self-satisfied (48)	Disturbs procedures and organization of group	Willing to accept judgments of authority	Haughty Self-satisfied
Stubborn and obstinate (48)	Haughty and self-satisfied	Fearfulness	Timid
Disturbing group organization and procedures (44)	Timid, shy, bashful	Timidity	Sophisticated
Domineering (43)	Stubborn, negativistic	Obedience	Quite
	Talkative	Courteousness	Obedient
	Faultfinding, objecting	Promptness in doing work	Faultfinding
	Critical of others	Socially well adjusted	
	Unsophisticated	Haughty and self-satisfied	
	Conforming	Neatness and orderliness	

Source: Fryer and Collings (1991), Sen and Sharma (2004), and Stoycheva (1996)

- Quickly understands real-life problem situation and suggests nontrivial but effective solutions

However, in research studies in which teachers were asked to describe their students so that a new teacher could become familiar with them, it was found that creativity and related behaviors was not among the most important characteristics and outlined by very few teachers. The ranking of creativity-related behaviors from a list of 61 items was low, perhaps indicating that the findings depend upon the instruments used, as the following shows:

- Searching for novelty, interested in the unknown, showing creative preference (49th)
- To do very well in uncommon situations (61st)
- To have original ideas (25th)
- A climate for creative work (37th) (Stoycheva 1996, p. 1)

Assessing Creativity

The Need for and Problems of Assessing Creativity

The Assessment and Learning Research Synthesis Group (ALRSG) in their review protocol for systematic review of research on "The impact of the use of ICT for assessment of creative and critical thinking skills" state that

> . . .if valued goals of education are to be effectively taught, they need to be effectively assessed. (ALRSG 2003, p. 8)

The NACCCE (1999) report defined assessment as the process of "judging pupils' progress and attainment" and made recommendations that "all schools should review their provision for creative and cultural education." It went on to highlight that

> reliable and systematic assessment is essential in all areas of the curriculum, to improve quality of teaching and learning and to raise standards of achievement. This is as true of children's creative and cultural education as for all other areas of education. (p. 124)

McCann (undated) also emphasizes that ". . .creative processes and products be part of the overall assessment plan in the curriculum," arguing that

> . . .in schools, work that is not linked to standards and assessed in some systematic way is treated as less important and less vital to educational purposes. When work is not assessed, it is treated as if it does not "count." (p. 9)

There are a number of reasons outlined for the need to assess creativity. It can lead teachers to prepare and plan for it (Rogers and Fasciato 2005) as well as to create the required environment (Foster 1971) and encourage it (Compton and Nahmad-Williams 2009).

Assessment of creativity is said to be a neglected area despite its importance. This is regarded as a reason for concern keeping in view the high profile that creativity currently has and its linking with education for preparing children for the future (ALRSG 2003). The cause for this neglect may be that assessment for creativity is regarded as "problematic" (Scoffham 2003, p. 5), "difficult" (Thorne 2007, p. 24), and "challenging" (Feldman and Benjamin 2006, p. 332).

There are various reasons given why assessment of creativity is seen to be difficult despite being investigated for over a century. These include having no definite standards or standard methods (Afolabi et al. undated). There are also said to be definitional problems in that creativity is no longer defined as production of something novel; rather, it also includes the outcome being useful. This makes it difficult to assess particularly since what is of value may differ from culture to culture (Scoffham 2003). In fact, some are of the view that the question of whether or not creativity can be assessed depends upon the definition of creativity adopted (Cartier 2001) and in order to assess it a definition is needed (Rogers and Fasciato 2005). Other problems include the different opinions over what is deemed as creative across different subjects and using instruments based on Western ideas in other cultures (Rudowicz 2003). In summary, McCann (undated) states that assessment is challenging because creative work is

> . . .multi-faceted, multi-layered, and do not yield a single, correct, and easy-to-score response. (p. 9)

Instruments for Assessing Creativity

Nevertheless, despite the attributed problems of creativity assessment, many efforts have been made resulting in the development and use of various methods and instruments. Fishkin and Johnson (1998) outlined 60 instruments for use with school-age children. These were grouped into process, personality, products, press, combination measures, and systems or procedures approach. Hennessey and Amabile (1993) grouped assessment methods into three categories: personality inventories, biographical inventories, and behavioral assessments (p. 7). Afolabi et al. (undated) divided these into ten categories: divergent test, attitude and interest inventories, biographical inventories, personal inventories, teacher nomination, peer nomination, supervisor ratings, judgments of products, eminence, and self-reported creative activities and achievement (p. 2). These are not without criticism either. One of these is that they are not adequate for the task (Loveless 2002). There are also problems of reliability and validity (Diakidoy and Kanari 1999) as well as "subjectivity and bias" (Afolabi et al. undated, p. 4). In the case of tests, there are also scoring problems (McCann, undated).

Children's creativity, it is claimed, can be assessed informally or formally using "tests or expert judgments" (Sharp 2001, p. 6). Tests which have been used in education and regarded as the most popular are the divergent thinking type which includes the Torrance Tests of Creative Thinking (TTCT) (1974) and the Wallach and Kogan (1965) tests (Plucker 2001). Such tests are also said to be effective when used to evaluate the effect of programs introduced to develop creativity (Fishkin and Johnson 1998). The TTCT (also called the Minnesota Tests of Creative Thinking) has been used across the world from Brazil (Wechsler 2006) to India (Misra et al. 2006) and "remain the most widely used assessments" (Sternberg 2006, p. 87). It is regarded as appropriate for identifying and educating gifted children but more so for "discovering and encouraging everyday life creativity" (Kim 2006, p. 11) being useful for researchers and teachers for assessing children's creative abilities.

However, despite much praise for the TTCT, it is not considered as useful if teachers are interested in day-to-day changes in children's creativity. For this, the Consensual Assessment Technique is suggested to be more appropriate. This uses judges who "are familiar with the domain to independently evaluate products and then reach consensus" (Fishkin and Johnson 1998, p. 43). In this, the respondent is asked to complete a task, and then experts in that particular "domain" such as poetry are required to rate the creativity of the product (Hennessey and Amabile 1993).

Other tests which have been used in classroom setting include the Remote Associations Test (RAT), which requires respondents to find connections between items. However, it has been criticized for being more of a measure of intelligence than creativity (Taylor 1975). There is also the Guilford's Unusual Uses Test which requires the respondent to come up with as many names for common objects as possible (Hennessey and Amabile 1993). Instruments which collect data about the personality and attitude aspects based on details of past achievements are not regarded as good for primary school children. The approaches in which information about the creative environment is collected are said to lack "well-researched" instruments; however, one of the instruments given in this category and the only one related to classroom observation for creativity is the "Classroom Creativity Observation Schedule (CCOS)." Other more recent measures are combining the standard measures with some alternative approaches such as "performance assessment techniques" which include "direct writing assessments, open-ended written questions, hands-on experiments, performances or exhibits, and portfolios." But evaluating children's work requires "clear standards and knowledgeable judges" (Fishkin and Johnson 1998, pp. 42–43).

All measures, however, are said to have their strengths and weaknesses. It is therefore suggested that in order to assess children's creativity, multiple measures should be used (Plucker 2001). The measures used will depend upon the assessment purpose and the definition of creativity adopted (Fishkin and Johnson 1998) as well as the aspect of creativity that is of interest such as the "product, process, person, and environment" (Auh 2009, p. 1). Taylor (1975) suggested that thought be given to how the creative process occurs over long periods of time using a variety of techniques. The methods for assessment, whichever used, will have some implication for the way teachers "think about creativity" (Hennessey and Amabile 1993, p. 9).

Identifying and Assessing Creativity, Table 3 Teachers' preferred criteria for assessing creativity in pupils' work

Assessment criteria	Percentage of teachers reporting the criteria
Imaginative	87
Original for pupil	85
Showing initiative	79
Pleasing to pupil	74
Expressing depth of feeling	70
Useful	13
Accurate	6
	$N = 1{,}028$

Source: Fryer and Collings (1991)

Teacher Views on Assessment of Creativity

Studies of teacher views on creativity assessment have shown mixed attitudes. Fryer and Collings (1991) reported that three quarter of the teachers said that test scores were not useful for assessing children's creativity. The preferred assessment criteria were as given in Table 3 which includes, as the top rated, imagination and originality in the pupils' work.

In another study of UK trainee teachers ($N = 315$), it was found that 12% of all respondents (Rogers and Fasciato 2005) said creativity could not be assessed. This study included teachers from two universities, and 43% from one said they were certain that it could be assessed and 12% from the other. The majority of the teachers said that assessment should be informal. It should be assessed "in order to share ideas and develop enthusiasm and creativity even more." Some suggested assessing children's implementation of their ideas, while others suggested assessing the process rather than the outcome, yet some said that children should not be assessed on their creative ideas. Some trainees suggested that pupils could assess their own creativity as well as being assessed by the teacher.

However, the teachers were of the view that assessment could pose certain problems as well. It could lead to discouragements, which raises the question, the author says, of whether creativity should be assessed. It was also considered as subjective, as it may mean different things to different people and may be different in different areas. Teachers felt that they lacked set criteria and guidance for assessing creativity and thus were unprepared. They wanted a creativity definition and criteria for assessment. Some said that "creativity is individual" and so there cannot be any criteria for assessment or that there is no one way of assessing it since pupils are creative "in different ways" (Rogers and Fasciato 2005).

Having discussed the existing literature and findings from previous research, the identification and assessment of creativity seemed to be the two weaker areas. In this, Foster (1971) was of the view that the chances of teachers being able to identify creativity can be increased if they have

> . . .sound knowledge of the psychological bases of creativity, an understanding of the creative process and personality, an awareness of the conditions which are likely to elicit creative response.

With this, teachers can also attempt to assess creativity. However, he was apprehensive about this as he stated:

> . . .this seems like an entire study of a subject in itself which teachers need to master, [it has] implications for teachers training and may be very difficult in countries where teachers barely manage to have mastery of the subjects they teach, however the positive side is that once mastered it can be applied to all subjects where only the contents will differ. (p. 53)

This completes the discussion on the various methods and problems related to identification and assessment of creativity. It has been found that research carried out in different countries shows that the teachers, to some extent, value different characteristics for creative students. The remaining chapter presents the findings from a large-scale study conducted in Pakistan related to the question of assessment of creativity. First, the findings from the review of the educational policy and primary curriculum documents are presented, followed by the primary school teacher survey, and lastly, the creativity scores obtained from administering the Torrance Tests of Creative Thinking (TTCT) to primary school children.

Assessment as Outlined in the Policy Documents and National Curriculum

The assessment system in Pakistan has been widely criticized in policy documents, as the White Paper states:

> . . .the examination system like most others is compartmentalized into a limited role of promoting or failing the student. Even within this limited role there are shortcomings that have serious consequences for the quality of the learner produced in the country . . .Since the "learning" is rote based, assessments simply test the memory (Aly 2007, p. 20).

In the Green Paper, it is stated that

> in Pakistan the assessment systems are usually designed to measure individual student ability to move further up the system and there are critical examinations at the matriculate and intermediate levels that determine the career options for students.. . .there is general criticism that these assessment systems encourage rote learning and selective study. (Aly 2006, p. 8)

The National Education Policy, 1998–2010, outlines the assessment mechanisms but not the contents with reference to assessment of creativity (Government of Pakistan 1998). The White Paper for review of this policy defines the five "pillars of quality" which also include assessment (Aly 2007, p. 17). In reviewing the National Curriculum for Science, Mathematics, and English, it was found that all three provide assessment guidelines. In the math curriculum, the assessment objectives include developing relationships, identifying patterns, making predictions, hypothesizing, deducing relationships, identifying problems, planning and conducting investigations to solve problems, and proposing solutions to problems, all related to creativity. The science curriculum advocates assessment which must be:

> Open-ended, allowing for discussion and revision of new understanding
>
> Tolerant of divergent thinking and promote the notion of no "one right answer" (Ministry of Education 2006b, p. 67)

In the science curriculum, it is also emphasized that such test items be used which measure students' achievement in problem-solving skills and analytical and creative thinking (Ministry of Education 2006).

The English curriculum outlines a range of assessment methods, including use of multiple-choice items. The different types described include "best answer type" and "incomplete statement" type, both of which are said to measure "higher order thinking," and also the multiple response type which is "used in dealing with questions to which more than one clearly correct answer exists" (Ministry of Education 2006, p. 154). However, following this is a contradiction in that

> it is recommended that only correct answer type and best answer type multiple choice items should be used. (Ministry of Education 2006, p. 154)

The English curriculum further states that assessment

> requires students to create or produce their own answer in response to a question or task. This allows teachers to gain insight into students' thinking and creative processes, and to assess higher order thinking.... (Ministry of Education 2006, p. 155)

It can be seen from the evidence above that the curriculum documents allow some role for creativity in assessment.

Methods Reported by Teachers for Assessing Children's Creativity

Teachers have reported using a number of methods for assessing children's creativity (Table 4). It has been seen from the classroom observation that children are only asked questions which require recitation of previously learned information, they are also only invited to talk for this purpose as well, there is no practical work in class, and group work is a rarity. It is therefore questionable if all these techniques are really used for assessment at all. Teachers do take exams, mark children's work, and listen to them recite learned text ("sabaq") verbally, which are the only methods of assessment observed in most schools. It is therefore interesting that more teachers have not reported using these as compared to other methods. The fact that 80% of the teachers reported that they use reciting previously learned text as a way of assessing children's creativity implies that creativity is rote learning and regurgitating information which shows a different understanding of creativity held by teachers. This would imply that creativity means learning and regurgitating learned facts. There was not very much variation in the teachers' views on methods to assess children's creativity, across the background variables; however, there were fewer teachers reporting using some of the methods from the other public sector and those with no professional qualification. This research did not involve any further work on assessment in the classroom; therefore, more cannot be said.

Identifying and Assessing Creativity, Table 4 Methods used by teachers to assess primary school children's creativity (closed response)

Reported methods of assessing creativity	Percentage of teachers reporting using each method
Asking children different questions	97
Giving children opportunity to speak	94
Observation	93
Practical work	92
Group work	87
Exams	85
Marking or grading children's work	82
Listening to children recite their "sabaq" (learned text)	80
Playing games	79
	$N = 1{,}008$

Source: Shaheen (2011)

From the open comment section, the methods outlined for assessing children's creativity are given in Table 5. One of the interesting things is teachers outlining that they use methods in which children do things such as observation, designing questions, and asking questions rather than the teachers doing this and also giving children material beyond the curriculum. It is also interesting that teachers are reporting that they assess by getting children to obtain answers, whereas in the lessons, as the findings from the classroom observation show, it is the teachers who give children the answers. Perhaps these are methods not used but suggested for assessing creativity.

Identifying and Assessing Creativity, Table 5 Methods of assessing children's creativity from open response section

Method of assessing creativity	Percentage of teachers reporting using each method
Children obtaining answers to questions (including from outside curriculum)	19
Problem-solving activities	16
Holding competition	12
Involving them in extracurricular activities	9
Drawing	9
Holding debates among children	7
Speeches	7
Through writing	5
Children designing questions (objective type)	3
Children asking questions (each other and the teacher)	3
Amount of interest shown in work	2
Children doing observations	2
Giving topics beyond the curriculum	2
Giving lesson-related assignments	2
Giving topics of interest	2
	$N = 58$

Source: Shaheen (2011)

Torrance Tests of Creative Thinking (TTCT)

The Torrance Tests of Creative Thinking (TTCT) were developed by Dr. E. Paul Torrance in 1966. There are two versions of the test, TTCT-Verbal and TTCT-Figural. Each of these has two forms, A and B. In this study, the TTCT-Figural Form A was used because it was deemed as the best possible instrument which can be implemented, translated, understood, and scored with given the time scale available. In each of these activities, a shape or a number of shapes are given as a stimulus. In activity one there is an egg shape, in activity two there are 10 incomplete figures, and in activity three there are 30 pairs of vertical parallel lines. The respondent is instructed in each activity to use the given shapes to draw something (picture, object). The essential thing is to make these shapes part of the drawing. The instructions urge the respondent to think of something which no one else will think of and to keep adding ideas so that the drawing tells an interesting and exciting story. Once the drawing is complete, they are required to add a title which is "clever" and "unusual," helping to tell the story already started in the drawing (Torrance et al. 2008 p. 2; for more details refer to Torrance 1979; Torrance and Safter 1999). The test requires 30 min of working time, 10 min for each activity. Additional time is required for initial interaction with the children. The TTCT tests for "creative thinking abilities" which are described as a "constellation of generalized mental abilities that are commonly presumed to be brought into play in creative achievement." Although there is a debate about the terming of these abilities, Torrance has however maintained that "high degrees of the abilities measured by tests such as TTCT increase the chances that the possessor will behave creatively" (Torrance et al. 2008, p. 2). These abilities are part of a model for studying and predicting creative behavior (Torrance and Safter 1999, p. 51). A description of the creative abilities scored for in this study is provided in the next section which describes the methods used to administer the TTCT.

Method Used to Administer the TTCT

The TTCT test booklet (originally in English) was translated into Urdu and recomposed, making it the 38th language into which the TTCT has been translated so far. The Urdu version of the test was then pretested in the UK with one child and 30 class five children in Pakistan. These children were of mixed academic abilities. The test was revised in the light of findings obtained from pretesting and then administered by the researcher to 154 children from 17 primary schools in Pakistan using the procedure described below. The schools were both from private and public sectors as well as urban and rural locations consisting of both single and mixed gender student intake.

In each school, an introductory meeting was held with the head teacher to discuss the nature of the test, the number of class five children required to participate, and their selection criteria. If there were more than 10 children in the class, then a group was selected consisting of academically high-, average-, and low-performing students. In mixed sex schools, an attempt was made to select an equal number of girls and boys for each of the three categories. All the children participated in schools where there were fewer than 10 children in the year group.

Once the children were selected, familiarization activities were conducted for rapport building to create a more relaxed, friendly, and nonevaluative atmosphere. The activities included introductions, telling jokes, discussing likes, favorite TV programs, celebrities, cricket, and a magic trick. The children could easily relate to and talk on these topics without hesitation or shyness. One of the things which helped to develop a closer rapport was the researcher also sharing information about herself and answering the questions asked by the children as well relating to them as their "baji" (elder sister) rather than a teacher or researcher.

As an introduction to the test-type activities, the children were asked to describe ways in which they could improve their schools. This was aimed at stimulating them to think in the manner required for the TTCT activities. Another step toward this was asking them if they do drawing as the test is drawing based, although the aim is not to test their ability to draw. The children were then given the test booklet and asked to fill in their identification information on the front page such as name, age, and gender. They were then asked to look at the picture on the cover page of the test booklet and generate as many ideas about what the picture could possibly represent. They could share ideas with each other and work in groups for discussion. It was emphasized that there were no wrong responses and everybody's answer could be different. The drawing could represent anything, and everybody must try to think of something different. For children who found this activity difficult, the researcher pointed to sections of the picture and asked what they thought it could be or generated the first idea. The children's responses were noted and used as a means to appreciate and encourage their ability to generate ideas. After this, the test activities were administered.

For each of the three activities, the children were asked to turn to the required page. The researcher also showed the page, indicating to the stimulus and the accompanying instructions. The instructions were read out loud from the Urdu instructions manual, and the children followed the written text from their own test booklets. They then read the instructions either silently or aloud, and some were asked to repeat these. Effort was made to ask those children who, it was felt, may not have understood. This was also a means of verification to check that the instructions had been understood, and if not, they were repeated again both in Urdu and the local language. Children were encouraged to ask if they did not understand instructions or the meaning of any words. For example, in one government girls school, one girl asked what the word "ajeeb-o-ghareeb," that is, "unusual and original," meant.

It was felt that conceptually some of the instructions did not convey the meaning and were not understood by the children such as "using the stimulus to make a picture," "adding ideas to ideas to tell a story," and "connecting ideas." In this regard, efforts were made to find examples to clarify the instructions. Some of these examples included finding a word to complete a sentence, arm being part of the body, and threading bead after bead to make a necklace. In a school where the building was without a roof, this was used as an example of the building being incomplete until the roof was added.

Children were encouraged to ask questions even during the activities, and in order to answer these, the researcher went to them to prevent others from being disturbed. Those who did not start immediately or at all were encouraged to draw anything. Continuous encouragement and motivation was given throughout the test, and instructions were reinforced, particularly if the children were making random drawings and not using the stimulus. Some children repeatedly erased their drawings so much so that erasers were taken from them so that they concentrated more on their drawing rather than erasing. This may have been due to the children being unsure of their drawings being "right" or appropriate such as heart, alcohol bottle, or simply that it was not a good drawing.

If children had writing problems, they were advised to complete the pictures first and then after the test were helped to write the suggested titles. Since writing seemed to be a problem for a number of children in different schools, the researcher included, as part of the instructions, to write without worrying about spelling. It was hoped that the fear of misspelling a word would not prevent the children from doing the activities.

In case children finished before time, they were encouraged to continue adding more detail as some had the habit of working quickly, usually the children regarded as bright by the teachers. In order to explain that there was a time fixed for each activity but at the same time trying not to create a test-like atmosphere, examples were given where timings are important, for example, one-day cricket match and school timings. Some children were very keen to work beyond the activity time and were worried that they had not finished. When two boys were asked to stop drawing and give titles, they said, "we haven't finished pictures yet, how can we write the titles."

Once the three activities were completed, the researcher checked each child's booklet. The purpose of this was to ensure that all titles had been added and writing was legible. If children had difficulty with writing, the researcher supported by writing down the titles suggested. If a title was not added but picture drawn, then the child was asked to add a title. Some of the children had written titles in the local language such as "Saraikee" and could not be understood. In this case, the children themselves were asked to elaborate or the translator was asked. The booklets of children who were shy or seemed to be easily intimidated were checked last and not in the presence of other class children.

The test booklets were scored using the guidelines provided. The scoring provides information about the "creative functioning of a child" (Torrance et al. 2008, p. 1) and results in five norm-referenced and thirteen criterion-referenced measures (also known as creative strengths). The norm-referenced measures are fluency, originality, elaboration, abstractness of titles, and resistance to premature closure. The criterion-referenced measures (the checklist of creative strengths) are emotional expressiveness, storytelling articulateness, movement or action, expressiveness of titles, synthesis of incomplete figures, synthesis of lines, unusual visualization, internal visualization, extending or breaking boundaries, humor, richness of imagery, colorfulness of imagery, and fantasy. The results discussed in this chapter are related to the norm-referenced measures only, and a description of these "creative abilities" is provided next:

- Fluency is the ability to produce alternatives, and it is claimed that those who produce many alternatives have a greater chance of generating more workable solutions and succeeding in problem solving (Torrance and Safter 1999, p. 58). Creativity itself is considered by Torrance as a "special kind of problem solving" (Torrance 1970, p. 2). The fluency score represents the ability to produce a large number of images.
- Originality involves "getting away from the obvious and common place or breaking away from habit bound thinking." It is stated that the measure of originality predicts creative behavior more accurately than other measures such as fluency (Torrance and Safter 1999, p. 87).
- Elaboration is the "ability to develop, embroider, embellish, carry out ideas" and it is claimed that in reality "the ability to elaborate, work out plans, implement, and sell solutions is important" (Torrance and Safter. 1999, p. 109).
- In order to successfully solve problems and produce something creative which is also valuable, it is important not to become entangled in the information available. This is the rationale behind "abstractness of title" where the ability "to produce good titles involves the thinking processes of synthesis and organization" (Torrance et al. 2008, p. 12). Producing something of value is considered by many as a definition of creativity.
- The "psychological openness" of a person is considered to be an important and accepted

characteristic of a creative person. This involves not jumping to premature conclusions but rather taking time to understand the problem, considering the important factors involved, thinking of alternative and better solutions (Torrance and Safter 1999, p. 117), and considering the available information (Torrance et al. 2008, p. 13).

With a description of the various scoring criteria (creative abilities), the next section discusses the scores obtained by Pakistani primary school children beginning with the fluency scores.

Identifying and Assessing Creativity, Table 6 Percentage of raw fluency scores and percentage of children obtaining these scores

Percentage of children obtaining the raw fluency scores	Percentage of raw fluency scores obtained
1	0
4	10
5	20
8	30
14	40
25	50
19	60
10	70
8	80
3	90
3	100
$N = 154$	$N = 40$

Source: Shaheen (2011)

Pakistani Children's Performance on the TTCT

Fluency Scores

Most children exhibited some ability to generate ideas and alternatives which indicates that they are able to solve problems and provide solutions. This is shown by their attainment of raw fluency scores (total fluency score for three activities), with almost 60% of the children achieving scores in the range of 40–60%. In fact, 23% of the children obtained at least 70% and above (Table 6).

The fluency scores when examined independently for each activity showed that children performed better in activity two. There is a positive relationship between the percentage of children and the percentage of fluency scores obtained. In fact, majority of the children (70%) obtained scores from 70% to 100%. This may have been due to having more time to complete fewer shapes, that is, 10 pictures in 10 min, or that the stimulus shapes appeared more meaningful and easily triggered children's thinking to generate ideas. Therefore, the type of initial shape, the number of shapes, and the amount of time given to complete the activity may affect the child's performance on fluency. Almost one third of the children obtained 100% fluency scores for this activity. These children were from private, government, rural, urban, all boys, as well as mixed sex schools. This shows that having a high level of fluency ability does not perhaps depend upon the school sector, location, or gender of students. However, no girl from an "all girls" school achieved 100% score which may be attributed to the difference in the school environments. There were more boys achieving 100% fluency score than girls which indicates that boys are perhaps more fluent in their ideas and that there may be a relationship between the ability to be fluent and the child's sex and/or the type of school they attend (in terms of student gender).

For activity three, the scores obtained by children were not as high as activity two. Initially, as the scores increase, the number of children obtaining these also increases, but beyond 40% of the scores, this trend then reverses with fewer children obtaining higher scores. The highest percentage of scores (60%) is obtained by only 11% of the children. Only 2% of the children obtained full scores. These were from both government and private schools although belonging to the same district. The low scores for this activity are in contrast to activity two. One of the reasons for this may be that there were three times as many pictures to complete, 30, but the time given was the same (10 min) as in activity two. In this regard, it may be said that where time is limited, the children's ability to solve problems is perhaps also limited. Another explanation for the poorer performance in activity three is that the same stimulus, pair of lines, is repeated each time which may not give fresh food for thought, may reduce interest and motivation, and may cause boredom. It may also be that this activity required children to rely more on their imagination which was difficult because they are more used to recalling and regurgitating facts. Both children and teachers in Pakistani schools are very particular about getting things right, and it may be that more children spent more time on each picture in an attempt to get them right, while a few who may not be so right answer fixated, and do not usually get things right, worked faster and finished more drawings, hence obtained higher scores.

In summary, children overall performed well on the fluency criteria although the scores were better for activity two than three.

Originality Scores

While the children were able to demonstrate that they could generate ideas (fluent) and hence be on the path of creative behavior, they showed poor performance on the originality criteria. This is shown by the majority of the children achieving less than 40% originality score (Table 7). This means that they were unable to break away from the "obvious," "common," and everyday way of thinking. The performance on the measure of originality is regarded as a better predictor of creative behavior than other measures such as fluency (Torrance and Safter 1999, p. 87) which indicates that with the obtained scores, Pakistani children have demonstrated very little creative behavior.

The achievement of low originality scores could perhaps be explained by the fact that children are not into the habit of generating original ideas and work and therefore have not been able to display the desired ability which would show indication of creative behavior. In fact, there is evidence, gathered as part of this study through teaching observation, which shows that teaching in the schools does not involve activities which encourage and develop their abilities to be original. The major and only focus is on knowledge acquisition through rote memorization and regurgitation of the learned material. However, having said this, it is important to mention that teaching in these schools also does not include activities to specifically develop children's fluency ability; nevertheless, children performed better in this as already discussed. This perhaps means that it is more difficult to be original than fluent and that the ability to be original perhaps comes with more guided practice. In this, the children's ability to understand the test instructions may have also influenced their performance particularly as the children are unlikely to have been exposed to the terminology used in the test as evidenced from the lack of its use in the textbooks which is the only teaching material used in schools by both teachers and students. Another important factor contributing to the low scores may have been the children's fear of getting things wrong as many asked during the test "what if I get it wrong?" and "can I draw anything?" despite being repeatedly reassured that nothing they draw is wrong and they are free to draw anything.

Identifying and Assessing Creativity, Table 7 Percentage of raw originality scores and percentage of children obtaining these scores

Percentage of children obtaining the scores	Percentage of raw originality scores
1	0
15	10
24	20
32	30
16	40
9	50
2	60
0	70
1	80
0	90
0	100
$N = 154$	$N = 57$

Source: Shaheen (2011)

On a positive note, it is interesting to note that there were also a few children who obtained scores as high as 80% and 60%, and therefore this raises further questions of how, despite all children going through same school routine, they are able to perform better and whether teaching for abilities such as originality is solely down to school or there are other influencing factors such as just natural ability, family background, and environment.

The discussion regarding originality has so far focused on the total scores obtained by children; however, a closer examination of the scores for each of the three activities showed that children obtained relatively higher scores for activity two than three as described below.

Examination of the originality scores obtained on each of the three activities showed that for activity one, less than half (42%) of the children ($N = 154$) were able to produce something original. Some examples of these include pictures such as "bird-balloon," "butterfly-spider," and "chicken egg and a baby inside." Less children producing something original can perhaps be attributed to the difficulty of the shape, despite being given 10 min to work on this single drawing as compared to 10 in activity two and 30 in activity three. This highlights the need to give time to develop ideas to produce something original. It may also be attributed to the fact that since it was the first activity in the test, the children may have been nervous, unsure about what to do, and out of their comfort zone since they were not being asked to reproduce something previously learned which is what they are habitually required to do. The pictures drawn by the children for this activity were categorized, and it was found that many things drawn were common everyday objects from the children's surrounding environment, such as names of animals, plants, fruits, and body parts. However, the list used to determine the originality of these responses is not produced based on the Pakistani context which raises the question of the difference it may have made to the originality scores if such a list existed and was used. This is perhaps a limitation of the TTCT list itself for use in different contexts.

For activity 2, almost half (49%) of the children obtained scores within a range of 40–60%, while 20 were able to obtain 80%. There were also nine children who demonstrated (obtained zero scores) no originality. These were from all boys, mixed sex, rural, government, and private schools. Those who achieved full scores (3) (Table 8) were from rural, urban, government, private, all boys, and mixed sex schools. This is interesting since the mean originality score was higher for children from private schools, but the two boys obtaining 100% originality scores were from rural government schools and the girl from mixed sex school. This shows that the variation in originality ability is perhaps not due to school sector but something else, perhaps the individual child.

Identifying and Assessing Creativity, Table 8 Percentage of originality scores for activity 2 and percentage of children obtaining these scores

Percentage of children obtaining the scores	Percentage of originality scores for activity 2
6	0
3	10
8	20
5	30
12	40
18	50
19	60
8	70
13	80
6	90
2	100
$N = 154$	$N = 20$

Source: Shaheen (2011)

The originality scores for activity 3 showed that majority of the children scored lower on this with 125 children obtaining scores between 10% and 40%. Only 22 obtained scores between 50% and 80%, and no child obtained a score beyond 80% (Table 9). This pattern may be explained by the fact that children also performed lower on fluency for activity three which left less figures to be scored for originality and/or that the children drew pictures which were less original. There were also 8 children who obtained zero scores who were almost all from rural, government, and boys' schools which raises questions about the government schools and their current ability to develop children's originality.

Another criterion through which the children's originality was assessed included their ability to join one or more shapes given in the test to complete a picture. This is called the "bonus" scores for originality. Children performed very poorly in this as well. No child obtained any bonus scores for originality for activity 2 which is surprising since children produced combinations of things (the requirement for obtaining bonus scores for originality), using the stimulus in activity one where they were not required to do so.

Identifying and Assessing Creativity, Table 9 Percentage of originality scores for activity 3 and percentage of children obtaining these scores

Percentage of children obtaining the scores	Percentage of originality scores for activity 3
5	0
20	10
23	20
19	30
19	40
5	50
5	60
3	70
1	80
0	90
0	100
$N = 154$	$N = 30$

Source: Shaheen (2011)

One of the explanations for this is that they were not provided instructions to do this and following instructions is the core of their teaching. If the children had been told that they could join figures together to make something, it would have been interesting to see the results. For activity three, 92% (154) of the children achieved a zero score, four children obtained 30% ($N = 13$), and two obtained 100% who were from urban private mixed gender schools. This perhaps shows that a coeducation gives a freer environment which is more conducive for enhancing the ability to be original.

In summary, few children obtained bonus scores for originality, over one third of the children produced something original for activity one, whereas the originality scores obtained for activity two were higher than three. This may be because for activity two children had higher fluency scores. Since the shapes in activity 2 are more suggestive than those in activity 3, one would assume that this may restrict children and prevent them from thinking beyond the obvious and rather recall and reproduce things from their existing experiences than making something new. Whereas in activity three where the shapes are less suggestive, one would assume that they provided more freedom for children to let their imagination go wild and come up with weird and wonderful things. But the less suggestive shapes in activity three giving lower fluency and hence originality scores mean that children may have felt more comfortable with the clues in the shapes in activity two than thinking for themselves which is something they are not habitually required to do. This is because it has been observed in classroom teaching that all answers are provided by the teachers in the lessons so children do not have to think for themselves.

The ability to generate ideas and original ideas (fluency and originality) seems to go hand in hand as there is the highest correlation, which can be explained by the fact that the more objects/pictures are drawn, the greater the chance of generating some original ones. It also indicates that creativity in the sense of producing something original is not a short snappy process but one that involves repeated effort (producing many ideas); hence, it could be said that idea generating is a prerequisite to producing original ideas. An important aspect which has emerged from the above discussion is that there appears to be a high correlation between fluency and originality as found in the scores for activity two. This has also been found by other authors such as Torrance himself. Besides this, the children have shown better performance on fluency criteria than the originality criteria which leads onto the next aspect of assessment, the elaboration criteria which assessed the children's ability to elaborate their ideas and produce something which is creative but at the same time valuable without becoming entangled in the information available.

Elaboration Scores

The majority of the children obtained a raw elaboration score in the range of 30–50%, while only 13 obtained a higher score than this. This included one girl who scored 100% (Table 10). She was from a mixed sex urban private school which perhaps suggests that girls may be better at developing and implementing ideas. It is also important to mention that the four children who obtained zero scores were all from rural government schools.

A comparison of elaboration scores across the three activities showed that these were higher for

Identifying and Assessing Creativity, Table 10 Percentage of raw elaboration scores and percentage of children obtaining these scores

Percentage of children obtaining the score	Percentage of raw elaboration score
2	0
6	10
8	20
21	30
36	40
18	50
5	60
3	70
0	80
0	90
1	100
$N = 154$	$N = 18$

Source: Shaheen (2011)

Identifying and Assessing Creativity, Table 11 Percentage of raw abstractness of titles scores and percentage of children obtaining these scores

Percentage of children obtaining the score	Percentage of raw abstractness of titles score
60	0
28	10
9	20
3	30
	40
	50
	60
	70
	80
	90
	100
$N = 154$	$N = 33$

Source: Shaheen (2011)

activities which contained more figures to complete, for example, 48 children obtained 20% for activity one where there was only one stimulus, 52 children obtained 20% for activity 2 where there were 10 figures, but 58 children obtained 60% for activity 3 where there were 30 figures. This perhaps suggests that children perform better if there is more choice for elaboration and more opportunities to exhibit this ability.

In summary, the overall low score on elaboration may be attributed to the fact that children had to work within a limited time which left them less time to add detail to their drawings. However, more importantly, this poor performance shows the children's lack of ability to further develop ideas to produce something creative. Further to producing something creative is the ability to communicate what is produced. In the test, the children were provided an opportunity to exhibit this ability through thinking up abstract titles for their pictures. This required them to synthesize and organize the information they had from their pictures. The children's performance on this criterion (abstractness of title) is discussed next.

Abstractness of Title Scores

The children seemed least able on this measure of creativity as evidenced by 60% being unable to produce any abstract titles. However, the remaining were able to produce the required titles and obtain scores ranging from 10% to 30% (Table 11).

Although the aggregate score for abstractness of title was low, more children had higher score for activity 2 than activity one. This can perhaps be attributed to children having more chances to exhibit this ability in activity 2 because they had more drawings to do than in activity 1. For activity one, 81% of the children failed to score, and only 12 achieved a score of 3, which was the highest obtainable. Those who achieved the maximum score were more boys and from urban private schools. Although the scores for activity two were higher than for activity one, these were still low with the highest being 30% obtained by 3 of the children and 105 obtaining no score who were more from private sector schools than government. These low scores indicate the children's inability to synthesize and organize information and communicate it in a creative way through providing written titles.

Premature Closure Scores

The children's performance on premature closure is better than that on the abstractness of titles although still weak with majority of the children obtaining below 50% scores (Table 7). Only 14 children were able to achieve a score between

Identifying and Assessing Creativity, Table 12 Percentage of raw premature closure scores and percentage of children obtaining the score

Percent of children obtaining the score	Percentage of score for closure
8	0
15	10
18	20
17	30
14	40
19	50
5	60
3	70
1	80
	90
	100
$N = 154$	$N = 20$

Source: Shaheen (2011)

Identifying and Assessing Creativity, Table 13 Percentage of creativity index score and percentage of children achieving the score

Percentage of children obtaining the score	Percentage of creativity index scores
1	0
0	10
3	20
16	30
25	40
27	50
23	60
5	70
	80
	90
	100
$N = 154$	$N = 186$

Source: Shaheen (2011)

60% and 80%. The highest score of 80% was obtained by only two children (Table 12). The low scores can be explained by the fact that children are not required to do such activities, hence, not trained to think this way and cannot do what is being asked. It may also be due to the fact that children are more hesitant to give unusual titles, afraid that they may get them wrong or afraid of the response it may attract. One child wrote “alcohol” (forbidden in Muslim cultures), and when I asked him to tell me what he had written, he whispered this to me.

Resistance to premature closure is about being open enough to be able to make what Torrance called the “mental leap” (2008) which it is claimed makes possible original ideas. The children’s low scores on this criteria again have shown that they have not been able to open up their thinking which would have enabled them to produce something creative which can again be attributed to the rigid and repetitive routine they are expected to follow daily in schools, rote memorize material and regurgitate it.

This completes the primary school children’s performance on the five norm-referenced measures of creativity, and it has been seen from one criterion to the next that most children have not performed well. Nevertheless, it is admirable at the same time that children did demonstrate some performance, more on some criteria and less on others despite being totally new to the test and the test-type activities. In total, their overall performance can be seen through their creativity index score which is discussed next.

Creativity Index

Almost all children showed some creativity as evidenced by their attainment of scores on the creativity index. The majority, 140, achieved scores ranging from 30% to 60% with only seven achieving 70% of the CI score which was the highest obtained (Table 13). In this, there were more boys than girls. All these children were said by the teachers to have creativity, but only one was said to be high academic performing, while the remaining were rated as average in their studies. Children who achieved scores above 50% were children from private, urban, and mixed sex schools.

Intercorrelations Among the Separate Assessments of Creativity

There is a high correlation between the separate elements of creativity and the overall indicator of creativity (creativity index) (Table 14), which is what we may expect considering that each

Identifying and Assessing Creativity, Table 14 Intercorrelations among the separate assessments of creativity, along with correlation of each with the creativity index (Pakistan)

Ability	Creativity criteria				
	Originality	Elaboration	Abstractness of title	Resistance to premature closure	Creativity index
Fluency	0.7	0.5	0.2	0.5	0.7
Originality		0.5	0.2	0.5	0.7
Elaboration			0.4	0.5	0.8
Abstractness of title				0.3	0.6
Resistance to premature closure					0.7

Source: Shaheen (2011)

Identifying and Assessing Creativity, Table 15 Intercorrelations among the separate assessments of creativity, along with correlation of each with the creativity index (USA)

Ability	Creativity criteria				
	Originality	Elaboration	Abstractness of title	Resistance to premature closure	Creativity index
Fluency	0.8	0.25	0.23	0.61	0.73
Originality		0.26	0.28	0.57	0.75
Elaboration			0.48	0.28	0.68
Abstractness of title				0.39	0.67
Resistance to premature closure					0.74

Source: Torrance (2008)

element contributes toward the overall creativity. However, there is variation in the contribution of each element which may indicate that children are stronger on some aspects while weaker on others such as the ability to add abstract titles. However, it could also be that this is due to weakness in the children's writing ability, that is, the ability to express creative thoughts in words, and not the ability to think up abstract titles. Hence, it may be that the method being used to test this creative ability is inhibiting children from exhibiting it because of poor writing ability. It could also simply be that children are not required to do such activities, hence, not trained to think this way and cannot do what is being asked. It may also be due to the fact that children are more hesitant to give unusual titles, afraid that they may get them wrong or afraid of the response it may attract. One child wrote "alcohol" (forbidden in Muslim cultures), and when I asked him to tell me what he had written, he whispered this to me. Similarly, the correlation of this score with other elements is also low, with a common variance of 4–9% indicating its independence and the fact that it may be testing something different.

The ability to generate ideas and original ideas (fluency and originality) seems to go hand in hand as there is the highest correlation, which can be explained by the fact that the more objects/pictures are drawn, the greater the chance of generating some original ones. It also indicates that creativity in the sense of producing something original is not a short snappy process but one that involves repeated effort (producing many ideas); hence, it could be said that idea generating is a prerequisite to producing original ideas. What is interesting from the findings when compared to those of other countries such as the USA (Table 15) is that the correlations are highest for both, which seems to point to the fact that these elements of creativity are common in children across cultures.

The children in Pakistan may be required to be more particular and detailed in their routine school work partly because of the tradition of learning whole chunks of text and reciting it in lessons or regurgitating it in exams, which may explain the high correlation of elaboration with fluency, originality, and closure as compared to the American scores, with a common variation of 16–25%; for American children, this is 4%. This also shows that children with the ability to embellish their work may be more likely to be fluent in their ideas, original, and able to resist the temptation to quickly complete their work in the easiest possible way rather than deeply think about what they are doing. From this, it could be said that children who exhibit one type of creative ability are likely to exhibit a number of others. This therefore indicates that separate elements of creativity may vary in their strengths and weaknesses but are likely to be present to some degree with one affecting the other.

Conclusions and Future Directions

In this chapter, the findings have been presented from the policy documents and the teacher survey regarding assessment of creativity in primary school in Pakistan. Also presented are the primary children's creativity scores as obtained on various criteria of the TTCT.

It has been found that Pakistani obtained low scores on the TTCT measures of creativity. Although in this they may have perhaps been disadvantaged as the TTCT-type activities are not part of their teaching, it is very clear that children are unable to generate, develop, and communicate original ideas, all of which requires them to use their ability to synthesize, organize information, and remain open enough to move beyond the everyday, common way of thinking. These findings raise questions about the extent to which the primary education system in Pakistan is supporting children's creativity. In this, it could be argued that despite the policy provisions and directives for inclusion of creativity into the education system, there are gaps at the implementation level in schools. The children's poor performance on the TTCT has shown that just enabling children to acquire knowledge through rote memorization and regurgitation of these facts is doing little to develop their creativity. These findings call for immediate and radical interventions to develop children's creativity through education if creativity is to be used as a tool for the country's progress and development. Unless this is done and some outcomes emerge, it is very difficult to accept existing claims of creativity being a tool for achieving economic progress and development.

References

Afolabi M, Dionne S, Lewis III H. Are we there yet? A review of creativity methodologies. 2006. www.cs.cornell.edu/Conferences/ASEE2006/ASEE%20Papers/Session%204/ASEE%20Final%20vs%203_Afolabi.pdf. Accessed 24 Aug 2009.

ALRSG. A systematic review of the impact on students and teachers of the use of ICT for assessment of creative and critical thinking skills. London: EPPI-Centre; 2003.

Aly J. Education in Pakistan: a white paper document to debate and finalize the national education policy. Pakistan: Government of Pakistan; 2006.

Aly J. Education in Pakistan: a white paper, revised document to debate and finalize the national education policy. Pakistan: Government of Pakistan; 2007.

Auh M. Assessing creativity in composing music: Product-process-person-environment approaches. 2009. www.aare.edu.au/00pap/auh00016.htm. Accessed 23 Dec 2009.

Cartier F. Notes, quotes, and anecdotes. Mens Res J 46. 2001;32(1):6–14.

Compton A, Nahmad-Williams L. Searching for creativity in initial teacher education assessments. Manchester: BERA Conference; 2009.

Diakidoy NA, Kanari E. Student teachers' beliefs about creativity. Br Educ Res J. 1999;25(2):225–44.

Feldman D, Benjamin A. Creativity and education: an American retrospective. Camb J Educ. 2006;36(3):319–36.

Fishkin A, Johnson A. Who is creative? Identifying children's creative abilities. Roeper Rev. 1998;21(1):40–7.

Foster J. Creativity and the teacher. London: Macmillan; 1971.

Fryer M, Collings J. Teachers' views about creativity. Br J Educ Psychol. 1991;61(2):207–19.

Government of Pakistan. National education policy 1998–2010. Islamabad: Ministry of Education; 1998.

Hennessey B, Amabile T. Creativity and learning. Washington, DC: National Education Association Publication; 1993.

Kim K. Can we trust creativity tests? A review of the Torrance tests of creative thinking (TTCT). Creat Res J. 2006;18(1):3–14.

Loveless A. Literature review in creativity, new technologies and learning. Report 4, Futurelab Series. 2002. www.futurelab.org.uk/resaerch/lit_reviews.htm. Accessed 14 May 2009.

McCann M. The creativity/IQ interface: Old answers and some new questions, undated. www.cpsimoes.net/artigos/art_creat_iq.html. Accessed 21 Jan 2009.

Ministry of Education. National curriculum for English language, grades I-XII. Islamabad: Government of Pakistan; 2006a.

Ministry of Education. National curriculum for general science, grades IV-VIII. Islamabad: Government of Pakistan; 2006b.

Misra G, Srivastava A, Misra I. Culture and facets of creativity: the Indian experience. In: Kaufman J, Sternberg R, editors. The international handbook of creativity. New York: Cambridge University Press; 2006. p. 421–55.

NACCCE. All our futures: Creativity, culture and education. 1999. www.cypni.org.uk/downloads/alloutfutures.pdf. Accessed 14 Dec 2009.

Plucker J. The death of creativity measurement has been greatly exaggerated: current issues, recent advances and future directions in creativity assessment. Mensa Res J 46. 2001;32(1):15–24.

QCDA. National curriculum. 2009. http://curriculum.qcda.gov.uk/key-stages-1-and-2/Values-aims-and-purposes/index.aspx. Accessed 26 Sept 2009.

Rogers M, Fasciato M. Can creativity be Assessed? Paper presented at the British Educational Research Association annual conference; 2005 Sept 14–17, University of Glamorgan; 2005.

Rudowicz E. Creativity and culture: a two way interaction. Scand J Educ Res. 2003;47(3):273–90.

Scoffham S. Thinking creatively. Prim Geogr. 2003;50:4–6.

Sen R, Sharma N. Teachers' conception of creativity and it's nurture in children: an Indian perspective. In: Fryer M, editor. Creativity and cultural diversity. Leeds: The Creativity Centre Educational Trust Press; 2004. p. 153–69.

Shaheen R. An investigation into the factors enhancing or inhibiting primary school children's creativity in Pakistan. UK: Lap Lambert Academic Publishing; 2011.

Sharp C. Developing young children's creativity through the arts: what does research have to offer? Paper presented to an invitation seminar; London: National Foundation for Educational Research; (2001).

Sternberg R. The nature of creativity. Creat Res J. 2006;18(1):87–98.

Stoycheva K. The school: a place for children's creativity? Paper presented at the 5th ECHA Conference; Oct 19–22. Vienna, Austria; 1996.

Taylor I. Retrospective view of creativity investigation. In: Taylor I, Getzels J, editors. Perspectives in creativity. Chicago: Aldine Publishing Company; 1975. p. 1–36.

Thorne K. Essential creativity in the classroom: inspiring kids. London: Routledge; 2007.

Torrance E. Encouraging creativity in the classroom: issues and innovations in the classroom. Dubuque: W. C. Brown; 1970.

Torrance E. The search for satori and creativity. Buffalo: The Creative Education Foundation; 1979.

Torrance E. Torrance tests of creative thinking, norms-technical manual figural (streamlined) forms a & B. Bensenville: Scholastic Testing Service; 2008.

Torrance E, Safter H. Making the creative leap beyond. Buffalo: Creative Education Foundation Press; 1999.

Torrance E, Ball O, Safter H. Torrance tests of creative thinking: streamlined scoring guide for figural forms a and B. Bensenville: Scholastic Testing Service; 2008.

Wechsler S. Validity of the Torrance tests of creative thinking to the Brazilian culture. Creat Res J. 2006;18(1):15–25.

Illness

▶ Technological Invention of Disease

Imagery

▶ Imagination

Imagery and Creativity

Barbara Colombo and Alessandro Antonietti
Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Synonyms

Imagination; Mental image; Visualization

Key Concepts and Theoretical Background

Mental images – a kind of representation people often employ in everyday life (Antonietti and Colombo 1996–1997) – play a facilitating role in thinking processes as a means of *simulation* and as a means of *symbolization* (Kosslyn 1983).

As simulation cognitive tools, images allow people to anticipate mentally the actual operations and the physical changes and provide an internal representation that keeps an analogical correspondence with the outside world. As symbolization tools, mental images stand for objects or concrete events, which are replaced by conventional signs. In the first case, images are useful because they offer the opportunity to view the mental consequences of the situation that the representation in verbal or abstract terms does not make immediately obvious. In the second case, images help individuals to mentally manipulate the elements of a situation, because mental images require less memory load than other representations, thus prompting at smooth and rapid transformations of the elements.

With more specific reference to creativity, the search for similarities and differences and the identification of links between distant realities – operations which are assumed to be involved in creativity – are facilitated by mental images that are sensitive to structural symmetries and organizations (Shepard 1978). These mental images permit people to modify data so that the changes which are to be produced in reality may be more flexibly stimulated in the mind. Furthermore, mental images allow a person to reorganize the way in which he/she represents a situation, so that it can be reconsidered in a more productive manner. Finally, the mental representation of information in a visual form can help people by providing a pictorial counterpart of abstract concepts, thus allowing individuals to represent simultaneously various elements of a situation so that they can identify the relationships between those elements. Mental images can therefore help the creative process because they are a kind of representation which is particularly flexible, easily convertible and useful to combine multiple elements into a new concept (Antonietti 1991).

Biographical Reports and Experimental Findings

Several autobiographical reports suggest that mental images have significantly contributed to scientific discovery (Shepard 1978). For example, the French mathematician Jacques Hadamard used visual representations when he thought of algebraic problems. Hadamard relied on these mental images especially when problems become too complex, so much so that the visual encoding allowed him to have a simultaneous understanding of all elements of the problem. Another example is Albert Einstein's use of mental images while working on the theory of relativity. Einstein, at the age of 16, imagined himself traveling at the speed of light sitting on the end of a light beam with a mirror in front of him. In this mental image, the observer could not ever see the image of the traveler. The light and the mirror, in fact, were traveling in the same direction and at the same speed, so that the mirror was always a little ahead of the beam and that the traveler could not reach the mirror and could not see his reflection. From this mental image, Einstein concluded that there can be no observer (i.e., nobody) that can reach or exceed the speed of light. Thus, it passed the assumption, shared by physicists afterward, that an object could achieve any speed, given a sufficient enough acceleration, and hence, the way for the subsequent theory of relativity was opened. A final example is that of Nikola Tesla, who used mental images in the process of inventing neon lights and self-starting engines. He, in fact, used to develop images of mechanical models that ran in his mind for several weeks in order to determine which parts were subject to premature wear.

These autobiographical anecdotes are confirmed by research (Roskos-Ewoldsen et al. 1992). In adults, high correlations have been found between the use and control of mental images and divergent thinking, ideational fluency, and ability to rebuild squares from cuts (a task which is assumed to be associated to the creative manipulations of the given elements). Furthermore, it was found that originality in thinking is associated with the tendency to process complex mental images. Finally, the ability to compose mental images is related to creativity too: Finke (1990) showed that the synthesis of mental images is particularly effective in inspiring original objects that can be used in everyday life.

Not only transformation of mental images but also a static feature, that is, vividness, has some functional significance, especially in situations of intellectual impairment, as suggested by some studies on so-called idiot savants. Research by Selfe (1983) indicated that children with autism and mental retardation with strong artistic skills possess high visual abilities: they use photographically realistic proportions more than normal children for the representation of three-dimensional space as well as the size, distance, and occlusion of overlapping objects. For idiot savants, mental images are one of the forms of representation which they use to perform intellectual operations which majority of people cannot perform (Treffert 2000).

Positive correlations between imagery vividness and divergent thinking skills have been reported, whereas no correlation between vividness and flexibility of thought was found. However, the ability to form vivid mental images is a skill which is separate from the ability to transform images. Kosslyn (1983) supported the componential nature of imagery by showing that at 5 years it is possible to distinguish four distinct types of imagery skills: image generation, maintenance, inspection (scanning), and rotation. The distinctiveness of these skills is supported by research showing that the vividness of the mental image, the main feature in the generation and maintenance of mental images, is not correlated with visual-spatial ability measured by tests based on the rotation and the synthesis of figures.

Implications for Practice

Eckhoff and Urbach (2008) maintained that imagery is crucial for educators to promote creative thinking in informal and formal learning environments. Imagery promoted creative language skills linked to poetry writing. The spontaneous use of imagery in preschool playing behavior was predictive of creative skills in older children and adults. The link between imagery and creativity also appeared to be in the opposite direction: creativity induced a more frequent and complex use of mental imagery.

These findings support the attempts to enhance creativity by means of training activities based on imagery. This can be achieved both by devising structured educational programs aimed at improving mental visualization skills and at addressing such skills to the accomplishment of creative task (Mc Kim 1980) and by inducing people to develop the spontaneous tendency to rely on mental images when creativity is needed in everyday-life situations (Shone 1984).

Western culture has generally underestimated the power of visual thinking. In many theories, both philosophical and psychological, images are considered preparatory or auxiliary forms of thinking, which play the role of substitutes of more sophisticated forms, such as logical, verbal, or mathematical thinking. Imagery is viewed either as a set of cognitive representations and strategies that precedes the development of nonvisual ways of reasoning (a sort of “springboard” for abstract thinking) or as a sort of “crutch” which abstract thinking relies on when one is in trouble (e.g., when he/she needs to explain a concept to a person for whom it is difficult to follow logical arguments).

In other cultures, however, is not so. For example, in certain nomadic tribes, shepherds are aware of the lack of some sheep in the herd, not counting the animals one by one but through a simple “look” thrown to the flock: a function that Western schools have accustomed pupils to play through a mathematical procedure is here performed through an intuitive and fast visual process. This explains why in some cultures children’s games also insist on the development of capacities of the latter type. For example, in some parts of Africa, a childhood favorite play is to build piles of stones and then determine their number simply by looking at them: the child who approached more to the exact number of stones piled up won the game. Imagery strategies are used also for solving complex problems. For example, for the inhabitants of the Polynesian islands, orientation in navigation is established by means of a spatial mental model, rather than through a complex system of calculations.

There are populations who pay very special attention to images, in particular to images that occur while dreaming. Reporting and processing dreams are an important part of youth education in some tribes of Central Malaysia. Every morning, children and adults talk about the dreams of the night. The aim is to help those who have made a dream in which negative elements (fear, death, and so forth) occurred to take advantage of these experiences to turn them, in reality, toward positive goals. In fact, who told the dream that was later the subject of the discussion within the tribe is invited to dream it again differently during the day. From this second dream, the individual has to come back with something creative that could be communicated to others so to accomplish an action, an inspiration for a piece of art (a poem, a song, a dance, a sculpture, a story), or the solution of a problem. For example, a child has dreamed of meeting a scorpion on the path and escaping from it. The child is then asked to revise the dream during the day. After several attempts, the child communicates to the elders of the tribe that he reached the desired outcome: In his mind, he saw the scorpion that blocked the passage; he went to call his older brother, who took the scorpion by the tail and let the path free.

Educational practices in various Eastern cultures make use of imagery as a technique to help one to overcome emotional or relational problems creatively. This is an example. There was a famous wrestler called O-nami (literally, Great Waves). He was the strongest, but when he had to compete in front of an audience, his shyness made him weak enough to be defeated by the worst of his colleagues. O-nami was entrusted to the wisdom of his Zen master, who thought to solve the problem in this way: “Your name is Great Waves – he said – So, next night you will stay in the temple and you will imagine to be those waves, those huge waves that destroy anything they meet in front of them. Do so and you will be the greatest wrestler in the country.” O-nami meditated the next night: He was no longer the fighter, but he imagined to be a great wave. In the morning, O-nami participated in the wrestling contests and won.

From all the suggestions reported above, it is clear that visual mental images can be highly effective to inspire insights and original ideas to be applied in everyday life, and as a consequence, people should be trained to use visualization creatively.

Conclusions and Future Directions

Training procedures and operational guidelines are extremely useful to strengthen both imagery skills per se and to improve their use to foster creative thinking. Few experimental studies have been carried out to assess the capacity of the imagery training to increase creativity. However, existing research data indicate that it is possible to improve the flexibility with which people perform mental figural synthesis and originality of the products that are generated in this way. In fact, with regard to the imaginative strategies followed, the comparison between pre- and posttraining showed that experimental groups had test-retest differences which reflect and increased mobility and transformation of mental images in comparison to control groups. Overall, data suggested that imagery training induces a greater dynamism for imaginative synthesis. One may conclude that the repeated exercise of the combination of images, far from generating repetition and mechanical executions, can stimulate new and more creative solutions, supported by enhanced flexibility in the processing of figures.

Cross-References

▶ Imagination
▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education

References

Antonietti A. Why does mental visualization facilitate problem-solving? In: Logie RH, Denis M, editors. Mental images in human cognition. Amsterdam: Elsevier; 1991. p. 211–27.

Antonietti A, Colombo B. The spontaneous occurrence of mental visualization in thinking. Imag Cogn Pers. 1996–1997;16:415–28.

Eckhoff A, Urbach J. Understanding imaginative thinking during childhood: sociocultural conceptions of

creativity and imaginative thought. Early Child Educ J. 2008;36:179–85.
Finke RA. Creative imagery: discoveries and inventions in visualisation. Hillsdale: Lawrence Erlbaum Associates; 1990.
Kosslyn SM. Ghosts in the mind's machine. New York: Norton; 1983.
Mc Kim RH. Experiences in visual thinking. Boston: PWS Engineering; 1980.
Roskos-Ewoldsen B, Intons-Peterson PF, Anderson RE, editors. Imagery, creativity, and discovery. Amsterdam: North Holland; 1992.
Selfe L. Normal and anomalous representational drawing ability in children. London: Academic; 1983.
Shepard RN. Externalization of mental images and the act of creation. In: Randhawa BS, Coffman WE, editors. Visual learning, thinking and communication. San Francisco: Academic; 1978. p. 133–89.
Shone R. Creative visualization. Wellingborough: Thorsons; 1984.
Treffert DA. Extraordinary people. London: Bantom Press; 2000.

Imagination

Jim Davies
Institute of Cognitive Science, Carleton University, Ottawa, ON, Canada

Synonyms

Chronesthesia; Daydreaming; Dreaming; Dynamic generation; Episodic future thought; False memory; Forecast; Hypothetical thinking; Imagery; Make-believe; Mental imagery; Mental modeling; Mental simulation; Picturing; Pretend play; Pretense; Procedural modeling; Prospection; Retrodiction; Retrospection; Supposition; Synthesis; Thought experimentation; Visualization

Imagination: A Cognitive Science Approach

The term "imagination" is used in two general senses. The first is synonymous with "creativity." The second sense, and the one that will be explored in this entry, refers to the ability to create and experience virtual situations in the mind that are independent of sensory input. For example, a person might picture what a new sofa would look like in her living room, dream of walking through a jungle, or entertain a hypothetical situation in which the Renaissance never happened.

Our imaginative abilities have given our species a great evolutionary advantage. In the Upper Paleolithic, humans were able to produce tools days before using them, created dwellings designed for lengthy occupation, and made stylized tools, cave paintings, and burial practices. All of these practices seem to require imagination, typically imagining possible futures. Harris (2000, pp. ix–xi) suggests that this might have been key to the success of our species, particularly in competition with the Neanderthals, who, lacking these behaviors, were likely to have lacked imaginative abilities.

Imagination can be roughly grouped into two kinds: sensory and suppositional (Goldman 2006). Sensory imagination refers to internally generated sensory-like imagery in the head, such as picturing a tree, hearing a voice or music in your head, or imagining the smell of cinnamon. Sensory imagination can be completely internal, as when dreaming, which is a kind of natural virtual reality. Imagination can also occur in the presence of normal perception, such as when, with one's eyes open, one imagines a new color on a wall. In these instances, imagination works as a kind of augmented reality. Though not related to the senses, motor and emotional imagery is often included in this category, such as imagining running or being happy (Markman et al. 2009, Chapter 18). Sensory imagination uses the same parts of the brain as perception (Kosslyn 1994), just as motor imagery uses the same brain areas as action (Markman et al. 2009, Chapter 2). As such, imagery can interfere with perception (Kosslyn 1994). For example, if you are trying to see something while you are vividly imagining something else, your perception will be compromised.

Sensory imagination also goes by the name of "mental imagery" and has received a great deal of scientific investigation, particularly for visual imagery.

There are two hypothesized formats that can represent visual information. The first, descriptive representations (Kosslyn 1994), are sentence-like statements, such as “ocelot in tree.” The second format, depictive representations, represents visual things at the level of points of color at particular locations. In computer graphics, this is known as a “bitmap.” In a bitmap, there is no explicitly represented content. To know that an ocelot (a South American wild cat) is in the picture, perceptual processes would need to be applied to the bitmap. In the descriptive representation, by contrast, the existence of the ocelot is explicit, as the symbol representing an ocelot would be present in the description.

The theory of visual mental imagery (which is somewhat controversial) holds that the human brain represents visual memories as descriptions but can transform those descriptions into depictions (called enactment-imagination, or e-imagination by Goldman 2006). Although the processes that do this are still poorly understood, the end result is theorized to be an activation pattern in the spatially organized neurons in the visual cortex (Kosslyn 1994).

It is generally assumed that perceptual reinterpretation is the function of visual mental imagery. For example, when asked how many chairs one has in one’s house, one typically will need to visualize a walk-through and count the chairs imagined to eventually arrive at an answer. After doing this once, however, the number of chairs in the house is stored as a descriptive memory and might be retrieved in the future without needing to use mental imagery and counting. Studies supporting this theory show that the same areas of the brain used for visual perception are used when generating mental imagery. However, behavioral evidence for people’s ability to use mental imagery for reperception has been inconsistent.

Although psychologists have studied how people can perceive and manipulate mental images and their effects on sport performance and depression, there has been relatively little work on how these images are generated and composed from descriptive long-term memories. Open questions include the following: What determines the relative amount of confabulation and memory retrieval in recollection? Does a mental image require refreshing from long-term memory? Is the answer different if the image is rotating? When imagining a new scene, such as a playground, how does the mind determine when to stop adding objects to the imagined scene? How do we keep from believing the things we imagine (e.g., if we imagine we can fly, how do our minds keep track of what is imagined and what is real)? How do causal mental models interact with visual memory for mental simulation and planning? When one imagines oneself doing something, when do they take a first-person point of view (in which it appears as it would if they were doing it), and when do they take a third-person point of view (as it might appear in a video)?

Suppositional imagination need not have any sensory element. It is pretense, or the hypothetical entertaining of counterfactuals (Markman et al. 2009, section III). For example, one might imagine the stock market crashing, how someone feels (also known as empathy, using theory of mind, or affective forecast), what the world would have been in like if President Kennedy had not been assassinated, or that one owned a pet ocelot.

Many real-world instances of imagination involve both sensorimotor and suppositional elements. This kind of imagination is studied with different subfield labels. “Mental modeling” studies the working internal representations people have and create to understand systems such as calculators and written descriptions. It has important implications for educational and interface design. “Chronesthesia” is mental time travel, that is, imagining the past (called recollection, retrodiction, or retrospection) or the future (called episodic future thought, forecast, or prospection). “Mental simulation” is a person’s sensory imagery informed by nonsensory understanding of systems, such as physical restraints. One might use mental simulation to decide if a sofa could fit through a given door. Mental simulation in a scholarly context is often called “thought experimentation.” “Pretend play” is treating objects as though they are something else, as when children use stones and sticks to represent teacups and people or when they have imaginary companions (Markman et al. 2009, Chapter 14; Harris 2000).

More familiar phenomena such as planning, dreaming, daydreaming, and fantasizing are subjects of study that also use both sensory and suppositional imagination.

Imagination is also studied with an eye toward how it can affect performance, memory, and mental outlook. Imagining doing something before you do it facilitates performance. Mental practice has been found to be helpful for over 20 sports, including pure muscle strengthening. Use of imagination can alter stereotypes (Markman et al. 2009, Chapter 3).

When we remember things that have happened to us, although it feels sometimes that we are recalling a veridical representation of what happened, it is actually an imaginative reconstruction based on a few accurately remembered elements. In fact, every time we remember an incident, we subtly change the memory itself. This benefit of imagination is also a drawback, as we sometimes remember our imaginings as real events. This happens not only upon recall of actual memories but when asked to imagine a completely new episode. There is a large literature describing this "false memory" effect (Garry et al. 1996).

Another drawback is that when planning for the future, one of the major uses of imagination, people tend to underestimate task-completion times (Buehler et al. 1997). This is, in part, because when imagining another situation, perhaps in another time (e.g., the future) or place (e.g., California), we imagine the only difference being the one under consideration or the most salient feature. For example, people will mistakenly believe they would be happier living in California when the good weather is the most salient difference with where they are currently living (Schkade and Kahneman 1998) and will fail to imagine unforeseen but inevitable difficulties that interfere with plans in the future (Lam et al. 2005).

Computer scientists have done work to automate imaginative abilities with computer programs (Ebert et al. 2002). Although most computer graphics are created by human designers, scientists in the graphics and artificial intelligence fields have made programs that imagine visual scenes. This work is referred to as synthesis, procedural synthesis, dynamic generation, procedural modeling, and visualization. Some programs create plants, others faces, mountains, planets, or cities. They have applications for the automatic creation of virtual environments and characters for art, entertainment (e.g., movies or computer games), and training.

Of the variety of methods that these computer systems use, I will describe grammars, fractals, and explicit knowledge.

A grammar is a set of rules that describe acceptable expressions. In language, a successful grammar will generate only grammatical sentences in a language. In procedural modeling of a city, the grammar would consist of rules describing, for example, what buildings can go next to others and what kinds of windows would appear on which buildings. In music, a grammar might describe what notes are allowed to follow other notes.

Fractals are shapes that are self-similar at different scales. For example, rivers often have a fractal structure, where the small branches upstream resemble the larger branching structures downstream. Fractals are particularly useful for describing natural scenes such as plants and mountains, as fractal geometry often appears in nature. In general, fractal geometry appears whenever a system needs to maximize the area of something in a finite space.

The benefit of grammatical and fractal descriptions is that they can generate many combinations of acceptable outputs with a relatively small description. The downside is that it is difficult for them to take larger context and common sense into effect.

Finally, procedural modeling can be done with explicitly encoded knowledge. For example, to describe a building, the knowledge base might have representations indicating that all rooms must have doors and that ceilings need to be higher than six feet tall. The system can then generate new buildings that satisfy the constraints in the knowledge base. The downside of this is that the knowledge takes a great deal of time and effort to put into the system. In particular, large knowledge bases are prone to contradicting themselves and become unwieldy.

Conclusion and Future Directions

We know little of how human minds decide what goes into an imagined scene (with the exception of the mental modeling literature) and how these things are transformed into mental imagery. Computer scientists have developed methods for automating the generation of scene descriptions as well as their visual rendering.

We know a fair bit about the nature of mental images in people, what we can and cannot do with them (e.g., rotation, reperception), and how they affect our mental states, creative processes, and performance.

However, as a scholarly discipline, imagination is fragmented by methodology (e.g., philosophical argumentation, psychological experimentation, and computer science program implementation) and phenomena of interest. In the future, interdisciplinary cross talk should shed light on the unexplored areas of this important topic.

Cross-References

► Cognition of Creativity
► Imagery and Creativity
► Nature of Creativity

References

Buehler R, Griffin D, MacDonald H. The role of motivated reasoning in optimistic time predictions. Personal Soc Psychol Bull. 1997;23:238–47.
Ebert DS, Musgrave FK, Peachey D, Perline K, Worey S. Texturing and modeling. 3rd ed. A procedural approach. Amsterdam: Morgan Kaufman; 2002.
Garry M, Manning CG, Loftus EF, Sherman SJ. Revelation without presentation: counterfeit study list yields robust revelation effect. Mem Cognit. 1996;27:339–43.
Goldman A. Imagination and simulation in audience responses to fiction. In: Nichols S, editor. The architecture of imagination. Oxford: Oxford University Press; 2006. p. 41–56.
Harris PL. The work of the imagination. Oxford/Malden: Blackwell; 2000.
Kosslyn SM. Image and brain: the resolution of the imagery debate. Cambridge, MA: MIT Press; 1994.
Lam KC, Beuhler R, McFarland C, Ross M, Cheung I. Cultural differences in affective forecasting: the role of focalism. Personal Soc Psychol Bull. 2005;31:1296–309.
Markman KD, Klein WMP, Suhr JA, editors. Handbook of imagination and mental simulation. New York: Taylor & Francis Group; 2009.
Schkade DA, Kahneman D. Does living in California make people happy? A focusing illusion in judgments of life satisfaction. Psychol Sci. 1998;9:340–6.

Imagination Engine

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In Search of Cognitive Foundations of Creativity

Yingxu Wang
Department of Electrical and Computer Engineering, International Institute of Cognitive Informatics and Cognitive Computing (ICIC), University of Calgary, Calgary, AB, Canada

Synonyms

Abstract intelligence; AI; Brain science; Cognitive computing; Cognitive informatics; Cognitive model; Computational intelligence; Creation; Creativity; Denotational mathematics; Invention; Mathematical model

Introduction

Creativity is a gifted ability of humans in thinking, inference, problem solving, and product development (Beveridge 1957; Csikszentmihalyi 1996; Holland et al. 1986; Matlin 1998; Smith 1995; Sternberg and Lubart 1995; Wang et al. 2006; Wilson and Keil 1999). A creation is a new and unusual relation between two or more objects that generates a novel and meaningful concept, solution, method, explanation, or product. Creativity has been perceived diversely and, sometime, controversially in psychology, intelligence science, knowledge science, and cognitive science (Csikszentmihalyi 1996; Guiford 1967; Leahey 1997; Mednich and Mednich 1967; Matlin 1998; Sternberg and Lubart 1995; Wallas 1926; Wang et al. 2009a, b). Creativity may be treated as a form of art that generates unexpected results by unexpected paths and means. It may also be modeled as a scientific phenomenon that generates unexpected results by purposeful pursuits. Matlin in 1998 perceived that creativity is a special case of problem solving (Matlin 1998). From this perspective, he defined creativity as a process to find a solution that is both novel and useful. However, problem solving often deals with issues for a certain goal with unknown paths. Therefore, creation is much more divergent than problem solving, which deals with issues of both unknown goals and unknown paths for a problem under study.

Human creativity may be classified into three categories known as the abstract, concrete, and art creativities. A scientific (abstract) creation is usually characterized by a free and unlimited creative environment where the goals and paths for such a creation is totally free and unlimited, while an engineering (concrete) creation is characterized by a limited creative environment where a creative problem solving is constructed by a certain set of goals, paths, and available conditions. The third form of creation is the art (empirical) creation that generates a novel artifact in order to attract human sensorial attention and perceptual satisfactory.

This entry formally investigates into the cognitive mechanisms of creation and creativity as one of the most fantastic life functions. The cognitive foundations of creativity are explored in order to explain the space of creativity, the approaches to creativity, the relationship between creation and problem solving, and the common attributes of inventors. A set of mathematical models of creation and creativity is established based on the cognitive properties of human knowledge.

Cognitive Foundations of Creativity

Human creativity as a gifted ability is an intelligent driving force that brings something into existence.

Definition 1. *Creativity* is the intellectual ability to make creations, inventions, and discoveries that brings novel relations, entities, and/or unexpected solutions into existence.

Definition 2. A *creation* is a cognitive process of the brain at the higher cognitive layer that discovers a new relation between objects, attributes, concepts, phenomena, and events, which is original, proven true, and useful.

Taxonomy of Creations

Various creativities and creation processes may be identified such as free/constrained creativity, analytic/synthetic creativity, inference-based creativity, problem-solving-based creativity, and scientific/technological/art creativity. The entire set of creativities can be classified into three categories according to their creation spaces, approaches, and problem domains as summarized in Table 1.

It is conventionally perceived that creations and discoveries are usually concrete and tangible. However, more creations and discoveries are abstract or intangible, such as new languages, theories, methods, and doctrines. Therefore, it is noteworthy that a much larger portion of human cognition information is abstract knowledge and wisdom beyond the base-level concrete knowledge about the physical world in the knowledge hierarchy (Wang 2009d). The abstract creations

In Search of Cognitive Foundations of Creativity, Table 1 Taxonomy of creativity and creation

No.	Category	Type of creation	Description	Reference
1	Creation space	Free	A creation process with an unlimited creation space S_c, which is determined by unconstrained sets of alternatives N_a, paths N_p, and goals N_g	Def. 4
2	Creation space	Constrained	A creation process with a limited creation space S_c' where one or more conditions such as the goals N_g', paths N_p', or alternatives N_a', are limited	Def. 5
3	Approach	Analytic	A top-down creation process that discovers a novel solution to a given problem by deducing it to the subproblem level where new or existing solutions may be found	Def. 7
4	Approach	Synthetic	A bottom-up creation process that discovers a novel solution to a given problem by inducting it to a superproblem where new or existing solutions may be found	Def. 8
5	Approach	Inference-based	An abstract creativity based on the deductive, inductive, abductive, and analogy inference methodologies	Def. 9
6	Approach	Problem-solving-based	A novel solution for a given problem by creative goals and/or creative paths	Fig. 1
7	Domain	Scientific (abstract)	A free and unlimited creative environment where the goals and paths for such a creation is totally free and unlimited	Section "Introduction"
8	Domain	Technological (concrete)	A limited creative environment where a creative problem solving is constructed by a certain set of goals, paths, and available conditions	Section "Introduction"
9	Domain	Art (empirical)	A free and unlimited creative environment where a novel artifact is generated that attracts human sensorial attention and perceptual satisfactory	Section "Introduction"

and discoveries are formed as a result of human intelligence by creatively mathematical, logical, and causal reasoning.

The Space of Creativity

Definition 3. A *creation space* Θ is a Cartesian product of a nonempty set of baseline *alternatives* A, a nonempty set of *paths* P, and a nonempty set of *goals* G, i.e.,

$$\Theta \triangleq A \times P \times G \tag{1}$$

where $\times$ represents a Cartesian product.
On the basis of the creation space, the nature of free and constrained creativities can be explained.

Definition 4. A *free creativity* is a creation process with an unlimited creation space S_c, $S_c \subseteq \Theta$, which is determined by unconstrained sets of alternatives N_a, paths N_p, and goals N_g, i.e.,

$$\begin{aligned} S_c &\triangleq N_a \bullet N_p \bullet N_g \\ &= |A| \bullet |P| \bullet |G| \end{aligned} \tag{2}$$

Equation 2 indicates that the creative space of a free creation may very easily turn to be infinitive, because N_a, N_p, and N_g can be extremely large. Therefore, the cost or difficulty of creation is often extremely high. That is, only mechanical and exhaustive search is insufficient for potential creations and discoveries in most cases, if it is not directed by heuristic and intelligent vision. In other words, creations and discoveries are usually achieved only by chance of purposeful endeavors of prepared minds, where an appreciation of highly unexpected result is always prepared. This is also in line with the empirical finding of Pasteur as stated that "Creation always favorites prepared minds (Beveridge 1957)."

Definition 5. A *constrained creativity* is a creation process with a limited creation space S'_c, $S'_c \subseteq S_c \subseteq \Theta$, where one or more conditions such as the goals N'_g, paths N'_p, or alternatives N'_a, are limited, i.e.,

$$S'_c \triangleq N'_a \bullet N'_p \bullet N'_g = |A'| \bullet |P'| \bullet |G'|,\ A' \subset A \wedge P' \subset P \wedge G' \subset G \quad (3)$$

Usually, a scientific and art creation is characterized as a free creation process, while an engineering creation is featured as a constrained creation process.

Approaches to Creativity

A variety of typical approaches to creation have been identified in literature, such as divergent production (Guiford 1967), remote association test (Mednich and Mednich 1967), analysis/synthesis (Wang et al. 2006), and inferences (Wang 2007c). Wallas identified five stages in a creative process (Wallas 1926) as follows: (1) *preparation*, (2) *incubation*, (3) *insight*, (4) *evaluation*, and (5) *elaboration*. Csikszentmihalyi pointed out that creativity can best be understood as a confluence of three factors: a *domain* that consists of a set of rules and practices; an *individual* who makes a novel variation in the contents of the domain; and a *field* that consists of experts who act as gatekeepers to the domain, and decide which novel variation is worth adding to it (Csikszentmihalyi 1996).

The approaches to creativity can be categorized into three categories known as the analytic, synthetic, and inference approaches.

Definition 6. The *analytic creativity* is a top-down creation process that discovers a novel solution to a given problem by deducing it to the subproblem level where new or existing solutions may be found.

Definition 7. The *synthetic creativity* is a bottom-up creation process that discovers a novel solution to a given problem by inducting it to a superproblem where common or general solutions may be found.

Definition 8. The *inference creativity* is an abstract creation process based on the deductive, inductive, abductive, and analogy inference methodologies.

Wallas (1926), Beveridge (1957), and Smith (1995) pointed out an important phenomenon in human creativity known as *incubation*.

Definition 9. *Incubation* is a mental phenomenon that a breakthrough in creation and problem solving may not be achieved in continuous and intensive thinking and inference until an interrupt or interleave action is conducting in a relax atmosphere.

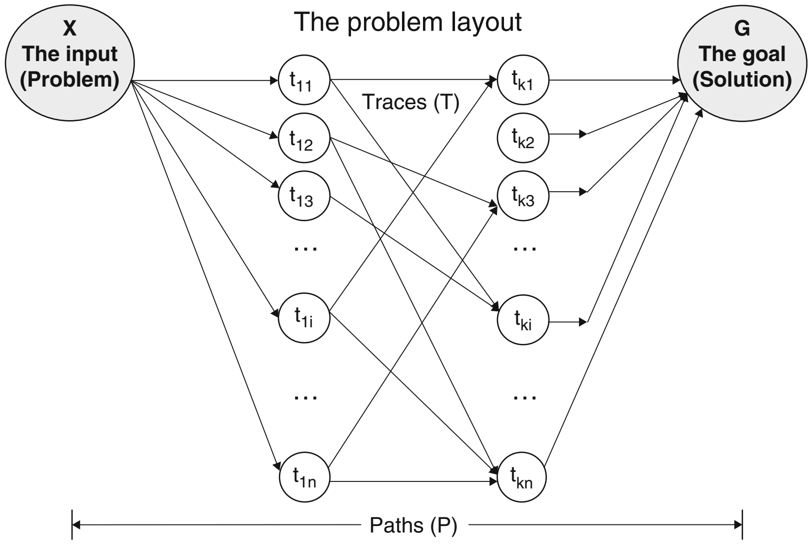
Incubation is often a necessary process in the middle of creation and discovery. The cognitive mechanism of incubation can be explained by the subconscious processes of the brain (Wang2012d) related to thinking and inference, such as perception, imagination, and unintentional search, which are involved in complex thinking and long chains of inferences. Whenever there is an impasse, incubation may often lead to a creation under the effect of active subconscious processes. Incubation has been observed playing an active role in the creation process by researchers.

As creativity is a novel or unexpected solution to a given problem, a creation may be perceived as a special novel solution in problem solving where the problem, goal, or path is usually unknown. Therefore, the study on creativity can analogue to the theory of problem solving (Wang and Chiew 2010). The solutions S and paths P in problem solving can be illustrated in Fig. 1.

In the layout of Fig. 1, a creation is a search for the unknown goals, unknown paths, or both under a given problem or a set of coherent problems. Therefore, creations can be classified into the categories of goal-driven, method-driven, and problem-driven. Among them, the problem-driven creation is a full open process because both goals and paths are unknown for the given problem.

Formal Models of Creation and Creativity

On the basis of the discussions on the cognitive foundations of creativity, a more rigorous



In Search of Cognitive Foundations of Creativity, Fig. 1 The layout of the solution space in problem solving

treatment of it can be developed in this section on the mathematical models of creation and creativity.

The Tree Structure of Human Knowledge

It has been empirically observed that the tree-like architecture is a universal hierarchical prototype of systems across disciplines of not only science and engineering but also sociology and living systems. The underlying reasons that force systems to take hierarchical tree structures are as follows: (a) the complexity of an unstructured system can easily grow out of control, (b) the efficiency of an unstructured system can be very low, and (c) the gain of system by coordination may diminish when the overhead for doing so is too high in unstructured systems.

An ideal structural form for modeling a knowledge system and the creation space of humans is known as the complete tree (Wang 2007a).

Definition 10. A *complete n-nary tree* $T_c(n, N)$ is a normalized tree with N nodes in which each node of T_c can have at most n children, each level k of T_c from top-down can have at most n^k nodes, and all levels have allocated the maximum number of possible nodes, except only those on the rightmost subtrees and leaves.

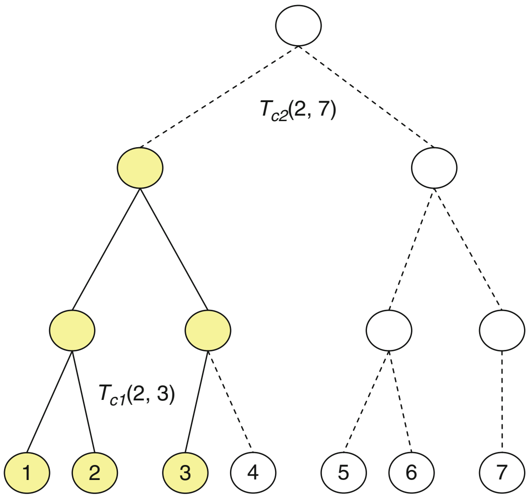
It is noteworthy in Definition 10, a tree said to be *complete* means that all levels of the tree have been allocated the maximum number of possible nodes except those at the leave level and the rightmost subtress. The advantage of complete trees is that the configuration of any complete n-nary tree $T_c(n, N)$ is uniquely determined by only two attributes: the unified *fan-out* n and the number of leave nodes N at the bottom level. For instance, the growth of a system from complete tree $T_{c1}(n_1, N_1) = T_{c1}(2, 3)$ to $T_{c2}(n_2, N_2) = T_{c1}(2, 7)$ is illustrated in Fig. 2.

Theorem 1. The *generic topology of normalized systems* states that systems tend to be normalized into a hierarchical structure in the form of a complete n-nary tree.

Systems are forced to be with tree-like structures in order to maintain equilibrium, evolvability, and optimal predictability. The advantages of the hierarchical tree structure can be formally described in the following corollary.

Corollary 1. *Advantages of the normalized tree* architecture of systems are as follows:

(a) *Equilibrium*: Looking down from any node at a level of the system tree, except at the leave level, the structural property of fan-out or the



In Search of Cognitive Foundations of Creativity, Fig. 2 The growth of a complete tree of hierarchical systems

number of coordinated components are the same and evenly distributed.

(b) *Evolvablility*: A normalized system does not need to change the existing structure for future growth.

(c) *Optimal predictability*: There is an optimal approach to create a unique system structure $T_c(n, N)$ only determined by the attributes of the unified fan-out n and the number of leave nodes N at the bottom level.

Based on the model of the complete tree, the topology of the knowledge space for creation can be denoted as a concept tree with each node of the n-nary complete tree as a concept.

Definition 11. A *concept tree*, $CT(n, N)$, is an n-nary complete tree in which all leave nodes N represent a *meta-concept*, and other nodes beyond the leave level represent *superconcepts*.

For instance, a ternary CT, $CT(n, N) = CT(3, 24)$, is shown in Fig. 3. Since the CT is a complete tree, when the leaves (components) do not reach the maximum possible numbers, the right most leaves and subtrees of the CT will remain open.

A set of useful topological properties of CT is identified as summarized in (Wang 2007a). CT can be used to model and analyze the knowledge space of creativity. It also shows that a well-organized knowledge tree in the brain is helpful for creation, because it can greatly reduce the cost and complexity for search.

Measurement of Creativity

On the basis of CT, the extent of creativity can be quantitatively analyzed by the relational distances between two or more concepts in the concept tree as shown in Fig. 3.

Definition 12. The *relational distance* of a creation, δ, is a sum of the distances δ_1 and δ_2 of a pair of concepts or objects c_1 and c_2 to their closest parent node c_p in a given concept tree CT, i.e.,

$$\begin{aligned}\delta(c_1, c_2) &\triangleq \delta_1 + \delta_2 \\ &= |c_1 \leftrightarrow c_p| + |c_2 \leftrightarrow c_p|\end{aligned} \tag{4}$$

where $\delta_i = |c_i \leftrightarrow c_p|$ denotes the distance between a concept c_i and its most closed parent concept c_p shared with the other given concept.

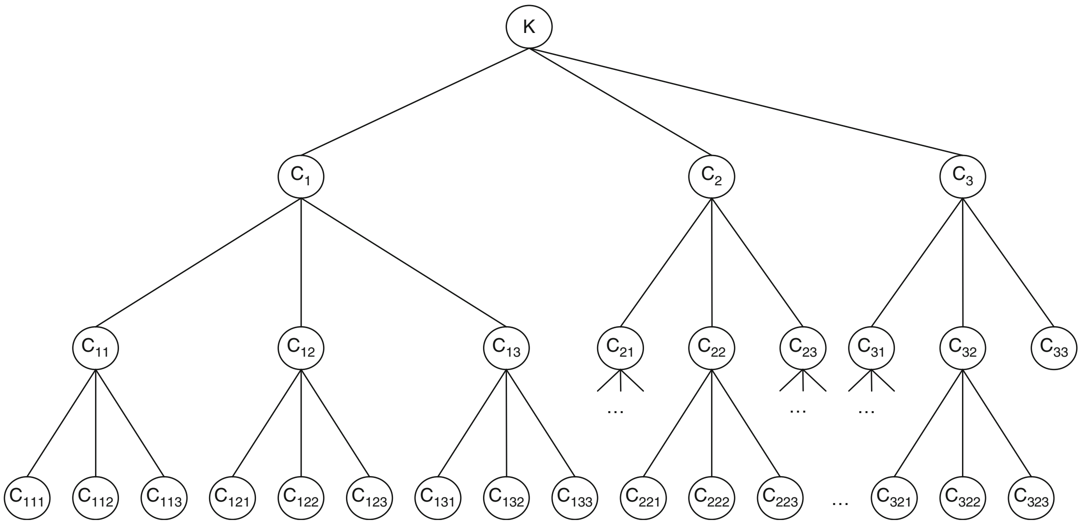
According to Definition 12, the minimum creation distance $\delta_{\min}(c_1, c_2) = 2$ when any pair of concepts at the same level of the CT under the same parent node.

Definition 12 can be extended to a more general case where multiple concepts are involved in a creation based on a given CT as follows.

Definition 13. The *general relational distance* of a creation, δ, is a sum of $n, n > 1$, subdistances δ_i, $1 \leq i \leq n$, between all individual concepts c_i and the closest parent node c_p in the given knowledge space modeled by a CT, i.e.,

$$\begin{aligned}\delta &\triangleq \sum_{i=1}^{n} \delta_i \\ &= \sum_{i=1}^{n} |c_i \leftrightarrow c_p|\end{aligned} \tag{5}$$

Example 1. Given a knowledge space modeled by a CT as shown in Fig. 3, any potential pairwise



In Search of Cognitive Foundations of Creativity, Fig. 3 A ternary concept tree $CT(3, 24)$

or multiple creation distances can be determined according to Definition 13 as follows:

$$
\begin{aligned}
\delta(c_{111}, c_{113}) &= |c_{111} \leftrightarrow c_{11}| + |c_{113} \leftrightarrow c_{11}| \\
&= 1 + 1 = 2 \\
\delta(c_{121}, c_{323}) &= 3 + 3 = 6 \\
\delta(c_{111}, c_{113}, c_{121}, c_{323}) &= 3 + (3 - 2) + (3 - 1) \\
&\quad + 3 = 9
\end{aligned}
\tag{6}
$$

It is noteworthy that the creativity of a creation is proportional not only to its relational distance but also to its originality and usefulness.

Definition 14. Assume $O = \{0, 1\}$ is a Boolean evaluation for the false or true originality of a creation, M the total number of nodes at level k out of the d level creation space for a given CT. Then, the extent of *creativity* C is a product of the creation distance δ, the size of the creation space M, and its originality O, i.e.,

$$
\begin{aligned}
C &\triangleq (\delta \bullet M) \bullet O \\
&= \delta O \bullet \sum_{i=0}^{d-k} n^i
\end{aligned}
\tag{7}
$$

where n is the fan-out of the given CT.

Example 2. Based on the three solutions as given in Example 1, assume their originalities $O_1 = O_2 = O_3 = 1$, then the creativities of the three solutions can be quantitatively evaluated as follows:

$$
\begin{aligned}
C_1 &= \delta_1 O_1 \bullet \sum_{i=0}^{d-k_1} n^i = 2 \bullet 1 \bullet \sum_{i=0}^{3-2} n^i = 2 \bullet (1+3) = 8 \\
C_2 &= \delta_2 O_2 \bullet \sum_{i=0}^{3-1} n^i = 6 \bullet (1+3+9) = 78 \\
C_3 &= \delta_3 O_3 \bullet \sum_{i=0}^{3-0} n^i = 9 \bullet (1+3+9+27) = 360
\end{aligned}
\tag{8}
$$

Obviously, Case 3 represents the greatest creativity among the three cases.

Corollary 2. The creativity of a creation is proportional to the product of the creative distance and the size of the creation space, subject to a satisfactory originality.

Corollary 3. The larger the size of the creation space, the greater the chance for the generation of a creation.

Further elaborations of Corollary 3 will be discussed on the relationship between the creation space and knowledge properties in the following section.

Knowledge Science Foundations of Creativity

On the basis of Corollary 3, it is recognized that the knowledge spaces and capacities of individuals may significantly influence the chance of one's creativity. According to the object-attribute-relation (OAR) model (Wang 2007d) of the internal knowledge representation in the brain, knowledge of an individual can be modeled as a concept network, which is configured by a set of concepts and their semantic relations (Wang 2007d, 2008b).

Definition 15. The *knowledge space K* of an individual is proportional to both the number of concepts, n, and the number of their pairwise relations in one's long-term memory (LTM), i.e.,

$$K = C_n^2 = \frac{n!}{2!(n-2)!} \tag{9}$$

where higher-order relations among concepts can be reduced into multiple pairwise relations.

A fundamental question in knowledge science is to what extent the differences of knowledge spaces could be among individuals. This question can be modeled by contrasting an expert with coherently m disciplinary knowledge K_Σ and those of m experts with separated single disciplinary knowledge K_m. A quantitative analysis of this problem, i.e., K_Σ vs. K_m, is formally described in the following principle.

Theorem 2. *The power of multidisciplinary knowledge* states that the *ratio of knowledge space* r_Σ between the knowledge of an expert with coherently m disciplinary knowledge K_Σ and that of a group of m experts with separated single disciplinary knowledge K_m is:

$$r_\Sigma(m,n) = \frac{K_\Sigma}{K_m} = \frac{C^2_{m\bullet n}}{\sum_{i=1}^{m} C_n^2} = \frac{\frac{(mn)!}{2!(mn-2)!}}{\frac{m(n)!}{2!(n-2)!}} \approx \frac{(mn)^2}{mn^2} = m \tag{10}$$

where n is the number of *average knowledge objects* (or concepts) in the discourses of multiple disciplines.

Theorem 2 indicates that the difference of knowledge spaces in term of the ratio, K_Σ vs. K_m, is m. In other words, an expert with coherently m disciplinary knowledge has a knowledge space that is m times greater than the sum of the group of m experts with separated single disciplinary knowledge. Based on Theorem 2, a new question may be raised as follows: What is the difference between the knowledge spaces of the m disciplinary expert, K_Σ, and that of an individual, K_1, from the group K_m? This problem can be reduced to one that seeks K_Σ vs. K_1 as stated in the following corollary.

Corollary 4. The *first property of knowledge* is that the *ratio of knowledge space* r_1 between the knowledge of an expert with coherently m disciplinary knowledge K_Σ and that of an expert with single disciplinary knowledge K_1 is:

$$r_1(m,n) = \frac{K_\Sigma}{K_1} = \frac{C^2_{m\bullet n}}{C_n^2} \approx \frac{(mn)^2}{n^2} = m^2 \tag{11}$$

Corollary 5. *The second property of knowledge* is that the more the interdisciplinary knowledge one acquires, the larger the knowledge space, and hence the higher the possibility for creation and invention.

Corollary 5 provides a rational explanation for another fundamental question in knowledge science: Which is more important in knowledge acquisition if there is a need to choose the preference from broadness and depth for an individual's knowledge structure? According to Definition 15, Theorem 2, and Corollaries 4 and 5, a rigorous answer to this question can be formally expressed in the following corollary.

Corollary 6. *The third property of knowledge* is that, in knowledge acquisition toward creativity and naval problem solving, broadness is more important than depth in one's knowledge structure.

The above corollary can be proven by Eqs. 10 and 11 as provided in Theorem 2 and Corollary 4, which is perfectly in line with the philosophy of holism. Corollary 6 also explains why most interesting problems in research are often at the edges of conventional disciplines. Therefore, the maintenance of a global and holistic view is one of the fundamental insights of scientific creation and knowledge development.

Analyzing the complexities and speeds of knowledge creation and acquisition, it is noteworthy that, on one hand, the creation of new knowledge requires tremendous time, effort, and ingenuity. However, on the other hand, learning and acquisition of such knowledge are relatively easy, fast, and only need normal intellectual ability. For example, the development of mathematics from arithmetic to calculus had to go through several centuries. However, all undergraduate students can learn and use all of them in the first year of university studies. In another instance, the digital computers have been created and developed as a result of over 60-year effort. However, digital computer architectures and principles can be understood and learnt by students and practitioners with a few months training. These phenomena in knowledge science can be described more formally as follows.

Corollary 7. The *fourth property of knowledge* is that the *effort* of knowledge creation, E_c, is far more greater than that of its acquisition, E_a. Therefore, the *speed* of knowledge creation, V_c, is far more slower than that of its acquisition, V_a, i.e.,

$$\begin{cases} E_c \gg E_a \\ V_c \ll V_a \end{cases} \tag{12}$$

Corollary 7 reveals another significant property of knowledge. That is, although human brains are capable to pragmatically and systematically learn existing knowledge, there is no systematical and predictable approach to create and discover new knowledge. This is because creativities that result in new knowledge are driven by curiosity and random processes, often by chances of well-prepared minds within an extremely large state space and capacity of synergized knowledge. It is noteworthy that the creation of knowledge is a conservative process, which establishes a novel relation between two or more objects or concepts by searching and evaluating a vast space of possibilities in order to explain a set of natural phenomena or abstract problems (Wang 2009d). Since the memory capacity of human can be as high as $10^{8,432}$ bits as quantitatively estimated in (Wang and Wang 2006), the complexity in search for new knowledge is necessarily infinitive if not a short cut shall be discovered by chance during extensive and persistent thoughts. However, the acquisition of knowledge is simply a process of adding a new relation into LTM of an existing knowledge structure. Therefore, the effort for acquiring a piece of existing knowledge is much lower than that of knowledge creation.

Attributes of Inventors and Researchers

A number of typical attributes sharing by inventors have been studied by Beveridge (1957). In his book on *The Art of Scientific Investigation* (Beveridge 1957), Beveridge perceived that the research scientists are fortunate in that in their work they can find something to give meaning and satisfaction to life. Beveridge identified a set of attributes required for researchers and inventors, such as enterprise, curiosity, initiative, readiness to overcome difficulties, perseverance, a spirit of adventure, a dissatisfaction with well-known territory and prevailing ideas, and an eagerness to try his own judgment, intelligence, imagination, internal drive, willingness to work hard, perseverance, and tenacity of purpose (Beveridge 1957).

In studies of inventive behaviors of creation in cognitive psychology, Sternberg and Lubart's (1995) elicited the following set of attributes of inventors known as intelligence, knowledge, motivation, appreciation, thinking style, and personality. Contrasting the two sets of attributes identifies by Beveridge and Sternberg/Lubart, it is interesting to note that the former would have understood scientific creation and invention deeper than the latter, because the former has much firsthand insight in research and discoveries than that of psychological observations on inventions.

Beveridge believed that an insatiable curiosity and love of science are the two most essential attributes of scientists. He pointed out that a good maxim for researchers is look out for the unexpected. He described that creators are those whose imaginations are fired by the prospect of finding out something never before found by man, and only for those will succeed who have a genuine interest and enthusiasm for discovery (Beveridge 1957). Another crucial attribute is perseverance or persistence as Pasteur wrote: "Let me tell you the secret that has led me to my goal. My only strength lies in my tenacity (Dubos 1950)." Pasteur has also revealed that "In the field of observation, chance favors only the prepared mind."

It is noteworthy that the above investigations into research itself and researchers have overlooked a more significant attribute for creativity and discovery ability, i.e., *mathematical skills* or the *abstract inference capability*, because mathematics plays the ultimate role of meta-methodology in science and engineering creativities. Actually, mathematical skills and abstraction capability are the most important foundation for efficient scientific creation and invention, which enables a scientist to inductively generalize a hypothesis into the maximum scope, usually the infinitive or the universal domain based on limited empirical studies and/or mathematical/logical inferences. It is noteworthy that mathematics is the generic foundation of all science and engineering disciplines, as well as all scientific methodologies. To a certain extent, the maturity of a discipline is characterized by the maturity of its mathematical means (Bender 2000; Zadeh 1965, 1973; Wang 2007a, 2008a, 2008b, 2012a). One of the major purposes of cognitive informatics is to develop and introduce suitable mathematical means into the enquiry of natural intelligence, computational intelligence, cognitive science, and knowledge science. The studies on denotational mathematics (Wang 2008a, 2008b, 2012a), such as system algebra (Wang 2008c), concept algebra (Wang 2008b), RTPA (Wang 2002b, 2008d), inference algebra (Wang 2011a, 2012b), and visual semantic algebra (VSA) (Wang 2009b) are fundamental endeavors toward the formalization of the entities that are conventionally hard-to-be-formalized.

According to cognitive informatics (Wang 2002a, 2003, 2007b, 2009a, 2009c, 2010, 2011b, 2012c; Wang and Wang 2006; Wang et al. 2006, 2009a, b), significant cognitive attributes related to creativity are those of knowledge organizational efficiency, searching efficiency, abstract ability, appreciation of new relations, curiosity, induction, and categorization, because those identified in the list are fundamental cognitive mechanisms and processes of the brain at the layers of metacognition and meta-inference according to the layered reference model of the brain (LRMB) (Wang et al. 2006), which are frequently used in supporting higher-layer cognitive processes.

Conclusions and Future Directions

This entry has presented the cognitive process of creation and creativity as a gifted life function according to the layered reference model of the brain (LRMB) (Wang et al. 2006). The cognitive foundations of creativity, such as the space of creativity, the approaches to creativity, the relationships of creation with problem solving, and the attributes of inventors, have been explored. A set of mathematical models of creation and creativity has been developed based on the hierarchical structures and properties of human knowledge known as concept trees. The measurement of creativity has been quantitatively analyzed. The knowledge science foundations for creativity have been systematically explored.

In this entry, a creation has been defined as a novel and unexpected solution, which is a subset of the entire set of the creation space that meet the criteria of *novelty, originality*, and *utility*. The extent of creativity has been modeled as proportional to the product of the creative distance and the size of the creation space, subject to a satisfactory originality. Various creativities and creation approaches have been identified such as free/constrained creativity, analytic/synthetic creativity, inference-based creativity, problem-solving-based creativity, and scientific/technological/art creativity. The entire set of creativities has been classified into these three categories according to their creation spaces, approaches, and problem domains.

According to Corollary 7, as well as observing the history of science development and human civilization, it is noteworthy that a modern society must encourage creativity and inventions of their elites. Because they are the locomotive for knowledge advancement who form an indispensable engine for the society, based on it the entire society will be enhanced and benefited.

Corollary 8. The *fifth property of knowledge* is that whatever the champions can achieve in knowledge development will then become the norm of the entire society.

That is, according to Corollary 8, no matter how fast the champions may run in creation and knowledge development, everybody in the societies can follow. However, in sports, hardly few may catch up the world record of a champion. Therefore, it will never be underestimated that how much a society may gain from the leading intellectual forces in creation and knowledge generation.

Cross-References

▶ Cognition of Creativity
▶ Creative Brain
▶ Invention Versus Discovery
▶ Science of Creativity

References

Bender EA. Mathematical methods in artificial intelligence. Los Alamitos: IEEE CS Press; 2000.

Beveridge WI. The art of scientific investigation. UK: Random House Trade Paperbacks; 1957.

Csikszentmihalyi M. Creativity: flow and the psychology of discovery and invention. New York: HarperCollins; 1996.

Dubos RJ. Louis pasteur: freelance of science. Boston: Little Brown; 1950.

Guiford JP. The nature of human intelligence. New York: McGraw-Hill; 1967.

Holland JH, Holyoak KJ, Nisbett RE, Thagard PR. Induction: processes of inference, learning, and discovery. Cambridge, MA: MIT Press/Bradford Books; 1986.

Leahey TH. A history of psychology: main currents in psychological thought. 4th ed. Upper Saddle River: Prentice- Hall; 1997.

Matlin MW. Cognition. 4th ed. Orlando: Harcourt Brace College Publishers; 1998.

Mednich SA, Mednich MT. Examiner's manual, remote associates test. Boston: Houghton Mifflin; 1967.

Smith SM. Fixation, incubation, and insight in memory and creative thinking. In: Smith SM, Ward TB, Finke RA, editors. The creative cognition approach. Cambridge, MA: MIT Press; 1995.

Sternberg RJ, Lubart TI. Defying the crowd: cultivating creativity in a culture of conformity. New York: Free Press; 1995.

Wallas G. The art of thought. New York: Harcourt-Brace; 1926.

Wang Y. Keynote: on cognitive informatics. In: Proc. 1st IEEE international conference on cognitive informatics (ICCI'02). Calgary: IEEE CS Press; 2002a. p. 34–42.

Wang Y. The real-time process algebra (RTPA). Ann Softw Eng: Int J. 2002b;14:235–74. Springer.

Wang Y. On cognitive informatics. Brain Mind: Transdiscipl J Neurosci Neurophilos. 2003;4(3):151–67.

Wang Y. Software engineering foundations: a software science perspective, CRC book series in software engineering, vol. II. New York: Auerbach Publications; 2007a.

Wang Y. The theoretical framework of cognitive informatics. Int J Cogn Inf Nat Intell. 2007b;1(1):1–27.

Wang Y. The cognitive process of formal inferences. Int J Cogn Inf Nat Intell. 2007c;1(4):75–86.

Wang Y. The OAR Model of Neural Informatics for Internal Knowledge Representation in the Brain. Int J Cogn Inf Nat Intell. 2007d;1(3):66–77.

Wang Y. On contemporary denotational mathematics for computational intelligence. Transac Comput Sci. 2008a;2:6–29.

Wang Y. On concept algebra: a denotational mathematical structure for knowledge and software modeling. Int J Cogn Inf Nat Intell. 2008b;2(2):1–19.

Wang Y. On system algebra: a denotational mathematical structure for abstract system modeling. Int J Cogn Inf Nat Intell. 2008c;2(2):20–42.

Wang Y. RTPA: a denotational mathematics for manipulating intelligent and computational behaviors. Int J Cogn Inf Nat Intell. 2008d;2(2):44–62.

Wang Y. On abstract intelligence: toward a unified theory of natural, artificial, machinable, and computational intelligence. Int J Softw Sci Comput Intell. 2009a;1(1):1–17.

Wang Y. On visual semantic algebra (VSA): a denotational mathematical structure for modeling and manipulating visual objects and patterns. Int J Softw Sci Comput Intell. 2009b;1(4):1.
Wang Y. A cognitive informatics reference model of autonomous agent systems (AAS). Int J Cogn Inf Nat Intell. 2009c;3(1):1–16.
Wang Y. Toward a formal knowledge system theory and its cognitive informatics foundations. Transac Comput Sci. 2009d;5:1–19, Springer.
Wang Y. Cognitive robots: a reference model towards intelligent authentication. IEEE Robot Autom. 2010;17(4):54–62.
Wang Y. Inference algebra (IA): a denotational mathematics for cognitive computing and machine reasoning (I). Int J Cogn Inf Nat Intell. 2011a;5(4):62–83.
Wang Y. Towards the synergy of cognitive informatics, neural informatics, brain informatics, and cognitive computing. Int J Cogn Inf Nat Intell. 2011b;5(1):74–92.
Wang Y. Inference algebra (IA): a denotational mathematics for cognitive computing and machine reasoning (II). Int J Cogn Inf Nat Intell. 2012a;6(1):21–46.
Wang Y. On long lifespan systems and applications. J Comput Theor Nanosci. 2012b;9(2):208–16.
Wang Y. The cognitive mechanisms and formal models of consciousness. Int J Cogn Inf Nat Intell. 2012c;6(2):15–28.
Wang Y. In search of denotational mathematics: novel mathematical means for contemporary intelligence, brain, and knowledge sciences. J Adv Math Appl. 2012d;1(1):4–25.
Wang Y, Chiew V. On the cognitive process of human problem solving. Cogn Syst Res: Int J. 2010;11(1):81–92, Elsevier.
Wang Y, Wang Y. Cognitive informatics models of the brain. IEEE Trans Syst, Man, Cybern(Pt C). 2006;36(2):203–7.
Wang Y, Wang Y, Patel S, Patel D. A layered reference model of the brain (LRMB). IEEE Trans Syst, Man, Cybern(Pt C). 2006;36(2):124–33.
Wang Y, Kinsner W, Zhang D. Contemporary cybernetics and its faces of cognitive informatics and computational intelligence. IEEE Trans Syst, Man, Cybern (Pt B). 2009a;39(4):823–33.
Wang Y, Kinsner W, Anderson JA, Zhang D, Yao Y, Sheu P, Tsai J, Pedrycz W, Latombe J-C, Zadeh LA, Patel D, Chan C. A doctrine of cognitive informatics. Fundam Inf. 2009b;90(3):203–28.
Wilson RA, Keil FC, editors. The MIT encyclopedia of the cognitive sciences. Cambridge, MA: The MIT Press; 1999.
Zadeh LA. Fuzzy sets and systems. In: Fox J, editor. Systems theory. Brooklyn: Polytechnic Press; 1965. p. 29–37.
Zadeh LA. Outline of a new approach to analysis of complex systems. IEEE Trans Syst, Man Cybern. 1973;1(1):28–44.

Incentive-Diffusion Dilemma

► Intellectual Property, Creative Industries, and Entrepreneurial Strategies

Incubators

► Microfirms

Independent Entrepreneurship

► Corporate Entrepreneurship

Individual Determinants of Entrepreneurship

Imen Selmi[1] and Samia Haddad[2]
[1]National Engineering School of Gabes (ENIG), Gabès, Tunisia
[2]Institute of High Commercial Studies of Tunis (IHEC), Tunis, Tunisia

Synonyms

Internal factors; Personality/traits explanations; Psychological determinants

Introduction

Everyone agrees on the importance of entrepreneurship in the development of regions and its contribution to generate innovation and economic growth. To better understand this phenomenon, the determinants of entrepreneurship have attracted the interest of several researchers. Some are interested in the individual factors; others looked at the determinants related to the environment in which individuals are situated.

Moreover, many researchers have shown that entrepreneurship is a function of the interaction between the individual determinants and other environmental determinants.

The main goal of this entry is to provide a road map for researchers interested in the individual determinants of entrepreneurship. It tries to review the major individual factors that prior researchers have suggested should influence the entrepreneurial activities.

The origin of individual determinants of entrepreneurship as a research topic has its roots in the 1960s in the classic entrepreneurship literature. This literature attempted to explain the creation of new venture with a focus on personality traits and characteristics of entrepreneurs. The board conclusion of this literature is that determinants related to the individual are composed of special qualities and motivations that endowed entrepreneurs with unique abilities or driving forces encouraging them to create new ventures.

A growing literature examines the impact of individual determinants on entrepreneurship. Researches emphasize the importance of personality traits and characteristics in the decision between self-employment and salary work. Authors identified two categories of explanations. The first class emphasizes entrepreneurial motivations. Previous researches have explored several motivations and their effects on entrepreneurship.

Entrepreneurial Motivations

The Need for Independence

The most studied motivation in this context is the need for independence. Individuals having a preference for autonomy desire freedom from organizational constraints and control from supervisors (Schein 1990). They want to work independently and be "their own boss." They prefer to be maximally free in their work so that they can define their own objectives and achieve them as they would like. They want to take the responsibility to fix their own decision instead of following the orders of others. To achieve all these ambitions, individuals having a need of independence turn away from salary work and prefer to move towards an entrepreneurial career.

The Need for Achievement

Within the research domain of personality traits and entrepreneurship, the concept of need for achievement (nAch) or the need for personal development has received much attention. Mc Clelland (1961) identified it as a key influencing personal characteristic on the creation of new ventures. This motivation is related to the need for the individual to learn every day, to exercise his creativity, and to innovate. Individuals with a high need for achievement have a strong desire to set their own goals and carry them out. They want to take responsibility for actions and do well in competitive situations. They dislike routine activities, and they have a tendency to choose difficult tasks. While those with a low need for achievement choose very easy tasks in order to reduce the risk of failure. Thus, they consider the creation of business as a challenge to meet which encourages them to create their own businesses.

The Locus of Control

The locus of control is another motivation of interest, which emerged from Rotter's (1966) original research on entrepreneurs. Rotter (1966) argued that individuals having a high internal locus of control believe that they will realize their success by their own actions. They have the perception that all events are under their control so that they do not attribute outcomes to the chance or external environment. However, individuals with an external locus of control believe that the result of an event is out of their control. Individuals having an internal locus of control prefer to pursue an entrepreneurial career because they desire situations in which their personal actions have a direct impact on outcomes.

Thus, the study of the most considered entrepreneur's motivations like the need for independence, the need for achievement, and the locus of control is relevant because they have been interpreted in the entrepreneurship literature as potential internal driving forces among entrepreneurs.

Entrepreneur's Qualities

The second class of explanation of self-employment emphasizes entrepreneur's qualities that are necessary to become an entrepreneur. The decision to create a new business has been considered in many researches as a function of the qualities associated to the individual. Entrepreneur's qualities are defined as the skills and abilities of an individual encouraging him to create a new venture.

Entrepreneurial Self-Efficacy

One of the key factors that have received attention is entrepreneurial self-efficacy which is developed by Bandura (1977) and has been demonstrated to play a crucial role in the development of entrepreneurial intentions and actions. The concept of self-efficacy or self-confidence is based on individuals' self-perceptions of their skills and abilities to succeed in creating new businesses. These perceptions are able to increase the level of interest in pursuing an entrepreneurial career. Individuals with high entrepreneurial self-efficacy are also more likely to believe that they possess a viable idea for a new venture. They exert more effort for a greater length of time and persist to achieve this idea and to improve their performance.

Risk Tolerance

The classic work of Knight (1921) stresses the importance of risk tolerance in the entrepreneurial decision. Risk tolerance consists of a general tendency to pursue and take calculated risks. Entrepreneurs often accept uncertainty; however, other individuals desire to avoid risk because they are afraid of failure. As a result, they prefer easy and safety situations because there is a high chance of success. In a recent study, Fairlie and Holleran (2011) note that creating a new business is inherently risky, and individuals who are more risk tolerant have higher levels of entrepreneurial intentions and opportunity-identification efficacy.

Creativity

In addition to these individual determinants, many other significant factors have been identified by an important number of researchers. Schein (1978) found that individuals with a strong creativity and innovative anchor are motivated to create "something new" for the chance to use their skills to innovate and develop new ideas. They are characterized by the ability to produce an original and useful work in the same time.

Some Empirical Studies About Individual Determinants of Entrepreneurship

A large number of empirical studies examine whether these motivations and qualities in addition to other identified characteristics are important determinants of entrepreneurship.

In his study, Hornaday (1982) lists 42 attributes of entrepreneurs. These attributes include need for achievement, risk-taking propensity, and internal locus of control. Additionally, he notes the importance of other special qualities such as dynamism, adaptability, taking initiative, and the ability to resolve problems in the creation of new ventures.

In a study based on 40 success stories of entrepreneurs, Hernandez (2006) explored the reasons why individuals start enterprises and make career choices. The results of his research indicated that the main reasons individual's start enterprises are passion, self-realization, autonomy, authority, financial success, and difficulty to find a salary work.

A recent empirical study of Fairlie and Holleran (2011) tried to examine the influence of several personality characteristics on the creation of new ventures in Germany. On the basis of a large representative household panel survey, they found that tolerance to risk, entrepreneurial ability, and locus of control are important in determining who creates a new venture. Moreover, they identified extraversion and openness to experience as key influencing factors on entrepreneurship. Extraverted individuals are defined as self-confident, ambitious, energetic, sociable, and dominant persons. With regard to openness to experience, it consists of the individual's ability in looking for new experiences and exploring novel ideas.

Conclusion and Future Directions

Thus, this entry contributes to review the major individual determinants (and does not provide an exhaustive list of these determinants) that prior researchers have suggested should influence entrepreneurial activities. The literature analyzing this question has examined the impact of personality traits on the creation of a new venture. Authors identified two categories of explanations. The first class emphasizes entrepreneurial motivations such as the need for achievement, the locus of control, the need for independence, the need for approval, and the need for personal development. The second class of explanation emphasizes entrepreneur's skills and qualities such as self-efficacy, risk preference, creativity, and dynamism.

Studying the individual determinants of new firm creation is relevant. However, the entrepreneurial phenomenon is multidimensional and cannot be fully understood by only individual factors. There might be important and interesting interaction effects between the qualities and motivations of the entrepreneurs and factors related to the environment in which he is situated.

This may explain why the focus of entrepreneurship research changed in the late 1980s with authors proposing a more holistic approach taking into account both individual and environmental determinants at different stages of the entrepreneurial process. Then, the inclusion of both individual and environmental factors in understanding entrepreneurial behaviors is crucial in theoretical as well as empirical studies.

Cross-References

▶ Creative Personality
▶ Creativity and Innovation: What Is the Difference?
▶ Psychological Aspects of Entrepreneurial Dynamics
▶ Psychology of Creativity

References

Bandura A. Self-efficacy; toward a unifying theory of behavioural change. Psychol Rev. 1977; 84(2):191–215.

Fairlie RW, Holleran W. Entrepreneurship training, risk aversion and other personality trait: evidence from a random experiment. J Econ Psychol. 2011. doi:10.1016/j.joep. 2011.02.001.

Hernandez EM. Les trois dimensions de la décision d'entreprendre. Revue Française de Gestion. 2006;9:168–9. 337–357.

Hornaday JA. Research about living entrepreneurs. In: Kent CA, Sexton DL, Vesper KH, editors. Encyclopedia of entrepreneurship. Prentice Hall: Englewood Cliffs; 1982. p. 28.

Knight F. Risk uncertainty, and profit. New York: Houghton Mifflin; 1921.

Mc Clelland D. The achieving society. D. Van Nostrand: Princeton; 1961.

Rotter JB. Generalized expectancies for internal versus external control of reinforcement. Psychological Monographs (General and Applied). 1966;80(1):1–28.

Schein EH. Career dynamics; matching individual and organizational needs. Reading, MA: Addison-Wesley; 1978.

Schein EH. Career anchors; discovering your real values. San Diego: University Associates; 1990.

Individual Enterprise

▶ Small Business

Individual Initiative

▶ Entrepreneur and Economists
▶ Heroic Entrepreneur, Theories

Individual Musical Creativity

▶ Creativity in Music Teaching and Learning

Individual-Opportunity Nexus

▶ Entrepreneurial Opportunity

Industrial Activity

▶ Heroic Entrepreneur, Theories

Industrial Atmosphere

Jacques-Laurent Ravix
University of Nice Sophia Antipolis and CNRS, Valbonne, France

Synonyms

Innovative milieu; Localized knowledge

Introduction: Key Concepts and Definitions

Industrial Atmosphere and Industrial Districts

The term "industrial atmosphere" is used in economic literature in relation with the issue of localized business activities and more specifically with the notion of "industrial district." The latter notion describes geographical concentrations of firms characterized by specific relationships among participants. Industrial districts are localized clusters of firms, generally small or medium firms, where special modes of business cooperation among firms can be found, be they rivals or based on customer-supplier relationships, with some degree of loyalty and cooperative attitude creating a peculiar business-friendly "atmosphere" in the local industry.

Italian Industrial Districts

The modern economic literature on districts is based on the observation of specific forms of localized industrial activities that emerged in Italy during the 1960s and 1970s, called "Italian industrial districts." These localized clusters of firms defined the new industrial model of the "Third Italy," the structure, mechanisms, and rationale of which differed from both the classical industrial development of the Italian northwestern region, in the Milan-Turin-Genova triangle, and the underdeveloped "*Mezzogiorno*" of Southern Italy. Economic studies on Italian industrial districts such as the Prato textile industry, for instance, describe clusters of small firms mostly specialized in a single production phase and linked together in a complex process of cooperation and competition giving birth to an "industrial atmosphere," meaning close business relationships among participants. These relationships are based on technological information sharing, loyalty, social and family ties, interpersonal friendship, and cooperative connections (Becattini 1989, 1991).

Overview

From a historical viewpoint, localized clusters of firms have been initially observed and analyzed by Alfred Marshall in the British industry of the nineteenth century. Modern analyses owe much to Marshall's founding intuitions. In the first section, the works of the famous Cambridge master will be evoked to show how a peculiar "industrial atmosphere," as he called it, emerges from the historical, geographical, and organizational characteristics of localized industrial activities. The second section focuses on the specific role of entrepreneurial activities in the crystallization of industrial atmosphere.

Marshallian Industrial District and Industrial Atmosphere

The notion of industrial atmosphere was first coined by Alfred Marshall. In Marshall's *Principles* (Marshall 1920), the concentration of specialized industries in particular localities is considered as one of the main forms of industrial organization leading to economic development. Industrial localization and the division of labor and its influence on machinery, production on

GREDEG research group (*Groupe de Recherche en Droit, Economie, Gestion*), a joint unit of the University of Nice – Sophia Antipolis and CNRS (*Centre National de la Recherche Scientifique*).

a large scale, and business management are the main causes of a long-term tendency to increasing returns. Alfred Marshall first pointed to the industrial atmosphere of some clusters of firms such as Sheffield's cutlery industry, a prototypical example of this form of industrial organization in the nineteenth century. For Marshall, interestingly, an industrial district is not simply a localized industry. Inside the district, interactions among firms matter because they give birth to external economies leading to aggregate outcome equivalent to scale economies that can be observed in big firms.

According to Marshall, people following the same skilled trade take great advantages from near neighborhood to one another. These advantages come from knowledge sharing leading to the diffusion and enhancement of knowledge, the seizing of new ideas that are simply "in the air" among participants, and the speeding up of the innovative pace. In Marshall's words:

> The mysteries of the trade become no mysteries; but are as it were in the air (. . .) Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed; if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas. (Marshall 1920), p. 225

The reasons for a geographical concentration of firms may be various, depending on local resources, physical conditions, demand conditions, etc., whereas Marshallian industrial districts are more significantly characterized by a particular combination of competition and cooperation through which entrepreneurial talent must be allowed to express itself. In districts, some relationships prevail among firms; firms specialize in particular phases of the productive process from where on they interact through many forms of cooperation, subcontracting, and exchange processes. Thus, because of this dense network of relations, subsidiary industries devoted to small phases of the productive process but working for a large number of neighbors are able to use and maintain machinery of a very specialized character. Another advantage of industrial districts is the existence of a local market for special skills where employers are likely to find a good choice of workers of many different skills. However, according to Marshall, whereas small districts specialized only in one kind of work can rapidly lose their advantages, the most efficient forms of cooperation are seen in large industrial districts and large manufacturing towns where many specialized branches of industry are put together into an "organic whole."

In *Industry and Trade*, the author explicitly uses the term "industrial atmosphere" to express the environment into which the firms are immersed and obtain "more vitality than might have seemed probable in view of the incessant change of techniques" (Marshall 1919, p. 287). Marshall explains in detail how the problem of the scale of production can be overcome if small and medium firms closely collaborate. The most common system used by English firms was interfirm cooperation or, as Marshall calls it, "associated action" among firms in the same district (see Belussi and Caldari 2009, pp. 338–339).

According to Giacomo Becattini, the main revivalist of the Marshallian approach, "the term localization stands for something other than an accidental concentration in one place of production processes which have been attracted there by pre-existing localizing factors. Rather, the firms become rooted in the territory, and this result cannot be conceptualized independently of its historical development" (Becattini 1990, p. 40).

Thus, the origin and development of an industrial district is not simply the local result of the matching of some sociocultural characteristics of a community, of historical and natural conditions of a geographical area, and of technical aspects of the production process. It is "also the result of a process of dynamic interaction (a virtuous circle) between division-integration of labor in the district, a broadening of the market for its products, and the formation of a permanent linking network between the districts and the external markets" (Becattini 1990, p. 44).

Marshall's approach to interfirm relations cannot be separated from his conception of the dynamics of industry developed in the *Principles*. His vision of firm and industry shows a great homogeneity because it inextricably links the principle of organization resulting from the division of labor, and the principle of substitution which is mainly based on the evolutionary notion of natural selection in which entrepreneurship plays an important part.

Entrepreneurship and Industrial Atmosphere

Industrial districts are a special form of industrial organization which needs a cognitive interpretation of industrial atmosphere. The latter is mainly based on the emergence and intervention of entrepreneurs whose abilities and competence are, for the most part, to organize the division of labor and specific forms of cooperation among competitors. Take, for instance, the "*impanatore*" of Italian textile industries of the twentieth century; this entrepreneur is instrumental in the linking up of customers located outside the district and the different suppliers working inside of it at various levels of the supply chain. The *impanatore* mainly plays an architectural role for the district, giving instructions or advice to the suppliers for organizing, or reorganizing, their production processes according to his knowledge of the changes of customers' taste and needs.

Entrepreneur, Undertaker, and Promoter

The analysis of geographical concentration of firms is inseparable from a vision of the economic actor embedded in complex social relationships and business relations assuming honesty and good faith. The importance of neighborhood is central to this idea: "the desire to earn the approval, to avoid the contempt of those around one is a stimulus to action which often works with some sort of uniformity in any class of persons at a given time and place" (Marshall 1920, p. 19). In this neighborhood, entrepreneurs are those who take the risks and the management of business and participate to the organized industry.

The central figure of the "undertaker" is the main spring of economic development. The undertaker must deploy "ability" which corresponds to knowledge, a quality which can be acquired and improved by education and learning. On the other hand, the undertaker must also exhibit "energy," synonymous with creativity and innovativeness. Business management is considered as part of industrial organization and necessitates the following abilities, listed by Marshall: an entrepreneur must be endowed with "a thorough knowledge of things in his own trade," "power of forecasting the broad movements of production and consumption," and the capacity of "seeing where there is an opportunity for supplying a new commodity that will meet a real want or improving the plan of producing an old economy"; finally, the business manager must be "able to judge cautiously and undertake boldly," and he must be "a natural leader of men" (Marshall 1920, quoted by Pesciarelli 1991). The entrepreneur's role is improved particularly through the advantages of large-scale production. The emergence of joint-stock companies studied in *Industry and Trade* (Marshall 1919) gives rise to another entrepreneurial figure, the "promoter," who organizes industrial cooperation on purely business lines and forecasts future businesses based on new inventions leading to new opportunities and new profitable alliances between industries.

Localized Knowledge and Innovation

The emergence of different kinds of territorial development and industrial districts in the twentieth century called for a general analytical background that could be used to explain, not only the districts of Northeast and Central Italy but also other forms of industrial localization experienced in different countries and regions, such as Orange County and the Silicon Valley in California, or some attempts of industrial development areas in the Third World, such as the shoe industry in Rio Grande do Sul. In these territories, small and medium firms substituted for mass production and large firms using heavily structured production processes based on machinery and unqualified workers. Industrial districts were characterized by flexible regimes of production using more specialized workforce and decentralized forms of coordination in which market relations and reciprocity replaced the managerial hierarchies of multidivisional corporations (Piore and Sabel 1984).

However, during the last two decades, localization phenomena turned back to more traditional modes of organization because of globalization and the emergence of new technologies (especially ICT) and when leading innovative firms were taken over and merged into bigger corporations. This is the reason why, for instance, the success stories of some famous Italian districts of the 1970s came to an end (Prato district, Benetton system).

The modern approach to localized industries proceeds from a reflection on technological progress which is structured around two main themes: (a) specific human resources obtained through localized learning processes and (b) organizational framework characterized by cooperative links among participants. In this modern context, the innovative process takes the form of a collective learning activity sequentially organized along the different phases of the production process. Thus, innovation becomes endogenous to the dynamics of industrial development (Lecoq 1993; Antonelli et al. 2008).

Entrepreneurial alertness is still at work in this framework. Industrial dynamics is mainly dependent of actors who organize complex processes, but the classical notion of district cannot cover the entire logic of the phenomenon. Industrial territories such as those of the nineteenth century described by Marshall were specialized in a single industry like the cotton industry in Lancashire or Sheffield cutlery trade. Likewise, their modern Italian equivalents specialize, for instance, in the textile industry as in Prato, or pottery in Sassuolo. More generally, industrial districts greatly differ according to the way complementary activities are organized; the main activity develops a large range of secondary activities, be they horizontal or vertical, along the different phases of the production process. These activities can also differ because of more or less formal social relationships and differently structured social networks. Finally, they also diverge because of the disparity among training institutions and the divergence in cooperative relationships.

Conclusion and Future Directions

The common central aspect of the various forms of localized activities that can be observed in modern industry lies in the fact that they incorporate a dense network of local communities and neighborhood interactions. The background created by close and tangled up relationships between the organization of productive activity and the functioning of social structure is at the basis of contextual connection and business cooperation which explain the very meaning of "industrial atmosphere." The coherence of this complex "organic whole" is not attained by chance or any natural process or market mechanism; the viability of the system must be organized by specific actors who take care of the durability and continuity of the industrial atmosphere. Different sorts of atmospheres can be found depending on the nature of the localized network: in a science park driven by start-ups, business angels, and academic entrepreneurs; in an industrial district dominated by buyer–supplier relations; in a knowledge-based metropolis; or in a localized system of innovation organized by innovative institutions. The mix of localized knowledge, competitive spirit, emulation, and cooperation that exist in these different industrial milieus is the basic material of the kind of entrepreneurship that is exerted in them.

Future developments of the concept lie in the possibility of maintaining a creative industrial atmosphere in large multidivisional and multiproduct firms. This can be obtained by encouraging the emergence of islands of corporate entrepreneurship in the administrative ocean of giant companies.

Cross-References

▶ Business Climate and Entrepreneurialism
▶ Innovative Milieu
▶ Network and Entrepreneurship
▶ Territory and Entrepreneurship

References

Antonelli C, Patrucco PP, Quatraro F. The governance of localized knowledge externalities. International Review of Applied Economics. 2008;22:479–498.
Becattini G. Sectors and/or districts: Some remarks on the conceptual foundations of industrial economics. In: Goodman E et al., editors. Small firms and industrial districts in Italy. London: Routledge; 1989. p. 123–135.
Becattini G. The Marshallian industrial district as a socio-economic notion. In: Pyke F, Becattini G, Sengerberger W, editors. Industrial districts and inter-firm co-operation in Italy. Geneva: International Institute for Labour Studies; 1990. p. 37–51.
Becattini G. The industrial district as a creative milieu. In: Benko G, Dunfod M, editors. Industrial change and regional development: the transformation of new industrial spaces. London/New York: Belhaven Press; 1991.
Belussi F, Caldari K. At the origin of the industrial district: Alfred Marshall and the Cambridge school. Cambridge Journal of Economics. 2009;33:335–355.
Lecoq B. Dynamique industrielle, histoire et localisation: Alfred Marshall revisité. Revue Française d'Economie. 1993;8(4):195–234.
Marshall A. Industry and trade. London: Macmillan; 1919.
Marshall A. Principles of economics. 8th ed. London: Macmillan; 1920.
Pesciarelli E. The undertaker's role in Marshall's approach to economic growth. Quaderni di Storia dell'Economia Poltica. 1991;9(2–3):133–160.
Piore M, Sabel CF. The second industrial divide: possibilities for prosperity. New York: Basic Books; 1984.

Industrial Mathematics

► Innovation by Applied Mathematics

Industrialization

► Heroic Entrepreneur, Theories

Informal Venture Capital

► Angel Investors

Information and Knowledge Stock

► Knowledge-Capital and Innovation

Information Asymmetry and Business Creation

Pierre Barbaroux
French Air Force Research Center, BA 701-EOAA/CReA, Salon Air-France, France

Synonyms

Adverse selection; Market failures; Moral hazard

Definition

Information asymmetry is considered by economists as a major source of market failures. When an information asymmetry affects the quality of a good, a service, or a project, it is likely to generate a failure in the process of allocating resources. Akerlof (1970) first demonstrated that "when there exist information asymmetries between buyers and sellers, high- and low-quality goods and services can coexist in the marketplace" (Nayyar 1990, p. 514). This situation induces search costs for buyers who have "to determine the quality of goods and services they buy" (Nayyar 1990, p. 517). Because of information asymmetry, "prices do not accurately convey all information necessary to coordinate economic decisions" (Eckhardt and Shane 2003, p. 337). More precisely, scholars discriminate between two types of information asymmetry: moral hazard and adverse selection. The latter are central features of principal-agent relationships which characterize standard agency theory. As Picard (1987, p. 305) observed, "moral hazard results from the inability of the principal to monitor an agent's actions while adverse selection corresponds to the inability of observing an agent's private information." Guesnerie et al. (1988, p. 807) referred to the notions of "hidden knowledge" and "hidden actions" to identify these two sources of inefficiency in resource allocation. Hence, moral hazard and adverse selection, respectively, emerge when buyers are (1) incapable of evaluating the quality of goods and services or (2) unable to observe "either the seller's characteristics or the contingencies under which the seller operate" (Nayyar 1990, p. 517). If a market exhibits these two types of information asymmetry, "bad-quality providers can enter the market and drive out the good-quality providers by so lowering price that the latter cannot obtain returns on their investments for competence enhancement" (Nayyar 1990, p. 517).

Research Questions

The literature investigating the relationships between information asymmetries and business innovation focuses on three subthemes: (1) the financing of innovation, (2) the relationships between information asymmetries and business opportunities, and (3) the impact of information asymmetries on collaborative approaches to innovation.

Information Asymmetries and the Financing of Innovation

Within the context of capital markets for R&D, information asymmetries between entrepreneurs (agents) and investors (principals) about what the entrepreneur knows and does are likely to create what Akerlof (1970) called a market for lemons. Therein, a funding gap might emerge because entrepreneurs hold information that potential financiers do not possess and/or cannot observe. The risk is that only undesirable transactions will be accessible to investors "by raising entrepreneurs' sunk costs" (Shane and Cable 2002, p. 365), provoking a market failure when high-quality entrepreneurs leave the market (Emons 1988). As Aboody and Lev (2000, p. 2750) argued, "the uniqueness of R&D investments makes it difficult for outsiders to learn about the productivity and value of a given firm's R&D from the performance and products of other firms, thereby contributing to information asymmetry." In addition, it has been demonstrated that "market players in closer touch with a firm and its business (. . .) are those who possess better information about that firm" (Bharath et al. 2009, p. 3215). It follows that when entrepreneurs seek financing, financiers must address two problems: information disclosure and opportunism. As Shane and Cable (2002, p. 364) argued, "entrepreneurs are reluctant to fully disclose this information to potential investors because such disclosure will make easier for other people to pursue the opportunity" (e.g., through imitation). In addition, since entrepreneurs hold information that investors lack, they "may act opportunistically towards them (. . .) because entrepreneurs vary in their ability to identify and exploit opportunities" (Shane and Cable 2002, p. 364). In this context, scholars investigated how seed-stage venture capitalists manage to mitigate the effects of information asymmetries. In particular, scholars addressed the following question: how do potential investors find ways to confront the difficult challenges of identifying and selecting promising ventures to fund?

As Shane and Cable (2002, p. 364) explained, "three mechanisms –the allocation of contractual rights, the staging of capital, and risk shifting- led entrepreneurs to self-select and disclose information in ways that overcome this information asymmetry." The explanations provided by economists – namely, the allocation of contractual rights, the staging of capital, and risk shifting – are considered by the authors as incomplete for at least two reasons. "First, the over optimism of entrepreneurs (. . .) undermines the effectiveness of the contractual mechanisms described by economists" (Shane and Cable 2002, p. 366), making self-selection ineffective. The argument brought by the authors is that early-stage investors cannot shift all the risk of investing in a new venture to entrepreneurs and "must make investments that risk the total loss of their capital" (Shane and Cable 2002, p. 366). In addition, information disclosure through patenting for example (Antelo 2003), cannot lead outsiders (i.e., venture capitalists) to gain all the private information they need. As Kyle (1985, p. 1326) argued, although insiders' information get progressively incorporated into market signals through information disclosure, "not all information is incorporated into prices."

Contrasting economists' explanations, organizational theorists have generally proposed that potential investors rely on social relationships to select which ventures to fund. Scholars have argued that two different mechanisms – information transfer through social ties and social obligation – influence investors' decision. Adopting a socio-organizational lens, Shane and Cable (2002, p. 366) contended that "social obligations between connected parties, and information transfer through social relationships, influence venture finance decisions." On the one hand, social ties enable investors to obtain private information about the ventures to fund and their potential opportunities. The foregoing argument is consistent with a self-interested approach to investors' behavior, the latter exploiting their social capital to identify and select better projects. On the other hand, direct and indirect ties "create social obligations between the parties, which cause them to behave generously towards each other" (Shane and Cable 2002, p. 370). By referring to these two complementary mechanisms, the authors underlined the role played by entrepreneurs' reputation in providing investors with additional information about his or her capacity of implementing, managing, and developing the venture which, in turn, "help disentangle the effects of social obligation and information access" (Shane and Cable 2002, p. 371).

It should be noted that the creation of a spin-off company is likely to hamper the effects of information asymmetries on venture finance decisions. Basically, a good reason for founding spin-offs is the reduction of information asymmetry. Following Woo et al. (1992, p. 435), "the proposed benefits of spin-offs have often been articulated under the guise of an improved agency relationship between shareholders (principal) and managers (agents)." Within this framework, the benefits in a spin-off lie in the reduction of information asymmetries characterizing the evaluation of firm's activities. As Krishnaswami and Subramaniam (1999, p. 78) argued, spin-offs enable the bidder "to value the separate entities better and thus the standard adverse selection problem that arises under information asymmetry is mitigated." Spin-off decisions, therefore, are likely to protect the firm from misevaluating its profitability and operational efficiency, in particular when "the spin-off is motivated by a need to raise external capital" (Krishnaswami and Subramaniam (1999, p. 79).

Information Asymmetries as Sources of Opportunities

Information asymmetries arising from investments in R&D and innovation projects are also viewed by scholars (notably those belonging to the Austrian tradition in economics) as sources of opportunities. Elaborating on the works of Hayek (1945) and Kirzner (1973), Ardichvili et al. (2003, p. 108) defined an opportunity as "a chance to meet a market need (. . .) through a creative combination of resources to deliver superior value." In its most elemental form, it describes "a phenomena that begin unformed and become more developed through time" (Ardichvili et al. 2003, p. 108). As a result, opportunities are likely to be limited in time. Shane (2000, p. 451) further suggested that "opportunities exist because different people possess different information." It follows that "everyone in society must not be equally likely to recognize all opportunities" (Shane 2000, p. 451) merely because people differ according to their prior knowledge, the latter being determinative for their ability to *discover* entrepreneurial opportunities.

As Eckhardt and Shane (2003, p. 339) explained, discovering an opportunity "is far from the trivial exercise of optimizing within existing means-ends frameworks because it requires forming expectations about the prices at which goods and services that do not exist yet will sell." However, the discovery and exploitation of (valuable) opportunities is likely to generate entrepreneurial profits which, in turn, might provide financiers with positive returns on investment (Eckhardt and Shane 2003). Since entrepreneurs hold information about what they know and do outsiders do not possess, scholars indicated that they can earn rents by exploiting information asymmetries, the latter being considered as a source of monopoly power. In particular, as Davis (2001, p. 327) argued, rents can be obtained by combining four information-oriented strategies: "(1) publish the details of the innovation in return for legal protection (patents, copyrights, and the like), (2) keep the information inside the firm (secrecy, tacit, and firm-specific knowledge), (3) make the information selectively available to others on an informal basis, and (4) widely disseminate the information making it freely accessible to all comers." In doing so, firms seek to control how information about the characteristics of their innovations get revealed to the market in order to confront potential competition (through imitation for example) and ensure sustainable profitability.

Within this framework, information asymmetries "can be a potent source of competitive advantage" (Nayyar 1990, p. 517), in particular, for firms that are capable of diversifying their offers through the implementation of an effective communication strategy. Miller (2003) introduced a three-step model that exemplifies how firms convert asymmetries into resources enabling them to benefit from competitive advantage. The author demonstrated that building capabilities out of asymmetries involves that the firm is capable of doing "three things well:

1. Discover the asymmetries (. . .) and discern the potential between them
2. Turn asymmetries into capabilities by strategically embedding them within an organizational design configuration that exploits them and sustains their development
3. Match asymmetry-derived capabilities to market opportunities" (Miller 2003, P. 965)

Therein, the identification and selection of valuable asymmetries require both internally and externally oriented processes, including experimentation, incremental learning, organizational introspection, reflective inquiry and search for weaknesses, and bootstrapping on emerging capabilities (Miller 2003, pp. 965–968).

Information Asymmetries and Collaborative Innovation

In the recent years, scholars reported many examples of successful companies that invented and commercialized new products and services by participating in collaborative networks (Nieto and Santamaria 2007). Collaboration enables the firm to access to a variety of external and internal sources of innovation that can be used in combination to generate new ideas, incorporate them into new products and services, and capture value from their commercialization (Chesbrough and Appleyard 2007). As Abramo et al. (2011, p. 885) suggested, "private enterprises use collaboration to solve specific technical or design problems, develop new products and processes, conduct research leading to new patents, recruit university graduates and access cutting-edge research." Within this framework, the firm must confront the challenge of selecting the "right" research partner based on their private information about the quality of the scientific knowledge available on the market and its cost. Here again, information asymmetries make it difficult for private companies to discriminate between the variety of offers. When market fails to provide agents with complete information, the selection of partners is guided by socio-organizational factors. In particular, "geographic and social proximity (. . .) should play a determining role in the choice of research partner" (Abramo et al. 2011, p. 85). Therein, social capital, direct and indirect ties, and reputation effects are likely to guide the firm in identifying promising research partners if information about their quality is lacking. Tödling, Lehner, and Kaufmann (2009) supported this assertion indicating that collaborative innovation "draw on new scientific knowledge generated in universities and research organizations" and that "the exchange of this type of knowledge requires personal interactions" (Tödling et al. 2009, p. 59). The adoption of collaborative business model therefore is likely to enable partners in innovation projects to mitigate the effects of information asymmetry but necessitate interaction and communication through formal (e.g., licensing, spin-offs) and informal (e.g., sociocultural proximity) relationships.

Conclusions and Future Directions

The relationship between information asymmetries and business creation is a key issue for both scholars and managers. Future research efforts could be directed towards deepening our understanding of how various stakeholders involved in business creation and funding (entrepreneurs, investors, public agencies, etc.) manage to balance (1) information asymmetries as sources of opportunities and (2) the sharing of information (and knowledge) as it enables collaboration and reduces financial and technological risks. This might lead to depart from market-driven models of information asymmetries to promote an entrepreneurial approach to business creation. The latter would insist on critical resources enabling agents to deal with information asymmetries and exploit opportunities such as relational networks, communication strategies, fiscal incentives, and public/private partnerships. This, in turn, would enlarge our understandings of the role played by information asymmetries on the nature and logics of business creation.

Cross-References

▶ Entrepreneurial Opportunities
▶ Financing Entrepreneurship
▶ Technological Entrepreneurship and Asymmetries

References

Aboody D, Lev B. Information asymmetry, R&D, and insider gains. J Finance. 2000;55(6):2748–66.

Abramo G, D'Angelo CA, Di Costa F, Solazzi M. The role of information asymmetry in the market for university-industry research collaboration. J Technol Trans. 2011;36:84–100.

Akerlof G. The markets for "Lemons": quality uncertainty and the market mechanism. Quart J Econ. 1970;84(3):488–500.

Antelo M. Licensing a non-drastic innovation under double information asymmetry. Res Policy. 2003;32:367–90.

Ardichvili A, Cardozo R, Ray S. A theory of entrepreneurial opportunity identification and development. J Bus Venturing. 2003;18:105–23.

Bharath TS, Pasquariello P. Does asymmetric information drive capital structure decisions? The Review of Financial Studies 2009;22(8):3211–43.

Chesbrough H, Appleyard MM. Open innovation and strategy. Calif Manage Rev. 2007;50(1):57–76.

Davis L. R&D investments, information and strategy. Technol Anal Strat Manag. 2001;13(3):325–42.

Eckhardt JT, Shane SA. Opportunities and entrepreneurship. J Manag. 2003;29(3):333–49.

Emons W. Warranties, moral hazard, and the Lemons problem. J Econ Theory. 1988;46:16–33.

Guesnerie R, Picard P, Rey P. Adverse selection and moral hazard with risk neutral agents. Euro Econ Rev. 1988;33:807–23.

Hayek F. The use of knowledge in society. Am Econ Rev. 1945;35(4):519–30.

Kirzner IM. Competition and entrepreneurship. Chicago: University of Chicago Press; 1973.

Krishnaswami S, Subramaniam V. Information asymmetry, valuation and the corporate spin-off decision. J Financ Econ. 1999;53:73–112.

Kyles A. Continuous auctions and insider trading. Econometrica. 1985;6:1315–35.

Miller D. An asymmetry-based view of advantage: towards an attainable sustainability. Strat Manag J. 2003; 24(10):961–76.

Nayyar PR. Information asymmetries: a source of competitive advantage for diversified service firms. Strat Manag J. 1990;11(7):513–9.

Nieto MJ, Santamaria L. The importance of collaborative networks for the novelty of product innovation. Technovation. 2007;27(6–7):367–77.

Picard P. On the design of incentive schemes under moral hazard and adverse selection. J Public Econ. 1987;33:305–30.

Shane S. Priori knowledge and the discovery of entrepreneurial opportunities. Organ Sci. 2000;11(4):448–69.

Shane S, Cable D. Network ties, reputation, and the financing of new ventures. Manag Sci. 2002;48(3):364–81.

Tödling F, Lehner P, Kaufmann A. Do different types of innovation rely on specific kinds of knowledge interactions? Technovation. 2009;29(1):59–71.

Woo CY, Willard GE, Daellenbach US. Spin-off performance: a case of overstated expectations? Strat Manag J. 1992;13:433–47.

I

Information Monitoring and Business Creation

Parina Hassanaly
IEP (Institute of Political Studies), Aix en Provence, France

Synonyms

Business intelligence; Competitive intelligence; Environmental scanning

Theoretical Foundation

Studies about business creation and business monitoring have multiplied and branched out over the last 30 years. For the sake of clarity, concepts are based on a classification adopted by business specialists Gilbert, MacDouglas and Audrestch (2006), i.e., approaches based on the theory of growth – with a focus on the individuals, business life cycles, strategies, population ecology, resources and coherence. In each of these, determinants are analyzed that either complete or respond to one another. Among others, analyzing the environment of business creation processes is key for approaches based on strategies, resources, and population ecology (Hrisman et al. 1999).

In these three approaches, analyzing the environment allows the entrepreneur to spot opportunities and make choices. As established for corporate governance practices (OECD 1999), information is at the heart of environmental analysis. Depending on the norms, this can either have an implied or implicit dimension, or an explicit dimension. In the latter case, it materializes as an information monitoring system that can be defined as an informational process through which an organization scans its environment to decide and act to pursue its objectives.

Research about business creation – which, depending on the author, is presented either as a result or as a process – is always centered on three notions: the entrepreneur, the new company, and the environment in which the process occurs (Marchenay and Messeghem, 2001). This environment is all about understanding and apprehending favorable and unfavorable factors. Studies of the couple "new company/its environment" deal with the forms it can take, the various possible locations (science parks, nurseries, etc.), and the business segment's characteristics (maturity, turbulence, etc.), as well as performances and the problems that are occurring (Porter 1985). It is then important for the creator to be given notions of environmental scanning in order for him/her to use it as a tool to orient his/her activity.

The very first paper about business intelligence dates back to 1974 and explains how environmental analysis must be conducted – not omitting to mention that the method and the tools it proposes are those used by US intelligence agencies.

Terminological confusion must be highlighted here, that arises from using an expression which simultaneously embodies two concepts: the monitoring process in itself, and the result of this monitoring process. Hence, "environmental scanning" or "business monitoring" now describes the process in itself, while "business intelligence" or "competitive intelligence" correspond to the end product of this process.

Business Monitoring Process

The scanning/monitoring process is described as a system by Dutton, Frayer, and Narayanan (1983), based on several subsystems, and relying on information provided both by external players and the organization itself. The macroenvironment has a political, an economical, a sociological, a technological, an ecological, and a legal dimension. The identified players are the clients, the suppliers, the employees, the unions, the partners, the competitors, the governments, the networks, the media, and the press conglomerates. The inner environment of the company consists of its resources, its culture, its strategies, its governing body, and its structure (Davenport and Prusak 1998; Kahaner 1996).

The main system of the business monitoring process comprises three elements, namely, the inputs, outputs, and cycle. Inputs refer to the many needs of the company's players. Listed by several authors (Beal 2001; Bryant and Richardson 1999; Fuld 1995), these needs pertain to identifying clients, markets, competitors, suppliers, and partners. Outputs refer to information products aimed at making decisions and taking action. Depending on the phase of the cycle, these can either be data, or information, or knowledge. There are several steps in the business monitoring cycle:

- Defining the need
- Collecting information, using a list of formal and informal sources of information
- Assessing the truth of, and validating, information relatively to the needs, through a workgroup
- Analyzing and interpreting the groups of documents to outline the emerging trends, spot weak signals, and make recommendations
- Disseminating information

Although spying is illegal and not part of the business monitoring process, protecting information should be added to that list, as violating it is more and more common practice in spite of rigorous ethics.

Conclusion and Further Reading

Information technologies play an important role in implementing business monitoring within companies, irrespective of their size and the phase of their life cycle. The ever-growing number of data mining software is now pushing science parks and nurseries to get their smaller companies acquainted with them, thereby giving them access to a better knowledge of their external environment – which for them is an asset both to predict potential external threats and to take advantage of every opportunity.

Cross-References

▶ Business Emergence
▶ Entrepreneurial Opportunities
▶ Small Business

References

Beal RM. Competing effectively: environmental scanning, competitive strategy and organizational performance in small manufacturing firms. J Small Bus Manag. 2001;38(1):27–47.

Bryant P, Richardson A. A study of small business needs, SCIP Conferences proceedings, 14th annual international conference, Montréal, Quebec, 1999, p. 463–484

Davenport TH, Prusak L. Working knowledge – how organization manage what they know. Boston: Harvard Business School Press; 1998.

Dutton JE, Fahey L, Narayanan VK. Toward understanding strategic issue diagnosis. Strateg Manag J. 1983;4(1):307–23.

Fuld LM. The new competitor intelligence. New York: Wiley; 1995.

Gilbert BA, McDougall PP, Audretsch DB. New venture growth. A review and extension. J Manag. 2006;32(6):926–50.

Hrisman JJ, Bauerschmidt A, Hofer CW. The determinant of new venture performance. Entrep Theory Practice. 1999;23(1):5–29.

Kahaner I. Competitive intelligence: how to gather, analyze and use information to move your business to the top. New York: Simon & Schuster; 1996.

Marchenay M, Messeghem K. Cas de stratégie de PME. Paris: Edition EMS; 2001.

OECD Principles of Corporate Governance, Paris, Organisation for Economic Co-operation and Development; 1999, 45p

Porter ME. Competitive advantage. New York: Free Press; 1985.

Information Processing

▶ Cognition of Creativity

Information Technology (IT)

▶ Digital Economy and Business Creation

Initiative

▶ Innovations of Direct Democracy

Innovate

▶ Invention Versus Discovery

Innovation

▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Creative Personality
▶ Creative Destruction
▶ Creativity and Church
▶ Creativity and Systems Thinking
▶ Creativity in Invention, Theories
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
▶ Entrepreneur and Economists
▶ Entrepreneurship Policies
▶ Game Theory and Innovation Analysis
▶ Innovation Systems and Entrepreneurship
▶ Knowledge Creation and Entrepreneurship
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index
▶ Nature of Creativity
▶ Promoting Student Creativity and Inventiveness in Science and Engineering
▶ Social Innovation
▶ Technological Invention of Disease

Innovation – Deviation, Alteration, Implemented Novelty

▶ Institutional Entrepreneurship, Innovation Systems, and Innovation Policy

Innovation and Democracy

Ludger Helms
University of Innsbruck, Institute of Political Science, Innsbruck, Austria

Synonyms

Democratic reforms; Democratization; Political change

The connections between innovation and democracy are numerous and complex. Many recent contributions to the field center on "innovating democracy" (Goodin 2008) in terms of designing, implementing, and using new or "unconventional" forms of decision making in democratic systems. But while this perspective covers a huge and quickly expanding field, and may capture some of the most intriguing aspects, it certainly marks not the only way of looking at innovation and democracy. The structural capacity of democratic systems to generate innovation in politics as well as in other areas, such as technology and science, constitutes another key component of the larger subject. The brief overview that follows considers both of these different, but related, topics.

Before we turn to this, a working definition of both key terms is in order. *Democracy* is here referred to as "a political system in which different groups are legally entitled to compete for power and in which institutional power holders are elected by the people and are responsible to the people" (Vanhanen 1997, p. 31). It is difficult to find a similarly clear-cut and substantive definition of innovation in the political science literature. Recent attempts to describe innovations as "special subsets of change" (Newton 2010, p. 4) are not fully convincing. *Innovations* are about change, but are nevertheless closer to reform than to change because change is neither an equivalent to nor necessarily the result of conscious and deliberate action. The latter, however, characterizes innovation as well as modernization and reform. What separates both innovation and reform from mere modernization is in particular the degree of projected change. But it remains difficult to establish what exactly distinguishes the former two from each other. As Ken Newton suggests, a meaningful general conceptualization of innovation may center on introducing "new ways of doing things" (Newton 2010, p. 4). By contrast, reforms tend to focus specifically on altering established rules or procedures. Reforms are also usually launched (if by no means always demanded in the first place) by actors who possess a special authority to formally initiate reform processes, which cannot be considered a necessary requirement of introducing innovations.

Democracy's Capacities for Innovation

From a normative perspective, democracies would appear to provide excellent conditions for innovations in such different areas as arts, science, and technology. Of the two main ideas, or principal norms, defining liberal democracy – freedom and equality –, especially the former is essential for making democratic political systems innovation-friendly environments. The free flow of ideas is strongly conducive to innovation (if not necessarily to invention and creativity which can be found even in contexts characterized by strong structural barriers against innovation). The possible effects of equality on the innovation capacity of different societies are more ambiguous. On the one hand, a strong commitment to equality may result in a wide distribution of resources within a given society which is likely to benefit the cause of innovation in different areas. On the other hand, a strong emphasis on equality in organizing a given society may make it harder for innovative actors to acquire an exposed position and prevail in the competition between innovation and established norms and practices.

Democracies also, and in particular, share a strong normative commitment to *political* innovation. As John Keane has pointed out, "When democracy takes hold of people's lives, it gives them a glimpse of contingency of things. They are injected with the feeling that the world can be other than it is – that situations can be countered, outcomes altered, people's lives changed through individual and collective action" (Keane 2009, p. 853). Even more to the point, Michael Saward has observed that "the story of democracy is nothing if not a story of innovation. One of the defining features of democracy may well be its restlessness, dynamism and comparative openness to new ideas" (Saward 2000a, p. 3). The latter properties are not just general defining characteristics of liberal democracies, however, but play a crucial role in the maintenance and persistence of democratic regimes. Indeed, the prospect of future change and political innovation is central for legitimizing democratic politics and democratic systems, and it is of special relevance to those citizens who are not supporting the government of the day (Anderson et al. 2005).

Further, democracies are not only characterized by a general appreciation of innovation and change in different areas, they also incorporate a special mechanism designed to bring about innovation in politics: elections and alternations in government. In fact, the single most important function of democratic elections is to be seen in empowering the citizens to "turn the rascals out," to clear the way for a fresh start. Other things being equal, major policy innovations in democracies are most likely to occur in the aftermath, and as a result, of alternations in government. This key assumption, which is explicitly spelled out particularly in some concepts of party government (Katz 1987), is obviously based on several other assumptions, including in particular that the different parties competing with each other for governmental office have reasonably different policy agendas.

But the structural capacity of democratic systems to bring about innovation is not exclusively concentrated in the hands of the governing elites. The opposition has long been acknowledged as "the other mover of politics," and the opposition actors performing innovation-related functions (at the level of public agenda setting and beyond) include both fully institutionalized actors, such as the parliamentary opposition in parliamentary democracies, and much less institutionalized actors, such as social movements (Helms 2010).

From an empirical perspective on the West European parliamentary democracies, one of the first things to mention about democracy's capacity for innovation is the fact that wholesale changes in the party composition of governments mark a comparatively rare occurrence. Often, elections tend to produce governing coalitions that include at least one party that has been a member of the outgoing coalition which, other things being equal, reduces the innovative potential of newly formed governments (Ieraci 2012). The innovative potential of (be it wholesale or partial) alternations in government is further reduced if there is a strong policy convergence of the parties competing for office, as Peter Mair suggests to be the case in much of Western Europe (Mair 2008).

Apart from the suggested trend toward policy convergence of the parties, that can be observed in some but by no means all established liberal democracies (Budge et al. 2012, pp.66–70), the innovation capacity of newly incoming governments, including majority single-party governments, has arguably always been overestimated. There is a strong element of inheritance in public policy even under the most favorable institutional and political circumstances, as Richard Rose and Phillip L. Davies have shown for the British Westminster democracy (Rose and Davies 1994). Even radical governments rarely repeal much of the legislation of the previous administration. This notwithstanding, all other things being equal, the overall capacity for innovation of newly incoming single-party governments in majoritarian types of democratic systems is larger than that of coalition governments operating in politically and institutionally complex systemic environments.

In presidential democracies, such as the United States, the closest equivalent to majority single-party governments in parliamentary democracies are administrations facing a legislative branch that is being controlled by the president's party ("unified government"). *Ceteris paribus*, their legislative leverage and capacity for innovation are larger than that of administrations operating under the conditions of "divided government" which can, to some extent, be compared with minority governments in parliamentary democracies. The political history in the United States since 1945 has been marked by a high share of "divided government" (in fact, more than two-thirds of all post-war administrations fall into this category) and, more recently, a strong trend toward party polarization (Baumer and Gold 2010) – a combination that has made the implementation of innovative policy agendas more difficult to achieve than ever.

In all those politically and institutionally different contexts, individuals can make a difference (Greenstein 1987), and innovative leadership is possible (Moon 1993). However, even if governmental decision makers are able and willing to initiate innovative policies, democratic governance requires the substantial support from social actors and society at large as well (Bevir 2010). What has been said about political reforms – that the process of institutional reform only begins after its passing and implementation (Scharpf 1987, p. 144) – would appear to hold just as true for political innovations.

Much research on the social aspects of innovation focuses on learning. If learning is conceptualized as "socialization in routines of proven value" (Ober 2008, p. 19), there is indeed "an inherent tension between learning . . . and the redeployment of knowledge for innovation," and "too much learning can compromise competitive advantage" (Ober 2008, p. 19, 274). If, by contrast, the emphasis is on learning something new, innovation – or more specifically the successful dissemination of innovations throughout society – has convincingly been conceptualized as a learning exercise (Rogers 2003). However, as Richard Freeman has argued, ultimately the successful diffusion of an innovation is at least as much about teaching as about learning (Freeman 2006, p. 370). And indeed, teaching – in terms of public leadership advocating innovative solutions to collective problems – is at the very heart of innovative or, more precisely, innovating democratic leadership.

Innovating Democracy

The overarching aim of democratic innovations in different areas and at different levels of democratic political systems can be seen in "improving the quality of democracy" (Geissel 2010, p. 164). There is an understanding in the recent comparative literature that there is no compelling reason to count only those innovations as genuine innovations that have not been tried and observed anywhere else. A "relative newness," that is, the novelty of a given idea within the boundaries of a given system, tends to be considered a sufficient defining feature of democratic innovations. This seems reasonable; otherwise, there would be little to study. In particular, comparative research in democratic innovations would bereave itself the valuable and important opportunity to study the differing effects of similar democratic innovations in different contextual settings.

Kenneth Newton has usefully distinguished between "top-down innovations" and "bottom-up innovations" (Newton 2010): Top-down innovations tend to focus on political structures and processes, in particular on the institutions of democratic government that regulate the performance of politicians and make them more accountable and responsive to the general public. By contrast, bottom-up innovations tend to focus more on the input of citizens into the political system; they are primarily concerned with improving the capacities, knowledge and participation of citizens in order to empower them to play a more active part in public affairs.

Both of these two main categories comprise a host of different ideas and measures. Arguably the single most important distinction within the category of top-down innovations relates to innovations that center on *horizontal* accountability, that is, on the relationship and the accountability between the branches of government, and those centering on aspects of *vertical* accountability, that is, accountability of government to its citizens. Most ideas and measures relating to horizontal accountability are concerned with expanding the control capacities of parliaments and courts toward the executive branch. Ideas and measures seeking to improve the state of vertical accountability in democratic regimes are usually not confined to aspects of democratic responsibility but extend to the related area of democratic responsiveness. Term limits for elected representatives and the possibility of recalling them before the end of the regular term are examples for democratic innovations in this area (Newton 2010, pp. 7–8).

Democratic bottom-up innovations comprise a vast number of rather different measures and ideas. Some agendas seek to transform and expand voting rights regimes, for example, through reducing the voting age (with ideas ranging from slightly below the legal age of majority to voting rights from birth) or through providing noncitizen residents or even noncitizen nonresidents with affected interests with the right to vote. Such innovations in the realm of representative politics (many of which have not been put into practice anywhere) have been accompanied by expansive agendas that seek to break the monopoly of representative democracy through the introduction of new forms of citizen participation. Within this category, it is ideas for introducing and/or expanding direct democracy that possess by far the most impressive historical track record reaching back to the early days of the progressive era (Cain et al. 2003 pp. 5–6), and political scientists have to work hard in order to capture the latest developments and the growing pluralism in real-world democracies (Altman 2011). However, it is "co-governance," direct citizen involvement in the activities of the state, and other forms of consultation and deliberation that have found most attention among contemporary scholars of innovative democratic procedures (Goodin 2008; Smith 2009).

The ubiquity of projected democratic innovations in different countries makes it all but impossible to identify any clear-cut cross-national trend. However, as Michael Saward has observed, to the extent there is a common denominator, most democratic theorists and democratic activists share a special commitment to, and appreciation of, new ways of constraining conventional democratic majorities and ways of building new majorities of a special sort (Saward 2000b). There is also a broad consensus that even the most radically innovative ideas at the level of direct democracy and/or deliberative democracy would not, and should not, abolish representative democracy as the bedrock of contemporary liberal democracy. The future of representative democracy may be difficult and demanding, but there would appear to be no credible alternative to an institutional formation that has proven for more than 200 years to possess a resilience being unmatched by any other form of organizing individual and collective action (Alonso et al. 2011).

Some of the most serious challenges of the decades ahead relate to safeguarding the accomplishments of democratic development into what could be described as an age of unprecedented global interdependence. While democratic innovators in nation-states, or in subnational entities, can draw on the experience of neighboring states or communities, there is little, if any, lesson-drawing when it comes to designing and implementing innovative solutions to global democracy. All the more so, genuine and ingenious innovations in democratic institutional engineering will be needed to master the towering challenges of an increasingly interdependent world, and to use the power of innovation for the sake of democracy's futures.

Conclusion and Future Directions

Innovation and democracy are likely to remain important subjects of political and social research whose complexity seems bound to increase further. A considerable proportion of future efforts will have to be spent on linking different strains of political and social research on "innovation" that share little more with one another than the use of the same key term. There is a fast-growing body of research focusing on innovation policy (see, for example, Llerena and Matt 2010; World Bank 2010; Bauer et al. 2012) that has been consciously omitted from the brief overview above, mainly because it has evinced conspicuously little interest for democratic issues. Some authors of course have sought to reach beyond treating democracy as a mere background condition of innovation processes. For example, Eric von Hippel has looked more specifically into the possibilities of democratizing innovation processes. However, in his work "democratization" is understood to mean no more than "that users of both products and services – both firms and individual consumers – are increasingly able to innovate for themselves" (von Hippel 2005, p. 1), which according to this author applies to information products such as software as well as to physical products. There is ample room for introducing considerably more demanding conceptualizations of democracy and democratization to the study of innovation policies.

Another link to be established and developed is that between political research on innovation and democracy, and the quality of democracy. While the innovative capacity of different political regimes (for example, as described above, in terms of government alternation) has been acknowledged as a crucial component of a given polity's overall democratic performance in many classic contributions to political theory, innovation has failed to be specifically included in the numerous more recently construed indices of democratic quality. Some of the foremost challenges in this area relate to specifying what exactly a reasonable amount of innovation, or the absence of it, may actually mean for the democratic quality of different political regimes. As with, for example, transparency whose true relevance for the concept of democratic governance is brought to bear only in combination with accountability, innovation (as conceptualized above) would appear to represent not so much a goal in itself but rather a crucial means for achieving other meta goals of democratic governance.

Cross-References

▶ Innovation Policy Learning
▶ Social Innovation

References

Alonso S, Keane J, Merkel W, editors. The future of representative democracy. Cambridge: Cambridge University Press; 2011.

Altman D. Direct democracy worldwide. Cambridge: Cambridge University Press; 2011.

Anderson CJ, Blais A, Donovan T, Listhaug O. Losers' consent: elections and democratic legitimacy. Oxford: Oxford University Press; 2005.

Bauer J, Lang A, Schneider V, editors. Innovation policy and governance in high-tech industries: the complexity of coordination. Berlin: Springer; 2012.

Baumer DC, Gold HJ. Parties, polarization and democracy in the United States. Boulder: Paradigm; 2010.

Bevir M. Democratic governance. Princeton: Princeton University Press; 2010.

Budge I, Keman H, McDonald M, Pennings P, editors. Organizing democratic choice: party representation over time. Oxford: Oxford University Press; 2012.

Cain BE, Dalton RJ, Scarrow SE, editors. Democracy transformed? expanding political opportunities in advanced industrial democracies. Oxford: Oxford University Press; 2003.

Freeman R. Learning in public policy. In: Moran M, Rein M, Goodin RE, editors. The Oxford handbook of public policy. Oxford: Oxford University Press; 2006. p. 367–88.

Geissel B. Impacts of democratic innovations in Europe. In: Geissel B, Newton K, editors. Evaluating democratic innovations: curing the democratic malaise. London: Routledge; 2010. p. 163–83.

Goodin RE. Innovating democracy: democratic theory and practice after the deliberative turn. Oxford: Oxford University Press; 2008.

Greenstein FI. Personality and politics: problems of evidence, inference, and conceptualization. Princeton: Princeton University Press; 1987.

Helms L. Strategie und Politische Opposition. In: Raschke J, Tils R, editors. Politische Strategie. Konturen eines neuen Forschungsfelds. Verlag für Sozialwissenschaften: Wiesbaden; 2010. p. 233–56.

Ieraci G. Government alternation and patterns of competition in Europe: comparative date in search of explanations. West Eur Polit. 2012; 3:530–50.

Katz R, editor. Party government: European and American experiences. Berlin/New York: de Gruyter; 1987.

Keane J. The life and death of democracy. New York: Simon & Schuster; 2009.

Llerena P, Matt M, editors. Innovation policy in a knowledge-based economy: theory and practice. Berlin: Springer; 2010.

Mair P. The challenge to party government. West Eur Polit. 2008;31(1):211–34.

Moon J. Innovative leadership in democracy: policy change under Thatcher. Aldershot: Dartmouth; 1993.

Newton K. Curing the democratic malaise with democratic innovations. In: Geissel B, Newton K, editors. Evaluating democratic innovations: curing the democratic malaise. London: Routledge; 2010. p. 3–20.

Ober J. Democracy and knowledge: innovation and learning in classical Athens. Princeton: Princeton University Press; 2008.

Rogers EM. The diffusion of innovations. 5th ed. New York: Free Press; 2003.

Rose R, Davies PL. Inheritance in public policy: change without choice in Britain. New Haven: Yale University Press; 1994.

Saward M. Democratic innovation. In: Saward M, editor. Democratic innovation: deliberation, representation and association. London: Routledge; 2000a. p. 3–13.

Saward M. Variation, innovation and democratic renewal. In: Saward M, editor. Democratic innovation: deliberation, representation and association. London: Routledge; 2000b. p. 213–20.

Scharpf FW. Grenzen institutioneller Reform. Jahrbuch zur Staats- und Verwaltungswissenschaft. 1987;1:111–51.

Smith G. Democratic innovations: designing institutions for citizen participation. Cambridge: Cambridge University Press; 2009.

Vanhanen T. Prospects of democracy: a study of 172 countries. New York: Routledge; 1997.

von Hippel E. Democratizing innovation. Cambridge: MIT Press; 2005.

World Bank, editor. Innovation policy: a guide for developing countries. New York: World Bank; 2010.

Innovation and Entrepreneurship

Jerry Courvisanos and Stuart Mackenzie
The Business School, University of Ballarat, Ballarat, Victoria, Australia

Synonyms

Breakthrough technology; Economic development; New venture creation; Paradigm shift

Introduction

Entrepreneurship is an ambiguous concept unless it is contextualized. The focus in this entry is the role of the entrepreneur within the context of innovation. Thus, if a business activity is conducted under what Schumpeter (1939) calls "competitive capitalism," then there is no innovative activity and the market is operating as a pure neoclassical mechanism in which the "nirvana" of market efficiency in the allocation of goods and services is achieved. This is a static equilibrium position in which there is no change, no economic development, and no entrepreneurs to drive innovation. All that is needed are efficient business managers. As a result, in neoclassical economics, entrepreneurship is merely seen as agency in any form of business activity, including routine managers. This, in one fell swoop, conflates the original work of Schumpeter and his entrepreneur with the mainstream market conception of an entrepreneur who simply operates a business.

Baumol (1968, p. 1) rejects the conflation of managing a business and the higher responsibility of driving free enterprise:

> The entrepreneur is at the same time one of the most intriguing and one of the most elusive characters in the cast that constitutes the subject of economic analysis. He has long been recognized as the apex of the hierarchy that determines the behavior of the firm and thereby bears a heavy responsibility for the vitality of the free enterprise society. In the writings of the classical economist his appearance was frequent, though he remained a shadowy entity without clearly defined form and function.

The role of the entrepreneur has proved difficult to formalize within the innovation process. Well expressed by classical economics writers, notably Adam Smith and Karl Marx, Schumpeter (1912) reintroduced endogeneity of innovation in the capitalist process after the 1870s marginalist absorption of classical economics into the neoclassical mainstream placed innovation firmly into the "black box," making the entrepreneur invisible. Despite Baumol's oft-cited 1968 quotation above, due to the nature of the neoclassical model itself, economists have not been able to find a way to formally endogenize the entrepreneurial function. A very large increase in the number of innovation studies and the bringing of technology into the endogenous growth function still cannot fill in the gap. To his credit, Baumol has made attempts to incorporate entrepreneurial behavior into the economics mainstream. The task is not easy when a major intellectual in neoclassical economics needs three books to do this (Baumol 1994, 2002, 2010). While this effort is commendable, and in particular Baumol (2010) serves a useful purpose in further conceptualizing (along the lines of Schumpeter) the role of the entrepreneur in the economy from a rich vein of historical studies, the actual integration of the dynamic role of the entrepreneur in the static neoclassical model remains problematic.

Baumol models the decisions of entrepreneurs by an optimality algorithm where new and innovative entrepreneurial activities are subject to known constraints. If the economy is at an equilibrium measured in a static state, then the algorithm has a clear resolution, and the role of the entrepreneur is insubstantial. Leave it to the routine manager. At this equilibrium, a potential exit exists where the dynamic entrepreneur is in her/his element. It is an "escape hatch" from the static state. Where is Baumol's optimizing entrepreneur at this point? It is at this very point that optimality breaks down because there is no way any optimal algorithm can provide an answer to this exit point. There is no theoretically logical and consistent way of escaping static optimality unless a stochastic shock is devised, which removes the endogeneity of the entrepreneurial spirit. Baumol (2010, p. 70) himself admits this optimality problem by stating: "…nor does it provide any rigorous standards by which the issue can be judged."

The contradictions within the neoclassical economics model in addressing innovation and the role of the entrepreneur responsible for such activity lead to a lack of a rigorous research model for future study. In the next section, imperfection in the market is seen as the way out of equilibrium, but is in effect "no way out" from a theoretical perspective. Having rejected this standard approach, it is necessary to reconceptualize the entrepreneur within a realist complex systems framework. This is the task of the following section "Risk and Uncertainty" provide the appropriate concepts from which to further develop this realist systems model of creative entrepreneurship, as set out after the entrepreneur is clearly delineated. The impact of this systems model on business creation and the path of economic development complete the realist account. The conclusion then sets up a more fruitful research path for entrepreneurship studies within a more coherent economic framework than the bland characteristics-based studies that have multiplied in the literature and encouraged by the individualist-based neoclassical model.

Market Imperfections

Baumol (2010, p. 100) states: “In order to achieve optimality, one must eliminate the externalities and then correct any new, undesired redistribution effects that result.” This is the neoclassical market imperfections argument justifying public policy actions to “correct” for externalities and “address” inequality of distribution issues. Such actions brings one back to the static model and its inability to handle dynamic variables. What is the “correct” action if there is no rigorous standard to evaluate public policy actions? Thus, lack of an optimal endogenous entrepreneurial escape from the static state, although termed “market imperfections,” can be more accurately described as a systemic failure of markets (Smith, 1998). This failure leads to total inability of the neoclassical abstract market mechanism to provide theoretical understanding or empirical guidance for action.

Without the rigor of a static model to provide algorithmic precision, economists revert to metaphysical analogies (Robinson 1962) to provide what Taleb (2008, pp. 62–84) calls a “narrative fallacy” in order to provide some meaning and causality to an event that is not able to be given a rigorous analysis. The problem arises when a metaphysical narrative is presented to rationalize an axiomatically rigorous model. This occurred in a powerful way at a symposium on entrepreneurship in the Carnegie-Mellon University, Pittsburgh in November 1997, when two Nobel Laureates in Economics were on a panel and asked to depict how entrepreneurs operate in the context of equilibrium in the market mechanism. Each presented a starkly different scenario.

Architect of the general equilibrium model, Kenneth Arrow, describes entrepreneurs as “dragging” markets out of equilibrium by innovative activity that is inconsistent with providing the same type of goods and services. In effect, successful innovation disrupts equilibrium. Arrow continues by explaining that the process of moving back into equilibrium can be discerned when other entrepreneurs follow the “first-mover advantage” entrepreneur and diffusion of innovation occurs. This process of “follow the (innovation) leader” continues until the market becomes again one in which there is a homogenous product with many sellers meeting the demand of many buyers. The proliferation of such homogenous markets delivers a general equilibrium.

The inspiration behind the concept of bounded rationality, Herbert Simon, describes the same process in very different terms. Simon depicts the entrepreneur searching in a world of discontinuities for opportunities to innovate. The successful entrepreneur finds a new good or service that creates a fresh market into which other entrepreneurs quickly follow, but the rush to market by followers leads to only a temporary equilibrium in which supply meets demand. Followers will continue to produce leading to overproduction and disequilibrium. Such disequilibrating markets provide the basis for new discontinuities and, thus, new opportunities arise.

The two metaphysical analogies described above clearly show that the neoclassical market equilibrium approach with its imperfections arising from the innovative activities of entrepreneurs is an inappropriate framework of analysis. The rest of this entry addresses entrepreneurship and the role of innovation as a dynamic concept within a complex adaptive system (CAS). Holling (1973) identifies the strength of relationships within a particular CAS, such that the more stable a relationship within a complex system, the less resilience the system possesses. In this context, the maintenance of equilibrium within a system endows a system with greater stability, but with less capacity to absorb variations with significant fluctuations. The essential aspect of innovation is change, so a framework that can adapt to change from first principles is a much more appropriate vehicle to understand the entrepreneurial process and the entrepreneur how instigates this change. More recently, Archer (1995) has extended the CAS model by arguing that the behavior of such a system is not a simple and direct consequence from an external stimulus. As a system becomes more complex, it develops endogenous autonomous processes that determine its behavior, such as adjusting the system to better deal with external influences. This is a better approach to systematizing the endogeneity of the entrepreneurial spirit that so troubled Baumol across three books.

Entrepreneur

Schumpeter (1912) brings the endogenous entrepreneur onto the center stage economic analysis unlike any writer previously. The entrepreneur for Schumpeter must be seen as the human agency, via innovation, to economic development. It is this agency role that makes the development process non-deterministic and instead, adapting to complex changes: "The economy does not grow into higher forms by itself" he says. "The history of every industry leads us back to men and to energetic will and activity. This is the strongest and most prominent reality of economic life." (Schumpeter 1912, p.75) In other words, human agency via the entrepreneur is involved in effecting the innovations required for economic development.

In trying to understand the totality of the economy, Schumpeter divides economic processes into three categories or classes: "...into those processes of the circular flow; into those of development; and into those which impede the latter's undisturbed course." (1934, p. 218). Throughout his body of work, he refers to the processes of the circular flows in the market process as "statics," and those of economic development in which innovation resides as "dynamics." As Schumpeter states in his first published book:

> This distinction is crucial. Statics and dynamics are two totally different areas. Not only do they deal with different problems, but they use different methods and they work with different materials. They are not two chapters in the same theoretical construction – they are two totally different buildings. Only statics has been worked on sufficiently, and this book mainly addresses this kind of problem. The analysis of dynamics is still in its beginnings; it is a 'land of the future'. (Schumpeter 1908, p. 626, translation cited in Swedberg 2007, p. 30).

Schumpeter's thinking on that "land of the future" would emerge 4 years later in *The Theory of Economic* Development (Schumpeter 1912). By "circular flow" or statics, Schumpeter means that part of the overall economy that can be conceptualized as operating as a general equilibrium system under stationary conditions as proposed by the neoclassical economists. Within this system, commodity and product prices settle at levels that cause supply and demand in each market to be matched and *homo economicus* is rational and narrowly self-interested as he seeks to maximize his economic gain. Incremental quantitative growth is achieved through stimuli such as changing consumer tastes in conditions of gradually increasing population, saving, and capital accumulation. Importantly, there is no endogenous development that results in qualitatively new phenomena.

Schumpeter, by this distinction between statics and dynamics, places the entrepreneur clearly into the dynamic process and questions the role of the entrepreneur in the neoclassical model. Either neoclassical theory accepts that its statics is only a partial analysis of a more complex real system, and cannot, therefore, make valid knowledge claims about the entire system, or it is claiming that the entire real economic system behaves as a self-reinforcing system in static equilibrium that maintains itself. The former interpretation can be seen as a realist view on the static approach that qualifies any knowledge claims deriving from it. The latter interpretation is fundamentalist and susceptible to knowledge claims derived from static analysis techniques and, thus, questions the role of the entrepreneur within the neoclassical system.

In Chap. 2 of the second edition of *Theory*, Schumpeter describes the individuals who carry out new combinations as entrepreneurs.

He immediately qualifies this, saying the concept is broader than a single individual:

> . . .we call entrepreneurs not only those 'independent' businessmen in an exchange economy who are usually so designated, but all those who actually fulfil the function by which we define the concept, even if they are, as is becoming the rule, 'dependent' employees of a company, like managers, members of boards of directors, and so forth. . .(Schumpeter 1934, pp. 74–5).

The reason for this formulation is explained in a note to the second edition (1934) he challenges ". . .one of the most annoying misunderstandings that arose out of the first edition." This was the suggestion that, in a variation of the "great man theory," he had identified the individual entrepreneur as the prime cause of innovation and hence economic change. "If my representation were intended to be as this objection assumes, it would obviously be nonsense" he says and points out that his concern is not with ". . .the concrete factors of change, but the method by which these work. . ." An individual is ". . .merely the bearer of the *mechanism of change*" (Schumpeter 1934, p. 61n, emphasis in the original), or simply, the agency for introducing novelty into the organization. Such novelty is regarded by Schumpeter as disruptive to the current *status quo* in the production system, whether that is the firm, industry, or the economy. Schumpeter categorizes this novelty into five types of discontinuous development: introduction of new products and new production processes, opening of new markets, acquisition of news sources of inputs, and reorganization of firms or industry sectors (Schumpeter 1934, p. 66). All five types can be new to the organization, to the industry or even to the system widely. Entrepreneurs who introduce novelty into their organization are effectively conducting diffusion of innovation (Rogers 1995).

Schumpeter has an example of railways and mail coaches which provides great insight to this dynamic mechanism of change and the role of innovation. His concern is not with the nature of any underlying technology *per se*, but with changes in its economic use. Mail coaches and railways in the nineteenth century were the temporal stages of development in two distinct means of transporting goods and people. The former were wheeled and freely steerable on any surface hard enough for the wheels to turn without a resistance greater than the power of their locomotive force, typically a team of two, four, or six horses. Mail coaches were an incremental technological development of a transport tradition that can be traced back through Roman chariots to the earliest and simplest of flatbed wagons that must have quickly followed the invention of the wheel.

The steam-driven locomotives with which the Liverpool to Manchester passenger and freight services began in 1830 were also an incremental technological development, this time of wheeled vehicles running on a prepared track that bears their weight and guides the vehicles and acts as a limit to their range and direction. The origins of this form of railed transportation can be traced back to at least the Greeks and Romans (Lewis 2001). Even the steam engine was not new technology in 1830. The earliest engines were novelties invented by Hero of Alexandria in the first century AD and practical stationary engines had been undergoing incremental development since Thomas Savery's invention for pumping water in 1698. However, none of these incrementally developing technologies had resulted in the type of discontinuous economic change with which Schumpeter is concerned until the performance of George Stephenson's Rocket at the Rainhill Trials in 1829 demonstrated that a mobile version of a steam engine on rails could be used to transport large numbers of people safely over long distances at speed (Encyclopedia Britannica 1984).

Success of the steam locomotive resulted in an economic discontinuity caused by change in the way in which people and goods moved around Britain. Before 1830, the primary means of land transportation was by horse-drawn mail coach, and steam locomotives progressively displaced the coaches after that date. It was not new technology *per se* that had produced the change, but a new combination of existing technologies brought forward by the entrepreneur. Thus, what is "new" for the entrepreneur is not technical

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knowledge, nor ability to finance innovation; instead, it is the skills and characteristics the entrepreneur brings to development in the sense of a transition from one norm to another which is not reachable through a series of incremental steps, i.e., when the change is discontinuous and disruptive. Conversely, he considers that "mere managers" have the ability to implement incremental change, i.e., that which *can* be decomposed into a series of infinitesimal steps. Since this, by definition, includes all incremental innovation intended to optimize processes or offer slightly improved versions of existing products and services, conclusion can be drawn that there is no role for the entrepreneur in such continuous innovation.

This interpretation is supported by concrete examples of how businesses organize for the two different types of change. For example, to bring a new product to market teams are typically formed outside the normal hierarchical management structure and only exist temporarily while engaged in this activity. Introduction of new products is one of Schumpeter's five types of discontinuous development. Once introduced as a new product, the tasks of launch, support, and maintenance (including release of new versions) is typically the responsibility of a permanent unit within the normal hierarchy of the firm. A similar situation prevails in software development, where a specially formed project team will carry out the development of new application software, while a separate support department will handle the subsequent maintenance and new releases. More generally, organizations implementing small process improvements to production or administration systems will normally entrust these to existing line management. It is only when attempting more complex and revolutionary process re-engineering that the task will be allocated to a specialist project team outside the day-to-day management structure.

The distinction in an organization is between the "dynamic" entrepreneur as a mechanism of change vis-à-vis the "static" manager as a mechanism of consolidation. Across organizations, Baumol (2010) makes clear there are two different types within the category of "dynamic entrepreneur." Crucially, and most importantly, there is the "true" productive entrepreneur as a person (or team) which is productive in a welfare-enhancing development process that adds to productive wealth. This is the type that Schumpeter envisages in his works. In contrast, Baumol recognizes also the "disruptive" entrepreneur who is unproductive since the activity being engaged is only rent-seeking, like identifying previously unused speculative or illegal opportunities. The term "disruptive" is used by Baumol in a subjective manner to indicate economic activity that is antisocial and unethical, while the same term is used by Schumpeter in an objective manner to indicate the outcome of discontinuous development. When used in the context of Baumol's subjective definition, the term needs to have quotation marks around it, i.e., "disruptive."

The "disruptive" unproductive entrepreneurs look initially to be adding value through employment or stockholder value, as did the entrepreneurs who innovated the sub-prime mortgages and collateralized debt obligations during the early 2000s (see Kregel 2008). Further down the track, such activity unravels into major costs to society and to the business community in general that far outweighs any initial positive value, as exhibited by the Global Financial Crisis that resulted in a banking collapse in September 2008, followed by the long-running "Great Recession" (see Arestis and Karakitsos 2010).

A question arises for the dynamic entrepreneur, be it productive or "disruptive." Is the change arising from innovation something the entrepreneur can calculate the risk of within the probabilities of failure and success? Or, instead is the change so novel and fundamental that no risk assessment can be made, leaving incalculable uncertainty in its wake that needs to be "managed" in the best way possible.

Risk and Uncertainty

There is much confusion in the entrepreneurship literature over the risk/uncertainty dichotomy, despite the clear distinction made in economics by both Keynes (1907) and Knight (1921). All the entrepreneurship textbooks identify entrepreneurs as being *risk-oriented*, but then emphasize that risk assessment is required in order reduce *uncertainty* on "wild chances" through business planning and preparation (Frederick et al. 2006, p. 31). This merging of the risk/uncertainty dichotomy distorts the entrepreneurs role, since "...[p]rofit arises out of the inherent, absolute unpredictability of things...that cannot be anticipated..." (Knight 1921, p. 281). The issue is that risk assessment is possible and recommended under continuous incremental innovation, where "things" are not unpredictable. Whereas, discontinuous innovation has such high level of uncertainty that risk assessment is impossible, with only some general scenario planning for different contingencies within a CAS is the only feasible approach. The risk/uncertainty dichotomy thus reflects the continuous/discontinuous distinction adopted in this entry based on the Schumpeterian perspective.

From this risk/uncertainty dichotomy, it transpires that the entrepreneur is not the same as the capitalist. Only the capitalist bears the risk of an investment failing. As Schumpeter (1934, p. 75n) makes clear: "Risk obviously always falls on the owner of the means of production or of the money capital which was paid for them, hence never on the entrepreneur as such." Some entrepreneurs are owners and thus take on risk and the role of capitalist, just like some entrepreneurs, as described in the previous section, can be technologists who take on the technical implementation. In this context, risk is an activity undertaken by the capitalist and not the entrepreneur.

What an entrepreneur takes on, Schumpeter argues, is the significant uncertainty involved in the introduction of new disruptive combinations due to the indeterminate nature of novelty. The depth of analysis typically required for the risk-oriented decision-making within the static state "circular flow" of incremental innovation is not available for discontinuous innovation due to the lack of relevant data for the latter decisions. The entrepreneur must, therefore, be comfortable operating with uncertainty and making decisions by "instinct" or "gut feel." This is related to another neoclassical axiom that is challenged in this continuous/discontinuous distinction. The axiom states all economic agents are rational and self-interested, which is essential for a robust equilibrium algorithm to exist. However, when there is discontinuous innovation, such a decision cannot be analyzed or rationalized in any coherent approach, since there can be no concept of rational choice in an environment of indeterminate uncertainty.

When it comes to entrepreneurial motivation, Schumpeter rejects narrowly defined hedonistic motives. Hedonism requires one to ignore uncertainty in the search for rewarding financial risks (e.g., trading on the stock market), whereas the entrepreneur needs to engage with uncertainty that requires much intellectual activity. In this context, entrepreneurs tend to be workaholics and "...activity of the entrepreneurial type is obviously an obstacle to hedonist enjoyment...usually acquired by incomes beyond a certain size, because their 'consumption' presupposes leisure" (Schumpeter 1934, p. 92).

At several points, Schumpeter draws comparisons between the characteristics of entrepreneurs and "mere managers" in the circular flow. Managers, in trying to keep their jobs and making an impact with the owners or directors, must consider that decision-making is based on the market and by the previous state of the business. Managers learn to read the signs, such as changes in demand from customers, from training and experience, and then adjust productive resources accordingly. Neither directing nor directed labor therefore exercises any real leadership over the business: The managers respond to consumers and workers respond to their managers. Day-to-day management of the business, in so far as it consists of adapting to normal fluctuations in supply of goods and services and the demands of customers, involves no creative input whatsoever and does not require handling uncertainty (Schumpeter 1934, pp. 20–2). In striving for the optimal methods of operation, managers tend to seek the best method of those that are familiar and have been tried and tested in practice.

The innovation decision-making of endogenous entrepreneurs under uncertainty occupies a different plane of activity. This is different because entrepreneurs in this world of uncertainty are one in which they elect the most appropriate method possible, which, by definition, may be untried, untested, and unfamiliar (Schumpeter 1934, p. 83). This means that optimizing rationality under *homo economicus* conditions is not an option. Such optimizing decision-making behavior is not an option due to the lack of data and inability to even identify where the data can be obtained (Courvisanos 2009). In this world of uncertainty, entrepreneurs conduct satisficing behavior under procedural (or bounded) rationality as explained by Herbert Simon (1976). This type of satisficing decision-making opens the door for new venture business creations that are truly innovative.

Business Creation and Innovation

Of course nothing in the Schumpeterian interpretation of an entrepreneur suggests that people who possess the ability to fulfill an entrepreneurial role may not be engaged on continuous innovation activities within the firm or organization. However, they are not acting as an entrepreneur when they do so and their entrepreneurial skills and capabilities are therefore latent and dormant. Neither does it mean that innovative entrepreneurial activity cannot take place within a firm; simply that business creation that is truly innovative has to consist of disruptive discontinuous change.

Throughout his career, the economic phenomenon that most fascinated Schumpeter was that of economic development, and it could only be seen in the context of history. As Michaelides and Milos (2009, p. 496) explain, "Schumpeter's notion of development is viewed. . .[as a]. . .theoretical approach of integrating theoretical and historical concerns." Schumpeter did not reject the usefulness of the popular equilibrium model as an analytical tool to analyze the stationary state of "ordinary routine work" (Schumpeter 1939, vol I, p. 40). However, he realized that the "circular flow" equilibrium of stationary capitalism with static markets could not explain the dynamics of economic growth.

In *The Theory of Economic Development* (Schumpeter 1912), three characteristics of economic development are specified. These three characteristics are the essence of disruptive business creation that Schumpeter calls "creative destruction." First characteristic of such development is the need to be endogenous to the economic system and not a reaction to external events or other stimuli. Second characteristic is based on business creation as discontinuous which does not occur in smoothly changing processes. In fact, Schumpeter explains it is at the trough of business cycles that such creative destruction is bound to be more successful, as there are around many failed previous continuous incremental innovations. Third characteristic is that such business creation is disruptive to the *status quo*, with old equilibrium conditions – and old competitors – all being radically changed. As a result, "creative destruction is the essential fact about capitalism" (Schumpeter 1942, p. 83) and the entrepreneur is the prime agent of this economic change. The endogenous stimulus is, Schumpeter argues, innovation which he sees as the creation of "new combinations" based around the five types of discontinuous development.

As his thinking developed, by 1942, Schumpeter was suggesting the disruption caused by innovation is traumatic, especially as new firms produce new products by innovative processes that puts old firms out of business. Such trauma led Schumpeter to predict that once these new businesses become powerful large capitalist firms, they will cease to be innovative, and this could threaten the viability of capitalism. Hamdouch et al. (2008) identify the integration of the two Schumpeterian models of small innovative entrepreneur and large firm "intrapreneur" into a new broader "networked" model based on strong collaboration and clustering activities using modern information technology. This network model has allayed the lack of innovation in emerging new industries like biotechnology (Hamdouch and He 2009) and software industry

(Salavisa et al. 2009), while established older industries like automotive and electrical appliances suffer from lack of disruptive innovation in order to merely fortify their market position (Buxey 2000).

From this economic development perspective, Schumpeter contends that expansion of credit is an important, but only secondary, part of the growth mechanism. Thus, the management of general levels of interest rates by central banks is ineffectual in stimulating recovery from a recession. Thus, with "quantitative easing" or lowering interest rates, firms reason that it better (as Schumpeter says) to cease:

> . . .to wonder why. In fact, it can be argued that the outcome is likely to be worse due to a two-fold dampening effect on the discontinuous innovation required to generate the growth required for the economy to emerge from recession. (Schumpeter 1935, p. 8).

Schumpeter (1935, p. 8) goes on to note that: '. . .any satisfactory analysis of the causes [of the cycle] must start with what induces that credit expansion. . .' and unless that credit demand is coming from entrepreneurs for the purpose of initiating discontinuous innovation, the expected economic development will not occur. Increasing the availability of cheaper credit to firms within the circular flow – as the US monetary authorities are doing to stimulate the economy out of a post-GFC stagnant malaise – will have the effect of, in the worst case, reducing costs, the benefit of which is returned directly to shareholders as companies seek to maintain their levels of dividend payouts to shareholders. In the best case, the reinvestment of profits stimulates investment in adaptive improvement which, by supporting the longevity of established businesses, reduces the likelihood of creative destruction occurring. In fact, the risk-adversity of firms in the circular flow and their reluctance to undertake any investment in recessionary conditions may tend to make the former outcome more likely than the latter. This is what Schumpeter refers to as the "two-fold dampening effect"; one is the increased dividend payout, the other is the reinvestment in minor incremental innovation.

A more effective monetary policy in recessionary conditions may be to hold general levels of interest rates steady while implementing policies to improve the flow of lower cost credit to potential entrepreneurs. Analysis of such a proactive policy is beyond the scope of this entry, but the objective would be to increase the flow of credit to dynamic discontinuous entrepreneurs while restraining the availability of credit to existing businesses.

Conclusion and Future Directions

This entry has taken a discernibly strong Schumpeterian perspective to entrepreneurship, since this perspective is the *only* rigorous approach that unites entrepreneurs with innovation without conflating the innovation process with simply the operation of a business. In neoclassical economics, there is no such clear perspective since it lacks an economic development approach, leaving entrepreneurship to be merely the organizing agency of the available resources of land, labor, and capital within a static equilibrium model. Instead, what is required by economic thought for future analysis is a dynamic complex adaptive model implied by Schumpeter with his description of innovative movement into disequilibrium. A growing body of evolutionary and neo-Schumpeterian economics provide this dynamic Schumpeterian perspective that has much to offer future economic analysis, but only if this "supply-side" is combined the "effective demand-side" work of Post Keynesians and Kaleckians on investment, consumption, and income distribution which determine how economic development out of innovation materializes (Courvisanos 2012b).

There are some significant implications that arise from the discussion above that provide clear suggestions for future research directions. One is systematizing endogeneity of the entrepreneurial spirit within a complex adaptive system and rejecting the static market equilibrium approach. This would then provide basis for better economic development models of national economies and major regions. Another suggestion is the role of the dynamic entrepreneur in combining existing technologies into new areas of activity that eventually diffuses such innovation to become major industries. This would then provide basis for better analysis of the role of the entrepreneur in the path of creative destruction. Third suggestion is based on satisficing decision-making under uncertainty that evaluates new venture business creations that are truly innovative. This would then provide basis for better understanding of role of uncertainty in innovation decision-making in the context of intuition and sensitivity to change. Final suggestion is based on the role of innovation in cycles and crisis, such that passive monetary policy to stimulate economies is ineffective. This would provide basis for distinctly proactive public policies that create "room to move" for new trajectories that reject incumbent powerful monopolies, but also do not eulogize small business operators (for more on this, see Courvisanos 2012a).

Cross-References

- ▶ Business Climate and Entrepreneurialism
- ▶ Business Cycles
- ▶ Corporate Entrepreneurship
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Entrepreneurship Policies
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Risk, Uncertainty, and Business Creation
- ▶ Schumpeterian Entrepreneur

References

Archer MS. Realist social theory: the morphogenetic approach. Cambridge: Cambridge University Press; 1995.

Arestis P, Karakitsos E. The post 'great recession' US economy: implications for financial markets and the economy. Basingstoke: Palgrave Macmillan; 2010.

Baumol W. Entrepreneurship in economic theory. Am Econ Rev. 1968;58(2):64–71.

Baumol W. Entrepreneurship, management and the structure of payoffs. Cambridge: MIT Press; 1994.

Baumol W. The free market innovation machine. Princeton: Princeton University Press; 2002.

Baumol W. The microtheory of innovative entrepreneurship. Princeton/Oxford: Princeton University Press; 2010.

Buxey G. Strategies in an era of global competition. Int J Oper Prod Manag. 2000;20(9):997–1016.

Courvisanos J. Optimize versus satisfice: two approaches to an investment policy in sustainable development. In: Holt R, Pressman S, Spash CL, editors. Post keynesian and ecological economics: confronting environmental issues. Cheltenham/Northampton: Edward Elgar; 2009. p. 279–300.

Courvisanos J. Cycles, crises and innovation: path to sustainable development – A Kaleckian-Schumpeterian synthesis. Cheltenham/Northampton: Edward Elgar; 2012a.

Courvisanos J. Innovation. In: King JE, editor. The Elgar companion to post Keynesian economics. 2nd ed. Cheltenham/Northampton: Edward Elgar; 2012b. p. 294–300.

Encyclopedia Britannica. "Railroad", The new encyclopaedia britannica, 15th edition, USA; 1984.

Frederick HH, Kuratko DF, Hodgetts RM. Entrepreneurship: theory, process, practice. South Melbourne: Thomson Learning; 2006. Asia-Pacific Edition.

Hamdouch A, He F. R & D offshoring and clustering dynamics in pharmaceuticals and biotechnology: key features and insights from the Chinese case. J Innov Econ. 2009;4(2):95–117.

Hamdouch A, Laperche B, Munier F. The collective innovation process and the need for dynamic coordination: general presentation. J Innov Econ. 2008;2(2):3–13.

Holling CS. Resilience and stability of ecological systems. Ann Rev Ecol Syst. 1973;4:1–23.

Keynes JM. "The principles of probability", Keynes Papers. Cambridge: King's College, 1907.

Knight FH. Risk, uncertainty and profit. New York: Harper and Row; 1921.

Kregel J. Changes in the U.S. financial system and the subprime crisis, Working Paper No. 530, The Levy Economics Institute of Bard College, New York, April; 2008.

Lewis M. Railways in the Greek and Roman World. In: Guy A, Rees J, editors. Early railways: a selection of papers from the first international early railways conference, London: Newcomen Society, pp. 8–19; 2001.

Michaelides P, Milios J. Joseph Schumpeter and the German historical, school. Cambridge J Econ. 2009;33(3):495–516.

Robinson J. Economic philosophy. Harmondsworth: Penguin; 1962.

Rogers E. Diffusion of innovations. 4th ed. New York: The Free Press; 1995.

Salavisa I, Videira P, Santos F. Entrepreneurship and social networks in IT sectors: the case of the software industry in Portugal. J Innov Econ. 2009;4(2):15–39.

Schumpeter JA. Das wesen und der hauptinhalt der theoretischen nationalökonomie (The essence and

principal contents of economic theory). Leipzig: Duncker and Humblot; 1908.
Schumpeter JA. Theorie der wirtschaftlichen entwicklung (the theory of economic development). Leipzig: Duncker und Humblot; 1912.
Schumpeter JA. The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle. 2nd ed. Cambridge: Harvard University Press; 1934 (English translation of 1926 2nd German edition of Theorie der Wirtschaftlichen Entwicklung).
Schumpeter JA. The analysis of economic change. Rev Econ Stat. 1935;17(4):2–10.
Schumpeter J. Business cycles: a theoretical, historical and statistical analysis of the capitalist process. New York: McGraw-Hill; 1939. 2 Volumes.
Simon H. From substantive to procedural rationality. In: Latsis S, editor. Method and appraisal in economics. Cambridge: Cambridge University Press; 1976. p. 129–48.
Smith K. Innovation as a systemic phenomenon: rethinking the role of policy. In: Bryant K, Wells A, editors. A new economic paradigm? Innovation-based evolutionary systems, discussions in science and innovation 4. Canberra: Department of Industry, Science and Resources, Commonwealth of Australia; 1998. p. 17–53.
Swedberg R. "Rebuilding Schumpeter's theory of entrepreneurship", Conference on Marshall, Schumpeter and Social Science. Tokyo: Hitotsubashi University; 2007.

Innovation by Applied Mathematics

Andreas Binder
Industrial Mathematics Competence Center, MathConsult GmbH, Linz, Upper Austria, Austria

Synonyms

Industrial mathematics; Mathematical modeling and numerical simulation

Introduction

Following the OECD Oslo Manual (2005), *an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations. [. . .]*

A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness, or other functional characteristics. Product innovations can utilize new knowledge or technologies or can be based on new uses or combinations of existing knowledge or technologies. [. . .]

A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment, and/or software. Process innovations can be intended to decrease unit costs of production or delivery, to increase quality, or to produce or deliver new or significantly improved products.

Techniques from applied mathematics belong to the main drivers of product and process innovations. For a range of examples, see Levy et al. (2011) or RICAM Video (2007).

The typical steps in the mathematical treatment of an industrial problem are the following:

1. Ask the right questions.
2. Formulation of mathematical models for the relevant phenomena to be covered: Translate the industrial problem into a problem in mathematical language.
3. Calculate a solution of the problem, typically by numerical simulation on computers.
4. Interpret and verify the results.

In most cases, this is not a sequential procedure but requires several iterations. It may also happen that reasonable solutions for a specific problem cannot be obtained within reasonable time, within a given budget, or due to a lack of data.

An Example from Heavy Industries

Blast furnaces have been in use for iron production at least for the last 2000 years (Fig. 1).

Innovation by Applied Mathematics, Fig. 1 Blast furnace of the Chinese Han dynasty (Source: Private photograph)

A modern blast furnace may be in continuous operation for 10 years and may produce 5 million tons of metallic iron per year. Questions of interest are as follows:

- How does the chemical analysis of the iron ore influence the properties of iron and slag?
- How much energy/coke/hydrogen is used per day?
- Can the operator influence the daily production?
- Can the melting point of iron or the viscosity of the slag be influenced by additional materials like limestone? How can this be done methodically?

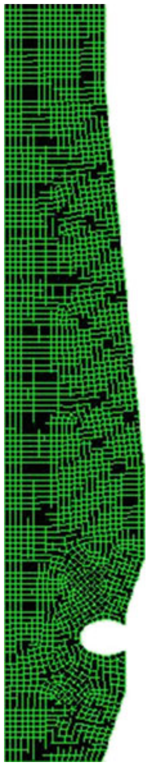
A mathematical model of a blast furnace covers the following phenomena:

- The flow of solid iron ore, coke, additional materials from the top to the bottom.
- The flow of reduction gas (hydrogen, carbon monoxide) from the tuyeres at the bottom to the top.
- A range of chemical reactions. To obtain a detailed understanding of the process, up to 40 or 50 chemical reactions and their kinetics have to be taken into account.
- Energy balance: The melting point of iron is between 1,400 °C and 1,500 °C. During the residence time of the iron ore in the furnace, its temperature has to be increased from surrounding temperature to the melting point.

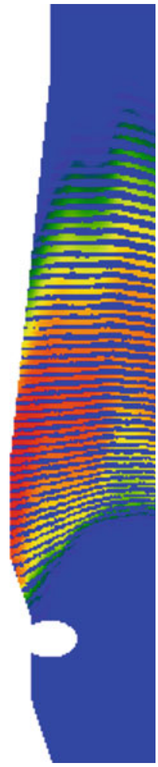
These phenomena are coupled: Chemical reactions may produce energy or consume it and may need a certain temperature level to start. Increased temperature influences the flow behavior of the solids; coke is finally burnt and thus changes from the downward solid flow to the upward flow of carbon monoxide and dioxide. The layerwise charging of iron bearing layers and coke is essential to avoid an obstruction of the gas flow.

The mathematical translation of these phenomena leads – by taking into account conservation of mass, momentum, and energy – to a system of nonlinear partial differential equations describing, e.g., the temperature or the concentration of iron oxide FeO of a point (x, y, z) at time t. These equations are coupled in the sense that, as an example, the temperature at a point is influenced by the history of particles reaching that point, and, on the other hand, the temperature is a main driver for the kinetics of chemical reactions.

The solution of the coupled blast furnace model cannot be derived by applying analytic formulae but has to be obtained by numerical techniques. For these, the calculation domain (the furnace) is meshed by a finite element grid (Fig. 2). It turns out that the simplification of



Innovation by Applied Mathematics, Fig. 2 Typical calculation meh in a 2D calculation (Source: MathConsult)



Innovation by Applied Mathematics, Fig. 3 Concentration of FeO. The highest concentration is reached in the *red* layers. Coke layers between are *blue* (Source: MathConsult)

rotational symmetry is reasonable, which decreases the computational effort significantly. Nevertheless, as the thickness of the iron ore and the coke layers have to be resolved, a typical spatially two-dimensional blast furnace simulation needs 800.000 unknowns for which the equations are solved.

The numerical treatment of these coupled equations requires techniques from fluid dynamics and from chemical engineering in combination with sound programming skills. Additional difficulties arise from the different time scales (the gas flow is 1,000 times faster than the solid flow) and from discontinuities between the layers.

The interpretation of the results and their verification by measurements may, at least during the first modeling iterations, lead to the insight that additional chemical reactions have to be taken into account or that other phenomena may be neglected without a significant change in the results.

Depending on the number of chemical reactions to be considered and on the size of the numerical grid, a real world process day is computed within 2–5 h on a conventional personal computer. The results show a very good coincidence with experimental measurements. For details, see Fig. 3 (Engl et al. 2007).

There are several innovations related to this kinetic blast furnace simulation:

– New operational conditions of a blast furnace (e.g., different raw materials, a different burden distribution, or a more aggressive firing with additional fuel leading to an assumed higher productivity) may be analyzed in advance by computer simulation before an operational strategy is chosen. Such computer experiments are typically much cheaper and environmentally friendly.
– In the plant engineering and construction, different geometries of blast furnaces may be studied.
– The online control and monitoring of a furnace may lead to a safer operation, longer maintenance intervals, and therefore a higher productivity.

Sources of Innovation by Applied Mathematics

The mathematical modeling of industrial processes by applying conservation principles from physics has a long tradition since the development of modern calculus from the nineteenth century onward. However, an accurate quantitative analysis of industrial processes by means of manual calculations is often not possible due to the nonlinearity or the complexity of the process.

With the breakthrough of computer power and computer availability during the last decades, the numerical simulation of industrial processes has become feasible for a wide range of applications. On the hardware side, standard personal computers of today are certainly 1,000 times faster and have 1,000 times the memory of expensive workstations in the late 1980s. Even smartphones are equipped with more memory.

For the rapid development in mathematical simulation of complex processes, at least two more pillars have been essential.

The careful analysis of numerical algorithms for (here) differential equations has led to new methods of solution techniques, which often require much fewer iterations than conventional solvers. Parallelization, multigrid techniques, and preconditioning yield additional orders of magnitude in calculation speed.

Of equal importance is the development in software design and the availability of tools for rapid prototyping of small and medium-sized problems. Modern software architecture leads to a better usability and reusability of mathematical software for different application fields and to better maintenance properties of mathematical algorithms.

Automotive Industries

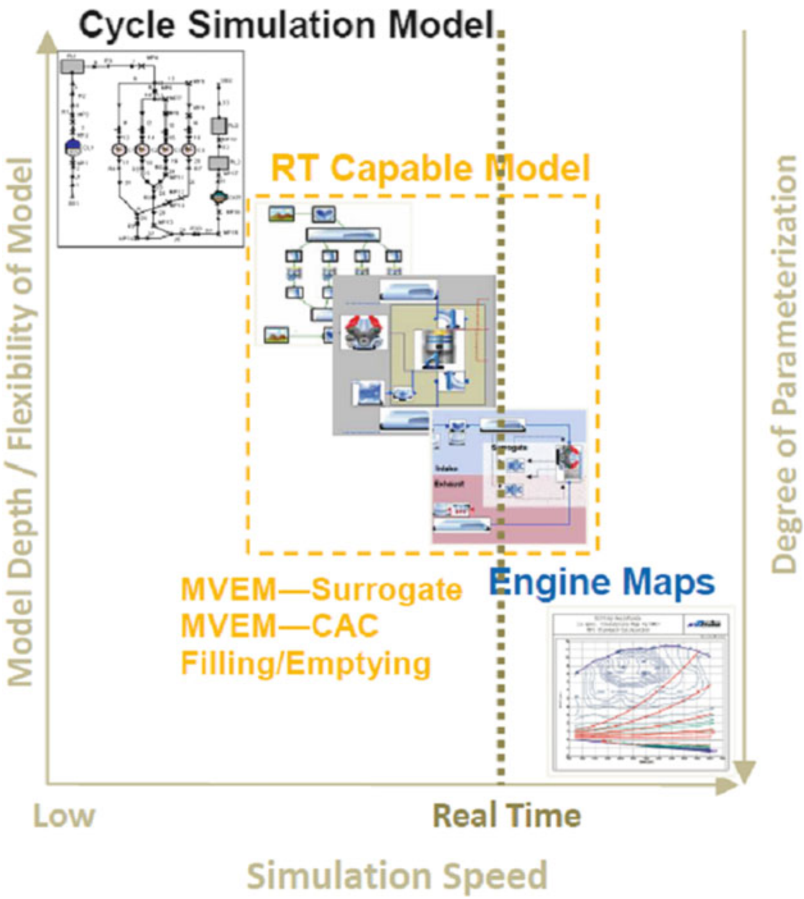
The technical specifications on modern cars are more and more demanding: Engines are either combustion or electrical engines or a combination of these. Although cars are significantly heavier than 20 years ago, fuel consumption should be reduced, the exhaust gas should satisfy tight environmental requirements, maintenance intervals are increased, and the safety of drivers and passengers is improved continuously.

Mathematical modeling and simulation in automotive industries are key factors to reduce development cycles, to optimize exhaust gas and its catalytic aftertreatment, and to adjust cars to the environment in which they are used.

Automotive simulation is also a good example to demonstrate multiscale modeling and different modeling depth (Fig. 4): For the detailed analysis of the combustion process, a three-dimensional fluid dynamics simulation will be necessary, which may take hours or even days to simulate a few combustion cycles; on the other hand, for the setup and optimization of the interaction between power train, gear box, wheels, brakes, and several more aggregates, a coarser modeling makes sense. So-called surrogate models, often realized as support vector machines or as neural networks, are used to obtain very fast input–output relations either from measurement data or by offline training cycles based on detailed simulation. In the past years, these surrogate models allowed to combine virtual engines and test beds of physical engines. Obviously, in such environments, the simulation software must be at least as fast as the physical motor and simulate each millisecond of physical time within a millisecond on the computer.

Mathematical Simulation in Medicine and Biology

Modern medical imaging would not be possible without mathematical computation. The basis of computerized tomography (by utilizing X rays in various directions) is the Radon transform, which was introduced by Johann Radon in 1917. Using other sources of waves leads to magnetic resonance tomography, electrical impedance tomography, or to medical ultrasound. When inverting raw data obtained from different imaging instruments, it is essential to take into account the noise characteristics of the specific instrument and to apply specific mathematical inversion algorithms.



Innovation by Applied Mathematics, Fig. 4 A schematic view of the relation between simulation speed and model depth in automotive simulation (Source: MathConsult and AVL List)

Systems biology is a relatively young biological discipline that claims to consider cells and organisms as entities in a holistic way. At the same time, it focuses on the interplay of components from the molecular to the systemic level. Quantitative measurements and recordings of biological processes are merged with advanced mathematical methods to yield predictive theoretical, mostly computational, models of biological systems. High mathematical complexity arises from the fact that the metabolism of the cell is the set of several thousands of catalyzed biochemical reactions resulting in molecular concentrations of a large number of substrates, products and enzymes as functions of time (Engl et al. 2009).

A major goal of systems biology is to provide an understanding of properties and behavior of cells or organisms emerging as consequence of the interaction of large numbers of molecules, which organize themselves into highly intricate reaction networks that span various levels of cellular or organismal complexity. The number of nodes in metabolic networks amounts to several thousand molecules.

Computational Finance and Risk Management

Computational finance, as it is widely understood in the mathematical finance community, deals with the valuation, the risk analysis, and the risk management of financial instruments like bonds, swaps, futures, options, and arbitrarily complex derivative or structured instruments (Albrecher et al. 2012). The necessary steps for valuating such financial instruments are as follows:

– Choose one or more models for the stochastic behavior of the underlying. This underlying may be the quoted spot price of an equity share, a Libor rate, or a foreign exchange rate.

– Determine the parameters of the model in a stable and robust way by utilizing market data of liquid instruments. Note that there may be severe traps hidden in this model calibration, which may yield misleading results.
– Valuate the derivative or structured financial instrument by applying numerical techniques. These are typically Monte Carlo techniques, methods form partial differential equations, or Fourier-based methods.

The requirements on the response times in quantitative finance are quite strict, so that almost real time calculation is needed.

The developments on the financial markets since 2007 showed that risk controlling and risk management need mathematical tools even mightier than those used at the trading floors in order to analyze market, credit, and liquidity risk properly.

Applied Mathematics and Education

It is observed that in high schools around the world, there are typically no real world problems to be solved, but intersections of planes are calculated, tangents on ellipses or hyperbolas have to be determined, or integrals have to be calculated by hand. (These are tasks that a computer (or even a cell phone) can do better.) For the sake of calculations, the steps (1), (2), and (4) of the Introduction are underweighted, and doing the calculations (3) lies in the main focus. See also Ziegler (2011), Wolfram (2010).

Doing more experimental mathematics (like in http://www.myphysicslab.com/dbl_pendulum.html) might bring curiosity back to school.

Conclusion and Future Directions

The mathematical modeling and numerical simulation of complex systems allow product and process innovation in a wide range of application fields. A few of these, in which the author was personally involved, have been mentioned, but there are many more areas in which research, development, and innovation are not possible without the heavy use of mathematical simulation.

While mathematical simulation has been used in physics, astronomy, and mechanical and chemical engineering since the emersion of computers, during the last years, heavy progress was made, e.g., in systems biology, drug design, and nanoscience.

The progress in modeling capability by a deeper understanding of the relevant processes and in computer hardware and algorithm development will allow problems to be tackled which today are out of simulatory reach.

Cross-References

▶ Product Innovation, Process Innovation

References

Albrecher H, Binder A, Lautscham V, Mayer P. Introduction to quantitative methods for financial markets. Birkhäuser. To appear 2012.

Engl HW, Gökler G, Schatz A, Zeisel H. Modelling and numerics for the transient simulation of the blast furnace process. In: Jeltsch R, Li T-T, Sloan IH, editors. Some topics in industrial and applied mathematics. Proceedings of Shanghai forum on industrial and applied mathematics. World Scientific Publishing, 2007, pp 95–119.

Engl HW, Flamm C, Kügler P, Lu J, Müller S, Schuster P. Inverse problems in systems biology. Inverse Prob. 2009;25:1–51.

Levy T, Primicerio M, Esteban MJ, Fontes M, Maday Y, Mehrmann V, Quadros G, Schilders W, Schuppert A, Tewkesbury H. European success stories in industrial mathematics. Berlin: Springer; 2011.

Oslo Manual. The measurement of scientific and technological activities Oslo manual: guidelines for collecting and interpreting innovation data. 3rd ed. Paris: OECD Publishing; 2005.

RICAM Video. http://www.ricam.oeaw.ac.at/media/video/ricam-720x576-hq.avi. Accessed 4 Feb 2013 (2007).

Wolfram. http://blog.wolfram.com/2010/11/23/conrad-wolframs-ted-talk-stop-teaching-calculating-start-teaching-math/. Accessed 4 Feb 2013 (2010).

Ziegler GM. Mathematikunterricht liefert Antworten: Auf welche Fragen? MDMV 19/2011:174–78.

Innovation Diffusion

▶ Epidemiology of Innovation: Concepts and Constructs
▶ Nonlinear Innovations

Innovation Diplomacy

▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams

Innovation Ecosystem

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
▶ Technology Push and Market Pull Entrepreneurship

Innovation in Business: Six Honest Questions

Anne Stenros
KONE Corporation, Espoo, Finland

Synonyms

Creative leadership; Design thinking; Innovation practices; Research and innovation

The Right Questions

> *Complex problems have simple, easy to understand, wrong answers.*
> Henry Louis Mencken (1880–1956)

> *I keep six honest serving-men*
> *(They taught me all I knew):*
> *Their names are What and Why and When*
> *And How and Where and Who.*
> By Rudyard Kipling, *Elephant's Child* (1902)

The fundamental idea behind creative activity and creative problem-solving – which is the cornerstone of innovation – is to question, that is, to ask the right question. Whatever the product, service, process, or solution, the crucial point is to answer the right question or rather questions. What, why, when, how, where, and who tell you everything essential that creative questioning includes. Deriving from the poem by Rudyard Kipling, these can be called *The Six Honest Questions*, with which one can achieve genuinely new answers and furthermore radical innovations that create something new. By answering deeply the questions of the six "serving men" about form, process, place, and time as well as competence and goals in addition to the user and the context, one can find the path leading to the future – the homeland of innovations.

Another way to examine this issue is to question the practices employed for seeking answers and to focus attention on those stages of the process and working methods which actually destroy creative thinking and prevent its development as well as, ultimately, the actual use of creativity and its realization. Ryan Jacoby, the head of IDEO, New York, has described *Seven Deadly Sins of Innovation* (Walter 2012) which in practice block the emergence of significant innovations. Most companies have processed the product development of innovation work, although the process as such does not guarantee the emergence of innovations – rather the opposite, in fact. According to Jacoby, the obstacles to innovation or innovation killers are the following seven business culture practices:

The Seven Sins of Innovation (as interpreted by the author)

1. *Thinking the answer is in here, rather than out there*. It is necessary to get out of the comfort zone in order to challenge the existing norm. One should look around and be open to external possibilities. In global competition, normal is not enough.
2. *Talking about it rather than building it*. Innovation should be an action, a verb, and an aspiration. There is a great slogan in the end of the famous IBM Innovation Man video: "Stop talking, start doing." Learning by

doing also speeds up innovation development since by doing so, one also has to apply tacit knowledge.
3. *Executing when one should be exploring*. Too often experts and managers rush forward when they should be taking a closer look instead, to study, to research, and finally to understand more profoundly the issue at hand. Making final decisions too early might lead to fatal decisions in long-term thinking.
4. *Being smart*. That will kill debate and block new ideas. Ideas are so fragile, as Jonathan Ive had said that you should protect them against intellectual attacks and indifference in order to keep them alive. Creative culture does not need "smarties."
5. *Being impatient for the wrong things*. Developing radical innovations takes definitely more time and resources than developing incremental ones. There should be a match between what is expected and what can be achieved.
6. *Confusing cross-functionality with diverse viewpoints*. Diversity is a key to innovation; different functionalities do not guarantee diverse approaches if the people do not have genuinely different backgrounds and competences.
7. *Believing process will save everything*. This is the most fatal single sin: trusting in the process to solve the problems and generate innovations. Many innovations happen by accident or they are done by taking another path rather than following mainstream thinking and processes.

True creative leadership, which is a prerequisite for innovation work, is by nature a visionary searching, guided by genuine, right, and honest questions. It does not follow predetermined processes and formulas but rather proceeds by questioning both methods and practices, finding its own genuine and unique path.

What: First Versus Fast Follower

Most national and regional innovation programs emphasize customer-oriented innovation and the importance of the customer-centered design that supports this. Different types of user experience tests and usability-simulation methods solidify the notion of the customer's omnipotence: people first! In the worst case, this situation leads to responsibility for developing products and the product needs actually being transferred to the end users, whose needs and wishes are then directly implemented in products and services – without ever questioning their true rationality, needfulness, and sustainability.

Two famous architects have decided on the opposite approach in their work, and both have attained a reputation as superb, visionary designers among the public and professionals alike. Architect Frank Gehry has wisely observed (Bell 2012):

> You can't just build a building based on what the clients say, because their vision is based on what's normal. How do you get out of the normal? You've got to question everything. Spend time with the user group. Glean all the information you can. And then throw it all away and begin to play.

Many gradually developed product improvements and small-scale innovations can emerge through the customer's wishes and insights – but real, radical, and creative innovations demand the ability to see further into the future while simultaneously still understanding the users' need continuum. Without "throwing ourselves into the creative play," it is impossible to detach oneself from the convention and step outside the comfort zone, which is where significant new insights and innovations emerge.

It is also a question about corporate culture and the role of the company: does it want to be first or a fast follower? The latter depends literally on the customer as, when asked, the user usually says he wants something like his "neighbor" – that is, a competitor – has. The first-mentioned builds his products and services on the foundation of a vision and turns it into a story which also extends into the future. Products of this kind, which look creatively into the future, change and revolutionize the world, creating new-generation products, services, and users.

The same creative freedom and the responsibility it entails were referred to by architect

Louis I. Kahn in the following quotation (Johnson 1975):

> I don't believe in need as force at all. Need is a current, everyday affair. But desire – that is something else again. Desire is the forerunner of a new need. It is the yet not stated, the yet not made which motivates.

Gehry's juxtaposition of the ordinary with the special gains support from Kahn's emphasis on the time dimensionality of innovation from the present into the future. A need-based product is already in existence – but a desire-based, aspirational product or service is the forerunner of a new need, thus pointing strongly into the future. It is something which has not yet taken on a concrete form; it is something which is still on the way. In innovation work, these "forerunners" Kahn refers to are signals of change, out of which significant new drivers in products, the economy, society, or culture may emerge. By understanding these drivers of change, it is possible to navigate to the future and create new, currently hidden future needs.

The desirability of Apple products and services is based on the fact that the company has succeeded, time after time, in surprising its users positively with new and unique products and services which have no predecessors in history. The crucial characteristic of innovation is that it surprises – usually even the person who made it – with the power it gains among users in the market as well as in the influence it ultimately has on the way of life and on society. Apple's products and services are a good example of how innovations can create new, emergent needs and transform familiar practices.

Why: Exploring Versus Executing

Questioning is part of the very core of innovation work: it forms the critical framework against which the assigned task, the problem itself, and any demarcation are tested. The most innovative team never accepts the problem as such as their starting point, preferring to ask each time: why this question in particular? Why-questions are among the toughest conundrums in science; by their nature, they are explanatory of a phenomenon and not descriptive of it. It is harder to ask the question why something is meaningful than to describe how it is meaningful. When profound questions have to be faced in innovation work, the answer cannot be only on the product level; the solution also takes a stance on its social influence and even its potential impact on human behavior. Social innovations are usually answers to why-questions and to great challenges: in addition to individual solutions, they also take a stance on the general social and philosophical-ethical discussion.

To creative people, why-questions are important: with them, creative curiosity is channeled toward new, unknown regions to discover what is essential in the answer. Core questions also generate far-reaching replies. These are so-called killer questions, which point beyond conventional solutions. In the future, more and more frequently, the race will go to boldly and profoundly phrased questions – not answers that lean on the normal and conventional.

Answering why-questions also creates new experiences for users. Power questions often lead to "killer applications," that is, products and services that change human behavior and the value chain paradigm. Sohrab Vossoughi, Ziba's founder, president, and chief creative director, has said (Vossoughi 2012):

> What Apple offers is an Apple experience. There is no equivalent Samsung experience. Crafting a consistent, compelling experience is extremely difficult. It takes nothing less than company-wide commitment to a purpose and a vision of what the world ought to be like: how it should look, feel, sound, and evolve over time.

> *I send them over land and sea,*
> *I send them east and west;*
> *But after they have worked for me,*
> *I give them all a rest.*
> By Rudyard Kipling, *Elephant's Child* (1902)

When: Flux Versus Flexi

Years ago, in the futurologists' conference, inventor Ray Kurzweil opened a talk by saying: "*Timing, timing – timing*." One of the most important elements of inventions and innovations is their timing: if a product or service is too futuristic, it will be left unexploited; on the other hand, if it is behind the times when it enters the market, it will no longer meet the criteria for innovation as it has no novelty value.

Today we talk about the flux environment of constant change in connection with business and innovation work. This means that long-term planning is almost impossible and that innovation has to be of a flexible, rapid, and agile nature, taking advantage of opportunities opened up by various situations. Reading the signs of the time correctly will rise in importance as a central part of the new creative activity. We will need more and more understanding of the future direction in support of creative product development and innovation work.

In his book *The Act of Creation* (1964), Arthur Koestler wrote about how a creative invention or innovation demands the right spirit of the times, "ripeness," for it to become possible and to win the acceptance of society (Popova 2012):

> The 'ripeness' of a culture for a new synthesis is reflected in the recurrent phenomenon of multiple discovery, and in the emergence of similar forms of art, handicrafts, and social institutions in diverse cultures. But when the situation is ripe for a given type or discovery, it still needs the intuitive power of an exceptional mind, and sometimes a favourable chance event, to bring it from potential into actual existence. On the other hand, some discoveries represent striking tours de force by individuals who seem to be so far ahead of their time that their contemporaries are unable to understand them.

The correct timing of an innovative product and service demands background work and above all vision, without which even the best idea cannot hit the "nerve of the times" and create new markets or reach new users through new needs.

The clock speed of corporate research and innovation work could as well be ahead as behind. Only the most visionary leaders can read and recognize the signs of the times correctly and respond to them in an anticipatory way time after time – mastering flux.

How: Navigating Versus Planning

Maps surround us and guide us – Google Map, GPS location, navigators, personal navigation systems (PNS) – these are all linked materially to travel today, on land, sea, and air. Actually, cartography has become one of the great innovation potentials for the future. Smart phones have put the user in the mobile map hub, unlike in the past, when the central hub of maps was always a fixed geographical spot where everyone wanted to be. Simon Garfield has pointed out (Thorpe 2012):

> The amount of interest in maps and globes at the moment has probably got something to do with the fact that we are all able to find ourselves on maps now at the touch of a screen. – It used to be Jerusalem that was placed at the centre of Christian maps, or in China, it would have been a place called Youzhou. Now for the first time we are all at the centre.

The mapping of the world and voyages of exploration have a long history. There was a time when possession of a map also meant power, like the great seafaring nations and trading cities. Metaphorically, one can also chart the future with voyages of exploration. Like explorers, it is possible to develop skills and knowledge with which to understand and navigate flux and the opportunities of the future. In his book *Futuring: The Exploration of the Future* (2004) Edward Cornish recognizes seven characteristics in the work of explorers which are also significant in probing the future (Cornish 2004).

The seven lessons of the great explorers (as interpreted by the author):

- *Prepare for what you will face in the future*. One cannot forecast the future with certainty, but the more one study the possibilities of the future, the better one is prepared to face it. This applies also to the constant change or flux.
- *Anticipate future needs*. This means to be aware of what kind of competences and capabilities is needed next. Old tools can hardly craft tomorrow's products and services. One should also be aware of the changing environment; what applies today will not necessarily apply tomorrow.
- *Use poor information when necessary*. Fuzzy logic is the essence of creative work; there is no definitive right or wrong answer for many of the questions related especially to radical innovations in their early stage. Creative work is built on possibilities and probabilities.
- *Expect the unexpected*. One should not be afraid of facing the strange and the unknown,

that is, the land or seas of truly creative and revolutionary ideas. The further the distance, the bigger the resistance by mediocrity.

- *Think long term as well as short term.* There should be the good understanding of the life cycle and the impact of solutions – great innovations are also sustainable, they support economic, environmental, and social balance for years to come.
- *Dream productively*. Even super-ideas must have their roots somewhere. They should have good soil for growth potential that will nurture their blossoming. Sometimes grassroots are the best ground for high-growing ideas and their implementation.
- *Learn from your predecessors.* Tacit knowledge is something that cannot be bought with any amount of money. The better the teachers there are, the better the understanding one can develop. Great minds have a lot to give.

Visionary innovation leaders have never respected known borders: they are not afraid to cross the boundaries between sectors, to blend divergent methods together, or to open up new perspectives. They have an inborn ability to integrate different scales, large and small, rational and irrational data, short- and long-term goals, as well as facts and visions. They chart the unknown, in many ways and from many directions, creating a unique, visionary whole. Creative leaders are today's cartographers, whose maps lead one into unknown waters with vision as a beacon. This is why they are trained to meet the challenges of a changing environment and to exploit them – according to the situation and in a timely manner.

> *I let them rest from nine till five,*
> *For I am busy then,*
> *As well as breakfast, lunch, and tea,*
> *For they are hungry men.*
> By Rudyard Kipling, *Elephant's Child* (1902)

Where: Openness Versus Ownership

In the future, research and innovation work will become increasingly open and global as well as decentralized and mobile. This will mean that companies will seek research partners where the best global expertise is found. Decentralized research will also support a new feature of corporate innovation work, that is, close presence and collaboration with its research and product development organizations located around the world. The 24-h clock speed of companies' product development work will require innovation no longer to be concentrated in a single, large research center, but rather it will be operationally fragmented worldwide as needed. Companies will increasingly seek research partners in various "creative centers" – urban innovation hubs, more and more of which will constantly be formed. Future innovation work will also be "brain hunting," in which individual talented people will be found both locally and globally. In all, it will be a matter of optimizing local and global manufacturing and research relative to the available and necessary creative capital.

Open research and innovation work will also necessitate open science, which means open data and open access to data such as transparency of publication as well as citizen science and participatory research. Open science will raise the standard of research, making it more transparent and raising its profile, thus accelerating the development of science as a whole. Ideally, open science will unite the common goals of professional researchers and those of (professional-) amateurs in the form of collaboration for the common good.

Another part of the future's open research and innovation ecosystem will be an open and innovative educational system, which will be geographically within reach of everyone through the Internet (Dizikes 2012).

> "This is the new classroom", as Professor Anant Agarwal, president of edX, said when showing a picture of Mongolian students, studying with the aid of edX online course materials, to the audience at the "Future of Education" conference. EdX is a not-for-profit enterprise of its founding partners Harvard University and the Massachusetts Institute of Technology that features learning designed specifically for interactive study via the web. Along with offering online courses, the institutions will use edX to research how students learn and how technology can transform learning–both on-campus and worldwide.

Both mentally and geographically, research and innovation work can today be done almost anywhere. In China, for example, the future innovation ecosystem is being dynamically developed through such things as redirecting research centers to think tanks. China is also encouraging both social and innovative entrepreneurship more than previously.

Future generations will learn and do research side by side, in a multicultural environment and simultaneously in many places around the world. With the help of the new networked model, teaching and research work will be more efficient and will have greater impact with the same resources. The most important influence, however, will be in the social dimension of the results: how well new innovations serve society and how broadly they affect people's living conditions, behavior, and culture.

> *But different folks have different views;*
> *I know a person small –*
> *She keeps ten million serving-men,*
> *Who get no rest at all!*
> By Rudyard Kipling, *Elephant's Child* (1902)

Who: Mavericks Versus Managers

The strategic application of design – *design thinking* – has gained ground in the past decade, not only in the development of products but especially in the development of service innovations. Companies have created the same kind of processes for design as for product development or manufacturing, in order to integrate and streamline its impact. However, regrettably often this has led to an opposite trend: the narrow-based use of design as one element in assuring a product's attractiveness and quality. Many leading thinkers of design have recently begun to talk about creative capital or creative leadership instead of design management and design thinking. A rising trend is to understand the total significance of creativity in research and innovation work: in ideation, research, processing, implementation, and even use. Creativity with all its dimensions is the connecting thread running through all innovation development.

The Creative Industries KTN in the UK has carried out extensive research on future priorities in innovation from the perspective of Britain's competitiveness. The research focuses in particular on the growing importance of experience-led innovation which is based on a deep understanding of human behavior and its drivers (The Creative Industries 2012).

Experience-led innovation is based on the notion that the producer of an innovation and/or designer takes first responsibility for designing a product or service. This takes place by deepening the understanding and vision of what people really expect from the future, but which they are not yet able to recognize and express explicitly. Experience-led innovation plumbs deep waters, seeking answers with the help of all six "honest serving men": the questions what, why, when, how, where, and who.

Today design is understood as a central, essential part of innovation, not only for consumer goods but also for many B-to-B products. Technology alone is no longer enough of a competitive edge – instead, companies stand out from the competition primarily through high-end design. Also in user interfaces and in the user experience, design plays a central and constantly growing part. When demand intensifies between well-designed technology products, it can already be seen that even design is no longer enough on its own to differentiate the product and make it desirable in the eyes of the user. This sparks the question: what next?

John Maeda, President of the Rhode Island School of Design, has recently stated how the requirement for good design will expand "beyond" the potentialities for design in the future and how the next vital innovation factor will be art – or rather the uncompromising stance of artists, creative individuals, and their passion for their work, reflecting their profound values continuum and their strong commitment. Maeda has said (Maeda 2012):

> But what people want today goes well beyond technology and design. They don't just want four wheels and a means to steer, or to be surrounded by music and information wherever their eyes and ears may roam. What people are looking for now is a way to reconnect with their values: to ground how they can, will, and should live in the world. – The innovation now needs to occur elsewhere. Outside the design. Into, quite frankly, the world of art.

According to research called *Artistic Interventions for Innovation* (2012) in the CreativeClash program carried out by the European Union, artistic intervention has a generally positive impact on innovation and especially in the following three cases:

- *Developing services, products, and processes innovation*: disruptive thinking, creative approaches, and new methodologies of interaction generate new ideas.
- *Supporting social innovation*: improving social relations among employees and enhancing new skills contribute to creating better working conditions, social cohesion, and inclusion.
- *Rethinking ways of relating to users and communities*: artistic processes help identify or refine corporate culture and values, supporting the development of creative communication strategies.

But above all, the passion and unremitting stance of creative individuals is the factor that makes the difference. Creative individuals' desire to ask tough questions and to find tough answers – their ability to seek the truth is unmatched. Maeda describes this complexity as follows (Maeda 2012):

> Designers create solutions – the products and services that propel us forward. But artists create questions — the deep probing of purpose and meaning that sometimes takes us backward and sideways to reveal which way "forward" actually is. The questions that artists make are often enigmatic, answering a why with another why. Because of this, understanding art is difficult: I like to say that if you're having difficulty "getting" art, then it's doing its job... The artist needs to understand the truth that lies at the bottom of an enigma... Art speaks to us as humans, not as "human capital." Art shows us that human beings still matter in a world where money talks the loudest, where computers know everything about us, and where robots fabricate our next meal and also our ride there. Artists ask the questions that others are afraid to ask and that money cannot answer.

According to the current concept and practice, innovation is not exclusively produced by engineers – it is a joint development (co-creation) by engineers, designers, and researchers, a multidisciplinary team of science and economy. In the future, this multidisciplinary sphere of innovation will also include artists and independent, creative individuals with the ability to see intuitively into the future, to build a vision and to navigate there, at the same time serving as a catalyst in transforming the innovation culture. Future innovations will be made in a genuine multidisciplinary environment, in the nexus of art and science, technology and design, and natural sciences and anthropology, where ideas that transform the world and our understanding of it will be enriched and refined.

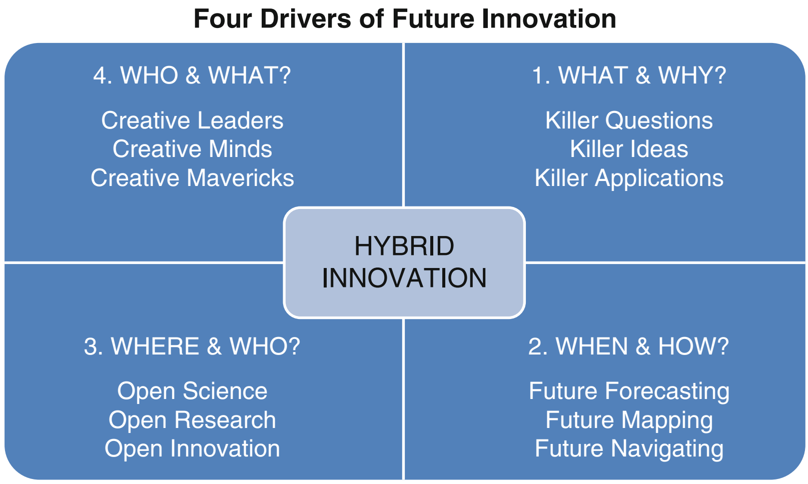
Because of the extensive availability of data (everyone has access to the same data), competition over ability and talent (editing and application of data) will intensify in innovation. In reality, we are already moving on from an information-based innovation system to a talent-based system. It has been found in many contexts that competition for talent will be the core of innovation work in the future, as innovation will tomorrow be primarily the work of pioneers – mavericks, who are independent thinkers and incorruptible visionaries. They will open the window to the unknown and take development forward. They will be at once interpreters and cartographers of the future. Many artists are by nature independents of this kind, going their own way, rather difficult members of the working community – but they are essential to innovation precisely because of their bold characters and visionary attributes. As Bob and Gregg Vanourek has said (Vanourek 2012):

> Mavericks are the independent innovators or performers – often quirky – who do not run well with others. They think and act differently. Many mavericks take mischievous delight in shaking things up... Mavericks can be exceptional innovators, critical in our ultracompetitive world.

> *She sends 'em abroad on her own affairs,*
> *From the second she opens her eyes –*
> *One million Hows, two million Wheres,*
> *And seven million Whys!*
> By Rudyard Kipling, *Elephant's Child* (1902)

Future: **Six Honest Answers**

Many successful innovations of the future will be social by nature – meaning that they will have



Innovation in Business: Six Honest Questions, Fig. 1 The hybrid innovation model. Four drivers of future innovation based on the six honest questions (Source: Anne Stenros 2012)

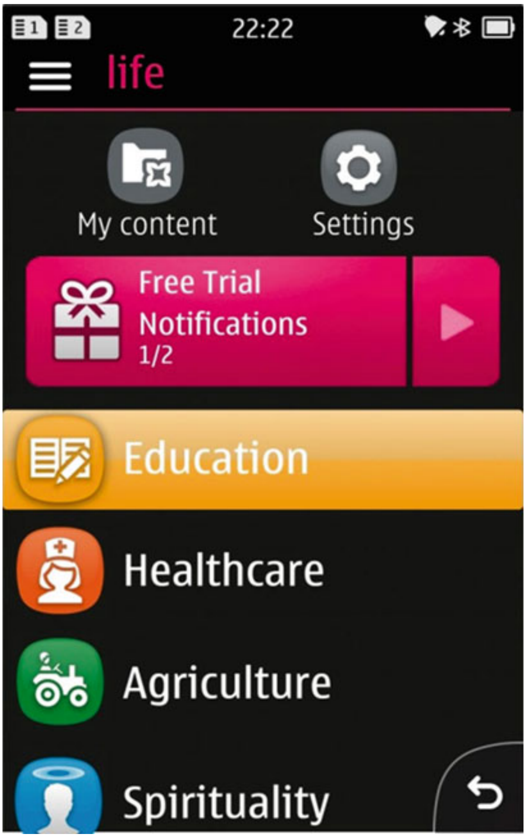
a significant impact on society. Tomorrow's innovations will be sustainable in nature – that is, they will change human behavior and habits for the better and improve the quality of life. Significant innovations of the future will also be the best examples of transformation between technology and art, science and art – they will be not only of instrumental value to their users but their significance will itself be greater than their practical value.

However, the most important innovations of the future will most often be hybrid models, in which, for example, collaboration between art and technology or art and science generates a social innovation. These hybrid innovations will also provide a solution to the great global challenges: environmental questions, the trend in urbanization, food and water supply, and renewable energy sources. Hybrid innovations will also in general answer all six honest questions – with profound and honest answers (Fig. 1).

Of the social innovations made possible by technology, more and more will come from the bottom of the "pyramid," that is, from developing countries and from the needs of their populations. A good example of this is the Nokia Life service (2009), which featured India-focused, hyper-local, SMS-based service and content production for people in developing countries. The service is intended for the 1.2 billion people who do not have phones with data communication capability. The basic idea of the service is that access to information and data supports and makes it possible to improve people's lives and living conditions. The starting point is content-driven design and the aim is to create social experiences around increasing and distributing information.

Nokia Life services involve education, health, agriculture, and entertainment. The service producers include local ministries, NGOs, and international specialist organizations. A mobile phone gives the user access to learning content for school grades and English and local information about various everyday matters such as health, weather conditions, and selling prices of agricultural produce. The service does not aim to make a profit, and income is ploughed back into further developing the service. The innovative service now has some 80 million users in India, China, Indonesia, and Nigeria (Fig. 2).

A classic example of an innovation spanning the boundaries of modernity, technology, and art is the BMW Art Car concept dating back to 1975. What began as a one-off artistic experiment by Hervé Poulain has grown into a considerable collection over the decades. Poulain, who was enchanted by speed and its beauty while taking part in races at Le Mans, first invited four artist friends – Alexander Calder, Frank Stella, Roy Lichtenstein, and Andy Warhol – to paint BMW racing cars. Since then, artists including Ernst Fuchs, Jeff Koons, and Olafur Eliasson have added their visions of speed to the BMW Art Car collection. The end result is the



Innovation in Business: Six Honest Questions, Fig. 2 Nokia life tools (Photo credit: Nokia)

transformation of a practical object into a work of art – the conversion of concrete into conceptual, everyday into timeless, and technology into pure art. In its essence, the Art Car – concept is all about humanizing technology – giving a face and personality to the anonymous (BMW Classics 2010) (Figs. 3, 4).

A good example of a new kind of pioneer, an independent creative, is artist/designer/inventor Thomas Heatherwick, whose diverse output is astonishing in its innovativeness. Heatherwick combines technical wizardry with artistic vision and functional implementation in an extraordinarily interesting way. A famous example of his work is the sculpted, rolling bridge; the aim of which is to make movement itself a particular feature of the bridge (Fig. 5).

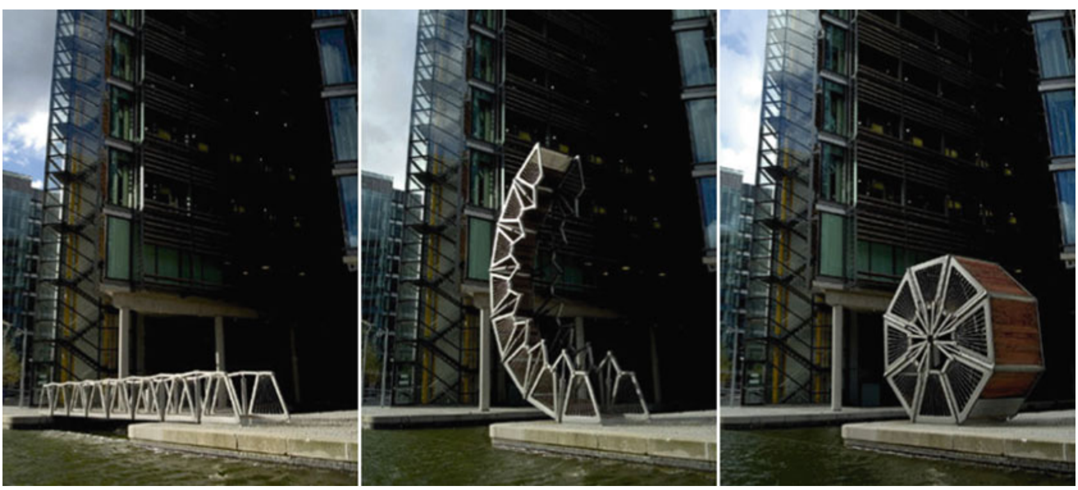
Multidimensional innovations may appear just as much among services as in products. The world-famous chef Ferran Adrià, who is renowned for his experimental cuisine and creative cookery, has started the elBulli Foundation in connection with his restaurant – "a centre of innovation allied with digital technology that would rethink haute cuisine in a way that would offer other creative endeavours a road map for innovation." According to Adrià, in cooking as in business or art, there is no process without an idea. The foundation focuses on understanding the nature of creativity and its fundamental question: where do ideas come from, and how do we best foster them? As Adrià has said it by himself, "Creativity is important. Innovation is also important. But the capacity to transform yourself is even more important" (Williams 2012).

Adrià's work has always been characterized by experimentation and a radically innovative take, and this has made him a leading name in his field. In accordance with its character, an innovation center must break barricades: Adrià aims to unite science and art and philosophy and technology "into a creativity-generating universe," which will yield today's most valuable raw material: creativity and talent. In accordance with the experience of the elBulli restaurant, operations are guided by five subdivisions: organization, philosophy, products, technology, elaboration, styles, and characteristics (Williams 2012) (Fig. 6).

A pioneer of the future's multidimensional hybrid innovations is *Little Sun*, a small and simple portable flashlight using solar energy, which is also an everyday art object. The lamp was designed by artist Olafur Eliasson, who is famous for his treatment of light in his works. *Little Sun* is intended particularly for conditions in developing countries where grid electricity is not available. The object combines the latest LED technology and artistic vision in a way that creates something new. The lamp makes it possible to work and read after sundown without electricity, which is beyond the reach of one fifth of the human race. Eliasson believes his Little Sun can change these people's lives in a positive way. A 5-h charge in sunlight provides 5 h of light in darkness (Fig. 7).

Innovation in Business: Six Honest Questions, Fig. 3 BMW art car by Alexander Calder (1975). The first car in the collection. *I am crazy about beauty and speed*. –Hervé Poulain (Photo Anne Stenros)

Innovation in Business: Six Honest Questions, Fig. 4 BMW Art Car by Sandro Chia (1992). *You can see the beauty of the car and yourself reflected in the surface. It is an interchange of beauty*. –Sandro Chia (Photo Anne Stenros)



Innovation in Business: Six Honest Questions, Fig. 5 Rolling bridge by Heatherwick Studio, London, UK (Photo credit: Steve Speller)

Innovation in Business: Six Honest Questions, Fig. 6 The Ideario of elBulli Foundation by architect Enric Ruiz-Geli. Costa Brava, Spain (Photo credit: Enric Ruiz-Geli)

Innovation in Business: Six Honest Questions, Fig. 7 Little Sun lamp by Olafur Eliasson (Photo credit: Little Sun)

Eliasson himself replied in an interview in The Guardian to the question of why he got started on this social innovation project (Higgins 2012):

> Art is always interested in society in all kinds of abstract ways, though this has a very explicit social component. The art world sometimes lives in a closed-off world of art institutions, but I still think there's a lot of work to show that art can deal with social issues very directly... People want beautiful things in their lives; they want something that they can use with pride . . . everyone wants something that's not just about functionality but also spirituality.

Little Sun superbly and profoundly answers the six honest questions:

What – a light for life

Why – improving the quality of life and inspiring to change

When – extending the hours of daylight in darkness by enabling more time for daytime activities

How – by transforming technology through art into an object of delight beyond its practical use

Where – giving access to light in areas not on the power grid

Who – to be used by those who are in the bottom of the pyramid, in this case 20 % of the world's population

As Olafur Eliasson sums up by himself: "An artwork is never just the object; it is also the experience and its contextual impact, how it is used and enjoyed, how it raises questions and changes ways of thinking and living. The same is true of Little Sun."

Future innovators will be creative leaders, creative individuals and creative mavericks who make their visions a beacon to others so that we can guide ourselves toward a better tomorrow for individuals and communities alike. Their role is to keep the light of creativity alive.

> *It is also a way of using the Little Sun to guide yourself, as*
> *if it were an eye*. – Olafur Eliasson

Conclusions and Future Directions

In today's world, the future is mostly unpredictable. However, the further we look, the better we will understand the transformation we face. The complexity of the everyday and great challenges calls for increasing creativity in solving problems sustainably. A new breed of hybrid innovations is emerging from demanding surroundings: responsible innovations which are capable of answering all the questions. In the future, art and science will bridge the gap between two different ways of seeing the world – and solve the problems of coexisting for the benefit of all. Creative industries will have a stronger say than ever before in building a better future and well-being. More artist-innovators – Leonardos of today – are on the way.

Cross-References

- ▶ Artistic Research
- ▶ Cognition of creativity
- ▶ Creative Leadership
- ▶ Creative Personality
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity Definitions, Approaches
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Creativity in Invention, Theories
- ▶ Divergent Versus Convergent Thinking
- ▶ Female Entrepreneurship
- ▶ Innovation and Democracy
- ▶ Innovation and Entrepreneurship
- ▶ Interdisciplinarity and Innovation
- ▶ Invention Versus Discovery
- ▶ Method for Creating Wisdom from Knowledge
- ▶ Multiple Models of Creativity
- ▶ Science of Creativity
- ▶ Social Innovation
- ▶ Strategic Thinking and Creative Invention

References

Artistic Interventions for Innovation. Policy paper. CreativeClash. 2012. http://www.creativeclash.eu/category/news/. Accessed 13 Oct 2012.

Bell K. Life's work: Frank Gehry; an interview with Frank Gehry. Harv Bus Rev, The Magazine, November 2011. http://hbr.org/2011/11/frank-gehry/ar/1 (2012). Accessed 8 Sept 2012.

BMW Classics. BMW classic live special: BMW art car collection 1975–2010. Germany: BMW Classics; Sept 2010.

Cornish E (2004) Futuring: the exploration of the future. World Future Society, Bethesda, p. 7.

Dizikes P. Innovation in the classroom. MIT News, 21 Sept 2012. http://web.mit.edu/newsoffice/2012/inauguration-future-of-education-symposium-0921.html. Accessed 24 Sept 2012.

Higgins C. Olafur Eliasson produces cheap solar lamp for developing countries. The Guardian, Thursday 12 July 2012. http://www.guardian.co.uk/artanddesign/2012/jul/12/olafur-eliasson-cheap-solar-lamp. Accessed 26 Sept 2012.

Johnson NE (ed) (1975) Light is the theme: Louis I. Kahn and the Kimbell Art Museum. Kimbell Art Foundation, Fort Worth, p. 69.

Kipling R. Just so stories: The elephant's child. A poem. The Kipling Society. 1902. http://www.kipling.org.uk/poems_serving.htm. Accessed 13 Oct 2012.

Maeda J. If design's no longer the killer differentiator, what is? Wired Opinion, 21 September 2012. http://www.wired.com/opinion/2012/09/so-if-designs-no-longer-the-killer-differentiator-what-is/. Accessed 26 Sept 2012.

Popova M. The role of "ripeness" in creativity and discovery: Arthur Koestler's seminal insights, 1964. http://www.brainpickings.org/index.php/2012/08/08/koestler-the-act-of-creation/ (2012). Accessed 14 Oct 2012.
The Creative Industries. Five key themes. 2012. http://creativeindustriesktn.org/beacons/cx/view#262697. Accessed 13 Oct 2012.
Thorpe V. From shopping to warfare, why maps shape our minds as well as our planet. The Observer, Saturday 22 September 2012. http://www.guardian.co.uk/science/2012/sep/22/why-maps-shape-our-minds. Accessed 14 Oct 2012.
Vanourek B, Vanourek G. Is the Maveric at your company a genius or a jerk? FastCompany, 25 September 2012. http://www.fastcompany.com/3001535/maverick-your-company-genius-or-jerk. Accessed 27 Sept 2012.
Vossoughi S. The way forward for Samsung, and innovation. Harv Bus Rev, HBR Blog Network. 2012. http://blogs.hbr.org/cs/2012/09/the_way_forward_for_samsung_an.html. Accessed 8 Sept 2012.
Walter H. The seven deadly sins that choke out innovation. Co.Design, FastCompany. 2012. http://www.fastcodesign.com/1663192/the-seven-deadly-sins-that-choke-out-innovation. Accessed 13 Oct 2012.
Williams G. Ferran Adrià, staying creative. Wired, UK Edition, October 2012. p. 100–109.

Innovation in Defense Technologies

Guy Ben-Ari
Defense Industrial Initiatives Group, Center for Strategic and International Studies, Washington, DC, USA

Synonyms

Defense technology; Military technology

Introduction

Innovation in defense technologies has traditionally been both a driver of invention, creativity, and entrepreneurship and a beneficiary of these. Technology and knowledge acquired in the development of defense goods, services, and processes were critical elements in the development of commercial technologies, and civilian innovations have contributed greatly to new defense technologies (Ruttan 2001). This entry covers the topic of innovation in the context of defense technologies. It will first briefly discuss defense innovation as a public good. It will then present the concepts of "demand pull," "technology push," "spin-off," and "spin-on" in a defense innovation context. Lastly, this entry will use these concepts to present two models for thinking about innovation in defense technologies. Note that this entry does not cover social innovations for national defense, i.e., innovations in the way defense establishments organize for and fight wars, as expressed in their organizational structures and in military doctrine, strategy, or tactics.

In discussing innovation in a defense context, it is important to accept that national defense is to a great extent an exceptional case in economics and public policy. As an almost pure public good, defense is nonrival (consumption by some does not leave less for others) and nonexcludable (nobody can be excluded from consuming it). As a result of the free-rider problem that exists for all public goods, public investment is a key element in the provision of national defense, and this also holds true for defense innovation. In effect, the benefits of an innovation that contributes only to national defense will not be captured by the entity delivering it. Furthermore, since the ability and legal right to acquire and wield military capabilities reside almost exclusively in national governments, the customer base for defense technologies, and therefore also of the creative and entrepreneurial processes that deliver them, is very limited. Essentially, the market for innovation in defense technologies is a monopsony with buyers almost completely dependent on – and reactive to – the end customer (Dombrowski and Gholz 2006).

"Demand pull" refers to the desire of users of defense technologies – whether they are national governments or nonstate actors – to access technologies that will contribute to achieving swift and decisive victory against an adversary. Ideally, these are technologies that an adversary is not aware of and/or cannot defend against,

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thereby creating what Lorber has termed "technological surprise" (Lorber 2002). However, such groundbreaking technologies are few and far between, and the more common demand is for defense technologies that will improve an organizations' ability to conduct its defense missions. "Demand pull" may also occur as a result of intelligence gathered on the capabilities of adversaries, which could require that new countermeasures be developed (Rosen 1991). The entity requesting the capability is often also the one that funds its development, and it is most likely to turn to technology suppliers that it has relied on in the past.

"Technology push" is the process by which new technologies are proposed to potential end users by the entities that developed them. For defense technologies, these entities can be organizations that have a history of supporting the defense establishment, such as defense companies or government laboratories, or entities that have generated a capability for a different customer but have also identified potential defense applications for it, such as individual inventors or companies developing commercial goods and services.

"Spin-off" occurs when technically sophisticated defense technologies are developed (often in parallel to institutional innovations), and the know-how accrued in their development is utilized in the development of goods, services, and processes for commercial purposes. "Spin-on," on the other hand, refers to the process in which civilian innovations are transferred to military applications. It is worth noting that the question whether defense spin-offs to the civilian technology base enhance economic growth or whether spending on defense innovation is a net cost due to its high opportunity costs and the ability to spin commercial technologies for military uses continues to be hotly debated in the literature.

Using the concepts discussed above and keeping in mind the public good nature of defense overall and defense innovation in particular, two basic models for innovation in defense technologies can be constructed. The first is the linear model, whereby a novel product, service, or process that is intended for military use is researched, developed, tested, and marketed to a military customer. The second is the nonlinear model, in which during testing or deploying of an existing product, service, or process – either military or commercial – a different application for use in defense is identified and explored.

The linear model of innovation for national defense has been observed throughout history but has been particularly prevalent in the decades after World War II with the rise of large-scale government defense research and development (R&D) establishments. The model fosters an innovation process that begins with basic or applied research, evolves into technology development and testing, and eventually delivers an end result to the customer which is deployed and disseminated within the defense organization. Key actors in this model are government laboratories and companies that make up the defense industrial base as well as certain research universities. Under this model, innovation can be initiated through a technology push by entrepreneurial innovators or demand pull from defense customers. This type of defense innovation is capital intensive and therefore usually funded either directly by national defense entities or indirectly through independent R&D (IR&D) of the institutions in which it is conducted. In the past few decades, it has resulted in innovations such as nuclear weapons, satellites, and stealth technology, as well as in commercial spin-offs such as jet engines and airframes, satellites, robotics, digital displays, and nuclear power.

The nonlinear model of innovation for defense purposes is also centuries old. It initiates innovations relevant to defense technologies at later stages of the innovation process (i.e., during testing and after deployment in the field as opposed to the R&D phases) and in institutions and disciplines that are not funded by defense establishments or by defense firms. In recent decades, many innovations in this model emerge from the global commercial marketplace in areas such as communications, sensors, cyber security, data fusion, and data management. As the commercial world demands higher performance and sophistication and reduces the life cycles of products, both the rate and the quality of nondefense innovation are constantly improving. Nonlinear innovations are also increasingly appearing in the hands of users, i.e., the soldiers who are issued a new capability – military or commercial – and utilize it in a way that is different from its original intent. This model presents more instances of spin-on than spin-off and more examples of radical innovation than incremental innovation (Boot 2006). The steam engine, the telegraph, the internal combustion engine, radio, the automobile, and the airplane are all examples of nonlinear innovations that originated from outside formal defense establishments yet resulted in breakthrough defense technologies. Many such nonlinear defense innovations were converted into defense technologies as a result of technology push on the part of their entrepreneurial developers, but demand pull is not uncommon either; formal defense entities have often recognized the military potential of commercial innovations and initiated processes to integrate them.

The policy implications for practitioners and students of innovation in defense technologies are different for each of the two models. For the linear model, the key policy challenge currently requiring attention is that of the increased complexity associated with providing innovative defense technologies via a linear process. While current and future security threats across the globe have created an appetite for increasingly complex R&D programs to deliver the next generation of defense capabilities, technology has evolved at a higher pace than have the policy frameworks and the management tools that are needed to bring R&D programs to successful fruition. As a result, defense innovation attempted under the linear model in recent years is costing significantly more and taking significantly longer to the point where it is no longer economically viable (Ben-Ari and Zlatnik 2009). This is not a new phenomenon; there has in the past been tension between the increasing complexity of required defense technologies and the policy and management tools available to provide them. To resolve this tension, new policy frameworks, governance models, and management structures were introduced that enabled organizations to advance to the next level of complexity. For example, the US Navy developed the Gantt chart to build the ships of World War I and PERT (the Program Evaluation and Review Technique) in the 1950s to help manage the Fleet Ballistic Missile program. However, the defense innovations that have been under development in the past 20 years or so require new policy frameworks and management models if they are to be completed within the time frame and budgets allocated to them and in a manner that is relevant to the military customer.

For the nonlinear model of innovation in defense technologies, the important policy challenge of the day is to identify and support innovations and innovators that are relevant for defense yet who emerge either in unexpected phases of the defense innovation process (e.g., within the testing, evaluation, and end-user communities) or outside the defense community altogether. Examples of the former include German soldiers in World War II using 88-mm antiaircraft guns as antitank weapons, the conversion of the C-130 cargo aircraft into the AC-130 ground attack aircraft during the Vietnam War, and, more recently, Canadian soldiers in Afghanistan intentionally driving their main battle tanks over improvised explosive devices, thereby using them as crude mine-sweeping tools. Examples of the latter include the use of smart phones as navigation and positioning devices and social networks as communications and knowledge-sharing tools in numerous militaries during operations in Iraq and Afghanistan. Such harvesting and reuse of military and commercial technology to generate innovative defense capabilities currently do not regularly occur at a formal, institutionalized level. Yet, the advent of what has recently been referred to as the BRINE revolutions, i.e., breakthrough technologies in biotechnology, robotics, information technology, nanotechnology, and energy, means that even more innovations with relevance to defense will be available for those militaries smart and fast enough to incorporate them into their arsenals (Wells 2012). Similarly, the increase in user-centric innovation (Van Hippel 2006) is not bypassing the military, and soldiers now have more ability than ever before to put both military and commercial technologies to use in innovative ways, essentially becoming inventors and technology entrepreneurs on the battlefield. The challenge for defense policymakers is to create an environment that fosters the harvesting of new commercial innovations and the creative redeployment of existing military technologies.

Conclusion and Future Directions

Ultimately, however, the most groundbreaking technology innovations for defense will not in and of themselves confer victory to the forces wielding them. If there is one consistent lesson that the history of defense innovation teaches, it is that without the social innovations discussed at the beginning of this entry, i.e., innovation's organizational structures, military doctrine, strategy, and tactics, innovations in defense technologies will be ineffectively utilized and sometimes not utilized at all. For example, during World War I, the British were the first to develop and use tanks but did so in small numbers and without adjusting their military doctrine accordingly; it was the Germans in the years before World War II who recognized the full potential of their adversary's innovation and innovated their own defense strategy to accommodate what by then was a well-known military technology. Thus, the military advantage gained from an innovative defense capability may go to the fastest adopter of the innovation and not to its first user. In addition to addressing the innovation challenges outlined above, defense policymakers will also need to tackle the issue of implementing organizational and cultural change to successfully incorporate new products, services and processes in their defense establishments.

Cross-References

- ▶ Corporate Entrepreneurship
- ▶ Models for Creative Inventions
- ▶ Political Leadership and Innovation

References

Ben-Ari G, Zlatnik M. Framing the complexity challenge. In: Ben-Ari G, Chao P, editors. Organizing for a complex world: developing tomorrow's defense and net-centric systems. Washington, DC: Center for Strategic and International Studies; 2009.

Boot M. War made new: technology, warfare and the course of history. New York: Gotham Books; 2006.

Dombrowski P, Gholz E. Buying military transformation: technological innovation and the defense industry. New York: Columbia University Press; 2006.

Lorber A. Misguided weapons: technological failure and surprise on the battlefield. Dulles, VA: Brassey's; 2002.

Rosen SP. Winning the next war: innovation and the modern military. Ithaca: Cornell University Press; 1991.

Ruttan V. Technology, growth and development: an induced innovation perspective. New York: Oxford University Press; 2001.

Van Hippel E. Democratizing innovation. Cambridge: MIT Press; 2006.

Wells L. Tech changes affect U.S. security. Defense News, 22 Jan 2012.

Innovation in Forestry: New Values and Challenges for Traditional Sector

Gerhard Weiss
Department of Economics and Social Sciences, University of Life Sciences and Natural Resources, Vienna, Austria
European Forest Institute Central–East European Regional Office (EFICEEC), European Forest Institute, Vienna, Austria

Synonyms

Forest sector; Innovation policy; Innovation systems

Forestry as a "Future Sector"

Forests are known to produce timber in the first place, and this is also the main income source for most forest owners. At the same time, it is also widely known that forests provide many more benefits to society: They provide landscape amenities and opportunities for recreation; they conserve biodiversity and protect environmental features; they deliver clean water and offer protection against natural hazards such as landslides, rockfall, or avalanches; and last but not least, they are a source for renewable energy and are an important means to mitigate climate change through their ability to sequester carbon. All of these goods and services, in fact, are increasing in significance. It seems that the image of forestry is currently changing from a quite traditional and declining sector to a "future sector" which offers solutions to a range of challenges that our society is facing today. Innovation plays a key role in making the sector able to fulfill this promising role.

What this entry aims for is to understand current innovation processes in the sector, including supportive and hampering factors, institutional conditions and drivers, the relevant policies and innovation systems, and success and failures.

Relevance and Innovation Fields

In order to understand innovation processes, it is necessary to look at spatial and sectoral, individual, and institutional factors. In the case of forestry, there are specific features that characterize the sector as well as condition the related innovation processes (Weiss et al. 2011a). In respect of the spatial dimension, there are at least two specifics to be considered: First, forestry production is dependent on the natural site conditions and mostly takes place in rural areas. Second, some of the forest products are territorial goods and services in that sense that they carry the very place of production as a strong characteristic. While timber is (normally) a commodity which is traded globally and uniformly, other ecosystem services of forests are bound to the site of production: This is true, for instance, for some recreational services where the experience is connected to a certain landscape, and it is true for protective services when a certain forest protects the neighboring field from wind erosion. The marketability of forest-based territorial goods and services is often limited, a fact which makes business difficult but all the more call for innovation on institutional or policy level. The many forest-based value chains differ strongly, whether regarding, for example, the traditional timber construction that does not look so traditional any more today or the recent rise of the energy production on the basis of renewable sources that is still undergoing fast technological changes. Forestry and the forest-based industries thus look very colorful, particularly when studying innovation.

Relevance of Innovation in the Forest Sector

The study of innovation in the forest sector is relevant in several respects: First of all, as in any other sector, international competition is growing also in the forest-based industries. Steady innovations are crucial to keep pace with global competitors, in terms of costs and quality. Another aspect is that the forestry sector – providing a range of ecosystem services and amenities – contributes to the quality of life in rural areas. Furthermore, forest-based products (including energy) use renewable sources and, therefore, contribute to the sustainability goals that are formulated in many policies. The forest sector also provides income and employment opportunities in rural areas, which often face a decline in their economic significance. This in turn relieves urban areas from migration pressure and provides health and recreation to all citizens.

These particular roles of the forest sector are increasingly recognized by policy makers and included in policy programs. The new interest in renewable energy sources and renewable materials comes from various policy fields, and the related opportunities are often not yet seen so clearly by actors within the sector. Ironically, forestry actors continue to praise the many benefits that forests provide to society but often do not see the new opportunities that arise from nature conservation policies, integrated rural development, sustainable development, climate change mitigation, and many others. It can be said that forestry and the forest-based industries play an important role in rural economies and have a strong potential to contribute to a sustainable global future, particularly in the following fields:

- Recreation and tourism
- Nature protection, biodiversity conservation, and landscape amenities
- Protection against natural hazards and erosion and protection of clean drinking water
- Bioenergy production and climate change mitigation
- Bio-based products, including food, fibers, chemicals, and wood construction

The forest sector is often considered as a mature, "low-tech," and declining industry. With the notion that our economy changes into a service economy and that our society changes into an information society, research and high tech receive a high level of attention in the media, in the public, and in policy as if they were the only source for economic growth and innovation. This is not true (Hirsch-Kreinsen and Jacobson 2008): Studies show that low- and medium-technology sectors still play a major role for employment and growth. Although these sectors invest less in research and development, they are still relevant for innovation. Innovations in mature sectors occur in different forms. Wood processing industries, for example, use sophisticated technologies in their production. By this, they are important also for the future development of information technologies. In other fields, for instance, in the production of berries and mushrooms, innovations rather come from new networks, organizational forms, or marketing methods and are important even without any connection to high technologies. We will further see that – being a sector with high social and environmental importance – institutional innovations play an important role in forestry. This is, however, not yet clearly seen by policy makers (Weiss et al. 2011a).

State of Research

There is a broad range of aspects that are highly relevant for the study of innovation and that have been studied in the field of forestry (Weiss 2011). On personal level, several aspects had been studied in forestry, such as value systems, entrepreneurial orientations and business goals of forest owners, and the diffusion of innovation, for example, in Scandinavia and Central Europe. A considerable body of literature exists on the financing and marketing of forest ecosystem services (timber and non-timber forest goods and services), in particular but not exclusively in southern Europe. In respect of organizational innovations, especially the role and function of forest owners' associations was studied. The supporting and hampering factors in the innovation processes and the contribution of forestry to rural development were studied from innovation systems and regional governance approaches. The role of different actors, networks, and clusters were studied for territorial goods and services and wood value chains.

Research that specifically addresses innovation processes in the forest sector started rather recently. In Europe, a strong push was given by the work program of an innovation-oriented research group within the European Forest Institute (Rametsteiner et al. 2005) and by two recent COST Actions (COST is a European program for connecting researchers within certain thematic "actions"). The COST Action E30 on the "Economic integration of urban consumers' demand and rural forestry production" gathered researchers from the field of innovation and entrepreneurship in forestry and the forest sector and was especially dedicated to entrepreneurship aspects of small-scale forestry, the multifunctional use of forests, as well as the timber and wood industries (Niskanen et al. 2007). The COST Action E51 "Integrating Innovation and Development Policies for the Forest Sector" particularly looked at the policy dimension of innovation (Rametsteiner et al. 2010) and at the innovation processes on the ground (Weiss et al. 2011a). It covered the two major production fields: territory-based goods and services (the provision of recreational services, non-wood forest products, and carbon sequestration) as well as wood-related production chains (furniture, timber frame housing, bioenergy, and timber harvesting operations) and included institutional and instrumental aspects (networks, clusters, forest owners' associations, and the European Union LEADER instrument for rural development).

Currently Important Innovation Areas

Currently, important innovation fields in forestry are found within territorial goods and services and in wood-related production chains. According to an expert survey in 18 European countries (Weiss et al. 2010), new wood products are developed in the fields of bioenergy, wood construction, and wood modifications. Bioenergy production in various forms – including solid wood, biofuel, and biogas – is the innovation field that yields highest attention. Within territory-based services, different ecosystem services of forests are important, particularly environmental services and recreational and educational services. New recreational services such as guided tours or hiking or biking trails seem to be the most important in terms of frequency although it has to be noted that they are in most cases not so much developed for profit but rather because of external pressure (Rametsteiner et al. 2005).

There are important differences between the two innovation fields: Within the wood value chain, process innovations (new harvesting technologies, use of ITC, logistical rationalization, as well as prefabrication and modular systems in the timber industry) as well as organizational novelties are important in the countries (horizontal and vertical cooperations and cluster initiatives). While in the field of wood production, horizontal and vertical cooperation can be solved among firms, for territorial services institutional innovations such as regional cross-sectoral coordination processes seem of particular importance. It seems that for territory-based services, the coordination of actors is more complex and needs activities on institutional level. The significance of regional cross-sectoral coordination mirrors the challenge of how to organize the provision of territory-based services which often has to involve many providers (landowners) and users (e.g., tourism).

Forestry Innovation Systems

From several studies of innovation processes and policies on institutional and firm levels, we are able to characterize typical forestry innovation systems. They can largely be described as sectoral innovation systems in that they are strongly governed by sectoral actors and policies. Only in countries such as Finland, where the forestry sector is perceived as contributing significantly to the GDP, forestry and forest-based industries are recognized by the national innovation systems. Furthermore, regional innovation systems are highly relevant, particularly when it comes to territorial goods and services, but this is hardly realized by the relevant actors – both from outside and inside forestry.

Unfortunate Frame Conditions for Forestry

The preconditions in forestry are not supportive of innovations. The one main important obstacle to innovation is the high fragmentation of forest ownership in many countries. The average size of private property is very small in many European countries, often below 10 or below 20 ha. This implies that the income from forests is negligible or at least not the main income source for many forest owners. Very few owners actually work full time in forest management; most owners do not even have any relevant education or training.

According to a survey of forest holdings in Central Europe (Rametsteiner et al. 2005), practically all of the work in forest holdings <100 ha is done by family members, of whom virtually nobody works full time in forestry. In small forest properties, forest work is usually not outsourced. There are strong indications that forest work remains simply undone if family members do not find the time. It is evident that these owners hardly develop any innovative management approach for their forest property, even if they would be highly innovative in their main occupation. Even in farm forests, there is seldom an innovative attitude toward their forests when the main farm product is from agriculture. A large majority of forest owners thus have one simple goal, namely, to maintain their forest (Rametsteiner et al. 2005). On the other hand, only very few people intend to abandon forestry altogether or to sell their property.

Innovation Activity in Forestry

The described unfortunate conditions in forestry result in a rather negative picture with regard to the overall level of innovation activity in the sector: Particularly in small forest holdings, there is little innovation activity, innovations are mostly incremental, and there is hardly any start-up activity in the sector (Rametsteiner et al. 2005). When looking more into detail, however, there are a few remarkable facts that show a more positive picture: Larger forest holdings (>500 ha) are as dynamic as an average EU manufacturing SME. Furthermore, forest owners in many countries have, at least verbally, an entrepreneurial orientation. This implies that forest owners or managers are not by themselves unwilling to innovate (a widely held opinion) but that it is more due to the framework conditions. Given the right conditions, forest owners are possibly more prepared and willing to actively pursue market opportunities through innovative approaches than national policy makers often consider them to be. This result then also implies that the right policy measures might be able to successfully change the situation. In the following, we will see that the innovation systems, however, are not well prepared to support innovations in forestry.

Weak Support from the Institutional System

A range of weaknesses are found with regard to the forestry innovation system and related policies (Rametsteiner et al. 2005): First of all, the national innovation systems usually do not include forestry matters. There are hardly any interactions between forestry actors and actors dealing with existing national innovation policies. But also within the sector, there are usually no comprehensive innovation policies formulated. Furthermore, the group of institutions, which is active in innovation-related matters, is usually very small and restricted to the forestry field. Often, as in Italy or Austria, forestry interest groups dominate the picture, but public administration and research and education institutions are hardly mentioned. In other countries, public administration and research organizations dominate, but forest owners' organizations have no significant role there. It is very typical that there is a lack of interaction with other sectors. Forestry institutional systems have strong sectoral boundaries, even to the wood and agricultural sectors and even more to other sectors such as energy, tourism, and nature conservation, where a considerable part of innovations are currently occurring (and are expected to occur in the future).

The forestry innovation system is active in the fields of technological and organizational innovations and in the diffusion of certain preselected innovations. Typical areas of activity are mechanization of forest work and, recently, the forming of forest owners' cooperations. Except for some selected topics – such as bioenergy or forest education – product and service innovations are rather disregarded. Specific support aiming at the development of new products and services is practically missing (Rametsteiner et al. 2005). Case studies of forest-related innovations in tourism or bioenergy reveal that the initial support for the development of these new innovations rather comes from regional-level ad hoc networks and from other sectors but not from the forestry innovation system.

Misconception of Supporting and Impeding Factors for Innovation by Institutional Actors

It seems that the institutional system does not fully understand the needs of forest holdings when it comes to innovation support. The forest holdings survey in Central Europe (Rametsteiner et al. 2005) shows that institutional-level actors assume different factors to be important for innovation processes. They underestimate the importance of information as an essential factor. With regard to impeding factors, the institutional system actors tend to overestimate the difficulties forest owners face with administrative and legislative obstacles. These certainly exist and are also pointed out by forest owners to be important. However, financing and know-how are much more a concern for forest owners. This finding has quite important implications on the design of innovation support activities.

How Well Are Innovation System Functions Fulfilled?

Three basic functions have to be fulfilled by innovation systems (Edquist and Johnson 1997):

reduction of uncertainties by providing information, the management of conflicts and cooperation, and the provision of incentives. The institutional system actors in forestry do fulfill those functions yet with limitations:

– Information provision is lacking for new markets and opportunities: Forestry agencies – authorities and interest groups – provide important forest-related information. They provide good information on traditional forestry topics, but there are severe information lacks about new market fields such as tourism and nature conservation. Only when not too far from the traditional timber production, institutional actors have built up new knowledge on new areas, for example, on biomass use.
– Weak conflict management and coordination with other sectors: In the coordination among foresters and forest owners, the institutional actors do well, but they are weak in the coordination with actors from other sectors. Even the coordination with sectors in the wood chain proves to be difficult.
– Little consideration of innovation support principles when providing incentives: Forestry subsidy measures such as the support of investments for the mechanization of forest work (forest roads, harvesting machines) or the support of cooperations (e.g., forest owners' cooperations) are hardly written from an innovation perspective. Financial incentives are therefore mostly conservative, and their design often disregards basic principles of innovation support. Two such principles are to systematically support new and risky projects or to limit the support to the starting phase. In practice, considerable incentives are provided for the diffusion of already known and preselected technologies or organizational rearrangements, but only little incentives are provided for the development and pilot testing of new ones. It is furthermore only seldom that the grant of support is restricted to the starting phase of a certain project or the stage of innovation development in the sector.

As a result from these weaknesses, it can also be observed that a considerable financing potential is hardly tapped by forest owners, namely, non-forestry funding sources, for example, from innovation or structural funds. Forestry companies and also supporting agencies very often do not know about non-forestry programs that could be utilized for supporting and financing forest-related innovations.

Policy Support

Innovation in forestry may be supported by competitiveness, innovation, and entrepreneurship policies in general or by the forest sector policies. Unfortunately, the general innovation support is often not used by the sector, and comprehensive and focused innovation support policies within the sector are rare (Rametsteiner et al. 2005). A detailed analysis of in how far and in which way the aspect of innovation is integrated into sector-relevant policies (Weiss et al. 2010) found that the relevance that is put on the topic of innovation not always goes along with the same understanding of innovation policy, traditional or systemic. Policies that mention many innovation-related goals and give innovation a rather high importance are the national reform programs, rural and regional development programs, and forest sector strategies. These policies tend to follow rather a systemic understanding of innovation. The forest programs and renewable energy plans are much less innovation oriented and represent a rather traditional view on innovation. The sustainable development strategies are a third type: They do not mention innovation frequently but often follow a systemic understanding of innovation.

Innovation issues are not systematically integrated into forest policies, and innovation is not specifically supported. The policies hardly support radically new ideas but only the diffusion of current solutions and technologies that are already known. This confirms earlier results from innovation research which say that the institutional system of mature sectors rather focus on rationalization and diffusion of innovation and are less oriented at the development of new products or services (Breschi and Malerba 1997).

For an effective support of innovation, the coordination of policy fields is important, the more so for a diversification into new forest goods and services. Formally, forest policy documents seem to be relatively well coordinated with other sectors, and even without a generally strong systemic orientation of innovation policy, there is a focus on cross-sectoral interaction. In relation to other traditional sectors, it seems that forestry is rather used to coordinate across sectoral boundaries (Weiss et al. 2010). These results contradict to what is known from extensive forest policy research in Austria. For the example of Austria, it can be shown in detail that other sectors hardly play a role in the sectoral innovation system; this is certainly true on national level, even if not so pronounced on local-regional levels. These contradictory results may be explained by the lacking implementation of the coordination goal. Furthermore, the coordination with other sectors is often rather forced because of strong interests from other social groups, and the mode of coordination is often more a negative than a positive coordination.

What are the factors behind the strong orientation of forest policies at timber production and the slow uptake of new policy goals and innovation fields in forest policies? The policy analysis explains it by the power of the related interest groups which are behind those goals: Forest industries aim to keep the production source oriented at timber and may hinder a stronger multifunctional use of the forests – as shown on the example of selected cases in Austria, France, and Scotland (Buttoud et al. 2011). Vice versa, new uses of the forest for other purposes are typically introduced from outside sectors such as energy, biodiversity conservation, or recreation.

Another factor may be the self-understanding of institutional actors with regard to innovation support: They often see innovation as a sole market issue and feel their role primarily connected to public goods. Traditionally, forest authorities were concerned with ecosystem services from a public good perspective: They provided regulatory limits for the use of the forest resource in order to secure a basic provision of the "nonmarket" benefits of the forest. Today, the trend is to give also their provision more in the hands of the market, but the role of the public administration is not yet clearly defined. At the same time, the private actors still expect state activity when it comes to the support of non-wood goods and services from the forest (Weiss et al. 2011b). This seems to be an indication that non-wood forest goods and services are still not seen as an important business opportunity.

In conclusion, the role of policy in innovation support in forestry can actually be seen paradoxically: Although innovation and market-based instruments become more important, state actors do not lose importance. The public financing of ecosystem services is growing, and public instruments need to be made more efficient through clearly defined goals. The scope and use of mixed public-private mechanisms such as contractual agreements, tendering schemes, or cap-and-trade schemes are increasing. The creation of new markets, for example, in carbon trade or nature conservation (conservation banks), is still only in an initial state. And finally, also in the field of traditional markets, the institutional-level actors have their tasks to fulfill: promoting entrepreneurship and innovation, providing market information, or supporting interaction among landowners and across sectors. As described, innovation support instruments such as the provision of seed money or providing support infrastructures for the development of new business activities such as extension services or rural development agencies are still a field to develop in forestry (Weiss et al. 2011b).

Conclusion and Future Directions

Although forestry is a traditional sector, there is an increasing interest in the important role that forests, wood, and non-wood products have for the sustainable development in Europe: These contributions range from recreational services and biodiversity conservation to the possible reduction of greenhouse gas emissions through the use of wood in construction and to the provision of new jobs in rural areas. Still, policy measures for the provision of forest ecosystem services do not come under innovation support while this is the case in the field of new timber or bioproducts.

This entry argues for a stronger role of institutional actors and policy in innovation support in the sector and a more systemic orientation of innovation policies. There is a too narrow focus on research which totally misses the needs of the sector enterprises in their innovation efforts which rather lie in the provision of information and cooperation support. Measures are needed to facilitate the two-way communication between researchers and the firms. Innovation support infrastructures such as cluster organizations and regional and rural development agencies need to be fostered as intermediary agents. They are important complementary knowledge and capacity providers. Developing and supporting networks, education, and training would be important fields of activity.

We always have to keep in mind, still, the particularities of the forestry production: The marketing possibilities are limited. All the more important are social, institutional, and policy innovations. Further specific challenges are the dominance of small and micro family businesses and the prevailing traditional business fields and non-research-intensive technologies. Traditional innovation policies fail because of their too strong focus on research and high-technology support and because of their orientation at larger firms. Small businesses are still disadvantaged by most industrial policies.

Cross-References

▶ Entrepreneurship Policies
▶ Innovation and Entrepreneurship
▶ Innovation Policy Learning
▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
▶ Nonlinear Innovations
▶ Small Business
▶ Triple Helics

References

Breschi S, Malerba F. Sectoral innovation systems: technological regimes, schumpeterian dynamics and spatial boundaries. In: Edquist C, Johnson B, editors. Systems of innovation. Technologies, institutions and organizations. London/Washington: Pinter; 1997. p. 130–56.

Buttoud G, Kouplevatskaya-Buttoud I, Slee B, Weiss G. Barriers to institutional learning and innovations in the forest sector in Europe: markets, policies and stakeholders. For Policy Econ. 2011;13:124–31.

Edquist C, Johnson B. Institutions and organizations in systems of innovation. In: Edquist C, editor. Systems of innovation. Technologies, institutions and organizations. London/Washington: Pinter; 1997.

Hirsch-Kreinsen H, Jacobson D. Innovation in low-tech firms and industries. Cheltenham: Edward Elgar; 2008.

Niskanen A, Slee B, Ollonqvist P, Pettenella D, Bouriaud L, Rametsteiner E. Entrepreneurship in the forest sector in Europe, Silva carelica, vol. 52. Joensuu: University of Joensuu, Faculty of Forestry; 2007.

Rametsteiner E, Weiss G, Kubeczko K. Innovation and entrepreneurship in forestry in central Europe. Leiden: Brill; 2005.

Rametsteiner E, Bauer A, Weiss G. Policy integration and coordination: theoretical, methodical and conceptual approach. In: Rametsteiner E, Weiss G, Ollonqvist P, Slee B, editors. Policy integration and coordination: the case of innovation and the forest sector in Europe. Brussels: OPOCE; 2010.

Weiss G. Theoretical approaches for the analysis of innovation processes and policies in the forest sector. In: Weiss G, Pettenella D, Ollonqvist P, Slee B, editors. Innovation in forestry: territorial and value chain relationships. Oxfordshire: CAB International; 2011. p. 10–34.

Weiss G, Salka J, Dobsinska Z, Rametsteiner E, Bauer A, Aggestam F, Tykkä S. Integrating innovation in forest and development policies: comparative analysis of national policies across Europe. In: Rametsteiner E, Weiss G, Ollonqvist P, Slee B, editors. Policy integration and coordination: the case of innovation and the forest sector in Europe. Brussels: OPOCE; 2010. p. 45.

Weiss G, Ollonqvist P, Slee B. How to support innovation in the forest sector: summary and conclusions. In: Weiss G, Pettenella D, Ollonqvist P, Slee B, editors. Innovation in forestry: territorial and value chain relationships. Oxfordshire: CAB International; 2011a. p. 17.

Weiss G, Ramcilovic S, Mavsar R. Financing mechanisms for forest ecosystem services in Europe and their implications for forest governance. Allg Forst-Jagdztg. 2011b;182:61–9.

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Innovation in Green Technology

▶ Entrepreneurial Behavior and Eco-Innovation

Innovation in Practical Work in Science Education

▶ Fostering Creativity Through Science Education

Innovation in Radical Economic Thought

Dimitri Uzunidis
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Forces of production theories; Systemic innovation, theories

For Marxists, radical economists, but also Classical economists, the historical context determines for most part the order of priority of the scientific phenomena to study, the techniques (methods and tools) to use, as well as the social use which will be made of the results. They highlighted three stages in the transformation of the production forces of capitalism: meetings of workers isolated under the same management, followed by the division of the work and the differentiation of the tasks, then by the clear separation between intellectual and manual work. In today's global economy, a fourth stage in the productive organization appears: an organization based on the spatial de-concentration of the achievement of this production and on decisional, financial, and informational centralization that the applications of contemporary science allow. This fourth stage is the one of the unprecedented marketability of science, organized as a network by enterprises and states in a clear technological aim.

All science would be superfluous if the appearance and the essence of things became confused (Marx 2012, vol. 3). The research of the essence of things is generally commonly accepted as being the aim of the scientific activity but the historical context determines for the most part the order of priority of the things and the phenomena to dissect, to understand, and to know the techniques (methods and tools) to use to penetrate the essential, as well as the social usage which will be made of the essence extracted. At the moment in time when, according to Marx (1993), industry has already reached a very high level, invention becomes a branch of business, and the application of science to the immediate production determines the inventions, at the same time as soliciting them. Then, for Habermas (1973, p.43), with the arrival of industrial research on a large scale, science, technique, and exploiting found themselves part of the same system. Capitalism provided the framework for the systematic application of science to production, which in turn gave impetus to the development of scientific knowledge concerning laws of nature and of the world. Capitalism redirects, in accordance with a productive end, a reserve of scientific and technical knowledge built up, making science a productive strength at the service of capital. Giving a scientific character to production is therefore the tendency of capital. (Marx 1993).

The Myth of Innovation: From the Formation to the Private Appropriation of Production Resources

Science, in the same way as technique, is always historical. But in capitalism, science is considered as a tank of knowledge from where technique feeds (see Nef 1953). It is considered as a tank of forces of production because the work process has become a technological application of science (Marx 1993). The growth in the size of the company and the amount of capital held or raised has furthered the enrolment of science in immediate production. (a) The domestic markets of the big industrial and international countries are getting bigger. (b) The social division of labor is extended. (c) Enterprises, in a context of competition, have to bear rising total costs. (d) Enterprises focus their strategy, on the one hand, on the achievement of high external economies (or externalities) and, on the other hand, on business intelligence in order to benefit from all profit opportunity. The usual term is that of externalities which can be defined (A. Marshall 1890) as being positive or negative effects, which involve an activity of an economic agent outside this activity or that the agent is subjected to from outside. The most attractive for a company is to achieve, in a setting favorable to investment, substantial external savings, without having to bear the slightest cost that its activity creates for the community as a whole (pollution or various nuisances). It is important therefore, to underline, that taking private property for granted, the private agent will create various effects on the local community, but in return, he will expect from the community means and opportunities to enlarge his property (assets) or where necessary, to defend it. The application of science to the economic activity of such and such a company or group of companies makes innovation the main function of growth and commercial strength.

The liberal and neoliberal economic thinking has, only very recently, been able to find some arguments to justify forming, in the aim of making them available to private firms, scientific and technical resources. The liberal economists are quick to thank R. Solow (1956) who started new methods of research into the links between technology and growth.

Firstly, as a residual factor of growth, new techniques have become a very popular subject of research with the neoliberals. The standard neoclassic growth model was changed drastically by the introduction of technical progress and innovation in the liberal approaches to accumulation. To consider, for example, that the activities giving birth to the diffusion of technical and scientific information have a positive impact (in terms of creation of wealth and profits) which is greater collectively than individually is a significant advance compared with the mechanical and ahistorical equilibrium of the original model. The question of economic repercussions on the community, of individuals' actions, especially concerning scientific production and commercial development, points the analysis toward the socio-holistic approach to the economy applied successfully by the classical authors. Innovation, more particularly, defined by J. Schumpeter (1982) as a new combination of productive resources, corresponds to a process of generation and private appropriation of a set of resources (scientific, technical, and financial) which, combined by the company or a group of companies, results in new products, the opening of new markets, and new organization. The conception of new products is a very important element in innovation. It is here that the large firms, with huge resources at their disposal, have a great advantage. They can fund research teams and experiment with a large number of innovations in the hope that one of them will stand out from the crowd, wrote J. Robinson in 1977. The supply creates its own demand, thanks to the insight, and the fighting spirit of the entrepreneur, then of the large firm. The second stage of the innovation process (appropriation) prevails these days over the first one (the generation). The company tends to take advantage of its environment rather than to invest in it, for instance, in all the stages of technological creation, which can be explained by the fact that the investments in the acquisition (appropriation) of production resources are less costly than those devoted to the formation of these resources. This also makes the neoliberals say that the collective profitability of the capital can be high, whereas the private profitability can become insufficient.

If the neoclassical economists struggled to get out of their model's dead end, a long time ago Marx himself and the economists who applied his method showed, as did L. Karpik (1972), that science becomes the base of industry; it is in this way that "heteronomous science" (which corresponds to the research applied to both the experimental development of new techniques and production methods and to finished goods) marks time on "autonomous science" (let us say basic research with no recognized private profit-making aims). The production process therefore determines the appearance of new techniques and defines their use. To do this, it directs the application of the scientific knowledge and defines the boundaries of scientific research. An organic relationship is thus created between science, technique, innovation, and society. And it is in this that technology (and innovation), as a transformation of knowledge into production and accumulation knowledge, is a social fact.

Marx's reasoning is as follows. First theoretical statement: Capitalism cannot exist without revolutionizing constantly the means of production, and therefore the production relations, that is to say, all the social relations. The means of production required to produce the different goods (destined for consumption or for production), after they have been adapted and used for private purposes to be transformed into capital, characterizes the state of the social relations. The quantitative expansion and the efficiency with which the capital is developed as fixed capital broadly indicates to what extent the capital is developed as capital, as being the power over the living work and to what extent it is subjected to the production process in general (Marx 1993). The technological use of science is the essential factor in the development of fixed capital; this being an index which shows to what extent the universal social knowledge has become a direct productive force. The development of (fixed) capital enlarges the scale of production at the same time as prompting this enlargement, requiring in parallel the specialization and the overlapping of different work forces which are more and more complicated: simple work/complex work, living work/dead work, socially necessary work, collective work, etc. Salaried work, and the salaried class as a capitalist norm of participation in the accomplishment of production and the social organization becomes the driving force behind accumulation.

Second theoretical statement: The general development of the production forces is the development of all the means (material and immaterial) that science in the hands of the capital injects into the production, natural forces, in the form of means of production, enabling higher usage value with less work (Marx 2012, vol. I). Science becomes capital under the pressure of the competition and possible political and social disputes. The authority of the capital and the power on the market of a given company depends on its capacity to make profits, to accumulate. Innovation is therefore essential in the daily battle that firms undergo to avoid the numerous barriers (lack of demand, increase in price of production resources, emergence of new competitors, social problems, restricting regulations, etc.) which can block the road to prosperity. Science is therefore called upon more and more; the new technology which it will create must be more efficient (allowing a greater mastery of the work process) and must achieve new exchange values (i.e., guarantee accumulation). The speed of the renewal of the capital is dependent on the accumulation barriers which play a major role in defining the integration of science into both production and the general development of the forces of production.

Third theoretical statement: For Marx, competition requires a continual increase in capital and imposes pervading laws of capitalist production as external coercive laws to each individual capitalist (Marx 2012, vol. I). To limit the risk of disappearing (through over-investment in relation to the solvency of the market in question), the firm must innovate and at the same time grow. Depreciation and centralization go hand in hand. Innovation links the two together: It allows the depreciation of the already old capital whose profitability has slumped; it creates a favorable climate in which to make further investments and it favors "creative destruction" (Schumpeter) and the involvement of finance, the merging of capital (centralization) forming huge companies so that the capital and its development appear as the starting point and the end, like the motive for and the objective of the production. For this reason, the capitalist economy tends to develop its production forces as though it only had the absolute power of the company as a limit. But this tendency enters into permanent conflict with the restricted objective, taking advantage of the existing capital (Marx 1993). The periodic crises mean the destruction of part of the existing production forces. About a century later, J. Schumpeter described as "creative destruction" the process of destroying old capital by new productive combinations which create, from their introduction to the market, new opportunities for profit and investment (Schumpeter 2006). The resumption of accumulation after the said destruction will not be possible without thorough modification of the foundations and the norms of accumulation (new social organization of work, new competition rules, new technology, new institutional forms of management, and economic regulation).

Innovation, Networks, and the Power of the Firm

As soon as the capital takes over the social production, the technical progress reflects the more or less significant changes (marginal or radical) in the techniques and the production methods, together with the social organization of the working process and thereby the historical type of society (Marx 2012, vol. II). The three stages in the transformation of the production forces of capitalism (meetings of workers isolated under the same management, that of the holder of the capital, followed by the division of labor and the differentiation of the tasks with the setting up of a salaried management team in the factories, then by the clear separation between intellectual and manual work which determine the status of scientific and technical workers compared with the immediate commercial objectives of the production process) are conceptually linked to the formation and the evolution of the "collective worker."

Capital instigates cooperation among the workers for the accomplishment of a given production. This results in collective of workers all the while depriving the staff of any role in the organization of their work, any control over their contribution (value added) to the production, and finally of any role in evaluating the use value that their workforce represents for the capital. A. Smith's spirit lurks: The machine was created by the division of labor. He also remarked that the specialization of labor will lead the worker to discover sooner or later the means to reduce the difficulty of his task. But these "minor innovations" are not the only ones; according to A. Smith, other inventions are a consequence of the work of scientists which consists in observing distinct physical and technical processes (Smith 2012). These inventions, when marketed, will represent the major innovations of the future.

The stages of the capitalist production organization therefore precede the technical transformations and transform science into a productive force and define technology as production knowledge. Innovation and more particularly, technology, said J. K. Galbraith (1967), undergo a major organizational effort, but it is also the result of the organization. This basis of perception of the evolution of production forces under the constraints of accumulation has inspired some of the neoclassical economists. The positive externalities, the increasing returns, or even the human capital are the concepts which illustrate in different words the state of the collective of workers and the state of the socialization of the capitalist production such as has been noticed since the beginning of the 1980s. The current phenomenon of a "knowledge-based economy" (see, for example, Laperche et al. 2008) is the continuation of the formalization of the scientific and technical knowledge and of the organization of science as a domain for accumulation whose origins date from the middle of the nineteenth century. Indeed, with the creation of schools and specialized publications, knowledge and all sorts of scientific and technical information is diffused. The process goes therefore progressively from a series of empirical results, logically organized, to a strictly scientific knowledge which results from experiments willingly carried out, not more uncertainly endured (see particularly: Noble 2011).

However, what it must emphasize is that the explanation that the superiority of the social return on investment in research and in innovation in companies in comparison to the return on the individual capital lies in the increase in the number of factors determining the profit-making potential in a given company. These factors (education, environment, health, finance, inter-industrial relations, communication, requirements and aspirations, etc.) of a general nature influence the marginal cost of a company or an operation and, with everything equal, have an effect on the return on the capital invested. The firm, in a competitive situation, be it apparent or latent, must appropriate these factors or at least monitor their impact on the profitability, or even better, take advantage of (abundant production resources which could be taken over, the opening of new markets) the noncommercial logic which these factors generate and reproduce (and nowadays this is how innovation is defined).

The firm, by investing in R & D, or by taking over small innovative companies, or by collaborating with other companies as strong as itself (joint research programs, cross-licensing, etc.) or with government research bodies (universities, for instance), appropriates knowledge which is the essential factor of competitiveness. Large companies consider that the knowledge which is vital for competitiveness entirely covers fundamental knowledge and insist that the university research institutes, with whom they sign research partnerships, accept their own criteria on who should be considered as "public" or "private" (Laperche et al. 2008).

It is the fourth stage in the organization of production: the combination in the same group of staff paid by the company itself and a salaried staff paid by other organizations, but appropriated by this company which makes use of the said group. The company keeps control of the group which is itself composed of productive capacity, trained and employed in various areas and by various social production entities (Laperche et al. 2008). This decentralization process of the constitution and the management of the private work groups affects all institutions. The diversification of the canals of scientific and technical knowledge and information transfer from public training centers for production resources (e.g., universities) toward the companies is proof of this; the refinement of the legal and financial system for the appropriation of the value constituted in the public sector by the company is further proof of this; the multiplication of the different levels of social status and salaries of the salesmen of all sorts of manual and intellectual competence is yet more proof.

The large controlling firm (or on a joint basis several large companies) constitutes the crux of the deployment of the production process. Having concentrated its means of production, defined, and divided up the production tasks and put together directly controllable collective of workers, it is becoming these days a decentralized organization and management center for its production resources. Capitalist production operates at the moment as if the power exercised by a firm on the market (and the coordination of the functions and activities that it can impose on it) was a factor of economic power (and of centralization of the ownership of the capital) more important than the power given by its own assets (scientific, technical, industrial, and financial).

But this is forgetting that this firm's power is a result of its financial capacity and of its potential concerning information. This "information potential" includes all information (scientific, technical, industrial, financial, commercial, political, sociological, etc.) which a company has access to, and can transmit to the market. Information and finance together enable the constitution and management of working groups which are geographically dispersed and remote (investment in industrial cooperation relations, in protecting the technological assets, in the appropriation of scientific knowledge and the creation of new products, in the coordination, using telecommunication means, of the different activities, etc.) (Laperche and Uzunidis 2008).

Technological innovations are today the outcome of this integrating decentralized process. They also provide the possibility for the process to be achieved and to prove itself more efficient (in relation to the costs of large amount of capital) than the huge factory which employs hundreds of people. The debates on the "networks" focus as much on the flexibility (to create or destroy production capacity according to the economic circumstances) that the large firm's decentralized management of the production provides, as on the increase in the firm's capacity to appropriate a large quantity of resources without investing in their formation. The large firm has turned into a center of concentration of the production resources, but also of formation and flexible coordination of collective of workers, depending on the accumulation requirements and the fluctuation of markets. It calls for cooperation and goes on toward this convergence by applying the strategies of growth and integration.

This coordination and innovation process, both flexible and evolutionary, imposes on the firm the pressing need to be provided with the different types of technological and intellectual means to acquire and combine uninterrupted flows of material and immaterial resources. The "knowledge theory" applied to the company says: The ability to adapt and the efficiency of the company depends on its cognitive categories, on the interpretation codes of the information itself, on the tacit skills, and its procedures in solving the problems it encounters (Dosi et al. 1999). The scientific, technical, and industrial information as a system of knowledge (Knowledge-capital) which is articulated, formalized, and likely to be communicated or transferred is a means of production, identifiable as such the use of which provides innovation for the economic process and the accumulation of capital. The task of the "technostructure" consists therefore of finding the balance between managing the "partnerships" and developing the internal instruments of organization (see Laperche et al. 2006).

Faced with the complexity of the private innovation process, M. Castells (1998) went as far as to maintain, quite cleverly, that the fundamental unit of the economic system is no longer the entrepreneur, the family, the firm, or the state, but the network composed of different organizations. Regarding innovation, the division of labor and the very refined specialization of skills in scientific research and experimentation remove any possibility of autarkical organization of the technological production. The network unfolds as a private form of organization of the instrumentalization of science. Partnerships between companies and between state research bodies and companies, and a whole panel of technical, financial, and commercial contributions, illustrate the theories of the classical economists (e.g., A. Smith and K. Marx) for whom once the capital takes over the social production (and enlarges its market by appropriating the resources at the time), the economy is subject to technical transformations and changes in the social organization of the production.

Conclusion and Future Directions

The new era of capital is not so much apprehended by the technological progress, but by the new way in which the production process is organized and developed. The industrial applications of science are the result of this, but also what prompts accumulation, the means to succeed, and also the cause of crises (Noble 2011). The current theories of networks, externalities, competition, and open innovation are based on an acquired principle: the benefits of the market, and on common finding that the market must not only be developed, organized, and regulated, but that it must also be created and preserved.

For the radical economists, the socialization of capitalist production has indeed taken on such dimensions that from now on, the appropriation of the technological elements gathered by the large companies is less costly than the raising of capital for their formation. The big firms are becoming, using relations of power, convergence centers for science and techniques, which they combine to supply their innovation process. To get from the stage of the concentration of production to the current stage of the contractual integration of the centralized property, capitalism has invented a new accumulation framework; the economic policies of "contesting the monopolies," privatization, flexible work management, international financialization, and integration have to a certain extent succeeded in depreciating the old capital, but they have also created the context of securitization and marketability of all individual and collective assets (science is of course part of this). In these conditions, how can economists be surprised by the regulatory power of finance? The system works by trial and error, finance facilitates the task. But in doing so, it directs the applications of science to production, it becomes a selection criterion to the research programs and at the same time, it weakens the potential for radical systemic innovations.

The age of the "captains of industry" is a bygone era (Boutillier and Uzunidis 1999). State management of innovation which the neoclassical economists are calling for shows, on the one hand, that the appropriation of scientific resources by companies is considered as one of the State's main economic reasons and, on the other hand, that the obstacles to accumulation become insurmountable without the organizing and planning role of the state. The introduction of commercial logic into scientific research falls within the scope of an innovation policy, but more surprisingly, so does the economic efficiency of the "network."

Cross-References

▶ Creative Destruction
▶ Joseph A. Schumpeter and Innovation
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Techno-Globalization and Innovation

References

Boutillier S, Uzunidis D. La légende de l'entrepreneur. Paris: Syros; 1999.
Castells M. The information age: economy, society and culture, vol. 1–3. Oxford: Blackwell; 1998.
Dosi G, Nelson R, Winter S, editors. The nature and dynamics of organizational capabilities. Oxford: Oxford University Press; 1999.
Galbraith JK. The new industrial state. Massachusetts: Houghton Mifflin; 1967.
Habermas J. La technique et la science comme idéologie. Paris: Gallimard; 1973.
Karpik L. Le capitalisme technologique. Sociologie du Travail, n°1; 1972: 1–34.
Laperche B, Galbraith J, Uzunidis D, editors. Innovation, evolution and economic change. New ideas in the tradition of Galbraith. Cheltenham: Edward Elgar; 2006.
Laperche B, Uzunidis D, editors. Powerful finance and innovation trends in a high-risk economy. London: Palgrave Macmillan; 2008.
Laperche B, Uzunidis D, von Tunzelmann GN, editors. Genesis of innovation: systemic linkages between knowledge and the market. Cheltenham: Edward Elgar; 2008.
Marshall A. Principles of economics: an introductory volume. Hamilton, Canada: McMaster University; 1890.
Marx K. Grundrisse: foundations of the critique of political economy. London: Penguin Classics; 1993. Original edition, 1857.
Marx K. Capital. 3rd ed. London: Penguin Classics; 2012. Original edition, 1867.
NEF J. Essence de la civilisation industrielle, in *Hommage à L. Febvre*. Paris: Armand Colin; 1953.
Noble D. Forces of production: a social history of industrial automation. London: Transaction Publishers; 2011. Original edition, 1984.
Schumpeter JA. The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle. London: Transaction Publishers; 1982. Original edition, 1935.
Schumpeter JA. Capitalism, socialism and democracy. London: Routledge; 2006. Original edition, 1942.
Smith A. The wealth of nations. London: Simon & Brown; 2012. Original edition, 1776.
Solow RM. A contribution to the theory of economic growth. Quart J Econ. 1956;70:65–94.

Innovation Internationalization

▶ Techno-Globalization and Innovation

Innovation Management

▶ Creativity Management Optimization
▶ Semantic Technologies in Knowledge Management and Innovation

Innovation Models

▶ Multiple Models of Creativity

Innovation Networks

▶ Innovation Systems and Entrepreneurship
▶ Nonlinear Innovations

Innovation of Democracy

▶ Quality of Democracy and Innovation

Innovation Opportunities and Business Start-up

Pierre Bourgogne[1], Vincent Boly[2], Laure Morel[3] and Mauricio Camargo[3]
[1]CAIRN-INNOVATION Consulting Agency, BLENOD-LES-PAM, France
[2]Equipe de recherche sur les processus innovatifs (ERPI), Université de Lorraine, Nancy, France
[3]ERPI, University of Lorraine, Nancy, France

Synonyms

Opportunities recognition; Spin-off; Start-up; Technology

Innovation opportunities are often recognized and valorized by new small companies. This chapter goes into details about the capacity of firms to seize innovation opportunities depending on their size. Then, the mechanisms mobilized are described, and the main sectors where start-ups are operating are listed. The question of the financial structure of start-ups is finally studied.

Introduction: Innovation, the Ability to Grasp New Opportunities

Innovation may be defined as a dynamic process to modify the functioning modes and the organizations of companies in order to develop new businesses (Boly 2009). These adjustments may concern new equipment, production processes, core competencies, and organizational variables such as the type of responsibilities assumed by employees, control processes, and information procedures (Simon 1979). One particular and radical form of this type of evolution is company creation: start-up launching among others. Generally, a start-up company is considered as a structure recently launched and based on up to date technological knowledge. Its potential development capacity and its reward profile are potentially important, but the associated risk is also high.

The aim of the innovation process is to invest in new economical areas: the company faces new customers, valorizes new knowledge, takes into account new constraints, and manages new relations (in terms of the nature of the interaction) with its present external stakeholders but also with new ones (this includes suppliers, partners, institutions). Consequently, innovation does not only concern the technical domain and the development of a new activity. Moreover, the ability to identify new opportunities constitutes a major asset for innovators. The behaviors and thought processes mobilized by entrepreneurs to see the unique potential in a situation and create an organization to pursue it are key success factors, while other individuals, when presented with the same information, either fail to see the opportunity or choose not to pursue it (Parks 2005). Note that entrepreneurs' skills are not the only explanation of the capacity to seize opportunity. As customers needs, technology, regulation, and political context evolve, innovation opportunities may be seized by entrepreneurs able to determine these new economical areas and acting in a favorable environment.

Finally, Parks (2005) suggests that innovation opportunity recognition is based on three compounds. The first component is the founding entrepreneurs who decide to create firms to pursue entrepreneurial technology ventures. The second component is the organization they build around themselves and how this collective organizational knowledge and experience (mostly in customer problem solving) impact on the success of the venture. It seems that in the field of high technology, expertise and experience constitute requirements in order to recognize opportunities within a mass of information and observation. Up to 50% and 90% of start-up ideas come from prior work experience. The final component of the process is the technology on which the venture is based, how this technology develops and evolves due to interaction with the founding entrepreneur, and the knowledge of the firm. The paper goes into greater detail about this theoretical model.

Are Start-up Organizations Adapted to Invest in Innovative Domains to Grasp Innovation Opportunities?

Organizations grow by gaining efficiencies of scale and scope in specific core competence areas that, ultimately, become core rigidities (Leonard-Barton 1992) or core incompetences (Dougherty 1995). Some scholars use the term "knowledge tunnel" to describe the incapacity to detect new market emergence. Moreover, innovation requires new production processes and new skills, and as a result, innovation requirements are often in contradiction with mainstream organization. Consequently, companies often hesitate to launch innovative projects, which require long-term R&D periods before ensuring a real return on investment. As a consequence, scholars conclude that radical innovation cannot be effectively managed within the confines of the firm, and they prescribe external incubators or investments in start-up firms and venture funds as the source of organic renewal for large established companies (Campbell et al. 2003). On the other hand, big companies attest to financial, human, and material resources that strengthen the innovative processes, and the innovative capacity of many international companies is evaluated as high (Wang et al. 2008) (Yam et al. 2004). One hypothesis is discontinuous innovation processes associated with disruptive technologies are better adapted to start-ups, whereas continuous innovation processes associated with sustaining technologies is better suited to large companies. However, a better understanding of the link between the size of the company and its ability to seize innovation opportunities remains a major research concern.

In fact, three scenarios may be defined at the beginning of the innovation process:

– An individual launches a start-up: thanks to their own entrepreneurial skills, a manager creates an ex nihilo organization able to develop knowledge and valorize it on the market.
– A big company launches a project through a team organized as a start-up: some individuals of the company work in an autonomous context within the company; the venture group is in charge of R&D tasks but also of the launching period. This may include the standardization of the business activity.
– An existing company establishes a partnership with a start-up. Different forms of partnership may be distinguished. Some companies organize venture capital structures. They act as financial institutions and provide funding to newly created companies. Hence, Aster Capital is a corporate capital fund federating Rhodia, Schneider Electric and Alsthom. Aster is more precisely dedicated to start-up support and participates among others to the development of Optireno, a start-up in the field of insulation. The objective is to get financial rewards or to facilitate any possible further purchasing procedure. The start-up development is accelerated thanks to this financial support and represents a possible temporary external structure seizing an innovative opportunity in place of the big company. Some companies directly acquire shares in young technological structures but some others establish strategic and technology partnerships. Procter and Gamble as well as Veolia, put researchers and equipment at the disposal of start-ups in order to strengthen their R&D. They previously negotiate the exclusive valorization of the new technology on certain markets which are strategically important for them, while the start-up runs the findings in any other domains.

Linked with these three scenarios, different business models are established within the start-ups:

– Business models based on the autonomous development of the company: they are characterized by the progressive growth of the capital
– Business models integrating the future purchasing of the start-up by large companies: important funds are invested at the very beginning in order to accelerate the R&D tasks
– Codevelopment business models: investments are calculated aiming at an acceptable return on investment by each partner

In conclusion, even if inner structures such as interdepartment teams, new business divisions, or new venture groups may be dedicated to innovation, start-ups are common organizations in the field of innovation.

Opportunities Seizing Mechanisms Associated with Start-Ups

An innovation opportunity is defined as an exogenous favorable context (market demand, time to enter this market among others) associated with an idea of a new product, technology, or service.

Technology transfer from national scientific community to economic stakeholder represents a way for companies to seize disruptive innovation opportunities. The major implication for technology transfer and commercialization is that the more channels of communication that exist between the technology source and the technology recipient, the more likely the technology will find its way to the market (Kassicieh et al. 2002). The company, managerial (especially those centered on learning), and scientific competences have long been associated with the capacity to succeed in the technology transfer process. Thus, two scenarios appear:

– The development of laboratory spin-offs
– The creation of a start-up by a former member of a research laboratory

In these two cases, people developing the research are also involved in the definition of application opportunities and in the development of the corresponding activities. In some countries, these mechanisms are stimulated with specific procedures, including the ability for a national researcher to take entrepreneurial leave or to invest in a spin-off. Finally, opportunities are seized by "direct human transfer."

Another mechanism observed in the opportunity recognition phase can be found in the local social network that entrepreneurs manage. The meeting and confrontation of people from the same geographical area, each having part of the required knowledge to launch an innovative activity, is one source of development (Lakoff 2008). Opportunities are then valorized thanks to local confrontation. National institutions try to stimulate this mechanism through policies favoring networking or clustering. Klevorick et al. (2005) investigating the source of knowledge of start-up states that the primary sources are customers and suppliers before academic structures (biology is an exception). Then start-ups emerge when a combination of expertise and experience (technology, marketing, distribution) gives a new expertise large companies do not have (Carayannis and Alexander 2002).

Foreseeing is a third mechanism. After treating information, entrepreneurs develop a vision, a description of a scenario for the future. These include future market specifications, new uses, new production constraints, and new needs. Thus, they use their own expertise or external knowledge to elaborate a strategy and the associated technologies. Anticipation is then the very first step in opportunity recognition.

Main Start-up Launching Sectors

Statistical data is not easy to collect, as long as "start-up" is not a reference term in national statistics institutions; moreover, the term "new technology" corresponds to a wide range of situations. Consequently, company creation databases are used to evaluate start-up launches.

Start-ups seems mainly to seize opportunities in the fields of information technology (software and services), telecommunication, electronics and electricity, chemicals and pharmaceuticals, new materials, and biotechnology. In France, the two first domains represent 75% of the total number of start-up creations.

Start-up Financing

The financing of the different phases of the life cycle of an innovative process, product, or service is one of the main issues of innovative start-ups. Different possibilities exist at each stage; these include public financing, permanent capital, long-term loans, short-term loans, and the role of the different actors, shareholders, bankers, politicians/policy makers, suppliers, and clients. Based on data collection campaigns within a multisector start-up panel, it is possible to determine general trends about the capital required depending on the type of technology developed.

At the proof of concept stage, little money is generally spent at this stage. At least, it could even be a serendipitous result or a kind of "by-product" of a more global research activity (Table 1).

On a second phase, based on feasibility and repeatability, the enrichment of the concept is achieved; the aim is confirmation, still at lab level, that the technologies to implement the concept are reliable. The possibility of reproducing the experiment with other operators and machines and initial conditions are also tested. Finally, the opinion of some of the main market stakeholders may be collected. Consequently, money is spent on experiments, tests, characterization, industrial property studies, and protection and premarket studies. Equity capital (when the company is already created), other public funds, and/or semipublic funds contribute to the financing (Table 2).

The third phase of industrialization is crucial and risky: it consists in developing knowledge to master the technology from lab level to an industrial scale. All the support activities are organized: sales and marketing, maintenance, and supply chain management. Generally, at this stage, larger investors are involved in the venture: initial investors have to adapt to this capital enhancement. Moreover, venture capital is needed and business angels may be associated. Other more institutional schemes may also be activated, technology transfer fund among others.

Innovation Opportunities and Business Start-up, Table 1 Step one – proof of concept (Source: Authors)

Risk extremely high		
Start-ups Steps	Financing	
	Needs	Sources
Ideas, concepts detection	Initial tests	Generally invisible when performed by public
Valorization services? Industrial liaison offices		R & D activities
Sensitization of students/researchers		Generally not individualized when performed by private
IP concerns (initial initiatives)		R & D activities
Analysis of the other projects of the laboratory		

Innovation Opportunities and Business Start-up, Table 2 Step two – feasibility and repeatability (Source: Authors)

Risk very high		
Start-ups Steps	Financing	
	Needs	Sources
IP protection (formal) – partnership agreements	Support to IP protection	Equity capital (shareholders, finance market)
Choice of the next steps (internal valorization in other research projects, sale to external existing company, start-up . . .). Scenario building	Pre-market studies	National, regional, local public financing schemes for R&D and tech transfer . . .
	Research for R&D partners	
	Technology broker hiring	Risk capital setups
Complementary studies	Development specialist hiring	Business angels
"Production" of the first samples – trials/tests		

Innovation Opportunities and Business Start-up, Table 3 Step three – industrialization. Step four: Continuous innovation dynamic (Source: Authors)

Risk still high		
Start-ups Steps	Financing	
	Needs	Sources
Engineering studies	Cofinancing of innovation project – industrialization	Equity capital (shareholders, finance market)
Research of financial (technical market) partners (capital increase, participative loans)	Phase Support to finance engineering	National, regional, local public financing schemes for R&D and tech transfer
Complementary studies (e.g., aging)	Support to market strategy elaboration	Risk capital set ups
Application exhaustive exploration, selection of first market segments)		Risk capital Long-term loans (quasi proper funds)
Investments (machines, people, demonstrators, market)		

The observation campaign within the studied start-up panel concludes that the ratio between the amounts of money required for step three is between 50 and 100 times higher than step two (Table 3).

At step four, processes are operating and products or services have been recently launched on the market, technical aspects required improved. A continuous innovation activity is managed, either to suppress defects observed at user level, improve performances, or allow access to new markets. At this stage, the necessary funds may be covered partially by the company outcomes, but complementary loans are often mobilized (Table 4).

If the new activity is successful (Table 5), operating costs are covered by the exploitation, but the increase in sales very often produces an increase in operating capital needs which could be covered by short-terms loans. Some contradictions have to be treated since some financing schemes (e.g., innovation loans) ask for the money to be paid back from the first sales when the needs in operating capital are highest. Precise treasury prevision and management is a key factor, and trust between all partners is challenged here. Finally, in order to wait for the dividend distribution period, different

Innovation Opportunities and Business Start-up, Table 4 Step four – continuous innovation dynamic (Source: Authors)

Risk		
Start-ups Steps	Financing	
	Needs	Sources
Technology (processes, products) updating	Support for consulting services	Equity capital (shareholders, finance market)
Services offer permanent analysis and upgrading	Support to strategic intelligence and knowledge management	Long-term loans (quasi proper funds)
New competitors (“fast second”)		Short-term loans (running capital increase for exploitation)

Innovation Opportunities and Business Start-up, Table 5 Step five – operation (Source: Authors)

Normal risk		
Start-ups Steps	Financing	
	Needs	Sources
Strategic decisions: internal production investments, contracting, client/supplier relations. . .	Support for financing productive investments (warrant for banks, incentives . . .)	Sales (margin, profit) if necessary short terms banks loans
Networks, clusters	Support to market studies and market development	Shareholders running accounts
Market penetration	Support to export	Banks (running capital needs)
	Support do staff recruitment	

financial possibilities are mobilized depending on the different levels of risk: the higher the risk, the higher the need of permanent funds. Since innovative start-ups or innovation projects are risky, manager attention is directed toward structural funds and low interest rates. Consequently, short-term money is not suitable for their development. Securing the financing scheme and using various possibilities of constituting the permanent capital are crucial strategic actions which are to be taken into account as much as technology or market.

Conclusion and Future Directions

Start-ups are adapted to innovation opportunities through specific processes of recognition considering the type of sector and technology considered. Start-ups represent more or less sustainable organizations able to develop technological knowledge and the associated business activities. Their ability to seize opportunities highly depends on the manager profile, the organization, its structures, and the type of technological sector concerned. The phenomenon of start-up development highly proves that technology is a complex system based both on scientific knowledge and also on connected knowledge (any expertise allowing to valorize a specific scientific skill into an industrial competence).

Considering financial aspects, a better understanding of the adequation between the amount of money required and the nature of the corresponding funds at each step of the development cycle of start-ups still remains necessary.

Cross-References

▶ Angel Investors
▶ Business Creation
▶ Business Start-up: From Emergence to Development
▶ Entrepreneurial Opportunities
▶ Financing Entrepreneurship
▶ Risk, Uncertainty, and Business Creation
▶ Technological Entrepreneurship and Asymmetries
▶ Venture Capital and Small Business

References

Boly V. Ingénierie de l'innovation. 2nd ed. Paris: Hermès science edition; 2009.

Campbell A, Birkinshaw J, Morrison A, van Basten BR. The future of corporate venturing. Sloan Manage Rev. 2003;45:30–7.

Carayannis EG, Alexander J. Is technological learning a firm core competence, when, how and why? A longitudinal, multi-industry study, of firm technological learning and market performance. Technovation. 2002;22(10):625–43.

Dougherty D. Managing your core incompetencies for corporate venturing. Entrep Theory Pract. 1995;19:113–35.

Kassicieh S, Kirchhoff B, Walsh ST, McWhorter PJ. The role of small firms in the transfer of disruptive technology. Technovation. 2002;22(11):667–74.

Klevorick AK, Levin RC, Nelson RR, Winter SG. On the sources and significance of inter-industry differences in technological opportunities. Research Policy. 1995;24(2):185–205.

Lakoff S. Upstart startup: "constructed advantage" and the example of Qualcomm. Technovation. 2008;28(12):831–7.

Leonard-Barton D. Core capabilities and core rigidities: a paradox on managing new product development. Strat Manage J. 1992;13:111–26.

Lia Yan-Ru, Chen Y. Opportunity, embeddedness, endogenous resources, and performance of technology ventures in Taiwan's incubation centres. Technovation. 2009;29:35–4.

Park JS. Opportunity recognition and product innovation in entrepreneurial hi-tech start-ups: a new perspective and supporting case study. Technovation. 2005;25:739–52.

Simon HA. Models of thought. New Haven/London: Yale University Press; 1979.

Simon HA. The scientist as problem solver. In: Klahr D, Kotovsky K, editors. Complex information processing: the impact of Herbert Simon. Hillsdale: Lawrence Erlbaum; 1995.

Wang C-H, Lu I-Y, Chen C-B. Evaluating firm technological innovation capability under uncertainty. Technovation. 2008;28:349–63.

Yam RCM, Guan JC, Pun KF, Tang EPY. An audit of technological innovation capabilities in Chinese firms: some empirical findings in Beijing, China. Res Policy. 2004;33:1123–40.

Innovation Policies (vis-à-vis Practice and Theory)

Stefan Kuhlmann
Science, Technology, and Policy Studies (STePS), University of Twente, Enschede, Netherlands

Synonyms

Governance; Innovation policy; Innovation practice; Innovation theory

Innovation-driven economic and social change is a significant characteristic of today's economies and a driving force for international knowledge production, competition, and trade; this holds certainly for industrialized countries, but increasingly also for a growing number of late industrializing countries. National, often also regional, governments pursue, more or less explicitly, *innovation policies*, which can be defined as "as the integral of all state initiatives regarding science, education, research, technology policy, and industrial modernization, overlapping also with industrial, environmental, labor, and social policies. Public innovation policy aims to strengthen the competitiveness of an economy or of selected sectors, in order to increase societal welfare through economic success" (Kuhlmann 2001, 954). Public innovation policies reflect the "innovation culture" of a given society, not at least characterized by the particular interrelation of economic, knowledge-producing, and policymaking actors and organizations ("Triple Helix"), at various levels of action ("multilevel innovation system").

The concept of public innovation policy is built on the assumption that "innovation" – a perceived or intended process of material, social, and often also cultural change, incremental or disruptive – can be "governed." The present entry (largely drawing on Kuhlmann 2007) offers four considerations of this supposition: First, an illustration will be presented of *why* the

Innovation Policies (vis-à-vis Practice and Theory), Fig. 1 Innovation practice, theory, and policy as dancing partners (Source: Kuhlmann 2007, 5)

governance of innovation is an issue of concern and that there are governance routes of different character and quality. Second, three forces of the governance of innovation will be addressed: The (1) dynamics of *innovation in practice*, the (2) role of *public policy*, and (3) the role of *Innovation Studies*, as "theory in action." In order to illustrate the mutual interaction of the three forces, a metaphor will be used (following Kuhlmann 2007; Kuhlmann et al. 2010). Innovation practice, policy, and theory can be seen as "*partners on a dancing floor*," moving to the varying music and forming different configurations (see Fig. 1). Taking a closer look at the dance floor, one can see two of the dancers, innovation practice and policy, arguing and negotiating about the dance and music while the third, theory – not always, but often and to an increasing extent – provides the other two partners with arguments and sometimes also with new music: Practice and policy increasingly have expectations vis-à-vis the contribution of social science-based intelligence to their dance. Hence, the third consideration: (3) *Innovation Studies*, by now a widely respected academic field of interdisciplinary knowledge and research, may experience a tension between participating in the dance and academic discourse at arm's length to practice. Yet, there is a chance that Innovation Studies can cope with this tension and, in fact, make it a source of increased *reflexivity*. The fourth consideration will (4) exemplify some ways of deliberate interaction of Innovation Studies as theory in action, taking a closer look at *"fora" for the debate of innovation issues* and the role of research-based "strategic intelligence."

First Consideration: Why "Governance of Innovation"?

A better understanding of the governance of innovation both in terms of driving forces and with respect to the room for maneuver in policymaking is a precondition of successful practical attempts at shaping the character and direction of innovation processes or even changing them.

Innovation occurs within or vis-à-vis evolving "regimes." The term *regime* was first introduced by Nelson and Winter (1977) to characterize patterns in technical and economic change such as the frameworks of engineers in an industry constituting the basis for their search activities. Van den Ende and Kemp (1999) define a technological regime "as the complex of scientific knowledge, engineering practices, production process technologies, product characteristics, user practices, skills and procedures, and institutions and infrastructures that make up the totality of a technology" (835). Rip and Kemp (1998) add to the "grammar" of a regime explicitly the policies and actions of other innovation actors including public authorities.

Regimes differ in terms of the character and quality of their *governance*. The notion of governance is used here as a heuristic, borrowed from political science, denoting the dynamic interrelation of involved (mostly organized) actors, their resources, interests and power, fora for debate and arenas for negotiation between actors, rules of the game, and policy instruments applied (e.g., Kuhlmann 2001; Benz 2006; Braun 2006). Innovation governance profiles and their quality and direction are reflected not at least in the character of public debates between stakeholders, policymakers, and experts. Think of the debates on genetically modified organism (GMO), or debates on the governance of an emerging, cross-cutting innovation field such as "nanotechnology."

In a report of a European Expert Group on "Science and Governance" (Felt et al. 2007), two basic types of what the authors call "regimes" of innovation were identified:

- The regime of "*economics of technoscientific promise*": Promises to industry and society, often far reaching, are a general feature of technological change and innovation, particularly visible in the mode of governance of emerging technosciences: biotechnologies and genomics, nanotechnologies, neurosciences, or ambient intelligence, all with typical characteristics: They require the creation of a fictitious, uncertain future in order to attract resources and political attention. They come along with a diagnosis that "we" are in a world competition and that "we" (Europe, the USA, etc.) will not be able to afford "our" social model if "we" don't participate in the race and become leaders in understanding, fuelling, and exploiting the potential of technosciences. The regime "works with a specific governance assumption: a division of labour between technology promoters and enactors, and civil society. Let us (= promoters) work on the promises without too much interference from civil society, so that you can be happy customers as well as citizens profiting from the European social model" (Felt et al. 2007, 25). Under this regime of technoeconomic promises, politics, science, and industry take the lead, while the innovation needs and expectations represented in the society appear to remain in a rather passive consumer role.
- The second regime, "*economics and socio-politics of collective experimentation*," is characterized by emerging or created situations which allow to try out things and to learn from them. The main difference with the other regime is that "experimentation does not derive from promoting a particular technological promise, but from goals constructed around matters of

concerns and that may be achieved at the collective level. Such goals will often be further articulated in the course of the experimentation" (Felt et al. 2007, 26f). This regime requires a specific division of labor in terms of participation of a variety of actors, investing because they are concerned about a specific issue (see also Callon 2005). "Users matter" in innovation (e.g., Oudshoorn and Pinch 2003). Examples of such demand- and user-driven innovation regimes include the information and communication sector (where the distinction between developers and users is not sharp), or the involvement of patient associations in health research (e.g., Boon et al. 2008). The concept of "open innovation," debated around the user-driven development of non-patented Open Source software, and more generally in Chesbrough's influential book (2003), is largely overlapping with the collective experimentation concept. The governance of such regimes is precarious since they require long-term commitment of actors who are not always equipped with strong organizational and other relevant means, and there is always some room for opportunistic behavior. Nevertheless, the promise is innovation with sustainable effects.

In other words, the governance of innovation and related policies are neither neutral nor innocent. The precarious governance of the experimentation regime or the missing emphasis on stakeholder inclusion and demand-orientation indicate that strategists and policymakers may run the risk of missing valuable opportunities offered through variety and experimentation in the development of innovation processes. This leads to the second consideration.

Second Consideration: Three Interrelated Forces of Innovation Governance and Their Dance

An analysis of the governance of innovation has to cope with at least *three major forces*:

First force: While since the 1950s in economics and sociology "*science*," "*technology*," *and* "*innovation*" processes were plotted as a sequence of activities of institutionally and organizationally distinct units ("linear approach"; Bush 1945), this has changed in the course of the 1980s and 1990s. Today science, technological development, and innovation are conceived by most scholars as *overlapping fields of social practice*, forming a shared "space" of interactivity, driven by knowledge dynamics, economic forces, and framed by inherited institutions. Most concepts emphasize the interactive character of idea generation, scientific research, development, and introduction of innovative products and processes into markets or other areas of use – take as a simplifying tag the pervasive concept of an alleged new "mode 2" of knowledge production suggested by M. Gibbons et al. (1994). Eventually, the mode 2 perspective on knowledge production and innovation is building on a long strand of studies into the relation of science and technology (e.g., Zilsel 2003; Rip 1992) and, at least implicitly, alluding to older, more systemic concepts (e.g., List 1856). The evolutionary approach of Nelson and Winter (1977), the innovation system tradition as inspired by Freeman (1987) and developed further by many others (e.g., Lundvall 1992; Edquist 1997; Hekkert et al. 2007), take on board an interactive, holistic understanding. Also studies into the social construction of technology (Bijker et al. 1987), "system transitions" in socio-technical landscapes, related regimes, "innovation journeys" and niche management (see e.g., Geels and Schot 2007; Van de Ven et al. 1999), technology assessment and its "constructive" turn (Rip et al. 1995), understand science, technological development, and innovation as a an interactive social continuum.

Second force: If the dynamics of science, technological development, and innovation are interwoven in practice, then "*policy*" and "*governance*" in a given innovation field will reflect this heterogeneity. Today, innovation policy is characterized by an "increasing 'sophistication' of policy instruments" (Boekholt 2010, 334). Concepts on innovation policy have evolved from a linear model to a more systemic and even "holistic" model of innovation policy (e.g., Smits and Kuhlmann 2004). Consequently, the scope and variety of involved organized actors (such as science organizations, industries, governmental agencies, parliaments, nongovernmental organizations) has become broad and heterogeneous. Actors have different interests, resources, and power, and they negotiate in various interlinked arenas on all kinds of rules and policy instruments. Political science studies have shown that the patterns of policy governance for science, technology, and innovation develop mostly in an incremental and only rarely radical way (Bozeman 2000; Larédo and Mustar 2001; Biegelbauer and Borrás 2003; Edler 2003). The organizations involved in policymaking and the arenas for the negotiation of options and decisions are mostly characterized by institutional inertia. They evolve to path dependence, interwoven with historical innovation regimes. One can analytically distinguish between two types of policy rationales in the context of science and innovation (EPOM 2007): "*Knowledge production policy rationales*," on the one hand, are built on causal beliefs, often derived from Innovation Studies' insights, about the production of knowledge, providing a theoretical framework for the type of policy proposed, especially with socioeconomic arguments. An advanced production rationale is characterized by the fact that knowledge is often tacit, partial, scattered and collectively distributed, and built through collective processes of creation, sharing, access, diffusion of knowledge, and more generally through learning processes. "*Governance policy rationales*," on the other hand, reflect general causal beliefs in the political system about how the state should govern (EPOM 2007). An advanced governance policy rationale is offered by a "decentralized multi-space model, with a growing importance of a large variety of public and scientific interest groups (public opinion, consumers, patients, NGO, etc.) willing to be associated into the policy design, with a high heterogeneity among them (in terms of level of knowledge, means of expression, financial resources, representativity, etc.)" (EPOM 2007). Following this rationale, the actual policy choice and mixes depend on negotiation and learning processes in the development of a given regime: Whether the future governance of nanotechnologies, for example, will be driven mainly by technoeconomic promises or by socio-political collective experimentation hinges not at least on the way how the involved heterogeneous actors in multi-space articulation processes will interpret the production rationales associated to nanotech.

Third aspect: Social science research, in particular Innovation Studies, can turn into "*theory in action*." Given the variety and potential complexity of governance in the practice of innovation as well as in related policymaking, actors tend to develop assumptions or "folk theories" on governance, simplifying, guiding, and stabilizing their action: Innovators and policymakers develop rules of thumb based on experience, own analysis, or prejudice – or they refer to and utilize expertise based on Innovation Studies. Take, for example, the utilization of the "System of Innovation" approach: This analytical concept, a heuristic developed by economists and innovation researchers since the late 1980s, has been increasingly utilized by policymakers around the world. Innovation systems have been conceptualized as the "biotopes" of all those institutions which are engaged in scientific research and the accumulation and diffusion of knowledge, which educate and train the working population, develop technology, produce innovative products and processes, and distribute them; to this belong the relevant regulative bodies (standards, norms, laws), as well as the state investments in appropriate infrastructures. Innovation systems would extend over schools, universities, research institutions, industrial enterprises, the politico-administrative and intermediary authorities, as well as the formal and informal networks of the actors of these institutions (Kuhlmann 2001). The innovation system concept turned out to appeal to policymakers a lot, not at least because the systemic perspective provided an argument for a broadened scope and reach of public innovation policy (Smits and Kuhlmann 2004). Many used it as a sort of programmatic device: Since a number of years, for example, the Swedish state office for innovation policy calls itself "Governmental Agency for Innovation Systems."

Actually, when taking a closer look, it turns out that the very concept of innovation systems while being designed by innovation researchers had at the same time been inspired and strongly supported by Scandinavian policymakers (see Carlsson et al. 2010) and by the Organisation for Economic Cooperation and Development (OECD) (Lundvall 2007) – the concept became "theory in action." Scholars could have tried to maintain academic distance to the lifting of their concepts and findings by policymakers or practitioners in innovation – but they chose to offer the policymakers information, heuristics, analysis, and theory, longing further than their "folk theories." In other words, they danced with innovation practice and policy and even jointly composed new melodies.

Considering innovation practice, policy, and theory as "partners on a dancing floor," moving to varying music and exposing different configurations, one can interpret the "regimes" of innovation and their evolution from the perspective of learning. The ideas, rationales, and instruments – finally the governance – of innovation and related policy emerge as a result of interactive learning between actors involved in innovation practice, intervention strategies and policies, and Innovation Studies and theory. Figure 1 (above) represented an attempt to characterize the dance of the three groups. Practice, policy, and theory can be conceived as dancing partners in a performance setting. The dancers observe each other and react on the partners' movements: They copy, comment, complement, counteract, neglect, learn, and thereby create and change configurations. Sometimes innovation practice is the driving force in a configuration, sometimes theory, sometimes public, or private policy.

Learning on the innovation policy dance floor may occur as first-order or as second-order learning. According to Argyris and Schön (1978), *first-order learning* links outcomes of action to organizational strategies and assumptions which are modified so as to keep organizational performance within the range set by accepted organizational norms. The norms themselves remain unchanged. *Second-order learning* concerns inquiries which resolve incompatible organizational norms by setting new priorities and relevance of norms, or by restructuring the norms themselves together with associated strategies and assumptions, hence escaping tunnel vision and crossing borders. In other words, while first-order learning would help to improve the expression, harmony or elegance of an otherwise unchanged dance (or make an innovation regime more effective), second-order learning would help to change the melody and the dance (or introduce new directions and modes of governance).

Third Consideration: The Potential of Innovation Studies as a Dancing Partner

Today, Innovation Studies are a respected academic field of interdisciplinary knowledge and research, loosely interlinked with Science and Technology Studies (STS; Hackett et al. 2007). In short, most of the enormous scope of topics covered by Innovation Studies and STS can be subsumed within two very general rubrics (Silbey 2006, 538): First, the institutionalization, reception, and appropriation of science and innovation and, second, the production of science and innovation as a social process. The first perspective is interested in the working of institutions, organizations, policies (expectations, rules, regulation, funding), strategy-making and planning, the assessment of potential developments and impacts of science and innovation, and their constructive shaping (Constructive Technology Assessment, CTA). The other, second perspective of studies adopts an anthropological view on the working of scientists, engineers, or users trying to reveal the intrinsic organization, culture, and epistemology of social groups. The ambition is to understand innovation not as a completely distinct realm of social action but like other social settings ruled by habits, rules, conflict, compromise, constructions, and narratives (Silbey 2006, 539). Consequently, this perspective concentrated rather on innovation as social practice than on policy. This approach, nevertheless, has an important impact on policy concepts: It helps to understand that modeling the governance of "innovation in the making" would fall too short if practice were conceptualized mainly in terms of functional and normative requisites, suggesting rather mechanistic designs of public policy ("mode 1"). Applying the constructivist approach to technological development and innovation as fields of social practice, strategists and policymakers developed more and more sophisticated policy designs ("mode 2"). The above-sketched "production governance rationale" can be understood as a result of this new perspective.

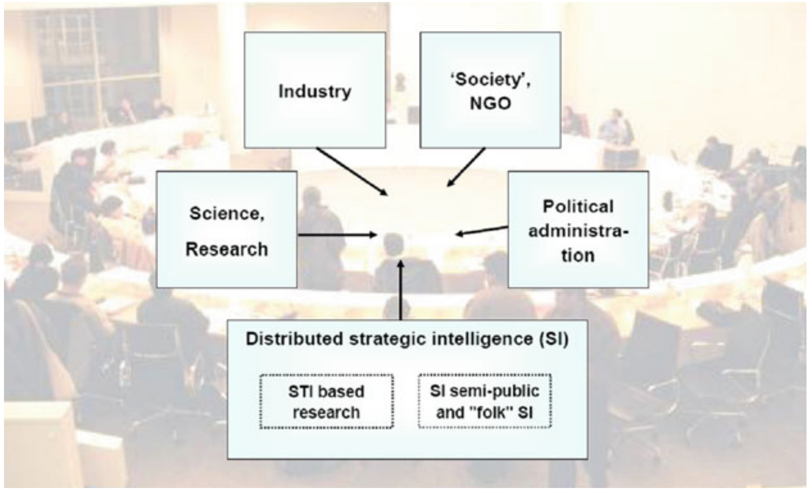
In short, one can state that Innovation Studies contributed a lot to a better understanding of the driving forces of each of the two other dancers, innovation in practice and policy, and became to some extent interwoven with them – sometimes very tightly, sometimes at some academic distance. Innovation Studies cope with this tension and even make it a source of increased reflexivity and enlightenment for their own purposes. The reflexive potential of Innovation Studies arises from the combined perspective of the interaction of practice, policy, and theory: Observing the dance and getting involved into it, Innovation Studies hardly can avoid adopting a *constructivist* position and *reflecting* upon their own impact on the dance and the evolution of images and beliefs of the other partners. And – one step further – Innovation Studies cannot escape questioning the origins and dynamics of their own beliefs. To which extend are they driven by concerns of practice and policy? Could such a drift be pictured as second-order learning, or are Innovation Studies scholars' beliefs sometimes also echoing the trends or fashions of their dancing partners or of the surrounding societal and cultural movement?

Obviously, Innovation Studies are not made up of one dominant theory; rather they appear as an assemblage of quite diverse intellectual strands, sometimes converging, sometimes diverting. Accordingly, innovation practice might prefer dances with other theory than public policy would like. In sum, there is no single recipe for coping with the ambiguity of being involved in the dance with practice and policy. Innovation Studies scholars moving with some passion on the dancing floor can only try to keep a precarious balance, based on some distance through reflection.

Fourth Consideration: Dance in Practice (Fora and Strategic Intelligence)

For a number of reasons, the governance of innovation and related policy has become ever more complex: Innovation processes themselves are subject of multiple forces and have become more uncertain; the number and heterogeneity of actors involved has grown, hence also the plurality of interests and values; and the borders between public and private spheres have become blurred. In order to cope with these challenges, actors seek to base their policy initiatives on increased interactivity, and often also on more evidence of actual or potential conditions, cost, impacts, etc. Interaction may be formally institutionalized and regulated, while in early phases, interactivity may occur in emerging spaces and semi-institutionalized platforms, where policymakers, public researchers, and industry as well as experts meet, articulate their views, provide intelligence in order to inform the process, and make attempts to set the scene. One means of organizing a policy-oriented discourse in semi-institutional environments are "fora," defined as *institutionalised spaces specifically designed for deliberation or other interaction between heterogeneous actors* with the purpose of informing and conditioning the form and direction of strategic social choices in the governance of science and technology (see Fig. 2, and Edler et al. 2006).

Fora can be seen as a dancing floor, a meeting place for innovation practice, theory, and policy with two related effects: (1) Interactive learning of policy analysts, policymakers, and relevant stakeholders and (2) improving the functioning of science and innovation policy and strategy. Fora can adopt several governance functions on the dance floor: They can offer a general, nondirected policy discourse, or offer policy information on specific issues, or prepare policy planning and development (visions, agenda,



Innovation Policies (vis-à-vis Practice and Theory), Fig. 2 Forum for debates of science, technology, and innovation issues (Source: Kuhlmann 2007, 17)

implementation), or facilitate the resolution of conflict and the building of consensus, or they can improve the provision and application of policy intelligence (e.g., see Edler et al. 2006).

In practice, there are manifold variations of fora. A specific characteristic of the sort of forum I am alluding to is the prominent role played by "*strategic intelligence*" (*SI*). SI has been defined as a set of sources of information and explorative as well as analytical (theoretical, heuristic, methodological) tools – often distributed across organizations and countries – employed to produce useful insight in the actual or potential costs and effects of public or private policy and management. Strategic intelligence is "injected" and "digested" in fora, with the potential of enlightening the debate (Kuhlmann et al. 1999).

SI can draw on semipublic intelligence services (such as statistical agencies), on "folk" intelligence provided by practitioners, and in particular on Innovation Studies. Meanwhile, a number of formalized methodologies, based on the arsenal of social and economic sciences, have been introduced and developed which attempt to analyze past behavior ("Evaluation"; e.g., Shapira and Kuhlmann 2003), review technological options for the future ("Foresight"; e.g., Martin 1995), and assess the implications of adopting particular options ("Technology Assessment"; e.g., Rip et al. 1995). Also, other intelligence tools such as comparative studies of the national, regional, or sectoral "innovation performance" were developed and used (e.g., the European "Community Innovation Surveys (CIS))".

Providers of SI play a number of roles in fora, often in combination: as a facilitator or moderator taking advantage of methodological capabilities, as an enabler or teacher supporting critical analysis and self-reflection (bird's eye view), as provider of issue expertise, or as entrepreneur using fora for advancing SI application in policymaking and for disseminating results (Edler et al. 2006).

Conclusion and Future Directions: "Strategic Intelligence" and New "Spaces" and New Models for Innovation Initiatives

Arenas of innovation policy have become more complex and sometimes unclear during the last two decades. Next to national governments, semi-independent regional and transnational institutions and agencies entered the arenas, partly as cooperation partners and partly as competitors. At the same time, public policymakers are confronted with multinational companies developing their innovation projects across the globe, drawing on public policy support wherever easily available, irrespective of the location of exploitation of innovation returns. National innovation policy will remain relevant, but actors will be urged to change their perspectives and policy designs: Hierarchical, fragmented, or stubborn strategies will fail in this complex environment.

Furthermore, many late industrializing countries have started to develop own innovation policy approaches, many of them drawing on the model of western industrialized countries. Yet, there are also more radical views, arguing that innovation policies are inspired on the wrong models, aiming at solving the wrong policy problems, too narrowly defined, too poorly managed and implemented, and/or lack the necessary supportive conditions from society due to historical, cultural, and political reasons (e.g., Rennkamp 2011). In particular, another concept of "innovation" will be required, beyond the presently prevailing business orientation, including aspects of social novelty and development, new ideas improving quality or quantity of life, not necessarily linked with economic profits. "The ultimate end of social innovation is to help create better futures" (Pol and Ville 2009, 884).

Hence, it will be crucial to systematically understand the diverging perspectives and interests of competing actors, to make them transparent and debatable – not aiming at weak compromises but stimulating learning capacity. This will require new interinstitutional and also international "spaces," fora where heterogeneous actors from different arenas meet and interact. "Strategic intelligence" can provide background information and alternative scenarios of potential future challenges for reflection. Otherwise, innovation policymakers will be reminded of the limits of an instrumentalist understanding and see "how great expectations in Washington are dashed in Oakland" (Pressman and Wildavsky 1973).

Cross-References

- ▶ Innovation Policy Learning
- ▶ Multi-level Systems of Innovation
- ▶ Political Leadership and Innovation
- ▶ Social Innovation

References

Argyris C, Schön DA. Organizational learning: a theory of action perspective. Reading: Addison-Wesley; 1978.

Benz A. Governance in connected arenas – political science analysis of coordination and control in complex control systems. In: Jansen D, editor. New forms of governance in research organizations. From disciplinary theories towards interfaces and integration. Heidelberg/New York: Springer; 2006. p. 3–22.

Biegelbauer PS, Borrás S, editors. Innovation policies in Europe and the US. The New Agenda. Aldershot: Ashgate; 2003.

Bijker W, Hughes T, Pinch T, editors. The social construction of technological systems. New directions in the sociology and history of technology. Cambridge, MA: MIT-Press; 1987.

Boekholt P. The evolution of innovation paradigms and their influence on research, technological development and innovation policy instruments. In: Smits R, Kuhlmann S, Shapira P, editors. The theory and practice of innovation policy. An international research handbook. Cheltenham: Edward Elgar; 2010. p. 333–59.

Boon WPC, Moors EHM, Kuhlmann S, Smits R. Demand articulation in intermediary organisations: the case of orphan drugs in the Netherlands. Technol Forecast Social Change. 2008;75(5):644–71.

Bozeman B. Technology transfer and public policy: a review of research and theory. Res Policy. 2000;29:627–55.

Braun D. Delegation in the distributive policy arena: the case of research policy. In: Braun D, Gilardi F, editors. Delegation in contemporary democracies. London: Routledge; 2006. p. 146–70.

Bush V. Science, the endless Frontier. A report to the President on a Program for Postwar Scientific Research. Washington, DC: U.S. Govt. Printing Office; July 1945.

Callon M. Disabled persons of all countries, unite. In: Latour B, Weibel P, editors. Making things public, atmospheres of democracy. Karlsruhe/Cambridge, MA: ZKM/MIT; 2005. p. 308–13.

Carlsson B, Elg L, Jacobsson S. Reflections on the co-evolution of innovation theory, policy and practice: the emergence of the Swedish agency for innovation systems. In: Kuhlmann S, Shapira P, Smits R, editors. Innovation policy – theory and practice. An international handbook. Cheltenham: E. Elgar; 2010. p. 145–66.

Chesbrough HW. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School; 2003.

Edler J. Change in European R&D policy as a complex consensus-building process. In: Edler J, Kuhlmann S, Behrens M, editors. Changing governance of research and technology policy – the European research area. Cheltenham: E. Elgar; 2003. p. 98–132.

Edler J, Joly P-B, Kuhlmann S, Nedeva M, Propp T, Rip A, Ruhland S, Thomas D, Understanding "Fora

of Strategic Intelligence for Research and Innovation". The PRIME Forum Research Project. Karlsruhe: Fraunhofer ISI; 2006. http://www.isi.fraunhofer.de/p/Downloads/PRIME_FORUM_Final_Reportv2.pdf
Edquist C, editor. Systems of innovation. Technologies, institutions and organizations. London/Washington, DC: Pinter; 1997.
EPOM, Unpublished reports from the project "Explaining the ST&I Policy Mix: From Policy Rationales to Policy Instruments (EPOM)" (PRIME Network of Excellence), coordinated by Laurent Bach, Dietmar Braun, Laura Cruz Castro, Luis Sanz-Menendez and Lucia Sell-Trujillo et al. 2007. http://www.prime-noe.org/
Felt U, Wynne B, Callon M, Gonçalves ME, Jasanoff S, Jepsen M, Joly P-B, Konopasek Z, May S, Neubauer C, Rip A, Siune K, Stirling A, Tallachini M. Taking European Knowledge Society seriously. Report of the Expert Group on Science and Governance. Brussels: European Commission; 2007.
Freeman C. Technology policy and economic performance: lessons from Japan. London: Pinter; 1987.
Geels FW, Schot J. Typology of sociotechnical transition pathways. Res Policy. 2007;36(3):399–417.
Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.
Hackett EJ, Amsterdamska O, Lynch M, Wajcman J, editors. The handbook of science and technology studies. 3rd ed. Cambridge, MA: MIT Press; 2007.
Hekkert MP, Suurs R, Negro S, Kuhlmann S, Smits R. Functions of innovation systems: a new approach for analysing technological change. Technol Forecast Social Change. 2007;74(4):413–32.
Kuhlmann S. Governance of innovation policy in Europe – three scenarios. Res Policy. 2001;30:953–76. Innovation policy in Europe and the US: new policies in new institutions [Special Issue]. Klein HK, Kuhlmann S, Shapira P, editors.
Kuhlmann S. Governance of innovation: practice, policy, and theory as dancing partners. Enschede: University of Twente; 2007. Address delivered upon the acceptance of the Chair Foundations of Science, Technology and Society Faculty Management and Governance.
Kuhlmann S, Boekholt P, Georghiou L, Guy K, Héraud J-A, Laredo P, Lemola T, Loveridge D, Luukkonen T, Polt W, Rip A, Sanz-Menendez L, Smits R. Improving distributed intelligence in complex innovation systems. Final report of the Advanced Science & Technology Policy Planning Network (ASTPP), a Thematic Network of the European Targeted Socio-Economic Research Programme (TSER). Brussels/Luxembourg: Office for Official Publications of the European Communities; 1999. http://publica.fraunhofer.de/documents/N-55510.html
Kuhlmann S, Shapira P, Smits R. Introduction. A systemic perspective: the innovation policy dance. In: Smits R, Kuhlmann S, Shapira P, editors. The theory and practice of innovation policy. An international research handbook. Cheltenham: Edward Elgar; 2010. p. 1–22.
Larédo P, Mustar P, editors. Research and innovation policies in the new global economy. An international comparative analysis. Cheltenham: Edward Elgar; 2001.
List F. National system of political economy. Philadelphia: J. B. Lippincott; 1856.
Lundvall BA. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992.
Lundvall BA. Post script: innovation system research. Where it came from and where it might go. GLOBELICS Working Paper Series, No. 2007-01, ISBN: 978-970-701-963-8; 2007. www.globelics.org.
Martin B. Foresight in science and technology. Technol Anal Strateg Manag. 1995;7(2):139–68.
Nelson R, Winter S. In search of a useful theory of innovation. Res Policy. 1977;6:36–76.
Oudshoorn NEJ, Pinch TJ, editors. How users matter. The co-construction of users and technology. Massachusetts: MIT Press; 2003.
Pol E, Ville S. Social innovation: buzz word or enduring term? J Socio-Econ. 2009;38(6):878–85. doi:10.1016/j.socec.2009.02.011.
Pressman JL, Wildavsky A. Implementation: how great expectations in Washington are dashed in Oakland; or, why it's amazing that federal programs work at all; this being a saga of the Economic Development Administration as told by two sympathetic observers, who seek to build morals on a foundation of ruined hopes. Berkeley: University of California Press; 1973.
Rennkamp B. Innovation for all? Legitimizing science, technology and innovation policy in unequal societies [PhD thesis]. Enschede: University of Twente; 2011.
Rip A. Science and technology as dancing partners. In: Kroes P, Bakker M, editors. Technological development and sciences in the Industrial Age. Dordrecht: Kluwer; 1992. p. 231–70.
Rip A, Kemp R. Technological change. In: Rayner S, Malone L, editors. Human choice and climate change, Resources and technology, vol. 2. Washington, DC: Batelle Press; 1998. p. 327–400.
Rip A, Misa TJ, Schot J. Managing technology in society: the approach of constructive technology assessment. London: Pinter; 1995.
Shapira P, Kuhlmann S, editors. Learning from science and technology policy evaluation: experiences from the United States and Europe. Cheltenham: E. Elgar; 2003.
Silbey S. Science and technology studies. In: Turner B, editor. The Cambridge dictionary of sociology. Cambridge: Cambridge University Press; 2006. p. 536–40.
Smits R, Kuhlmann S. The rise of systemic instruments in innovation policy. Int J Foresight Innov Policy. 2004;1(1/2):4–32.
Van de Ven AH, Polley DE, Garud R, Venkataraman S. The innovation journey. Oxford: Oxford University Press; 1999.

Van den Ende J, Kemp R. Technological transformations in history: how the computer regime grew out of existing computing regimes. Res Policy. 1999;28:833–51.
Zilsel E. The social origins of modern science. Dordrecht: Kluwer; 2003. Edited and introduced by Diederick Raven and Wolfgang Krohn.

Innovation Policy

▶ Entrepreneurship Policy
▶ Financing Innovation
▶ Innovation in Forestry: New Values and Challenges for Traditional Sector
▶ Innovation Policies (vis-à-vis Practice and Theory)
▶ Patents and Entrepreneurship

Innovation Policy Learning

Peter S. Biegelbauer
Department Foresight and Policy Development, Austrian Institute of Technology, Vienna, Austria

Definition

The term innovation policy learning stands for the change of innovation policy-relevant knowledge, skills, or attitudes, which are the results of the assessment of past, present, or possible future policies (Biegelbauer 2013).

Emergence of the Term and Development of Research

The approaches utilizing notions of policy learning share a conviction that the activities of policy-makers can be explained by understanding these actions in terms of feedback cycles used in order to assess previous actions. Policy-makers engage in learning in order to make sense of the world they live in, to gain a better understanding of the effects of their policies, and to arrive at better decisions in the future.

The notion "innovation policy learning" can be traced back to two different discussions, one rooted in political science and the other in economics. In political science, learning has been discussed as a category of policy analysis since the 1960s, when Karl Deutsch introduced his cybernetics of government (Deutsch 1966). Another milestone for the development of the term was Hugh Heclo's book on British and Swedish social policy (1974), in which he writes: "Governments not only 'power' . . . they also puzzle. Policy-making is a form of collective puzzlement on societies behalf" (Heclo 1974, 305). With this terminology, he captured one of the basic premises of the discussion on policy learning, namely, that political action cannot be explained alone by looking at interests and institutions and how they relate to power, which would be the classical categories of political science. Rather policy-makers also engage into efforts to solve what they perceive to be policy problems (Bandelow 2003; Biegelbauer 2013).

Similarly influential is the "advocacy coalition framework", developed mainly by Paul Sabatier (Sabatier and Weible 2007). In this framework, political processes are located in policy subfields, which are characterized by competing advocacy coalitions that may or may not change their belief structures through learning. At about the same time Peter Hall found that the change from Keynesian to monetarist economic policies in the early 1980s was best explained through social learning. His theory engulfs three targets of policy change, settings of policy instruments, policy instruments themselves, and finally policy paradigms, which are the ideational structure policies are embedded in and which most importantly explain the scope and the workings of policies. Social learning proper encompasses the change of policy paradigms, something happening only rarely (Hall 1993).

In the 2000s, policy learning approaches have been further developed, through, for example, critique of key terms (Maier et al. 2003), the further expansion of concepts of social learning (Oliver and Pemberton 2004), the advocacy coalition framework (Sabatier and Weible 2007), and of interpretative approaches (Grin and Loeber 2007), which also have integrated ideas from organizational sociology (Argyris and Schön 1978).

The second debate in which the term innovation policy learning is rooted stems from evolutionary economics. Neoclassic economic theory originally has exogenized innovation as a factor of economic development (Biegelbauer 2000). Yet with a number of empirical studies analyzing the production factors' input on growth carried out in search for new growth models, a new set of models was created in the late 1970s (Rosenberg et al. 1992). Joseph Schumpeter's vision of a dynamic and evolutionary economy (Schumpeter 1971) was integrated into a number of studies (e.g., Nelson and Winter 1982; Carayannis and Ziemnowicz 2007), which transcended the disciplinary boundaries of economics and led to a view of economic growth and technological change, which has increasingly been rivaling the neoclassical economic model ever since.

The key difference between the old neoclassical models and the newer Schumpeterian ones is that the latter are more dynamic in their evolutionary perspectives (Hofer 2003). With regard to technological change, this means an endogenization of the innovation process. Similar to the neoclassical model, the new models see technological change as the main driving factor for economic growth. However, since the new models are interested in explaining technological change, they assume the production function to include factors such as the level of technology or more broadly the stock of knowledge, investments into R&D, skills of the work force (human capital), indicators of the complexity of institutional arrangements, and the like, aside physical capital (Biegelbauer 2000).

In evolutionary economics, an important mechanism for the creation of knowledge and skills is learning. This notion has been developed especially by Bengt-Age Lundvall's concept of the "learning economy" (Lundvall 1992). Lundvall has differentiated between different forms of knowledge and skills, some of which had been rather neglected by economic theorizing before. This is especially the case with non-codified knowledge which accrues through "learning by doing" and forms an important knowledge base upon which a lot of innovation activities are based.

The wider framework of Lundvall's conception of a learning economy is the concept of "national systems of innovation" (Freeman 1987; Lundvall 1992; Nelson 1993), "the network of institutions in the public and the private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman 1987).

The notions of learning economies and national systems of innovation transformed in an ongoing process what was before science, technology, higher education, and industry policies into innovation policy (Biegelbauer and Borrás 2003; Edler 2003; Carayannis and Campbell 2006). This move impacts on the selection of policies as well as on the ways policies are perceived. Policy instruments have become more complex and are constructed to fulfill a multitude of purposes for the needs of a multitude of actors, and their effects are expected to be systemic (Kuhlmann and Smits 2004; Weber 2009). These changes have been interpreted as policy learning closely connected to the developments in the area of evolutionary economic innovation theory (Mytelka and Smith 2001).

Ramifications for Innovation Policy and Policy Analysis

A number of policy instruments have been devised to foster policy learning: evaluations, benchmarks, foresight exercises, impact assessments, expert commissions, and studies have been utilized to make policy-making ever more evidence-based and rational (Biegelbauer 2007, 2009; Biegelbauer and Mayer 2008).

Especially the European Union has built a whole learning architecture as part of the Lisbon Agenda and the Strategy 2020, both featuring the main goal of making the EU the most innovative and competitive region of the world. These strategies make use of the open method of coordination and its plethora of learning instruments. The exact nature of the open method of coordination, for example, the degree of its formality, differs from policy field to policy field (Borrás and Greve 2004; Borrás and Radaelli 2011). In RTDI policy, it engulfs a variety of rather informal networks, projects, and platforms in which experiences with RTDI policy-making are to be analyzed and exchanged (Lisbon Expert Group 2009). An important role plays a set of indicators, the Innovation Union Scoreboard, which has been developed in order to ease a systematic comparison of the EU member states' experiences – the Innovation Union Scoreboard covers the 27 EU member and 7 additional countries with 25 innovation research-related indicators as part of the EU's Strategy 2020, which has replaced the EU Lisbon Agenda in 2010 (Biegelbauer 2012).

In the 2000s, efforts have been made to integrate the two strands of research described here, one from political science and another one from evolutionary economics, in order to better understand innovation policy learning. This has taken the form of historical analyses of innovation systems and innovation policy on national (Biegelbauer 2000) and supranational (Edler 2003) levels, of comparisons of national systems of innovation (Biegelbauer and Borrás 2003), analyses of the relation between innovation theory and policy development (Mytelka and Smith 2001), critique of (naive) benchmarking exercises (Lundvall and Tomlinson 2001), and the open method of coordination in innovation policy (Lisbon Expert Group 2009).

Conclusions and Future Directions

From the research on innovation policy learning, several conclusions can be drawn for the further development of policy analysis. First of all, the concentration in the research field on rational decision-making in the sense of the maximization of personal utility should be balanced with other perspectives on decision-making processes. Policy-making is not only about a quest for power and influence, it is also about gaining knowledge, solving problems, and dealing with historically contingent norms and practices in the form of institutions, discourses, and culture (Gottweis 1998; Prainsack 2011).

Second, these different factors, for example, interests, cognition, institutions, discourses, and cultures, all play a role in the policy-making process, which is much messier, less sequential, and rational as usually depicted in the statements of politicians, accounts of journalists, but also social scientists (Hoppe 2009; Biegelbauer 2013).

Third, there is an urgent need for a fine-grained empirically driven policy analysis recognizing the messiness of decision-making processes instead of producing more schematic depictions of policy-making utilizing models of lower solution. Such a policy analysis could lead to a deeper understanding of the interplay of factors leading to policies and stay closer to accounts of policy-making one can hear from policy workers once the microphone has been turned off. Such a policy analysis could further our understanding of policy-making, and it moreover would be also useful for providing orientation and reflection knowledge for politicians and civil servants.

Cross-References

- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovation Systems and Entrepreneurship
- ▶ Joseph A. Schumpeter and Innovation
- ▶ National Innovation Systems (NIS)

References

Argyris C, Schön DA. Organizational learning. A theory of action perspective. Reading: Addison-Wesley; 1978.

Bandelow N. Policy Lernen und politische Veränderungen. In: Bandelow N, Schubert K, editors. Lehrbuch der Politikfeldanalyse. München: Oldenbourg; 2003. p. 289–321.

Biegelbauer P. 130 years of catching up with the west: a comparative perspective on Hungarian industry, science and technology policy-making since industrialization. Aldershot/Vermont: Ashgate Publishing; 2000.

Biegelbauer P. Learning from abroad: the Austrian Competence Centre Programme Kplus. Sci Public Policy. 2007;34(9):606–18.
Biegelbauer P. Erfahrungsorientiertes Lernen in der österreichischen Forschungs-, Technologie- und Innovationspolitik. In: Fröhlich J, Leitner K-H, Weber KM, editors. Innovationsforschung und Technologiepolitik in Österreich: Neue Perspektiven und Gestaltungsmöglichkeiten. Innsbruck: Studienverlag; 2009. p. 197–214.
Biegelbauer P. Wie lernt die Politik – Lernen aus Erfahrung in Politik und Verwaltung. Wiesbaden: VS Verlag; 2013.
Biegelbauer P, Borrás S, editors. Innovation policies in Europe and the US. The new agenda. Aldershot: Ashgate Publications; 2003.
Biegelbauer P, Mayer S. Regulatory impact assessment in Austria: promising regulations, disappointing practices. Crit Policy Anal. 2008;2(2):118–42.
Borrás S, Greve B. Concluding remarks: new method or just cheap talk? J Eur Public Policy. 2004;11(2):329–36.
Borrás S, Radaelli C. The politics of governance architectures: creation, change and effects of the EU Lisbon strategy. J Eur Public Policy. 2011;18(4):461–82.
Carayannis E, Campbell D, editors. Knowledge creation, diffusion and use in innovation networks and knowledge clusters: a comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006.
Carayannis E, Ziemnowicz C, editors. Rediscovering Schumpeter. Creative destruction evolving into 'Mode 3'. Houndmills, Basingstoke: Palgrave Macmillan; 2007.
Deutsch K. The nerves of government. Models of political communication and control. New York: The Free Press; 1966.
Edler J. How do economic ideas become relevant in RTD policy making? Lessons from a European case study. In: Biegelbauer P, Borrás S, editors. Innovation policies in Europe and the US. The new agenda. Aldershot: Ashgate Publications; 2003. p. 253–84.
Freeman C. Technology policy and economic performance: lessons from Japan. London: Pinter; 1987.
Gottweis H. Governing molecules: the discursive politics of genetic engineering in Europe and in the United States. Cambridge, MA: MIT Press; 1998.
Grin J, Loeber A. Theories of policy learning: agency, structure and change. In: Fischer F, Miller GJ, Sidney MS, editors. Handbook of public policy analysis. Theory, politics, and methods. Boca Raton: CRC Press/Taylor and Francis; 2007. p. 201–19.
Hall P. Policy paradigms, social learning, and the state. Comp Polit. 1993;25(April):275–96.
Heclo H. Modern social policies in Britain and Sweden: from relief to income maintenance. New Haven/London: Yale University Press; 1974.
Hofer R. Evolutionäre Ökonomie und historische Perspektive: Erklärung von Innovationsmustern? In: Pichler R, editor. Innovationsmuster in der Österreichischen Wirtschaftsgeschichte: wirtschaftliche Entwicklung, Unternehmen, Politik und Innovationsverhalten im 19. und 20. Jahrhundert. Innsbruck: Studienverlag; 2003. p. 43–56.
Hoppe R. Ex ante evaluation of legislation: between puzzling and powering. In: Verschuuren J, editor. The impact of legislation. Leiden: Martinus Nijhoff Publishers; 2009. p. 81–104.
Kuhlmann S, Smits R. The rise of systemic instruments in innovation policy. Int J Foresight Innov Policy. 2004;1(1/2):4–32.
Lisbon Expert Group. The open method of coordination in research policy. Assessment and recommendations. Report for the European Commission (2009).
Lundvall B-Å, editor. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992.
Lundvall B-Å, Tomlinson M. Policy learning through benchmarking national systems of innovation – learning by comparing. Report for the advanced benchmarking concepts (ABC) project. Aalborg University, Denmark (2001).
Maier LM, Hurrelmann A, Nullmeier F, Pritzlaff T, Wiesner A. Politik als Lernprozess? Wissenszentrierte Ansätze in der Politikanalyse. Opladen: Leske + Budrich; 2003. p. 7–22.
Mytelka LK, Smith K. Policy learning and innovation theory: an interactive and co-evolving process. Res Policy. 2001;31(8–9):1467–79.
Nelson R, editor. National innovation systems: a comparative analysis. New York: Oxford University Press; 1993.
Nelson R, Winter S. An evolutionary theory of economic change. Cambridge: Harvard University Press; 1982.
Oliver MJ, Pemberton H. Learning and change in 20th-century British economy policy. Governance. 2004;17(3):415–41.
Prainsack B. The power of prediction: how personal genomics became a policy challenge. Österreichische Zeitschrift für Politikwissenschaft. 2011;40(4):401–15.
Rosenberg N, Landau R, Mowery D. Technology and the wealth of nations. Stanford: Stanford University Press; 1992.
Sabatier P, Weible C. The advocacy coalition framework: innovations and clarifications. In: Sabatier PA, editor. Theories of the policy process. 2nd ed. Boulder: Westview Press; 2007.
Schumpeter J. The instability of capitalism. In: Rosenberg N, editor. The economics of technological change – selected readings. 1st ed. Harmondsworth: Penguin Books; 1971. 1928.
Weber KM. FTI Politik im Spiegel von Theorie und Praxis: von Planung über Steuerung zu Governance. In: Leitner K-H, Weber KM, Fröhlich J, editors. Innovationsforschung und Technologiepolitik in Österreich: Neue Perspektiven und Gestaltungsmöglichkeiten. Innsbruck: Studienverlag; 2009. p. 231–54.

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Innovation System of India

Sonali Bhattacharya[1] and Shubhasheesh Bhattacharya[2]
[1]Symbiosis Centre for Management and Human Resource Development, Pune, Maharashtra, India
[2]Symbiosis Institute of International Business, Pune, Maharashtra, India

Synonyms

Creativity; Jugaad; Knowledge economy; Quadruple helix model

The Concept of Innovation

Goswami and Mathew (2005) have given a detailed literature review on the definition of innovation. Myers and Marquis (1969), Zaltman et al. (1973), and Drucker (1985) looked at innovation in the point of view of technological innovation. Lundvall's (1992) definition of innovation includes non-technological innovations, including institutional innovations. Freeman (1988) emphasized on the role of social and educational innovations (pp. 339–341). Carlsson and Stankiewicz (1995) extended the definition of innovation to include the development of new organizational setups. Schumpeter's definition sums up the following forms of innovations: (1) introduction of new product or qualitative change in existing product, (2) process innovation new to an industry, (3) opening of a new market, (4) development of new sources of supply for raw material, and (5) other inputs and changes in the industrial organization. Boer and During (2001) defined innovation as the combination of creation of a new product–market–technology–organization. Carayannis and Campbell (2012) defined "quadruple helix" model, under which government, academia, industry, and civil society are seen as key actors which promote a democratic approach to innovation through strategy development and decision-making with the key stakeholders acting as catalysts resulting in socially accountable policies and practices. The authors speak of three modal approaches: the first mode is the primary educational system and basic research which create knowledge, second mode constitutes application of knowledge in practical solving of problems, and third mode is the creation of knowledge cluster or network for creation, diffusion, and application of knowledge.

India's Historical Quest for Knowledge and Innovation

Indian Upanishad (Dasgupta 2001) speaks of four forms of education: learning from the teachers, learning through self-reflection and introspection, learning through peer interaction, and learning in time context through experience. Upanishads describe five layers of knowledge: knowledge for satisfying basic needs, knowledge for developing means of existence, knowledge for psychological well-being, knowledge based on rational thinking, and knowledge of purpose.

India's quest for knowledge began in the prehistoric period, with the discovery of zero and alphabetic numerical from 200 BC to 600 AD which replaced all other forms of numeration systems. Arab traders picked up the new numeration system, which subsequently spread to Europe.

Indian discoveries in astronomical science have been popularized by Al'Beruni. The Srimad Bhagvat Gita is the treasure house of spiritual knowledge, morality, ethical way of life, and knowledge of highest pursuit of differentiation between good and evil. Kautilya's Arthashastra, which disseminated ethical codes of conduct in administration and accounting rules, arguably was the first work ever on principles of governance. India's expertise in various fields of knowledge had attracted expedition by foreign travelers like Huin Tsang, Marco Polo, and Vasco Da Gama. India had developed skills in metallurgy in ancient times, and the iron pillar near Qutub Minar stands testimony to the fact. One of the oldest universities in the world, Nalanda University, established in India sometime between the fifth to the twelfth century, catered to the needs of 10,000 students from all over the world.

The eighteenth century saw emergence of another string of famous scientists in various domains of science and mathematics like Meghnad Saha, Chandrasekhara Venkata Raman, Jagadish Chandra Bose, and Srinivasa Ramanujan. The twentieth and twenty-first centuries saw human interest in multidisciplinary studies like biotechnology, genetic engineering, neurophysics, biochemistry, and econometrics. Edward Jenner (1749–1823), known as "father of immunology" and discoverer of vaccination against small pox, had originated his work in India. Taj Mahal the seventh wonder of the modern world is a spectacular masterpiece of architecture built by the Mughal Emperor Shah Jahan to commemorate the death of his wife.

Some works on knowledge economy highlight the contribution of knowledge-intensive industries like information technology industries to national productivity (Brynjolfsson and Hitt 2000; Gordon 2000). There is no denying to the fact that India is still moving ahead to assimilate itself in the modern knowledge economy brought in by the information technology revolution of the 1990s and signing up of the Intellectual Property Rights under World Trade Organization (WTO). Information technology, in the present era, provides the basic framework for acquisition and creation of knowledge repository on various domains and application and distribution of knowledge for betterment of the society.

The focus now in India has shifted substantially toward R&D and innovation having successfully registered several applications under US Patent and Trademark. Internet and broadband connections have penetrated to most urban household, but rural areas are still lacking on IT infrastructure. India has been included in the 34 nations under World Knowledge Competitiveness Indexes (WKCI). India, along with China, is considered to form the knowledge cluster of South Asia with three of its cities, Mumbai, Bangalore, and Hyderabad, enlisted among the 145 cities which form knowledge powerhouse under WKCI report. Revolution in the ICT has brought forth new opportunities by easy accessibility of knowledge at all levels. The knowledge workers, the managers, information technology professionals, the medico-professionals, lawyers, and educationists form a substantial part of the population than even a decade ago. Bangalore boosts to have nurtured three of the global leaders in software solution like Wipro, Satyam, and Infosys.

Present Scenario in Innovation and Entrepreneurship

After the modernization of Intellectual Property Right (IPR) in 1995 with full compliance with the World Trade Organization, there has been much focus in India toward promoting research and innovation and IPR infrastructure. India is considered to be the 24th largest patent office of the world in terms of number of patent filings by WIPO 2010. According to WIPO Statistics Database, July 2009, there have been 34,285 patent filings in Indian patent office out of which there are 4,145 resident filings. In fact annual growth rate of patent filings in India in 2000–2007 has been second largest with 24.5 % next only to China which has a growth rate of 32 %. Out of total filings India granted, there are 2924 nonresident patents and 1,396 resident patents. Relative specialization index, which shows a country's share in foreign oriented patents in a specific technology as compare to country's share in all foreign oriented patents, is especially high in organic fine chemistry (1.88), pharmaceuticals (1.672), food chemistry (1.13), and medical technology (0.711). India has filled 1,635 patents through business houses, 730 through government-owned organizations, and only 6 through other research institutes in 2000–2007. No patent has been filled by universities. India's research development expenditure is a little over 1 % in the last few years. According to WIPO Statistics Database and UNESCO, July 2008, the research and development expenditure (in millions of constant US dollars, based on purchasing power parities and lagged by 2 years to derive the resident filings to R&D ratio) of India is 0.398 which makes India 22nd ranked in R&D expenses. The figures for comparable economies are Brazil (0.519), Russia (3.385), China (2.439), and Republic of Korea (5.597). The average annual salary of researchers is US$11,526, and when adjusted for purchasing power parity, it is US $56,780. Bulk of R&D spending (about 75 %) is by government. The government agencies and pharmaceuticals form the bulk of patent filings in the US Patent and Trademark Office (USPTO) like Council of Scientific and Industrial and Research (CSIR), Dr. Reddy's Laboratory, and Ranbaxy Laboratory. In 2004–2005, out of total of 229 patents granted to Indian innovators, CSIR had 140. The research innovation in CSIR and other Indian research institutes has been in areas of pharmaceuticals and food chemicals (Chakrabarti and Bhaumik 2009). Out of the top 1400 global companies with highest R&D expenditures, there are only 15 Indian-based companies. By R&D as percentage of sales, these companies are Tata Motors (10.5 %), Mahindra & Mahindra (11.7 %), Bharat Heavy Electricals (3.1 %), Corus now part Tata Steel (5 %), Novelis (Canada) now part of Hindalco Industries (1.6 %), Reliance Industries (8.7 %), Ranbaxy Laboratories (6.7 %), Dr. Reddy's Laboratories (17.6 %), Sun Pharmaceuticals (23.1 %), and Cipla India (17.9 %). The software companies included in the list are Polaris, KPIT Cummins, Infosys, Aztecsoft, and Prithvi Information. The R&D innovations in software sector have mostly been by foreign companies. Of the top 50 most innovative companies by Business Week and Boston Consulting Group Survey 2009, there are three Indian companies: Infosys, Reliance Industries, and Tata group.

The major knowledge clusters in India are National Capital Region of Delhi, Mumbai, Pune, Bangalore, and Hyderabad due to the simultaneous existence of research laboratories, MNCs with high innovative index, and quality higher education institutes.

Efforts and Achievements in Application of Knowledge in the Present Era

Global innovation is recognized in form of product innovation, process innovation, and service innovation. Indian IP laws earlier allowed only process innovation. Indian pharmaceutical companies copied and developed low-cost molecules discovered in Western countries. With change of IP laws in 2005, product innovation has been allowed. Some of the ventures in India on product and process innovation are as follows.

Nanotechnology

On realization of the significance of nanotechnology in fields of health science and defense, there has been growing impetus on R&D in nanotechnology in Indian Institute of Technology, Indian Institute of Science, National Institute of Pharmaceutical Education and Research, and National Instrumentation Organization.

Innovation System of India, Table 1 Public and private partnership in nanotechnology (Source: Bhattacharya (author) 2011)

1.	Nano Functional Materials Centre, IIT Madras	Murugappa Chettiar and Orchid Pharma
2.	Nano Technology Centre, Univ. of Hyderabad	Dr. Reddy's Labs
3.	Centre for Interactive & Smart Textiles, IIT Delhi	ARCI, Hyderabad & Textile Industry
4.	Centre for Pharmaceutical Nanotechnology, NIPER, Chandigarh	Pharma industry
5.	Rubber Nanocomposites, MG University, Kottayam	Apollo Tyres
6.	Nanophosphor Application Centre, University of Allahabad	Nanotech Corp., USA

Besides, there are private–public partnerships as given in following Table 1.

There has been evidence of successful use of nanotechnology in the health sector like development of Nanoxel – indigenously developed nanotechnology-based drug delivery system for cancer treatment in Indian market by Dabur India, patented technology for gene repair therapy by Virtuous Innovation, a group company of Khandelwal Laboratories, etc. Success of nanotechnology has also been seen in other fields like creation of nano-shirts under the brand name of Park Avenue by Raymonds and successful launch of nanotechnology-based water purifier by Indian Institute of Technology (Chennai).

ICT-Based Inclusive Growth

Some of the ICT-based initiatives to ensure inclusive development have been in the field of telemedicine connecting 180 rural centers to 20 superspecialty health centers and more recently a tele-healthcare project which includes teleconsultation, tele-diagnostic, and tele-treatment. The project was initiated by Apollo Group of Hospitals at 24 clusters covering 50,000 villages around Aragonda village in Andhra Pradesh. Further there has been introduction of Max Vijay scheme, an insurance product targeted for deprived section of society to be sold by NGOs, microfinance organizations connected with IBM-designed wireless handheld devices, which enable data transfer through general packet radio service (GPRS) to the back end system and facilitate on-the-spot issuance of insurance policies.

In the education sector, EDUSAT is a satellite connectivity system which is used for teacher training and higher education programs in remote villages by Indira Gandhi National Open University. National Council of Education Research and Training (NCERT) also holds satellite-based interactive educational programs for teachers all over the country.

EducompTM MagiKeys solution is a unique software application that allows millions of government school students to surf the web, email, chat, and write documents in their mother tongue. It supports 11 Indian languages, namely, Hindi, Marathi, Gujarati, Kannada, Tamil, Malayalam, Punjabi, Urdu, Telugu, Bengali, and Konkani. Reliance Communications is collaborating with One Laptop per Child Foundation to provide network facility for providing every child with a low-cost, handy, rugged laptop to have a collaborative, joyful learning experience in 25,000 towns and 6,00,000 villages of India.

MCA21 is a Ministry of Corporate Affairs and Tata Consultancy effort for e-business transaction using direct identification number (DIN) and digital signature. State of Gujarat which has won the national award for best e-governed state has the largest optical fiber wire area network of 50,000 km in Asia. All activities of governances like procurement of business, taxation, and public grievance management are carried out mandatorily through the Internet.

EnAble India, an organization started by two soft engineers, works toward increasing employability of handicapped people by ICT-based training by using software like SAFA, a low-cost screen reader software based on windows, which transforms text on-screen into synthetic speech aimed for visually challenged people and also by creating digital audio books and other educational tools in collaboration with other NGOs. It also acts as a link with organizations which can provide employment opportunity for these people, by helping these organizations to create a barrier-free workplace.

Lifeline, a project initiated by One World Foundation in collaboration with CISCO and British Telecom, aims at providing its clients, the farmers, with requisite information on their queries using telephony and Internet in their mother tongue. Queries made through landlines or mobiles are passed through interactive voice response to a knowledge worker who tries to solve the problem with the help of database of 30,000 frequently asked question (FAQ) with answers or else refers it to an expert.

For providing white-collared employment to various unemployed youths, a project SMSOne was started by Pune-based entrepreneur under which an unemployed youth builds an SMS community of about 1,000 cell phone users in his area and provides them with news and updates through an SMS newsletter. The service is free of cost for the user and revenue is generated through advertising. Only one message per week is permitted. The news can be government messages, news and advertisements of shops of the locality, birthday alerts, and election propaganda of local leaders and politicians. CGNet-and ICT-based forum of journalists created by Shubhranshu Choudhary of Chhattisgarh that aims at ensuring public participation in development is a web-based discussion forum of ordinary people of local community which feeds in news related to tribal life, culture, farming, Dalit issues, the Naxal movement, education, gender issues, health, mining, employment, etc.

Some Innovative Business Models

Indian Premier League

In 2008, vice-president of Board of Control for Cricket in India (BCCI) Lalit Modi partnered with IMG executive Andrew Widblood to initiate Indian Premier League, a T-20 version of cricket, in which each match is to be of around 3 h with each competing to face 20 overs each. Teams were auctioned to leading business tycoons and Bollywood celebrities which ensured pumping in of huge money. The IPL was expected to generate revenue of nearly $2 billion in the period 2008–2019, including proceeds from TV rights ($918 million), promotion ($108 million), and franchises ($724 million). Players are being offered $1.55 million for an IPL season of about 5 weeks as against $50,000 to $ 1 million which they can earn playing their national team in a year, depending how engaging schedule their respective national teams have.

VNL

VNL, a start-up company, awarded as Telecom Asia’s best green infrastructure of the year in 2010 (http://www.telecomasia.net/content/ta-reader-choice-awards-2010-winner-list), is the first solar power-driven WorldGSM mobile service meant for rural areas with *low levels of average revenue per user (APRU)*. It has also been named as “Technology Pioneer 2010” by the World Economic Forum. It had to face the challenges of low power services, availability of less number of skilled engineers for installation and maintenance of the GSM system, and poor infrastructure.

The model developed requires less than 50 W power per base station and hence does not require power grid, nearly zero maintenance and entire base station can be packed into two carts and can be installed by even unskilled labor.

Narayana Hrudayalaya

According to the World Health Organization report, number of doctors per 1,000 population in India is less than one, and there is a requirement of 6,000 doctors, 1 million nurses, and 0.2 million dentists. Only 0.5 % of Indians have health insurance and out of pocket spending is about 85 %. About 2.4 million Indians require cardiac surgery per year and only about 60,000 operations are actually carried out. Narayana Hrudayalaya at Bangalore was established by Dr. Devi Shetty with the vision of providing highest quality healthcare services to patients with heart problem at lowest cost. It planned to achieve high volumes of OHS and catheterization operations per day which brought down the unit cost of surgery. Also high-cost machines are rented instead of purchasing to bring down the cost further. Suppliers are hired under short-term contract and low-cost dual medicines like cardio-diabetic medicines of Biocon are used for bringing down cost of medication. It has initiated India's largest telemedicine network and also has provision of mobile cardiac care. Dr. Shetty is also credited to have started the most successful microinsurance project in India called Yashwashini targeted for farmers of Karnataka. For INR 5 (US$0.11) a month, cardholders can have access to free treatment at 150 hospitals in 29 districts of the state for any medical procedure costing up to Rs. 100,000. It is now working to extend its clinical expertise to cancer with the launch of Biocon, a 1,400-bed facility providing treatment for head-and-neck, breast, and cervical cancers.

Apollo Hospitals which recently won the G20 Challenge on Inclusive Business Innovation has reached to masses in remote villages and semi-urban areas through their Apollo reach program.

Medical Tourism

Medical tourism in India as found by Brotman (2010) is outbound, inbound, and intrabound. Hospitals catering to both inbound and intrabound medical tours have shown significant profits with India's growing economy. Tourists from the USA prefer to go to developing nations for medical tours as many forms of surgery such as cosmetic surgery, dental reconstruction, and gender reassignments are not insured in the USA. Similarly, in Britain and some other European countries where healthcare is controlled by government healthcare system, long queuing for requisite operations may lead citizens to foreign lands (Horowitz and Rosenweig 2010). People also come here from different countries for certain specialized surgical operations like bone marrow transplant, joint replacement, and stem cell treatment for cancer which otherwise are not performed in their countries. Also, medical treatment cost in India is considerably lower. A heart valve replacement surgery would cost (Sinha 2008) patients $10,000 in Thailand, $12,500 in Singapore, $200,000 in the USA, and $90,000 in Britain and only $8,000 in India. While a bone marrow transplant would cost $30,000 in India, doctors in the USA would charge anywhere between $250,000 and $400,000 while those in the UK would charge $150,000. A cosmetic surgery would cost $3,500 in Thailand, $20,000 in the USA, and $10,000 in Britain and will cost only $2,000 in India.

According to the American Medical Association data, a spinal fusion would cost $62,000 in the USA, $5,500 in India, $7,000 in Thailand, and $9,000 in Singapore. Medical tourism in India is growing at the rate of 30 % annually. It is expected to reach $ 2 billion by 2012. Escorts, Apollo Group of Hospitals, Hinduja, and Jaslok are some of the major players in medical tourism. Indian medical treatments include alternative treatments like Ayurveda, Yoga, Unani, Siddha, and Homeopathy treatments (AYUSH). Medical tourism should be supported by insurance policy, travel support, online information on types of treatment availability, hospitality, and clean and hygienic condition in hospitals.

Teach for India Foundation

This is a nongovernment organization which trains young volunteers who are students of reputed educational institutes or professionals who are trained to educate underprivileged children through experiential learning. This initiative involves multiple credible stakeholders – Indian and United Nations' NGOs, corporates, educational institutions, and individuals – who will finally create an ecosystem of shared thought and knowledge.

Jugaad Innovation Complementing Systemic Innovation

Jugaad is an Indian method of playing around the legal system to create an innovative, sustainable economic product by mixing and matching local material (Radjou et al. 2012). For example, there is this product called MittiCool developed by Prajapati which is a refrigerator made out of clay.

Jugaad vehicles cost around INR 85,000 (less than US$2,000). They are powered by diesel engines which were originally intended to power irrigation pumps. They are known for having poor brakes and cannot go faster than about 60 km/h (37 mph). The vehicle is used to carry more than 20 people at a time in remote locations and poor road conditions. Today, jugaad is one of the most cost-effective transportation solutions for rural Indians. SELCO, which provides energy and power in underdeveloped villages in Karnataka, is perhaps a best example of jugaad technology. Another individual jugaad model was that adapted by medical practitioner Dr. Mohan. He experimented with a number of different ways to frugally yet effectively engage rural communities both as consumers (patients) and employees. He found that it was very difficult to motivate the team of highly competent technicians from his city hospital to continue work for a long time in remote villages. A training curriculum of three months duration was developed in the city hospital in Chennai to impart to youths of the villages basic skills of providing healthcare needs. These newly trained healthcare professionals would return to their rural homes, where they were more likely to want to remain. This in turn helped reduce costs and turnover. A cost-effective telemedicine platform was created with the help of Indian Space Research Organisation, which provided a roaming telemedicine van with a free satellite uplink to his clinic.

The dynamic director of SAP India is encouraging bottom-up approach for innovation through participative leadership. Employees are free to experiment with bold ideas during work hours which will improve their quality of life.

Shrishti, an autonomous organization under the government of India, promotes innovation at grassroots by awarding and supporting the best innovators and innovative ideas and creates a culture of participatory development. They are being supported by the Council of Scientific and Industrial Research, Indian Council of Medical Research, and Botanical Survey of India to add value to innovative ideas and traditional knowledge by converting them into useful products in areas of engineering, human health, agriculture, veterinary, and nutraceutical. Honeybee Foundation set up by Professor Anil Gupta maintains database of 10,000 grassroots innovations and helps to promote and commercialize them. Jugaad Innovation has already been adapted Indian firms such as Future Group, Suzlon Tatamotors, Yes Bank besides Indian subsidies like GE, Siemens, Philips, and PepsiCo.

Impediments to Innovation

1. *Lack of Innovation Culture*

   As Welzel–Inglehart cultural map puts India along with other developing nation at a position of higher survival values and low in self-actualization value. Hofstede (1991) scores also indicate that India has a low to moderate uncertainty avoidance, high power distance, low masculinity, and low individualism. Although it is only indicative, yet it reveals that Indians are probably risk-averse, hesitant to make important decisions in work-related matters, and probably lack attitude to take initiative. Mashalkar (2010) in his speech says that there are several ideas by Indians which have been converted into successful patented product by Japanese after research papers written by Indians related to same were published. The recently discovered "God particle" or "Higgs–Boson" particle are based on the works of Prof. Satyendra Nath Bose. Way back in 1924, Bose realized that the statistical method used to analyze the existent theories on the thermal behavior of gases was inadequate. He first sent off a paper on quantum statistics to a British journal, which turned it down. He then sent it to Albert Einstein, who immediately grasped its immense importance and published it in a German journal. Bose's innovation came to be known as the Bose–Einstein statistics and became a basis of quantum mechanics, which led to the discovery of this subatomic particle. Two of the most recent Nobel laureates from India in recent times, Amartya Sen for economics and Ramakrishnan Venkatraman in chemistry, are more known for their work abroad.

   Educational system has long been encouraging "rotting" rather than experimental learning in form of problem-solving, design, experimentation, etc., in the education curriculum. Evaluation in education should encourage subjective responses rather objective answers. Competency-based customized career plan and curriculum are required to be designed for each child.

2. *Lack of Innovation Ecology*

According to a National Knowledge Commission survey, the most important barriers to innovation, as perceived by both large firms and SMEs, are skill shortages due to the lack of emphasis on industrial innovation, effective collaboration for research between universities and R&D institutions, excessive government regulation, as well as insufficient pricing power to derive value from innovations. Further, it has been found, out of the graduates passing out of professional institutes (Mckinsey 2005), only 25 % of engineers, 15 % of finance and accountancy professionals, and 10 % of graduates with Indian degrees are employable by multinational companies. Fifty-four percent of the universities under University Grants Commission (UGC) are giving education in general discipline (Table 2).

Innovation System of India, Table 2 Distribution of central and state universities into types of discipline (Source: UGC Annual Report, 2004–2005)

Type	Number	%
General	126	54
Agricultural	35	15
Technological	14	6
Language	11	5
Medical	9	4
Law	6	2.6
Woman	5	1
Animal and fishery	4	1.7
Open	11	5
Others	16	5.7
Total	237	100

Further, the number of researchers in India has increased by only 20 % from 1991 to 2001 as compared to China where the comparative increase was about 80 % (Knowledge Commission Report). To develop quality researchers, India should promote university–industry link in running of PhD programs; for example, Reliance Life Sciences has developed a model under which they facilitate employees getting admission for PhD degree from Mumbai University. BITS Pilani similarly has Ph.D. program for working executives (http://www.knowledgecommission.gov.in/downloads/documents/moreQualityPhD.pdf). A report on 1473 NAAC accredited colleges between 2002 and 2004 shows that there are overall only 25.6 % Ph.D. teachers. Indian universities need to have good academicians with Ph.D. degree. According to Furqan Qamar and S. Sinha (2007), there are 57 % of teachers in higher education who are without M.Phil. and Ph.D. degree. With various universities not being able to fill up the posts under various reservation categories, universities are recruiting ad hoc and guest faculty.

To emphasize individual and industrial innovation, National Knowledge Commission (NKC) suggested to allow licensing and royalty arrangement in which the inventors as well as research institute would have share. To promote research several government programs have been initiated like the New Millennium India Technology Leadership (NMITL), Techno-Entrepreneurs Promotion Program (TePP), and Technology Development Board (TDB). To provide for need of talent pool, 8 Indian Institute of Technology (IIT) and 3 Indian Institute of Science Education and Research (IISER) are being opened. NMITL has so far evolve 57 largely networked projects in diverse areas, namely, agriculture and plant biotechnology, general biotechnology, bioinformatics, drugs and pharmaceuticals, chemicals, materials, information and communication technology, and energy involving 80 industry partners and 270 research groups.

3. *Lack of Venture Capital*

There is general lack of venture capital for start-ups who want to experiment with new ideas. The investment by venture capitalist has been in the late stage as can be seen from the Table 3 below.

To facilitate commercialization at early stage innovation, several incubation centers are being opened in all over the country like the ICICI Knowledge Park in Hyderabad; International Crops Research Institute for

Innovation System of India, Table 3 Venture capitalist investment at various stages of innovation (Source: Bhattacharya (author) 2011)

Stage of the company	Number of deals, 2006	Number of deals, first half 2007
Early stage	59	24
Growth stage	42	25
Late stage	104	67
PIPE	61	34
Buyout	11	6
Others	22	6

Semi-Arid Tropics (ICRISAT); Centre for Innovation, Incubation, and Entrepreneurship (CIIE) at Indian Institute of Management, Ahmadabad; National Institute of Technology at Calicut (NITC); and Society for Innovation and Entrepreneurship (SINE) at IIT Mumbai and at Vellore Institute of Technology (VIT). Some of the government initiatives taken are writing off research and capital expenditure in companies having in-house R&D centers, 10 years tax holiday to R&D companies approved by Department of Scientific Industrial Research (DSIR), no import duty charged on import for equipments by public R&D institute, and 125 % tax deduction on donation to research institutes carrying out social and statistical research.

4. *Corruption in the System*

Most studies validate the fact that either democracy or autocracy does not considerably able to combat corruptions. Corruption can only be prevented by greater accountability. In his keynote address at the Indian Independence Day Celebration of 2005 conducted by a nongovernment organization Nandini – Voice for the Deprived at Chennai, Mr. N. Vittal (2005), former Central Vigilance commissioner, said, "there are five basic reasons for corruption in India. (1) scarcity of goods and services; (2) red tape and complicated rules and procedures; (3) lack of transparency in decision-making; (4) legal cushions of safety for the corrupt under the "healthy" principle that everyone is innocent till proved guilty; and (5) tribalism among the corrupt who protect each other." The report of the Civil Services Examination Review Committee (October 2001), which was set up by the UPSC made the following observations:

> It is very crucial to understand what happens to the values and integrity, motivation and other qualities assessed at the time of recruitment after 10 years and 20 years of service. It is said that initially many of the officers have positive values, but they change during the course of service. When they appear before the UPSC interview boards, most of the candidates are idealistic, bright, committed and sincere. However, once they join the service, within a period of time they seem to become cynical, negative and possibly even corrupt. Even the most outstanding officers feel frustrated after their idealism has been dimmed by the systemic realities. Some of them succumb to pressures easily. Therefore, a deeper insight into the systemic mechanism is required to ascertain the causes affecting this change and take remedial action.

Corruption in the society has resulted in failure of several social development initiatives, like public distribution system and mid-day meal scheme. In a survey undertaken by Transparency International and Delhi-based Centre for Media Studies, it was found that value of corruption under PDS is as whooping as Rs. 375 crore per year. Kumar (2003) in his extensive study of corruption in India has indicated that implementation of the Prevention of Corruption Act (1988) has been a failure in India. He was of the view that the right to uncorrupted service should be made a fundamental right and right for jurisdiction against violation of this right should also be a fundamental right. Corruption can be thought of violation of human right as it has been established that only 17 % of the fund allocated by the government for poverty reduction actually reaches to the needy (Roy 2003) which is a great impediment to innovation for inclusive development. Citizens should be made aware of their rights and knowledgeable about government provisions which are meant for their development. The Mazdoor Kisan Shakti Sangathan, an NGO, had initiated awareness campaign and holding government accountable for any corruption or mismanagement of developmental fund in many parts of the country.

"India Against Corruption," a mass nonviolent movement started by veteran freedom fighter Anna Hazare to force the parliament to pass the "Lok Pal" Bill, which will put legislatures and administrators under its ambit for any acts of corruption, has been a huge success in the last few months.

Conclusion and Future Directions

India has an advantage of fast-growing GDP and large pool of English-speaking widely respected engineers and doctors. A combination of scientific temperament, quest for truth, and questioning mind which is the basis of Upanishad is required for India to innovate. Novelty will be developed if there is an infrastructure and ecology-supporting youths who think differently and seek a platform for their experiment with truth. A strong sense of ethics has to be inculcated from childhood to combat corruption which kills youthful zest for service and change catalyst. India must capitalize on its strengths in case of alternate medicine and supercomputers if it intends to be a global leader in knowledge economy. As defined in the "quadruple helix" model by Carayannis and Campbell (2012), there is need of a society which has a scientific and inquisitive spirit, government which stimulates entrepreneurial venture and industrial activism, and academia which envisages interdisciplinary research.

Cross-References

▶ Business Creativity
▶ Business Start-Up: From Emergence to Development
▶ Creativity, Intelligence, and Culture
▶ National Culture
▶ Triple Helix of University-Industry-Government Relations

References

Bhattacharya S. Innovation in India: a path to knowledge economy. J Knowl Econ. 2011;2(3):419–31.
Boer H, During WE. Innovation, what innovation? A comparison between product, process and organizational innovation. Int J Technol Manag. 2001;22(1–3): 83–107.
Brotman BA. Medical tourisms: private hospitals. J Health Care Finance. 2010;2037(1):45–50.
Brynjolfsson E, Hitt LM. Beyond computation: information technology, organizational transformation and business performance. J Econ Perspect. 2000;14:23–48.
Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems: 21st century democracy, innovation, and entrepreneurship for development. New York: Springer; 2012.
Carlsson B, Stankiewicz R (1995) On the nature, function and composition of technological systems, In: Technological Systems and Economic Performance: The case of Factory automation, pg24, ed: Kluwer Academic Publishing.
Chakrabarti A, Bhaumik PK. Internationalization of technology development in India. J Indian Bus Res. 2009;1(1):26–38.
Dasgupta AD. Corporate ethical dilemmas: Indian models for moral management. J Hum Values. 2001;7(2): 171–91.
Drucker PF. Innovation and entrepreneurship: practice and principles. London: Heinemann; 1985.
Freeman C. Japan: a new national system of innovation? In: Dosi G, Freeman C, Nelson R, Silverberg G, Soete L, editors. Technical change and economic theory. LEM book series. London: Publishers; 1988.
Gordon RJ. Does the new economy measure up to the great inventions of the past? J Econ Perspect. 2000;14:49–74. HarperCollins.
Goswami S, Mathew M. Definition of innovation revisited: a study on Indian Information Technology Industry. Int J Innov Manag. 2005;9(3):371–83.
Hofstede G. Cultures and organizations: software of the mind. Maidenhead: McGraw-Hill; 1991. 279 pp.
Horowitz MD, Rosenweig JA. Medical tourism: health care in the global economy. Am Coll Physician Exe. 2010;33:24–30.
Kumar CR. Corruption and human rights: promoting transparency in governance and fundamental right to corruption-free service in India. Columbia J Asian Law. 2003;17(1):31–73.
Lundvall B-Å. Introduction. In: Lundvall B-Å, editor. National systems of innovation toward a theory of innovation and interactive learning. London: Pinter Publishers; 1992. p. 1–19.
Mashalkar RA. Indian decade of innovation (2010–2220). In The Field Marshal S.H.E.J. Manekshaw Memorial Lecture; 2003.
Mckinsey Global Institute. The emerging global labour market, Part-II The supply of offshore talent in services. San Francisco: Mckinsey Institute; 2005.

I

Myers S, Marquis DG. Successful industrial innovation: a study of factors underlying innovation in selected firms. Washington, DC: National Science Foundation, NSF 69-17; 1969.
Qamar F, Sinha S. Quality and excellence in higher education studies. 2007. www.ugc.ac.in/pub/report/12.pdf
Radjou N, Prabhu J, Ahuja S. Jugaad innovation: think frugal, be flexible, generate breakthrough growth. San Francisco: Jossey-Bass; 2012.
Roy B. The power of information-A grassroots organisation defeats corruption in India. 2003. www.dse.de/zeithschr/de202-11.htm
Sinha K. Medical tourism booming in India. The Times of India, 4 Apr 2008.
Vittal N. "Moral values must prevail" in the tribune, Chandigarh, Saturday, Special Supplement, 24 Sept 2005, p. 15
Zaltman G, Duncan R, Jonny H. Innovations and organizations. New York: Wiley; 1973.

Innovation Systems

► Innovation in Forestry: New Values and Challenges for Traditional Sector

Innovation Systems and Entrepreneurship

Dimitri Uzunidis[1,2] and Blandine Laperche[1,3]
[1]Research Unit on Industry and Innovation/CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France
[3]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Enterprises; Entrepreneur; Innovation; Innovation networks; Innovative milieu; Proximity relations

Technological innovation is the surest way to restore, transform, and expand markets. The expansion of businesses and the globalization of markets have revealed the importance of local pockets of productive resources. The geographical proximity between science, technology, industry, and finance contributes to the emergence of innovations. Interactions are organized by the combined effect of private and public institutions. Currently, economists consider the "local economy" as a pertinent geographical and economic level of organization of production, and therefore, of new activities emergence, new goods and services, new jobs, new revenues... Over the past 40 years, the approach of innovation based on proximity – and especially the concept of innovative milieu (see for example, Aydalot, 1986) – has shown its always more and better relevance as a model of decentralized economic growth but also of enrichment of businesses' technological competencies, including international ones. These economists do not refer to a purely linear model of innovation (which would correspond to the idea that the increase in inputs – here the R&D – would meet the increase in outputs – innovations here) while identifying the need to increase spending on R&D to strengthen the knowledge base. They are more in an interactive vision, which emphasizes the importance of networks of public and private actors, at the territorial level, recognized as relevant to the development of the innovation policy (Tidd et al. 2005).

Indeed, in a changing and highly unpredictable environment, the enterprise, whether large or small, is at the center of public policies and of economists' concerns and sociologists' interests. Its main function – innovation – is regarded as the main source of job creation, wealth, and prosperity. But on two conditions: (a) the structures must be flexible enough so that the company can adapt itself to market fluctuations and (b) the constant renewal of its productive resources can only be achieved if the financial and industrial framework of the country or the region is sufficiently strong and diversified so that the company may combine networks of producers and consumers in the constitution of its supply and in creating a demand for its products. Once these two conditions are met, the creation of innovative small businesses and the strengthening of the innovative potential of large firms can be linked together. As a matter of fact, to strengthen the innovation potential of large firms and to facilitate the emergence of new businesses, specialists put forward the importance of innovation systems.

An innovation system describes the relationships between institutions (scientific, technological, industrial, commercial, financial, political), being public or private (companies, research laboratories and engineering, administration...). These relationships mostly consist of informational and financial flows and people movements. The purpose of such a system is to produce innovations (new organizations, new goods and processes, new resources, new combinations of productive resources). The systems are national (or local) with a focus in this case on the regulation framework. They can also be "private": In that case, the analysis focuses on the "network" which can be defined as a set of businesses legally and/or financially linked to one or several larger ones. The network is a system that is intended to make one (or more) production (s) integrated in a same value chain, and under the direction and coordination of parent companies.

An analysis from the innovative milieu gives the possibility to study the environment of businesses and understand their innovation dynamics. The systemic nature of relationships that characterize a social and economic environment explains what promotes or not innovation. But should we reduce innovation, product of the environment, only to interindividual exchanges leading to a new productive combination? Does it only result from a specific organization of economic relations? Our thesis is that the systemic environment does not only refer to economic interactions but also takes into account the social structures that are the source of innovative behavior. However, institutions (government, local authorities) take a significant role in the organization and evolution of socioeconomic structures. And in turn the innovative environment contributes to the performance of innovative companies by providing scientific and technical resources.

Proximity and Innovative Milieu as the Engines of Innovation

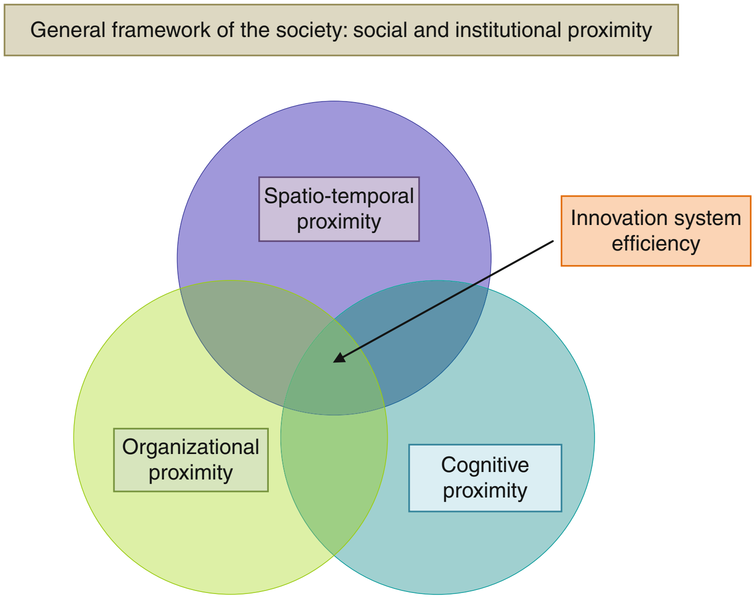
Proximity and Innovation

The notion of proximity is largely used today, both in industrial economics and economics of innovation. But the ambiguity of the term, as the variety and scope of its applications, implies a careful use of it. Proximity is linked to the existence of externalities that produce spatial agglomeration effects and territorial dynamics. **This is spatial and temporal proximity**. Other meanings were added to this first definition of physical or geographical proximity (Boschma 2005; Uzunidis 2008; Nooteboom 2009).

Another kind of proximity is **organizational proximity**. It refers to the coordination of activities within the organization and between organizations, whether this coordination is organized by the market (contracts) or by the hierarchy (ownership). The similar or different coordination arrangements within organizations (in the case of big corporations) or between the organizations may facilitate or not the creation of networks.

The specific activities involved in the production of new knowledge and in the associated interactions led economists to introduce, in addition to spatial and temporal proximity and organizational proximity, the concept of **cognitive proximity**. This refers to more or less formalized sharing of experiences, representations, codes, languages, and models resulting from and at the same time facilitating the communication of information within or between organizations. By nature, cognitive proximity has a special place in research activities, but it is also present through all kinds of communication flows within or outside the firm. In the case of interactions related to industrial research, cognitive proximity not only affects the internal interactions within research centers but also the external interactions with other centers of business services, as well as interactions with the environment (other laboratories and partners in research and innovation).

Other forms of proximity are identified and notably the **social and institutional forms of proximity**. They refer to the relationships



Innovation Systems and Entrepreneurship, Scheme 1 Forms of proximity and innovation system efficiency (Source: Authors)

that can be created at the microlevel (social proximity) and at the macrolevel (institutional proximity). They are the results of habits and routines built by the social and institutional history. As such, they can contribute to the good functioning or hinder the functioning of networks.

It seems relevant to suggest a three-dimensional approach to proximity, before presenting the importance of proximity in generating new businesses and launching innovations (Scheme 1). The following graph presents the ways the types of proximity interact. The more they are linked together, the more efficiently the innovation system may operate, that is to say generate new innovations and new businesses. The social and institutional forms of proximity are related to the functioning of the whole society and are not specific to an innovation system. This is the reason why there are presented outside the three dimensions of proximity.

The Local Economy as an Innovative Milieu

The local economy (or local productive system) can be defined as a geographic area formed as a set of systemic relationships between businesses and between businesses, state and local governments. These systemic relationships characterize the local area by a certain type of activities and final products. Economists observe and study this economy as a knot of productive relationships, which may contribute to the territorial organization (which has however remained national). They attribute qualifiers showing the dynamics of the combinatorial and complementary relationships between businesses of different sizes at the local level: "local production system" and "innovative environment."

The territorial efficiency of this mode of organization lies in what we call today the savings on transaction costs. The concentration on a single geographic location of the main players of the same production system (mainly the producers on the one hand and the users on the other) not only facilitates transactions but also the interrelationships of knowledge and trust between the partners. The formation and accumulation of skills will then form an "industrial atmosphere" conducive to condition the local labor market (Marshall 1919). This phenomenon, the industrial atmosphere, is connected to both the competence and experience of workers and also to the location of firms in the same area. In the sense of the Marshallian industrial district, the milieu gathers a population with proven expertise, a group of actors making up the various links of the same production system, and finally a know-how that defines the accumulated expertise. The main feature is the territorial organization of production, rather on a principle of collaboration and cooperation between different production units rather than on a hierarchical principle. Thus, the notion of solidarity among economic actors is very important. The local production system is mainly characterized by the proximity of productive units (individual businesses, services, research centers, and training…). These units maintain these relations of varying intensity that can take very different forms: formal or informal links, commercial or noncommercial alliances… These relate mainly to the flow of materials, services, labor, technology, and knowledge.

Basically, this is the GREMI (European Research Group on Innovative Environments: team of researchers from the Institute of Economic and Social Research at the University of Neuchatel, Switzerland) which, in 1985, developed the assumption that it is the regional communities that generate different forms of innovation (innovation-product-process innovations, organizational innovations, social innovations, innovations in training/qualification, etc.) (see Maillat and Perrin 1992). The explanation for the emergence of a "successful" region comes from the fact that it is primarily the latter that has managed its own capacity to develop new products, new technologies, and new organizations. This assumption, founder of the regional science, questions the traditional economic theories which on the contrary advocate a progress and a growth which main factors and engines mainly find their justification and their origin from the "outside" (so-called models of "development from the top").

Our central theoretical hypothesis to analyze the concept of innovative milieu, that is to say, the socioeconomic territory forged by history ("path dependence") is that it is the product of interactions of firms, institutions, and labor. These interactions are necessarily the result of reciprocal synergies (networks, linkages, partnerships, etc.) between the various local (public or private) agents of the economic and industrial development. We can take as an example the forms of cooperation between companies and research laboratories. Ultimately, it is primarily the socioeconomic, industrial, and scientific milieu that participates to the creation of new activities (including through entrepreneurship and spin-offs) and to the genesis of innovations. And it will "naturally" be done if certain conditions are met. Among them are the existence of, locally, a group of actors (companies, research centers and training, government, skills…); the existence of material, human, financial, technological, and informational resources geographically agglomerated; the existence of specific know-how giving the possibility of a quality of production; the existence of relational capital conducive to the formation of local, national, or international networks; and finally the existence of norms, rules, and values that determine the behavior of economic actors.

The concept of innovative milieu also highlights a strong principle in systems of innovation: it reinforces the idea that the innovative capacity of companies is closely linked to social, economic, and political issues surrounding them. The "innovative environment" most often designates the ability of a local economy to generate innovation through the emergence of new businesses and the location of more ancient firms in its geographical area, where the industrial exploitation of research organizes the creation of small innovative companies. The local economy takes the shape of a territorialized system of the exploitation/valuation of all kinds of capital and of market exchanges. Benefiting from a certain (legal and economic) autonomy of organization of productive resources, its primary characteristic is the formation and development of specific resources and the achievement of particular combinations of these specific resources. These are composed of capital and labor with specific forms and contents in relation to activities and specific sectors – specific in terms of technology, financial or demographic characteristics but also in terms of skills, qualifications, level of education, etc. The local economy becomes, then, an "innovative milieu," reducing the risks associated with the uncertainty of a given investment and initiator of the innovation process, including through business creation and the attractiveness of existing technology companies.

Enterprises' Strategies and Innovative Milieu

Understanding the Company

To understand and to study a company, the economist looks at the internal organization of production entities and their environment (market, competition, government…). His systemic vision leads him to consider the company as a living entity whose birth, growth, survival, and death are conditioned by a set of conflicting relations between the entity and its environment and between its internal organs. The economist goes so far as to say that a company as such has no meaning; what matters is its relationships with other companies, with the markets, or with institutions. This representation of the company highlights the role of trade, financial, or technology relations, generated by the company or to which it is subjected. Thus, we can then appreciate the role of a local innovation system or "innovative environment."

The company is commonly defined as an economic unit, a set of combined factors of production, whose activity results in the production of goods and in the provision of services sold in a market. Its objective is the achievement of sustainable profits, essentially higher than those of competitors and sufficient to finance its investments and growth. The expansion of its size is, for the enterprise, another condition that must preserve the attacks of competitors and of fluctuations in demand. The reality of the business is complex: the company is a legally independent center of decision that implements a strategy, sets goals, and creates the means to achieve it. The company is also a social organization that brings together people with different skills linked by hierarchical relations of power and responsibility. The economic independence of the company is relative. First, because the constraints imposed by its legal and commercial environment limit its room for maneuver. Its need to make a profit, a guarantee of good health, leads the company to get in conflict or cooperation with other companies, to change its status over the increase of its capital, to protect, diversify, and expand its markets. On the other hand, ownership of capital can sometimes belong, in whole or in part, to another company: subsidiaries and other companies subject to complex financial linkages and integration are dependent on decisions of the group to which they belong.

Decision and power are the hallmarks of business operations. The decision system of the company regulates its activities. It is constructed by the play of power and control between the company owners and is used to define the decision-making authority of its manager and staff. Generally, a decision is made at three levels of power: operational (production tasks in the company), management (organizational tasks and monitoring procedures), and strategic (task programming, planning, strategy). The charts that are set up according to this method reflect the administrative structure of the company. The chart of a company presents its hierarchies, its functions, and activities taking account of the place of decision, the information structure, the factors of consistency, and the center of dynamic operation. The functions provided by the organization are linked by (a) the order flow circulating from top to bottom between the three levels of authority which express some technical and decision-making rationality; (b) information, technical, economic, and financial flows between services, departments, and subsidiaries; and (c) financial flows generated by the activities of budgeting services, departments, and subsidiaries, but also through the implementation of contracts between the subsidiaries and the parent company and other independent companies.

The company is forced to increase its size (volume and value) in order to survive. It must indeed try to control its future in order to meet (in the best possible condition of profit-making and controlling as much as possible, financial and business risks) the expectations of its shareholders. To do this, it must reduce the market uncertainty by providing all necessary means to capture, sort, process, and use the largest quantity of economic, technological, financial, commercial, and political information. When the environment is quickly changing, the capital turnover and the pace of innovation evolve faster as well. . . the risk of failure in the process of "creative destruction" increases. The information then becomes the ultimate competitive weapon. Its mastery leads to the construction of barriers to entry. Not only does competition become imperfect, but it also becomes a power game (combining competition and temporary pacts of alliances and cooperation) between global industrial and financial groups. The place left to small entrepreneurs is then marginal and unstable.

Innovation and Investment Strategy

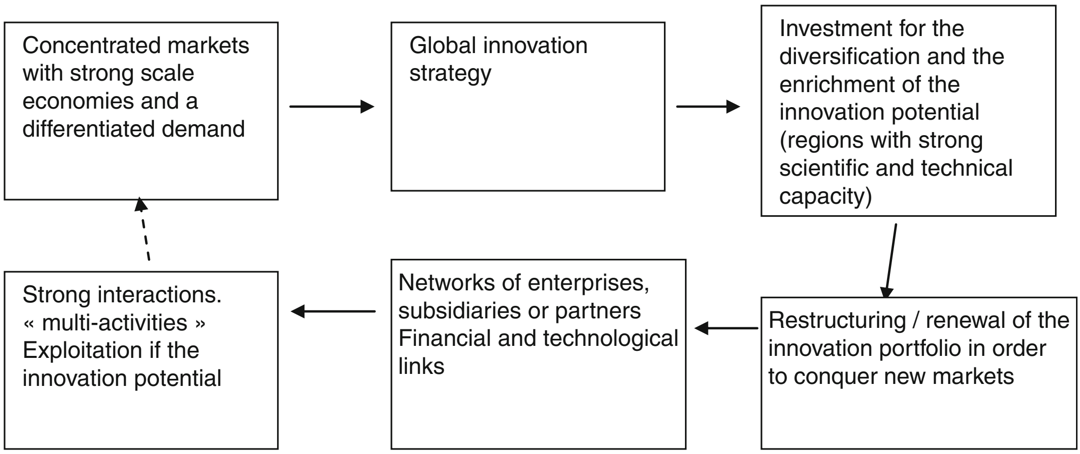
In this context, the choice of investing (whether to locate a company in a new place or to create a new business) is determined by the relative factors of centralization and decentralization. Centralization reflects the necessity to achieve economies of scale, to fertilize between projects, to communicate tacit information, to be in close contact with the functional departments of production and marketing, to control technology assets. . . Decentralization is explained by the need to access scarce skills, to benefit from externalities in an enabling environment, to be in close contact with customers and suppliers. . .

The nature of activities (technological level and degree of specialization) conditions quite well the level of compromise between, on the one hand, the search for externalities (agglomeration effects) and, on the other hand, the constraints of scale, of indivisibility, which conversely implies to concentrate locally the innovation resources.

Indeed, the enlargement, integration, and permanent renewal of markets, as determined by the combined evolution of profit and financial income, increase the business risks (how many products are withdrawn from the market before the investment made for their production is recovered and even before they are known by consumers?) and the financial risks (how many companies have faltered – see notably the examples of internet start-ups in the USA and Europe – for reasons of speculation and debt before they attack their market due to lack of customers?). The company has therefore to invest large amounts of capital to create an important information system, to protect itself from these risks, to constantly innovate, and to reassure its shareholders, its creditors, and its clients from all over the world.

The process of "permanent innovation" is the main feature of the global firm. This one is defined as a company whose organization is integrated by multiple information and financial flows and whose structures are largely decentralized: network firm with multiple affiliates and multiple partnerships with co- and subcontracting companies; company with a financial large amplitude in services and industry with high scientific and technical potential and benefiting from important external effects (clusters). It has a strong ability to innovate and to continuously adjust its structure and organization. It benefits from comparative and specific advantages of the different locations. It integrates into a "value chain" (R&D, logistics, innovation and financial engineering, manufacturing, assembling, marketing, and other services) all the activities it carries out all over the world.

The decentralized management options that the firm has added to the structural and short-term advantages offered by states and local governments determine the location of innovation activities of the global enterprise. This one in turn contributes to modify the development of chosen the territory. The globalization of firms' strategy (and notably of the innovative strategy) is explained by the concentrated structure of markets, characterized at the global by strong scale economies and a differentiated demand (for high, medium, and low income). To meet the consumers' demand, firms have to invest in the continuous expansion of their innovation potential (also called knowledge capital). To locate their innovative activities, they thus choose areas (territories) with a strong scientific and technical potential. These investments aim to renew their innovation



Innovation Systems and Entrepreneurship, Scheme 2 Location strategy of the global firm (Source: Authors)

portfolio to conquer new markets. Due to the costs and risks of the innovation process, big corporations develop networks gathering different enterprises, subsidiaries, and partners characterized by financial and technological links. Strong interactions emerge from these strategies. Firms develop multiple activities that aim to exploit their innovation potential (or knowledge capital). In turn, this contributes to the concentration of markets and leads to the deepening of inequalities between wealthy and poor regions (in terms of scientific, technological, and financial resources) (Scheme 2).

For global companies, the management of R&D and production aims to articulate the global strategic orientation with decentralized R&D – looking for a dynamic scientific environment and willingness to "stick" to the most dynamic markets. Then, "globalization" is not opposed to the strengthening of local interactions but tends to increase them.

Its local roots allow the company to benefit from a pool of resources (and sometimes a market) to amortize the costs associated with its investments in a constantly changing economy. But these local roots depend on the quality of the reservoir compared to the expectations of the company for its innovation and business development strategy. This explains the need for governments and local authorities to organize the development of resources. They have to facilitate the emergence of multiple innovation processes taking into account the competition-cooperation between the actors in an open economy. This is a system of supply of productive resources capable of generating a technological entrepreneurship and to attract large companies with assertive performance in innovation.

Policies of Emergence and Promotion of Innovative Enterprises

The Industrial Policy and the Formation of a Pool of Resources

Since the late 1980s, the financial, business, and production strategies of global firms have replaced the administered planning of territories, along with planning policy that has become deprecated. As a matter of fact, the opening of economies to competition (deregulation and contestability of markets in order to prevent the monopolistic practices) led to a strong overlapping of national economies to the point that the reasons (and objectives) of large international firms become reasons of state. Industrial policies are now focused on services and intangible and have an essentially territorial dimension. Cluster policy, implemented globally, reflects this orientation.

The role of the state in the formation and organization of a scientific and technological pool of resources for innovation and investment is essential and accurate. Public intervention has already exceeded the traditional areas of implementation and funding of a science and technology policy at the heart of which we find the public institutions of education and research. The conduct of the state in this area is increasingly comparable with the major industrial and financial groups, and the strong ties of interdependence between these organizations justify the transfer of resources from public to private. This means the formulation by the state of an innovation policy, in other words, the promotion of all means for scientific research, development, application, and technology choices to facilitate the creation and diffusion of new products and new processes. The intervention of the state and of local decision-makers in building and managing an "innovation system" can take various forms: granting activities that generate resources that can be individually or collectively appropriated by companies, creating mechanisms enabling enterprises to recoup their investments in research and development (e.g., patents that do not hinder the diffusion of innovation), and implementing procedures for cooperation between public and private entities aiming to ensure the financial feasibility of a private investment likely to have economic impact on a large scale.

The formation of a pool of productive resources that can be appropriated at any time by firms is now regarded by economists as the fundamental aspect of state intervention in the economy and in the organization of space. We may follow the reasoning of L. Branscomb and J. Keller (1998): noting that the creation and dissemination of knowledge increase the performance of a national or local economy (and of the companies that compose it), they put forward the idea that traditional science and technology policy (emphasis on finance and implementation of major research and development programs, primarily in the areas of defense, energy, space, and medicine) has been replaced by the policy of research and innovation. To be successful in terms of competitiveness, this policy must aim as much to the achievement of all public or publicly funded research programs as to the distribution of their results to "users" (businesses). The state should ensure the effectiveness of the procedures of research commercialization, by the regulations (protection of industrial property rights, antitrust laws, etc.), taxation, budget, etc., in order to create propagation effects. Economists conceptualize the formation of a "stock" (reservoir) of resources that are shared in these multiform, multifunctional, and multistakeholder cooperation processes.

The Promotion of Investments: Creation and Attractiveness of Enterprises

Local economies, in the "network economy," are now trying to grow by relying on private initiative, combined with a public and territorial focused policy. The attractiveness of investments, the ability to create business, and job creation define the performance of a local economy. All three indicators are related in time and space. But territorial institutions put forward a number of arguments to attract direct investment and create enterprises and jobs in the short term. There are two types of policies for growth and investment promotion: the short-term policy and structural policy.

The short-term policy refers to budgetary and fiscal measures with the aim of having rapid effects: create businesses to create jobs and attract production units to create jobs. As the expected results in terms of investment must be done very quickly, the government targets (a) companies with mobile production units (Fordist or heavy, for which the total costs of production are the factors that determine the choice of investment) and (b) potential entrepreneurs with low added value with an existing core business immediately exploitable. The main measures of this policy are:

– Financial incentives: direct allocation of funds to the investor (big company and entrepreneur) by the state or local government (investment grants, subsidies, subsidies for new jobs, subsidized loans)
– Fiscal incentives: reducing the overall tax burden of the investor (temporary tax reduction, exemptions from import duties of raw materials, intermediate goods, capital goods)

– Indirect incentives: to provide the investor with land, buildings, telecommunications facilities (see enterprise zones), privileged access to public procurement, flexible, part-time, fixed-term jobs, etc.

The structural policy refers to the industrial and innovation policy measures with the aim to establish or maintain a strong technological and economic specialization: enrichment of the scientific and technical potential in order (a) to facilitate the creation of innovative companies and (b) to attract large companies' centers of research and units of production specialized in high technology. The results are cumulative and visible in the long run. Governments develop instruments of commercial and technological watch to guide decisions in the constitution, the restructuring, and the enhancement of networks of innovation (investment and marketing).

The main measures of a structural policy of investment are:

– Public investment in creating the conditions for an endogenous growth in the long term: transport and communication infrastructures; facilities for education, research, and engineering performance; local financial system oriented toward innovation; complete health system; quality of life through cultural activities, organization of space, and leisure, etc.
– Implementation and funding of a research and innovation policy (instead of a purely industrial policy) whose objectives are: (a) the federation around a specific program of business skills, public institutions, and private research associations and institutions and (b) the networking of actors in research, industry, commerce, and forecasting for the implementation of value-added investment in a backbone area (and its niches) defined by the regulatory authorities.
– Creation of a center for the delivery of services and of financial means to businesses attracted by the project and to entrepreneurs specialized in the same field and in related activities (information engineering, development and socioeconomic studies), for example, the establishment of an observatory of the local economy with real organizational advisory power.

Innovation Systems and Innovation Networks

Business Creation in Local Innovation Systems

In a local innovation system, a particular emphasis is put on the creation of small innovative companies. In the current economic uncertainty and following the trends of decentralization, the creation of new businesses is as a matter of fact supposed to solve many problems related to the rigidities created by institutional intervention. Their flexible structures enable them to respond more readily to consumer expectations, and their failures do not threaten the financial and industrial structure of a country, region, or locality. The creation of small businesses is seen as a preferred means of industrial policy and planning. While large companies, made of various activities of production, finance, and marketing, are trying to organize markets and change technologies, through alliances, mergers, pacts, and political interference, the hope of economic revival is concentrated in small business. The small business fits perfectly with the needs of the economy. It is a formidable machine for the use and destruction of capital; it also presents itself as a sort of vector of values, to the extent that it establishes bridges facilitating the transport of productive resources (financial capital, technology, workforce different qualifications and skills) toward the activities, markets, and big businesses able to make a profit.

The entrepreneur is a figure, a concept, and a function difficult to define by the existing theoretical tools. Personal qualities and personality of the entrepreneur certainly play an important role in the decision to establish a small business. But undertaking, as a function and an act, is defined by the macrosystemic dynamics of accumulation and profit. This dynamics creates barriers and opportunities for personal enrichment which make an individual an entrepreneur and subsequently either succeed or fail. The fact is that "one is not born an entrepreneur, one becomes one": one becomes one through the mobilization of a potential of resources composed of capital, knowledge, and relationships (Boutillier and Uzunidis 2006). Capital is required for investment and operation; knowledge is needed for the choice and the decision; relations are important for the funding, the gathering, and the diffusion of the production.

The creation of a new business is thus the result of the emergence of a flaw in the economic structure made by (a) the differential of profit due to market imperfections and barriers to the mobility of productive resources and goods, (b) the institutional apparatus supporting and enhancing the entrepreneur function, and (c) the mobilization of the required expertise and capital. The current entrepreneur and his small business are therefore essential to (a) the coherence of large enterprises' entrepreneurial space, (b) the reactivation of local microsocial milieus, and (c) the alleviation of the burden of unemployment, inactivity, and precariousness. The creation of a business is a social act that is part of a social network or "social capital," which develops in a given social and economic environment. The network of social relations of any actor consists of a part of proximity social networks (usually consisting of parents and family), and other larger social networks (usually composed of neighbors, friends, professionals).

Entrepreneurs and Innovation Networks

We could say that currently small businesses are "created" by the combined action of governments and large industrial and financial corporations: to be competitive in international markets, a big business transforms its internal functions into independent units and often resort to small companies having a specific expertise. On the other hand, this process of outsourcing and the simplified organization of groups is facilitated by the legal and fiscal policies: the laws on tax relief for holding companies and on the extraterritoriality of financial subsidiaries give the possibilities to big companies to manage with more flexibility their partnership, subcontracting and licensing contracts. The financial control that this burst of production structures requires encourages the creation of small businesses that flourish in the "niches" of markets and in specific technology.

In the industrial history, a large enterprise concentrated its means of production, defined and compartmentalized production tasks, and built directly controllable collective of workers. It now becomes (it has now become) a center of organization and of decentralized management of its productive resources. The way production is now organized tends to mean that the market power of a business (and the coordination of functions and activities that it can impose) is a greater factor of economic power (and of centralization of ownership of assets) than the power that can give it its own (scientific, technical, industrial, and financial) assets. The market power of the company results from its financial capability (ownership of financial assets and ability to raise funds) and from its information potential. Information and finance are used to build and manage the group of small entities geographically dispersed and physically distant (investments in interindustry relations of cooperation, in the protection of technological assets, in the ownership of scientific knowledge, and in the design of new goods, in the coordination, by electronic means, of the various activities, etc.). The managerial coordination strengthens the role of the manager in industrial organization and subjects the entrepreneur to the decisions of the managerial power.

Small innovative firms are introduced into the networks formed by large groups and often coordinated in relation to the territory (Boutillier et al. 2008; Boutilier and Uzunidis 2010). This is the case of science parks where large firms having large technology and business advantages create themselves small innovative businesses (kinds of research laboratories) managed by entrepreneurs and researchers. In other cases, it is the managers of big businesses that are requested by the parent to create a company to experiment new technologies (intrapreneurship). It is not uncommon to see the emergence of a "speculative entrepreneurship" in favor of big businesses. These are highly skilled individuals who, assisted by soft loans and government subsidies, create a company to sell it to a larger one after the product or production process is developed. Connecting small businesses with large corporations is achieved through a financial and intelligence strategy. The venture capital (equity investment firms in the capital of a company that has just been created), business angels (wealthy individuals who invest in innovative projects), and other investors (pension funds are very active) commit capital in innovative new businesses (e.g., in information technology and biotechnology). In sum, complex innovation networks are built, characterized by diverse financial, technological, and informational links between different type of actors, which are all dependent from the ones to the others and which have strong (even if flexible) local roots.

Conclusion and Future Directions

Both the local and entrepreneurial aspects of innovation reveal the mechanics of formation and appropriation of all ingredients of productive activity. The issue of appropriability has become crucial for the operation (the location or creation) of a company. The company tends more to tap into its environment than to invest in the formation of its own resources, notably in all the phases of technology creation. This can be explained by the fact that investments in the acquisition (appropriation) of production resources are less expensive than those dedicated to the formation of these resources. This also explains the attractiveness (open economy) of an area benefiting from abundant scientific and technical resources. The creation of innovative or more traditional enterprises depends on the richness of the "milieu." If the factors related to education, environment, healthcare, finance, infrastructure, housing, etc., impact the marginal cost of a business or activity, they also impact the return on investment. Therefore, the idea of the "network" and of the "innovative milieu" appeared to establish itself in the observation and economic analysis.

The achievement of innovation networks follows four ways: reducing the spatial, organizational, and cognitive distance between firms of different sizes and between companies and institutions; the institutional support for the creation of a pool of resources into which businesses can tap; the creation of new scientific, technical, and commercial opportunities; and the support of the entrepreneurial process. These are the areas of industrial and innovation policy in most countries. The current focus is mainly placed on linking actors and less on investments in the constitution of the stock of scientific and technical resources from which the actors can act. However, the entrepreneurial dynamics of industrial countries will largely depend on this dimension in the coming years.

Cross-References

▶ Business Climate and Entrepreneurialism
▶ Entrepreneurial Opportunities
▶ Knowledge Capital and Small Businesses
▶ Proximity
▶ Risk
▶ Risk, Uncertainty, and Business Creation

References

Aydalot P. Les milieux innovateurs en Europe. Paris: Economica/GREMI; 1986.

Boschma RA. Proximity and innovation: a critical assessment. Reg Stud. 2005;39(1):61–74.

Boutilier S, Uzunidis D. The innovative milieu as the driving force of entrepreneurship. In: Laperche B, Sommers P, Uzunidis D, editors. Innovation networks and clusters. The knowledge backbone. Brussels: Peter Lang; 2010. p. 135–57.

Boutillier S, Uzunidis D. L'aventure des entrepreneurs. Paris: Studyrama; 2006.

Boutillier S, Laperche B, Uzunidis D. The entrepreneur's 'resource potential', innovation and networks. In: Laperche B, Uzunidis D, Von Tunzelmann N, editors. The genesis of innovation. Systemic linkages between knowledge and market. Cheltenham: E. Elgar; 2008. p. 187–207.

Branscomb L, Keller J, editors. Investing in Innovation. Cambridge: MIT Press; 1998.

Maillat D, Perrin JC, editors. Entreprises innovatrices et développement territorial, Enquête GREMI II. Neuchâtel: EDES; 1992.

Marshall A. Industry and trade. Londres: Macmillan; 1919.

Nooteboom B. A cognitive theory of the firm: learning, governance and dynamic capabilities. Cheltenham: Edward Elgar; 2009.

Tidd J, Bessant J, Pavitt K. Managing innovation. Chichester: Wiley; 2005.
Uzunidis D. The logic of the innovative milieu. In: Laperche B, Uzunidis D, Von Tunzelmann N, editors. The genesis of innovation. Systemic linkages between knowledge and market. Cheltenham: E. Elgar; 2008. p. 187–207.

Innovation Systems and Individual Initiative

▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship

Innovation Theory

▶ Innovation Policies (vis-à-vis Practice and Theory)

Innovation Through Language

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Innovation Training

▶ Creative Thinking Training

Innovation Versus Critical Thinking

▶ Divergent Versus Convergent Thinking

Innovation Waves

▶ Nonlinear Innovations

Innovations

▶ Financing Entrepreneurship

Innovations in Geometry

Georg Glaeser
Institute of Arts and Technology, Department of Geometry, University of Applied Arts Vienna, Vienna, Austria

Synonyms

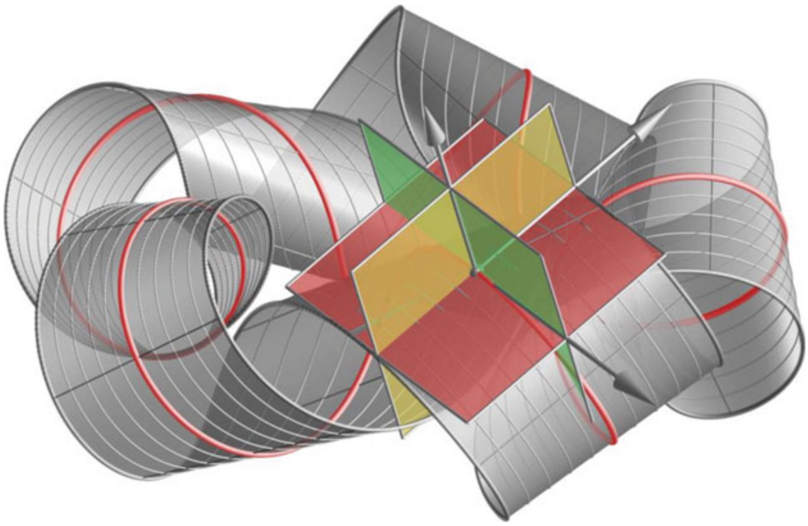
Architectural geometry; Geometrical design

Introduction

Geometry is one of the oldest sciences of mankind, dating back 5,000 years and more. Today it is considered a branch of mathematics and deals with questions of shape, size, relative position of figures, and the properties of space. The geometry of the ancient Greeks (Euclid, Archimedes and many others) served as a base for scientific developments in the two millennia that followed. From about 1800 until the computer age, Descriptive Geometry, introduced by Gaspard Monge, was the tool for developing many industrial products – especially for architecture. The rules and results of Descriptive Geometry also contributed to knowledge of design processes.

The introduction of digital production technologies in the automobile and aircraft industries required new geometric research for the design and development of 3D modeling software.

The last two decades once again brought remarkable innovations in the development of even more sophisticated software that – based on geometric and mathematical considerations – allows solving different kinds of problems that were more or less unsolvable so far.



Innovations in Geometry, Fig. 1 The accompanying "rectifying developable" of a *space curve* (Glaeser 2012)

Geometric Innovations in Modern Architecture and Industrial Design

Modern architecture and industrial design profit from the enormous increase of design possibilities. Creative architects and designers do not simply exploit the best CAD software, but rather want to engineer and design at the same time. This requires close cooperation between geometers, architects, designers and civil engineers.

Example 1: Approximation of Large Scaled Doubly Curved Surfaces

One of the problems that seemed impossible to overcome until very recently was to find surfaces that approximate doubly curved surfaces piecewise by single curved surface parts in a manner acceptable for the artistic designer. This requirement is so important because building costs of doubly curved surfaces tend to be very high. Figure 1 illustrates an important theorem of classic differential geometry: For any space curve, one can find a single curved surface (a "developable") such that the curve is a geodesic line that becomes a straight line when the developable is flattened into the plane.

The challenge is to choose space curves on a doubly curved designed freeform surface, such that the corresponding accompanying developables approximate the target surface as well as possible. When the chosen curves are geodesics on the surfaces, their rectifying developable will touch the target surface along the whole line. Neighboring rectifying developables intersect each other and form strips or "ribbons" like in Fig. 2 (Pottmann et al. 2008).

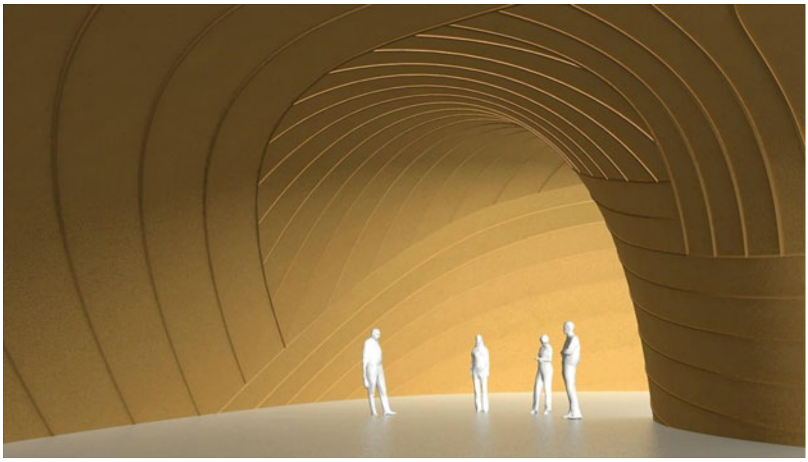
Figure 3 illustrates another way of finding developable strips by searching for series of planar quadrangles on the surface. Figure 4 shows an example of that kind of approximation.

Example 2: Curved Folding

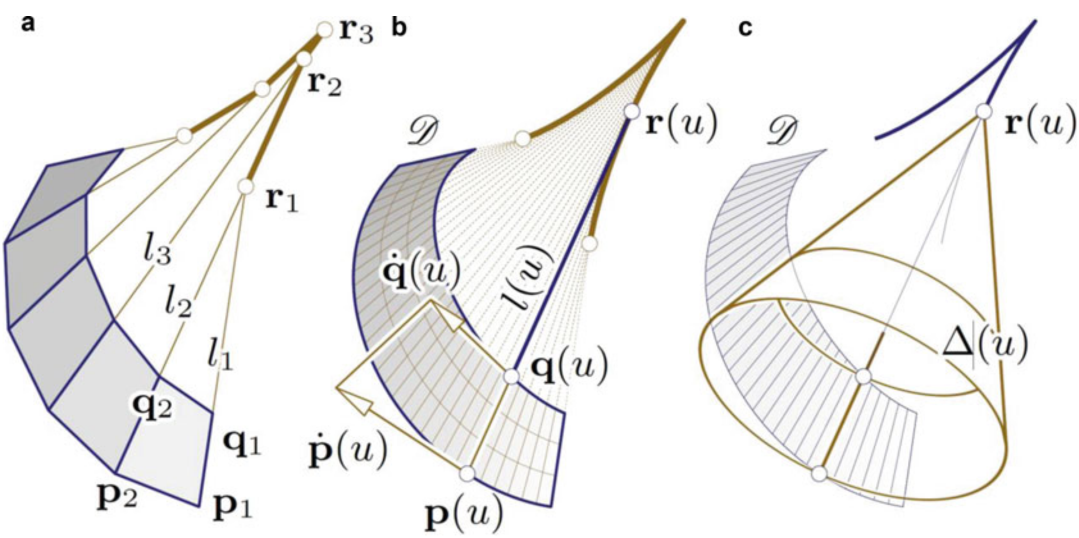
A problem that is also related to developable surfaces is a demand posed by industrial design: How could one fold interesting and practically useful shapes by means of scoring curves into a flat piece of material? Figure 5, e.g., shows what happens when only one curve – in this case a catenary – is considered (Kilian et al. 2008). Figure 6 shows two practically usable examples from industrial design and architecture. In both applications, construction costs are reduced considerably.

Geometry in Robotics

In robotics, geometric insights have lead to remarkable innovations (Lenarcic and Husty 2012). The kinematics of a manipulator or the



Innovations in Geometry, Fig. 2 "Rectifying developables" of geodesic lines on the target surface allow a rather smooth approximation by means of developable "ribbons" (Pottmann et al. 2008)

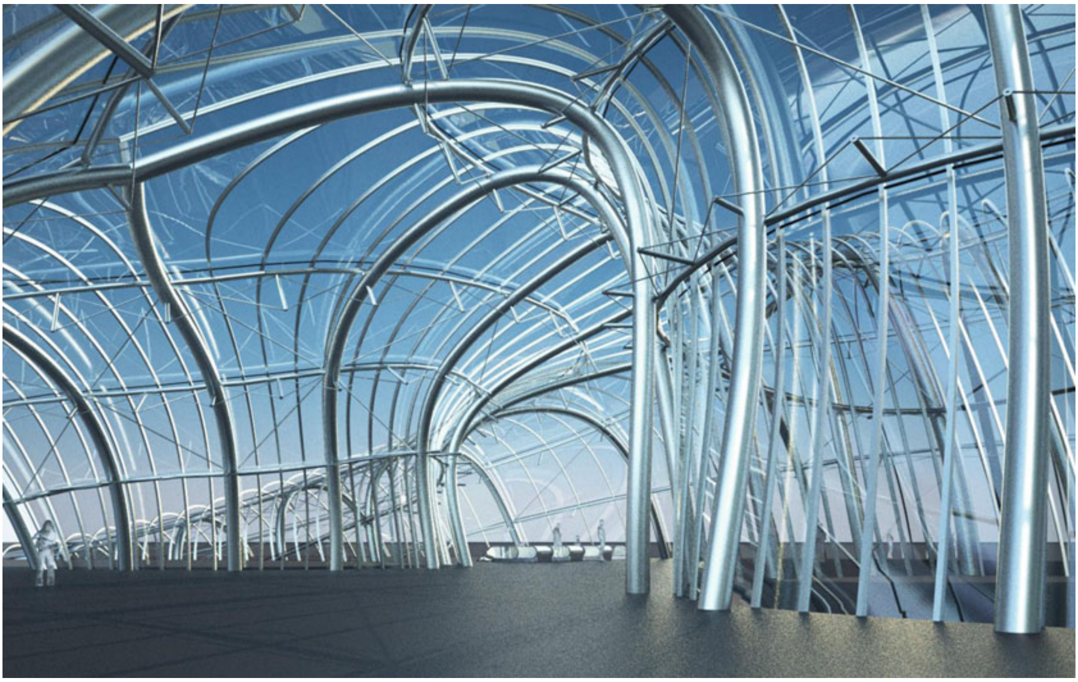


Innovations in Geometry, Fig. 3 Quadrangles on a discrete developable (Pottmann et al. 2008)

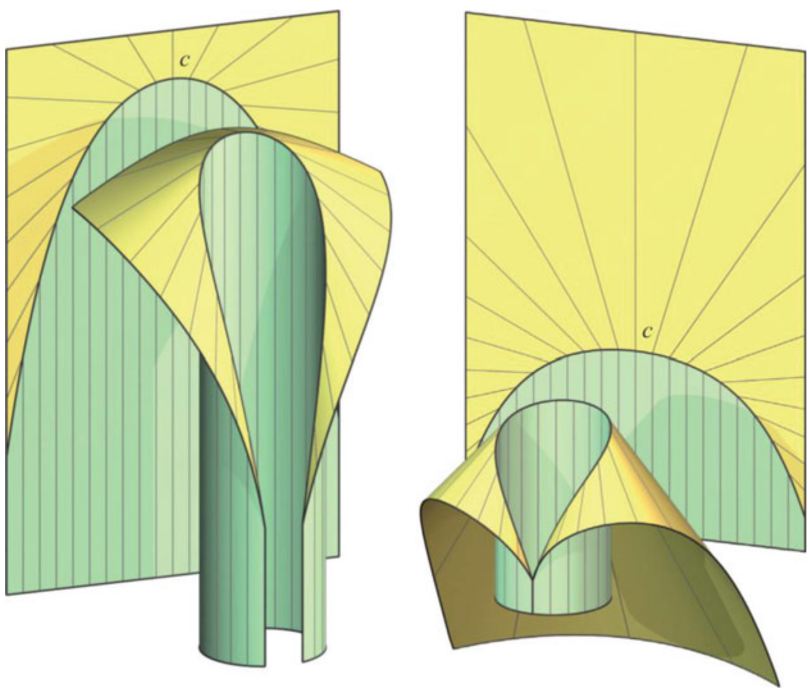
possibilities of moving the manipulator are meanwhile described by systems of algebraic equations. Thus, one can describe the working space of the manipulator by algebraic varieties which potentially split up into kinematically interesting components. In practice, one is mainly interested in mechanical restrictions or geometric limitations. The latter are called singularities and are – especially with parallel manipulators – described by fascinating algebraic objects (Schadlbauer et al. 2011). Figure 7 shows the singularities of a so-called 3-RPS manipulator which is a platform that is moved by the "legs" (consisting of the three different joints: rotational, prismatic and spherical) driven by linear motors that vary the lengths of each leg.

Flexible Magnetic Nets and Iterating Algorithms

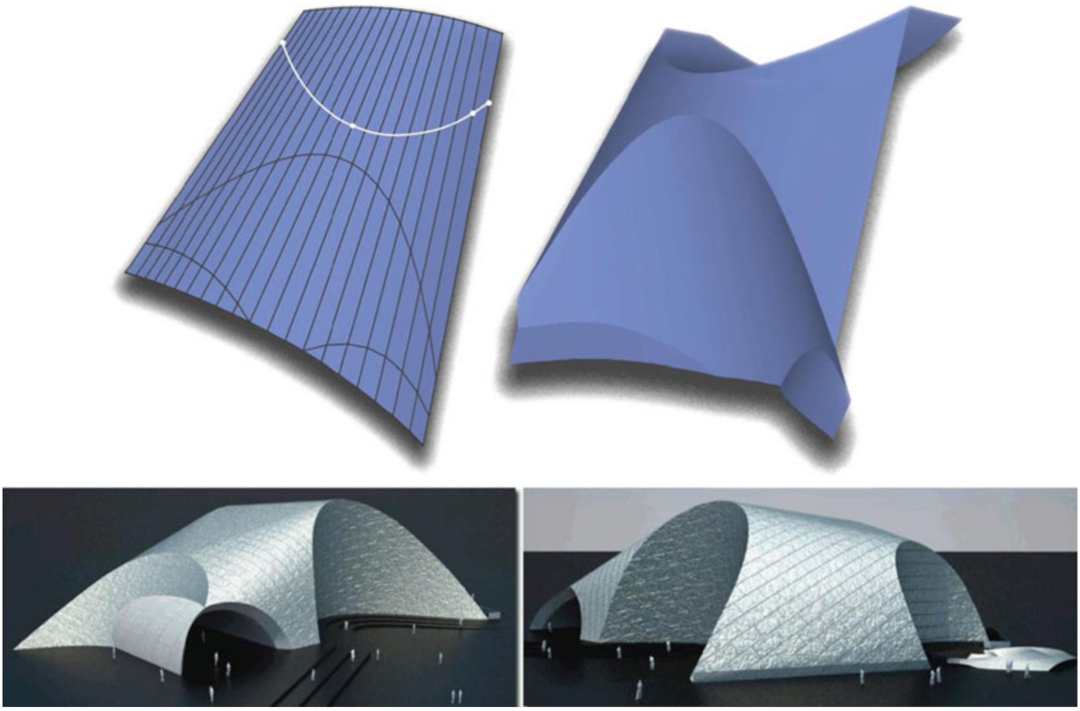
Many geometric problems do not have exact solutions, but algorithms may lead to good approximations and practically useful



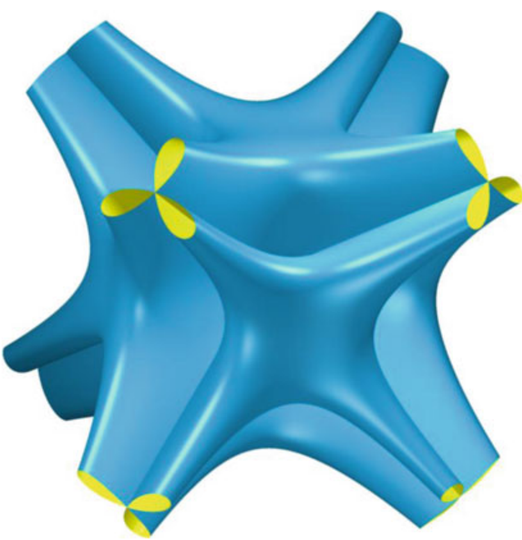
Innovations in Geometry, Fig. 4 Freeform surface entirely approximated by developable *strips* (Pottmann et al. 2008)



Innovations in Geometry, Fig. 5 "Collar surfaces" out of one piece (Glaeser and Polthier 2012)



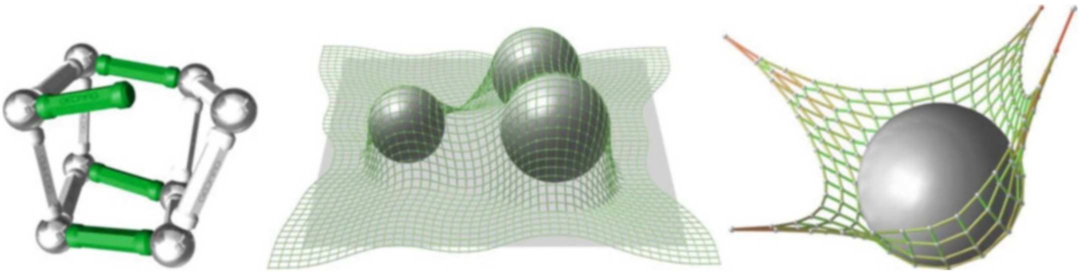
Innovations in Geometry, Fig. 6 Practical applications in design and architecture (Kilian and Flöry 2008)



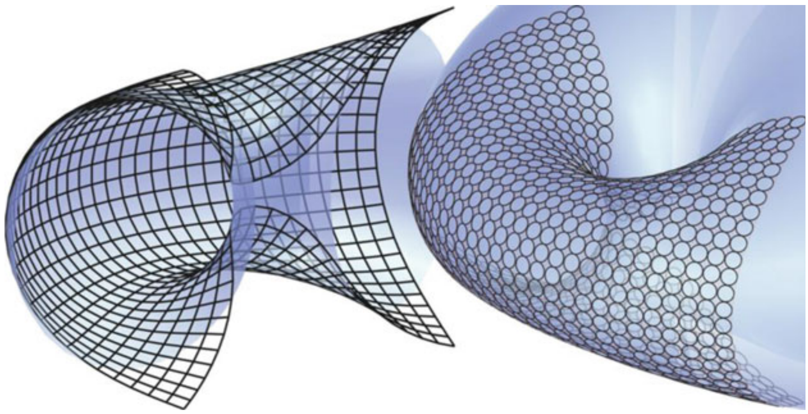
Innovations in Geometry, Fig. 7 Algebraic surface as the locus of all manipulator-singularities (Schadlbauer et al. 2011)

alternatives. A typical example is over 100 years old: The Thompson problem asks for the locus of a given number of points that are equally distributed on a sphere. Exact solutions only exist for a few special numbers (e.g., 20 points would lie on a regular dodecahedron). There are "best solutions" for all numbers, however, which can be found by various algorithms. One of these algorithms is based on magnetic repulsion: Points are considered to be magnetic and are allowed to "swim" on the surface. They push each other until a state of equilibrium is reached.

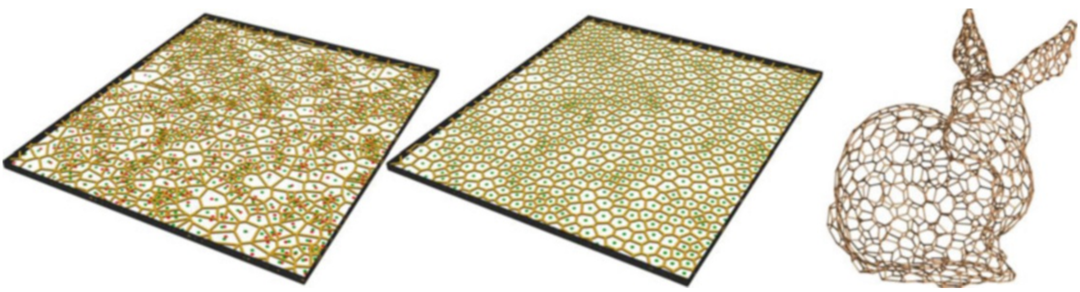
This algorithm can be extended and applied to various problems. Figure 8 illustrates the introduction of small magnetic spheres, from which four attached magnetic rods of equal length protrude. Such a flexible magnetic net can be fitted onto desired forms. In Fig. 8, the net was cast over three spheres. By means of stretching or compression of the rods – by as small an amount



Innovations in Geometry, Fig. 8 Simulation of magnetic repulsion



Innovations in Geometry, Fig. 9 Near orthogonal grid generation on surfaces (Gruber et al. 2010)

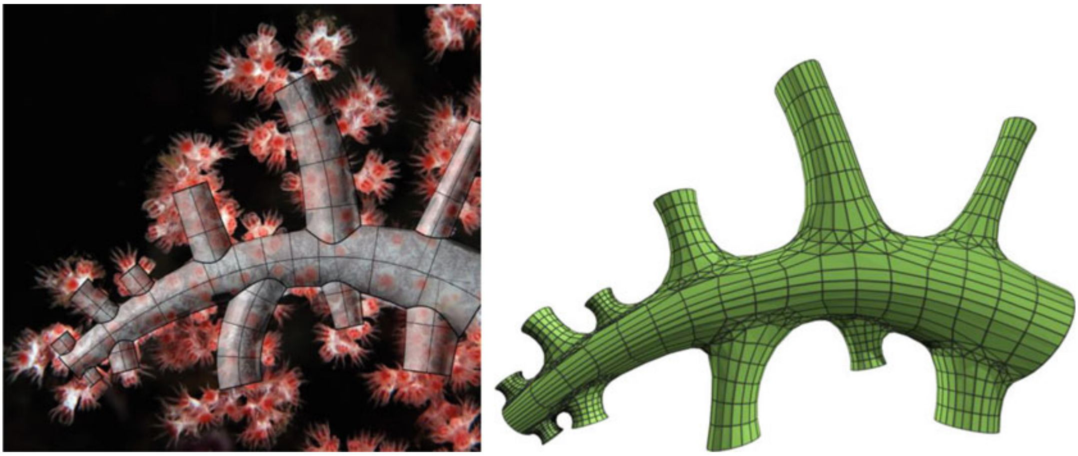


Innovations in Geometry, Fig. 10 Iterated Voronoi diagrams

as possible – the algorithm gets more practically useful for the solution of various problems, e.g., for force directed near-orthogonal grid generation on surfaces (Fig. 9). Such algorithms are iterative, i.e., small changes are made in various parameters, and the best result is taken as an input for the next step.

Comparable approaches can be applied in other situations. Figure 10, e.g., shows the generation of Voronoi-diagrams (in the plane or on surfaces) that can be improved iteratively (the area-barycenters of convex cells are the inputs for the next iteration).

Iteration of magnetic nets fitted onto geometric objects – with respect to area minimization – can also be the key for the generation of shapes that frequently appear in nature (Fig. 11).



Innovations in Geometry, Fig. 11 Iteratively minimizing the surface area of composed geometrical objects leads to organic forms

I

Conclusion and Future Directions

The computer is the main new tool of Geometry. It allows to realize otherwise hard to solve theoretical challenges. The underlying problems may be 100 years old (or even older), and large quantities of these problems have thus far remained unsolved.

Architectural Geometry has to provide construction-aware design tools that enable a completely digital work flow from design to manufacturing, especially for highly complex geometries, including animated geometry. This requires interaction of mathematicians, engineers and architects.

Cross-References

- ► Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
- ► Creativity from Design and Innovation Perspectives
- ► Innovation by Applied Mathematics

References

Glaeser G. Geometry and its applications in arts, nature and technology. New York: Springer Wien (Edition Angewandte), 2012.

Glaeser G, Polthier K. A mathematical picture book. Berlin: Springer; 2012.

Gruber F, Wallner G, Glaeser G. Force directed near-orthogonal grid generation on surfaces. J Geomet Graph (JGG). 2010;14:135–45.

Kilian M, et al. Curved folding, ACM trans. Graphics 27(3) Proceedings SIGGRAPH 2008. http://www.geometrie.tuwien.ac.at/kilian/; 2008.

Lenarcic J, Husty M. Latest advances in Robot kinematics. New York: Springer; 2012.

Pottmann H, et al. Archtectural geometry. Exton: Bentley Institute Press; 2007.

Pottmann H, Schiftner A, Bo P, Schmiedhofer H, Wang W, Baldassini N, Wallner J. Freeform surfaces from single curved panels. ACM Trans. Graphics, 27/3, Proceedings SIGGRAPH, New York, NY, (2008).

Schadlbauer J, Walter DR, Husty ML. A complete analysis of the 3-RPS manipulator. In: Bandyopadhyay S, Kumar GS, Ramu P, editors. Machines and mechanisms. New Delhi: Narosa Publishing House; 2011. p. 410–9.

Innovations of and in Organizations

Kurt Mayer
REFLACT – Sustainable Consulting, Vienna, Austria

Synonyms

Innovative firm; Open innovation

Introduction

At a first glance "innovations" and "organizations" seem to be somehow contradictory phenomena.

Organizations are designed for ongoing operations. Their reason of existence is to coordinate actions and actors effectively and to strive for productivity and efficiency to make operations as profitable as possible. They have to serve their customers better than and more efficient than their competitors do. Their performance is measured by being on time and on budget and by producing products and services with a constant quality. Hence, they are always striving for specialization, repeatability, and predictability, and they are inclined to work smoothly and perfectly even.

Innovation is the ability to define and develop new products and services and to deliver them to the market. Looking at the nature of the innovation process from an organizational point of view, we have to point out first that innovation involves strong elements that cannot be planned. If "innovation concerns the search for, and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organizational set-ups" (Dosi 1988, 222), then the dimensions of complexity, uncertainty, cumulativeness, interactivity, acting collectively, and learning play a major role in the innovation process. As a consequence the process of innovation is in clear contrast to processes of a rigidly planned implementation of well-defined action plans.

Despite this contrast it is quite obvious that organizations need innovation. Organizations that operate strictly within the bounds of their established norms and routines fail to develop. The better something works, the less excited, interested, and emotionally engaged people are. Organizations that operate strictly within the bounds of their established norms and routines get in danger to die. As a consequence the dual search for stability and exploitation on the one hand and change and innovation on the other hand poses a crucial challenge for organizations operating in the recent complex and dynamic business environment.

And as well innovation – defined as new products or services delivered to the market – usually is dependent on organizations. This is in contrast to mere inventions, which can be developed by single individuals or a group of people. The process of innovation is based on various activities of organizational creation. Different actors have to be coordinated and coupled with a wide range of activities across specialized functions, knowledge domains, and contexts of application. In the recent dynamic and complex "society of organizations" (Peter Drucker), society's problem-solving and innovation capacity rather is determined by the effectiveness and efficiency of its organizations then by individuals or groups. The processes of organizing and innovating may be seen as incompatible and mutually exclusive, but they are as well fundamentally interdependent and mutually enabling.

Against this background the following questions of (a) different perspectives to examine the relationship between organization and innovation and (b) organizational factors that influence innovation performance are focused on in this entry.

Innovation and Organizational Structure

Since the late 1950s classical organizational theory like Weber's bureaucracy or Taylor's scientific management have been challenged by the new approach of contingency theories. Classical organizational theorists like Weber, Taylor, or Chandler had based their work on the idea of universal organizational forms and the endeavor to find the "one best way to organize." In contrast contingency theories claimed that there is no best way to design organizational structures or to run a company. Rather variations in management styles and organizational structures are influenced and shaped by various aspects of the environment: the contingency factors of technology, suppliers and distributors, policy regulation, etc. Within this new theoretical context, Burns and Stalker (1961) investigated on the relationship between structure and innovation.

Mechanistic and Organic Organizational Structures

Burns and Stalker (1961) found that organizations operating in more stable environments tend to develop a more mechanistic organizational structure, while companies facing a more dynamic and uncertain environment tend to show a more organic organizational structure. Their main argument is that neither of the two types is right or wrong.

Mechanistic structures and rather rigid and hierarchical organizational patterns can be a functional and efficient structure for organizations operating in a more stable and certain environment where there is no need for quick decision-making or innovation.

On the other hand organic structures provide organizations with a more fluid set of arrangements to quickly adapt to conditions of rapid change and innovation. There, rapid communication and information sharing is necessary. Hence, departments and different functional areas need to be tightly integrated.

Building on these ideas Lawrence and Lorsch (1967) carried out a series of empirical studies in the chemistry industry. They recognized that organizations usually are not composed of one uniform structure, either mechanistic or organic. Instead mechanistic and organic structures can coexist in different subunits interacting with different demands of functional subenvironments.

Lam (2010) is pointing out that the arguments of these earlier authors developed under the theoretical umbrella of structural contingency theory had a considerable impact on both organizational theory and the provision of useful guidelines for innovation management. And they are still useful for understanding recent development in innovation and organizational change. Faced by the challenges of innovation pressures and an accelerated pace of change, we recently can better than ever observe how companies struggle to leave mechanistic patterns behind and to follow a more organic path of development. As well, the contemporary debate on hybrid organizations and ambidexterity is reflecting the most important argument of Lawrence and Lorsch. Mechanistic and organic structures can coexist within one organization and therefore strengthening the capability to deal with both revolutionary and evolutionary changes in the various technological and market environments.

Adhocracy as Organizational Archetype with High Potential for Radical Innovation

As a specialist in management theory, Henry Mintzberg (1979) aimed to prescribe effective organizational designs. Drawing on contingency theory and synthesizing much of the work on organizational structure, he argues that successful organizations develop a logical and consistent configuration of design parameters to cope with the specific challenges of their environment. As a result he concludes that organizations are likely to be dominated by one of the five pure archetypes identified he identified: simple structure, machine bureaucracy, professional bureaucracy, divisionalized form, and adhocracy. These archetypes exhibit profound differences with regard to their innovativeness (Lam 2010, 167 ff.).

Machine bureaucracy, divisionalized form, and professional bureaucracy are characterized by relatively low levels of innovativeness. The simple structure has higher innovation potential. Simple structures are characterized as being small and informal. They rely on direct control by one person, often the founding entrepreneur, who is free to searching for high-risk environments.

Adhocracy with the highest innovation potential is as well highly informal and flexible organization capable for radical innovation in a volatile environment. Distinctive traits are a highly organic structure, little formalization of behavior, low standardization of procedures, and a work organization based on specialized teams. Here it is not one single entrepreneur who searches for innovation but highly flexible and problem-solving project teams that can be quickly reconfigured in response to changes in the markets and technologies. The organizational boundaries of adhocracies are rather permeable and allowing for new ideas and knowledge from outside to come in. Adhocracies are characterized by an extensive absence of hierarchical structures. Within their areas of specialization and in coordination with coworkers, members usually have the authority for decision-making and to take actions affecting the future of the organization.

Innovation, Knowledge Creation, and Learning

In the organizational structure perspective innovation is perceived as an output of certain structural features and components of an organization. Organizations tend to shape their organizational design in line with the demands and challenges raised by the technological, competitive, and political environments they are operating in. If competitive, dynamic, and volatile environments demand for organic structures (Burns and Stalker; Lawrence and Lorsch), then innovation is an output of the structural features successful organizations are building within this context.

Another line of organizational theory is regarding innovation as process of problem-solving, knowledge building, and learning. These authors point out that innovation in the economy on the one hand and learning and knowledge building in organizations on the other hand are two sides of the same coin, since the increased speed of change confronts agents and organizations with new problems and to tackle the new problems requires new skills (Lundvall and Borras 1999). As a consequence, innovative firms select more learning-oriented employees and the market selects more change-oriented firms. Hence, the current market economy is characterized by a process of "circular cumulative causation" between innovation and learning.

These arguments reflect the fundamental shifts in the way knowledge is produced, organized, and utilized in the knowledge economy. The high rate of change and the new pressures of market competition force companies to obtain additional abilities, that is, to configure information resources in novel ways which cannot be easily imitated and replaced by competitors. Since ICTs make a vast amount of data and information available and easily accessible, the problem of information-based competitive advantages is to continually innovate and to stay one step ahead of other companies. Hence, in terms of innovation, the knowledge at the top end still seems to be insufficiently designed and hard to transfer in a routine manner that "provides the 'competitive edge' for firms which are trying to stay ahead of the pack" (Ducatel 1998, 11).

Tacit Knowledge and Organizational Knowledge Creation

Drawing on a concept of Polanyi (1958), this top end knowledge is referred to as "tacit knowledge," in contrast to "codified knowledge" or mere information. "Tacit knowledge is personal, context specific and therefore hard to formalize and communicate" (Nonaka and Takeuchi 1995, 160 f.). It refers to the observation: "We know more than we can tell" (Polanyi 1958).

Tacit knowledge has two dimensions, the "cognitive" and the "technical" elements (Nonaka and Takeuchi 1995, 60). The cognitive elements focus on "mental models" (schemata, paradigms, perspectives, beliefs, viewpoints), in which human beings create working models of the world by making and manipulating analogies in their minds. These cognitive elements, which help individuals to perceive and define their world, refer "to an individual's images of reality and visions for the future, that is, "what is" and "what ought to be." The technical elements include know-how, crafts, and skills. Both dimensions of tacit knowledge suggest that tacit knowledge defines how to use codified knowledge or even clearer: Tacit knowledge is a precondition to make use of codified knowledge.

Being "tacit" means that this knowledge is not migratory, as it is highly embedded in complex social interactions and relationships within organizations. Since tacit knowledge resides in the skills, shared experiences, and behavior of groups and individuals, it cannot be easily acquired or bought at the market place. Thus, it is different from codified knowledge, which can be obtained (through reading books, attending lectures, and accessing databases), transferred as information, and even sold in the market. Codified knowledge is accessible. Tacit knowledge, on the other hand, is rooted in practical experience and social contact. Since tacit knowledge is socially constructed knowledge, it can only be appropriated in a social context by interactivity and social interaction. It will typically have to be learned (Lundvall 1996).

The acceleration of creation processes and the use of codified knowledge via ICTs are intrinsically related to the increasing importance of tacit knowledge, which enables us to make use of information, in general, or to effectively acquire, select, and use the data and information created within a company or elsewhere. Hence, "codified and tacit knowledge are complementary and co-exist in time" (Lundvall and Borrás 1999, 33), and tacit knowledge seems to be necessary to define how to use explicit knowledge.

Having this in mind, Nonaka and Takeuchi (1995, 70 ff.) argue that only "when tacit and explicit knowledge interact (. . .) an innovation emerges." Their dynamic model of "knowledge conversion" "is anchored to a critical assumption that human knowledge is created and expanded through social interaction between tacit knowledge and explicit knowledge" (Nonaka and Takeuchi 1995, 61). According to this line of reasoning, the sources of innovation multiply "when organizations are able to establish bridges to transfer tacit into explicit knowledge, explicit into tacit knowledge, tacit into tacit, and explicit into explicit" (Castells 1996, 159).

The Knowledge-Creating Company

These collective and interactive knowledge processes imply that instrumental behavior will become mixed with "communicative rationality" where the common goal of the involved partners is to understand better what the problems are and what solutions can be developed. In this respect, interactivity, shared experiences, and learning stimulate the development and appropriation of shared beliefs and common interpretations of the social context.

Enhanced communication between (reduced) hierarchies, between departments, is intended to facilitate the "knowledge and competence puzzle" as a precondition for innovation. These strategies of social interaction are complemented by lifelong learning and HRD strategies for the whole workforce, since according to the principles of a "learning organization" (Senge 1990) "inventing knowledge is not a specialized activity.. (. . .).. it is a way of behaving in which everyone is a knowledge worker" (Nonaka and Takeuchi 1995). Guided by this line of argumentation, Nonaka and others (Nonaka 1991; Nonaka and Takeuchi 1995; Nonaka and Konno 1998) have developed the framework of a "knowledge-creating company," defining the firm as a collection of shared spaces for emerging relationships that provide a platform for advancing individual and/or collective knowledge and for generating collaborative processes that enable the transformation of this knowledge to other contexts (see the concept of "ba" developed by Nonaka (Nonaka and Konno 1998). These spaces exist in several different dimensions (Nonaka and Konno 1998):

- Physical: department within a firm, sphere of commercial influence, cooperation agreement
- Virtual: e-mail, teleconferencing
- Mental: shared experiences, professional interaction, shared ideas, and attitudes

These spaces enable the firm to become a permanent locus for the creation of dispersed knowledge.

The J-Form Organization with High Potential for Incremental Innovation

Knowledge-creating companies are commonly basing their innovation performance on knowledge embedded in organizational routines, team relationships, a shared culture, and tacit knowledge. Their knowledge strategy is emphasizing the continuous improvement of the existing and embedded knowledge. "If HP only knew what HP knows, we would be much more profitable" (former CEO Lew Platt).

In management sciences those organizations are often called "J-form" organizations referring to "Japanese type" of organizations (such as Aoki's model of the "J-firm"). The J-form of organizations tend to develop an orientation towards incremental innovation as a strategy and generally perform well in relatively mature technology fields characterized by rich possibilities of combinations and incremental improvements to existing products or components. Like adhocracy J-form organizations exhibit strong innovative capabilities; nevertheless, they differ markedly from adhocracy in terms of their knowledge configurations, their patterns of learning, and the type of innovative competences generated. J-form organizations are especially good in exploiting learning and incremental innovation, but they are not as effective in gaining knowledge from external sources and triggering radical innovation (Lam 2010).

Knowledge Management and Innovation Management

The reflections above provide the theoretical background for the extensive literature on "knowledge management" and "innovation management," which has emerged during the second half of the 1990s. Successful innovation requires the production of appropriate knowledge. In this perspective knowledge management is a complex and demanding task, aiming to gain access to fragmented knowledge domains and to organize cooperative processes, wherein the different sources of knowledge are integrated. According to Brödner et al. (1998), knowledge management has three important tasks: (a) to explicate and codify socially incorporated knowledge, (b) to connect people to these explicit knowledge bases for their effective use, and (c) to integrate the different perspectives needed for problem-solving.

However, the goal of innovation is more than production of new knowledge; it is geared towards new products or services delivered to the market. As a consequence the focus of innovation management in complementing knowledge management is on the provision of appropriate structures and spaces for managing the different phases of the innovation process. This starts with idea generation and comprises the stages of idea selection, idea evaluation, business decision, and finally the successful implementation of the idea into new products, services, processes, or business models. As a consequence a series of innovation management techniques (e.g., technology watch, patent analyses, brainstorming, lateral thinking, CAD systems, rapid prototyping) was implemented in organizations to support the process of innovation in organizations and help them in a systematic way to meet new market challenges.

Recently the innovation management approach is increasingly challenged by systemic and cybernetic perspectives on organizations. Peschl and Fundneider (2011, 44) suppose innovation management techniques to be a trial of classical managers to solve the mentioned contradiction between organization and innovation in a mechanistic way. "If innovation should be incorporated at all, it should fit into their routines and processes. In other words, their secret wish is to 'domesticate' innovation to a process, which is predictable, deterministic and scalable." Innovation management is not changing the structure or even the culture of an organization; it is rather based on the assumption that innovation can be produced or controlled like any other process.

Learning Organizations and Organizational Change

Nevertheless, throughout the 1990s and especially in the first decade of the new millennium, the debate about organizational learning got an increasing focus on deeper aspects of organizational change. In this perspective the organizational learning architecture is not restricted to the production of new knowledge and the facilitation for new products and services. Radical and sustainable learning in organizations means that the organization continuously transforms itself. Therefore, Mezias and Glynn (1993, 78) define innovation as "non-routine, significant, and discontinuous organizational change that embodies a new idea that is not consistent with the current concept of the organization's business."

Peter Senge is one of the most influential writers to promote the concept of the learning organization. Senge (1990) mentions five disciplines that characterize a learning organization: personal mastery, mental models, development of shared visions, team learning, and systemic thinking. The "fifth discipline" of systemic thinking comprises all other disciplines and is supposed to contribute to an integrated development of the other disciplines. According to Senge, people do not just learn in a learning company, it is rather the company's consistent concern to discern and to create structures that are beneficial for learning. A learning organization will foster learning at all levels, develop new and innovative processes, and continually reflect and transform itself.

Learning as Strategic Activity

Deiser (2010, 39) points out that a powerful architecture for learning and organizational change "needs to provide common spaces that instigate cross-boundary dialogue and ultimately create enabling mechanisms that foster collaboration, trust, and openness – important conditions for high-performing networks." The creation of relationship networks that emerge through integrating diverse perspectives is often a more important goal than the topical learning content. Hence, the careful and suitable design of learning processes and facilitation becomes more important than content expertise or any specialized activities of innovation management.

He further emphasizes that relevant learning happens by encountering differences. As a consequence boundaries between people, departments, or companies "are the very space where learning happens; they are the place where difference is established." The design and permanent redesign of smart and boundaries between these entities is the most crucial task of a learning architecture. As a consequence he suggests as a new strategic perspective "to design our business encounters with the world in a way that they maximize insights, and then design processes that turn the insights into strategically reflected organizational activity (Deiser 2010, 27)." This is the core of his model of a smart organization.

In a complex network society, the long-term strategic success of an organization is especially dependent on strategic partners and external stakeholders. Radically new learning rather tends to arise from interaction and feedback from those outside the company who are in a better position to create "designed spaces of irritation" and thereby shake existing perspectives and paradigms. The new innovation challenge is to develop the capabilities not only of one's own organization but of the entire network. If suppliers, customers, strategic partners, or even competitors should be integrated in this learning network, then this requires the competence of establishing external nonhierarchical relationships and arranging the collaboration of stakeholders across the value chain. Hence, the competences of sharing, collaboration, and designing spaces of collective interaction and development are the new critical competences for innovation.

Enabling Spaces for Innovation

Peschl and Fundneider (2011) develop the concepts of "enabling" and "space" as basic pillars of the innovation process in an even more explicit manner. In this perspective innovation processes cannot be managed, they just can be enabled. This implies to give up the principles of control, determining, and making and provide instead "a set of constraints or a facilitating framework supporting the processes of bringing forth new knowledge." (Peschl and Fundneider 2011, 45) Hence, an enabling space is a space supporting enabling and facilitating processes of innovation and knowledge creation. This space is designed as a multidimensional space in which architectorial/physical, social, cognitive, technological, cultural, intellectual, and other factors are considered and integrated like a composition, a piece of art (Peschl and Fundneider 2011, 49/52). As a kind of container, an enabling space is providing qualities like offering an environment of protection, of listening and observing closely, of openness, and of enabling the free flow of knowledge and of silence (52). These design qualities have to be translated and integrated into the concrete enabling space of a concrete innovation process. With respect to organizational issues, Peschl and Fundneider indicate that organizational culture is a key constraint and makes the creation of enabling spaces a real design challenge since there do not exist standard solutions or simple rules which one just has to follow in order to establish a ready-made enabling space fitting organically into the organization" (Peschl and Fundneider 2011, 53).

Conclusion and Future Directions

Even if at a first glance "innovations" and "organizations" seem to be somehow phenomena, they are fundamentally interdependent and mutually enabling. In response to environment and contingency factors, organizations develop structures, rules, norms, and processes that provide stability for complex dynamic, uncertain, and volatile processes of knowledge production, learning, and innovation. Depending on environment and contingency factors, this structural framework is looking different in various sectors or even within various departments of one organization and exhibits more or less potential for innovation. Simple organizations, adhocracies, and the J-form are three organizational forms with powerful innovative capabilities but markedly differing in terms of their knowledge configurations, their patterns of learning, and the type of innovative competences generated.

However, without the stability provided by organizations, the innovation process based on dimensions of complexity, uncertainty, cumulativeness, interactivity, acting collectively, and learning is not probable. The microlevel processes of knowledge production, knowledge conversion, and organizational learning we analyzed in part 2 of this entry all take place in spaces and environments offered and shaped by organizations. However, if organizations apply established processes of efficiency and control to the field of innovation, then the innovation process is in danger of becoming predictable, deterministic, and scalable and losing its potential. This is the criticism the approach of innovation management is confronted with.

In the first period of the twenty-first century, we are facing an increasingly complex, chaotic, and confusing environment for organizations. Increasingly unpredictable market and nonmarket conditions, a volatile and ever-changing economic landscape, a complex brew of rapidly advancing technologies and ecological challenges are creating an unchartered territory for more and more organizations.

In this environment of volatility, uncertainty and change organizations are forced to constantly and quickly change themselves and to find new viable organizational solutions. Their success is becoming more and more dependent on the ability to think in terms of organizational alternatives. Deiser (2010) pointed out that the ability to develop visionary organizational structures in dealing with customers, with partners, in connection to the organized civil society and within the company, is gaining critical importance. Especially in knowledge-intensive sectors, recent concepts like "cellular forms," "modular forms," "self-organization," "project-based networks," or "holacracy" mirror the increasing emergence of new dynamic and flexible forms of organizations with a strategic focus on entrepreneurship and innovation (Lam 2010, 170). In this new organizational context, the innovation paradigm seems to be changing as well, and the dimensions of stakeholder networks at the boundaries of the organization, of sharing, of collaborating, of enabling, and of appropriately designing multidimensional spaces for innovation become critical for success.

Cross-References

▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
▶ Open Innovation and Entrepreneurship
▶ Organizational Slack and Innovation
▶ Risk, Uncertainty, and Business Creation

References

Brödner P, Garibaldo F, Oehlke P, Pekruhl U. Work Organisation and Employment. The crucial role of innovation strategies. Projektbericht des Instituts Arbeit und Technik 05/1998. Gelsenkirchen: Institut Arbeit und Technik; 1998.

Burns T, Stalker GM. The management of innovation. London: Tavistock; 1961.

Castells M. The rise of the network society. Oxford: Blackwell; 1996.

Deiser R. Designing the smart organization: how world class corporate learning initiatives drive strategic change and innovation. San Francisco: Jossey-Bass; 2010.

Dosi G. The nature of the innovative process. In: Dosi G, Freeman C, Nelson R, Silverberg G, Soete L, editors.

Technical change and economic theory. London: Pinter; 1988. p. 221–38.
Ducatel K. Learning and skills in the knowledge economy. Aalborg: DRUID; 1998. Working Paper No. 98–2.
Lam A. Innovative organizations: structure, learning and adaptation. In: BBVA, Innovation perspectives for the 21st century. http://www.bbvaopenmind.com/static/pdf/Libro_Innovacion_ingles.pdf; 2010. p. 163–75.
Lawrence PR, Lorsch JW. Differentiation and integration in complex organizations. Admin Sci Q. 1967;12:1–47.
Lundvall B-Å. The social dimension of the learning economy. Kopenhagen: Danish Research Unit for Industrial Dynamics (DRUID); 1996.
Lundvall B-Å, Borras S. The globalising learning economy. Challenges for innovation policy (Report based on contributions from 7 projects under the TSER programme, DG XII). Brussels: Commission of the European Union; 1999.
Mezias SJ, Glynn MA. The three faces of corporate renewal: institution. Revol Evol Strateg Manag J. 1993;14:77–101.
Mintzberg H. The structuring of organization. Englewood Cliffs: Prentice Hall; 1979.
Nonaka I. The knowledge-creating company. Harv Bus Rev. 1991;69:96–104.
Nonaka I, Konno N. The concept of 'Ba'. Building a foundation for knowledge creation. Calif Manag Rev. 1998;40:40–54.
Nonaka I, Takeuchi H. The knowledge-creating company: how Japanese companies create the dynamics of innovation. New York: Oxford University Press; 1995.
Peschl MF, Fundneider T. Spaces enabling game-changing and sustaining innovations: why space matters for knowledge creation and innovation. J Organ Transform Social Change. 2011;9(1):41–61.
Polanyi M. Personal knowledge. London: Routledge and Kegan; 1958/1978.
Senge P. The fifth discipline – the art & practice of creating the learning organization. New York: Doubleday; 1990.

Innovations of Direct Democracy

Marc Bühlmann
Année Politique Suisse, Institute of Political Science, University of Bern, Bern, Switzerland

Synonyms

Direct legislation; Direct say; Initiative; Referendum

Introduction

Direct democracy is often seen as the most pure and basic form of democracy. Representative democracy allows for indirect influence of citizens voting for representatives responsible for taking political decisions. Contrarily, with direct legislation each citizen has effective and direct control over political decision making and equal power to affect decisions through binding votes. The idea of direct democracy is not new at all. The ancient Greeks still knew some sort of assemblies where decisions were made directly by those few full citizens, who were entitled to vote. In Switzerland and some of the US states, forms of direct legislation have been installed since the nineteenth century. Today, some sort of direct democratic mechanisms can be found all over the world (for overviews, see Altman 2011; Gallagher and Uleri 1996; Scarrow 2001).

Given its long heritage and the widespread use, how can direct democracy be treated as an innovation? The reasons are twofold: First, direct democracy is increasingly seen as a remedy for the problems democratic states face in the twenty-first century. The growing mistrust of citizens regarding the political elites, the declining willingness for individual political engagement, and the declining output legitimacy of representative systems are interpreted as signs of a veritable crisis of democracy. It is argued that giving the citizens more direct say – that is, enlarging their possibilities for democratic decision making and control – has the potential to foster motivation to take part in politics, to craft trust, and finally to renew democracy. In this sense, direct democracy is an innovation for representative democratic states and holds great potential for a new democratic turn. Even if direct democratic institutions can be found in many countries, citizen polls are very rare events.

Second, direct democracy has an inherent innovative potential because it enlarges the scope of political arguments. In direct democracy, it is not only the political elite but – at least theoretically – all citizens who contribute to the discussion of politics. In this sense, the more legislation is direct, the higher is the probability of new and innovative political solutions. Direct democracy allows for policy innovation and inclusion of new ideas and approaches even from minorities and outsiders.

Of course, direct democracy also has its dangers. A careful evaluation of the innovative potential of direct legislation needs a look at both the benefits as well as the dangers of direct say and control by all citizens. An appropriate juxtaposition of pros and cons must be based on theoretical as well as empirical insights. Prior to this, there must be given a proper definition of direct democracy that indeed has very different notions, features, and instruments.

Notions of Direct Democracy

Basically, direct democracy means decision making by eligible citizens as opposed to representative democracy, where decisions are taken indirectly (i.e., by representatives for whom the citizens have voted). To distinguish the existing forms of decision making by the people, and to understand their different potential for innovation, three characteristics must be clarified: activation, approval, and definition.

Activation

The first important attribute of direct democracy relates to the question: Who has the right to start a process of direct legislation and under which conditions?

First, the activation of a process of direct decision making can either be a political right for each citizen (bottom-up) or explicitly rest in the hands of the political elite (top-down). In the latter case, direct democracy takes the form of a pure public opinion poll. The government or (a part of) the parliament submits a political issue aiming at hearing the citizens' opinion on this issue, at increasing legitimation for it, or at consolidating of power. Often, this form of direct decision takes the notion of "*plebiscite*" (sometimes also "ad hoc referendum"). When the right of the activation of direct legislation is given to the citizens, this instrument can be considered either as an abrogative or rejective veto or as a citizen's proposal. The veto allows for holding a vote on whether a given law (already implemented or not) should be rejected. To avoid misunderstanding, it is only this veto-form of activation that should be denominated "referendum." The citizen's proposal grants the possibility to suggest new laws. This suggestion can either lead to a popular vote – in this case, this instrument normally is called a "citizen's initiative" – or to a more or less binding request for the elected representatives to take into consideration propositions for new laws. In Austria or in some German Bundesländer, this form takes the notion of "citizen demands" (sometimes also called "agenda initiatives").

Second, the activation of a direct decision making process depends on different legal conditions. In some countries (e.g., Switzerland, Uruguay), the renewal or modifications of the constitution must lead to a popular vote by rights, normally called "mandatory referendum" (also called regulated referendum). In other countries (e.g., Austria, France, or Spain), the representatives have the right to decide whether the people should vote on a given law or not ("ad hoc referendum"). In contrast, the launch of an "optional or facultative referendum" or a "citizen's initiative" has to fulfill conditions, normally the collection of a given amount of signatures within a given timeframe. Of course, such hurdles can be more or less high. To call for an optional referendum in Switzerland – where direct democracy is most widely used – one needs to collect 50,000 signatures (roughly 1 % of the eligible citizens) within 90 days. For a citizen's initiative, 100,000 signatures must be collected within 18 months.

Approval

The crucial feature of direct democracy is approval – whether a decision in direct legislation in the end is legally binding or not. Most often, pure plebiscites in terms of citizen opinion polls are only consultative and non-binding. Thus, even if the citizens reject a proposal, the parliament can implement it. On the other end of the scale, there are direct democratic decisions that are binding without consent of the parliament

Innovations of Direct Democracy, Fig. 1 Different notions of direct democracy

<table>
<tr><td></td><td></td><td colspan="4">Degree of Definition Power of Initiators</td></tr>
<tr><td></td><td></td><td>Low</td><td>High</td><td>Low</td><td>High</td></tr>
<tr><td rowspan="2">Activation</td><td>Bottom up</td><td colspan="2">Citizen demand</td><td>Referendum</td><td>Initiative</td></tr>
<tr><td>Top down</td><td colspan="2">Plebiscite</td><td colspan="2">Counterproposal</td></tr>
<tr><td></td><td></td><td colspan="2">Advisory/consultative</td><td colspan="2">Legally binding (depending on quorum or not)</td></tr>
<tr><td></td><td></td><td colspan="4">Approval</td></tr>
</table>

or even against the expressed opposition of the elected representatives. Between these two extremes, there are several levels of conditions for the legal binding, mostly depending on approval quorums and participation quorums. Approval quorums ask for more than simple majorities such as super-majorities (e.g., a majority of all enrolled citizens) or double majorities (e.g., a majority of citizens plus a majority of federal states). As for participation quorums, whether a decision is binding or not depends on a minimum number of citizens participating.

Definition Power

Foremost in the case of direct democratic processes initiated by the people, one has to consider the power of definition. First, the use of a referendum or an initiative can be restricted to special cases only or be allowed for all policy fields. Second, a citizen's proposal can be more or less set out – that is, it can give more or less possibilities to the political elite to re-formulate the initial request of the initiators. In some US states and Swiss cantons, citizens are allowed to propose legislative measures (via a "statutory initiative"). The definitional power of this instrument is greater than that for a "constitutional initiative," where citizens are allowed to propose a constitutional amendment that must afterward be specified by the parliament. In some countries (such as Uruguay and Switzerland), the legislatures are allowed to make "counterproposals" against the citizen-initiated proposal. The above-mentioned "referendum" in the sense of a pure veto against a decision taken by the parliament has no definition power, because it only aims at the rejection of an existing law proposal.

The three defining elements of direct democracy are summarized in Fig. 1.

Innovations of Direct Democracy

Based on the typology in Fig. 1, considering the theoretical arguments of merits and drawbacks, and leaning on empirical findings of the advantages and dangers of direct legislation, the innovative potential of direct democracy can be estimated.

Bottom-Up Versus Top-Down

The vertical axis in Fig. 1 depicts the trigger of a process of direct legislation. The activation of direct democracy can either be top-down or bottom-up.

At first sight, innovative potential for direct legislation is greater when it is activated by citizens. At least two reasons underline this suggestion: the argument of the many and the inclusion effect of direct democracy. *First*, allowing citizens to bring in propositions for new legislation measures enlarges the scope of possible arguments and the range of political solutions. Marsilius of Padua (1967) already praised the idea of decision making by many. According to the medieval physician and philosopher, the probability that many citizens do find a better political decision than only parts of the people is high. The deliberative theory of democracy concentrates on the process of decision making and highlights the public discussion based on the mutual justification of political arguments as the essential element of democracy. *Second*, bottom-up direct legislation has an inclusive effect. Minorities – often excluded or only marginally involved in representative decision making – have the possibility to bring their specific preferences into the political arena. They can force the political elite as well as fellow citizens to think and discuss about the minorities' interests. In this sense, initiatives have an important function as a megaphone or a valve or can even help to break taboos. New, innovative, and even displeasing themes come on the agenda, and the political elite as well as the citizens are forced to argument for or against them. The innovative potential of bottom-up direct legislation lies in the inclusion and enlargement of political ideas, proposals, and arguments.

Furthermore, a citizen's right to directly take part in legislation has a system-stabilizing effect. The acceptance of laws that are directly made by citizens themselves is higher. Empirical research further shows that satisfaction with democracy and even with one's life as well as trust in political institutions and representatives is higher when there is direct democracy (for overviews on empirical findings of the impact of direct democracy, see Lupia and Matsusaka 2004; Maduz 2010). In this sense, direct democracy has the potential to innovate representative democratic systems that suffer from growing mistrust and political apathy.

Contrarily, top-down activation of direct democracy seems to have less innovative potential. Plebiscites normally only have a consultative function. The political elite quite selectively asks the citizens to legitimize a more or less disputed legislative proposal. This seems not to be innovative, neither in terms of content nor in terms of enlargement of arguments. However, enlarging the scope, one can find innovative potential in top-down activation of direct legislation, too. *First*, even consultation – compared to no direct democracy at all – holds the capability for renewal. Asking the citizens for their opinion forces the representatives to argue for or against their proposal and to explain their points of view. This can lead to a broader and probably innovative discussion on a given topic. Given the possibility of plebiscites, opposition parties could even use this instrument to force the government to take clear positions. *Second*, top-down direct democracy is not necessarily only consultative. In Switzerland, the parliament has the ability to formulate a counterproposal for a citizen's initiative. Normally, Swiss representatives absorb some requests of the citizen's proposal but reject those going too far. A counterproposal is a reformulated and attenuated form of the initial initiative. Sometimes the initiators recall their initiative when there is a counterproposal, but most of the time, both the initiative and the counterproposal are voted on. A counterproposal not only innovatively enlarges the discussion and the scope of arguments, but it presents an interesting interplay between representative and direct democracy. As such, it also can weaken a widespread criticism of direct democracy: the danger of misuse of direct democratic instruments by powerful groups aiming at promoting their own interests or constraining the power of the state (Bernhard 2012). With a counterproposal, the representatives have the chance to counter, attenuate, or enlarge one-sided proposals.

Advisory Versus Binding Decisions

The horizontal axis in the typology distinguishes binding from non-binding instruments of direct legislation. In combination with the vertical axis discussed above, the approval of a direct decision can strengthen the innovative potential with regard to contents: the motivation to find new arguments and positions is bigger and the scope of new ideas is wider when the stakes are high, regardless of whether activation is bottom-up or top-down. As for the systemic innovation, consultative plebiscites that only serve to consolidate power or that are not binding even if rejected by the people rather lead to more political disappointment of the citizenry. The very idea of direct democracy is reduced to absurdity, and the feeling that the political elite comes close to some sort of oligarchy is aggravated. However, and again, a rejection of a non-binding proposal has also some innovative potential because it cannot be completely ignored by the political elite – at least in democratic systems. If nothing else, some tiny reforms must be undertaken if the representatives want to secure their re-election.

The innovative potential of the horizontal axis should be discussed further in terms of responsibility. It is the citizens who have the final responsibility for decisions of legally binding direct legislation. As for the non-binding advisory proposals, it is the political elite who finally decide what will be done. The question of ultimate responsibility lies at the very heart of the debate between supporters and opponents of direct democracy. The former state that giving the people more direct responsibility to decide on political issues leads to higher political engagement, greater accountability and awareness of political problems, more acceptance of the democratic process, and finally even more trust in the political elite (Barber 1984). Supporters of direct democracy, thus, would state that only real direct democracy (i.e., citizen-initiated and binding law proposals) has innovative potential for widening the scope of arguments and reforming representative democracies. The critics of direct democracy are very skeptical in consideration of the capabilities of the citizens. They argue that problems of modern societies are far too complex for ordinary citizens who do not consider anything except their own interests and thus lack a sense of responsibility and accountability. Furthermore, direct democracy allows demagogues to launch populist proposals that violate human or minority rights (Schumpeter 1962). Thus, critics of direct democracy deny a responsibility of citizens. In the end, the people do not bear the consequences of their decisions.

Empirical investigation confirms neither the naïve belief in the salutary effect of direct participation that brings citizens to perfection, letting them find a Rousseauian common welfare (Rousseau 2006), nor the fear of the anarchical tyranny of powerful populist and self-interested majorities. There are hints that citizens in direct democratic systems are more politically competent and do not blindly abolish taxes or demand higher government spending. Compared with elected representatives, citizens who have the power to decide directly even seem to be more economical in spending money: the level of public debt is lower in direct democratic systems than in representative systems (Matsusaka 2005). Some empirical findings even show positive effects of direct legislation on an individual's development of civic virtues, such as political trust or efficacy (Smith and Tolbert 2004). However, there are also empirical findings that identify at least partially discriminating effects of direct democracy. Turnout at polls in Switzerland or California often is quite low. This is not a problem as such because the absentees often do not take part because they are not interested in the topic, are not concerned or feel not competent enough. The problem of this self-selection, however, is its bias: well-educated upper-class people with high income participate much more in direct legislation than do structurally disadvantaged citizens (Mendelsohn and Parkin 2001). Analysis of all polls in Switzerland further shows that the danger of direct democracy for minorities cannot be denied. Sometimes citizen's proposals collide with basic rights (Vatter 2011).

Definition Power

For some opponents of direct democracy, the notion of innovative direct democracy is a contradiction in terms. Direct democracy, rather than being innovative, severely hinders reforms and improvements. Giving citizens the possibility to veto and even cancel parliamentary legislation leads to backlogs instead of political innovation. Thus, direct democracy is seen as a brake.

The discussion on the backlog potential of direct democracy should be enlarged by the third feature of the typology in Fig. 1: the definition power. A pure referendum, as defined above, indeed only blocks a given law or legislative reform when it is adopted. This is the literal sense of such a veto- or control-instrument. However, to consider the whole idea of direct democracy as a paralyzing system would ignore some significant facts. Such a view does not account for the definition power of other instruments than the pure referendum, such as statutory or constitutional initiatives, launched by citizens. Proposals that can be more or less drafted out do indeed have a great potential for innovation. As discussed above, bottom-up induced impulses for political reforms can even break up lethargic representative systems and lead to important reforms. In this sense, direct democracy is not a brake but rather an accelerator for political change.

The degree of definition power affects the scope of the elected representatives' contribution to a specific legislation. Citizen-initiated legislation can range from a simple mandate for the representatives to create a new law to a specific proposal that must be adjusted by the parliament or even a fully set-out law that – given the acceptance by the people at the polls – must be adopted wholesale. The larger the degree of definition power of direct democratic instruments is, the less representatives will have control over the specific legislation but the greater the potential of law-giving innovation there is.

Conclusion and Future Directions

To define the innovations of direct democracy, one must clearly define what is meant by direct democracy. There are several different instruments allowing for citizens to directly join in political decision making. Thus, there is no such thing as the "direct democracy." Further, direct democratic institutions should be seen as complementary to representative democracy. There is no question of either representative or direct democracy. The distinction between direct and representative democracy is not exclusionary, but the two concepts are complementary. In fact, an enlargement of representative systems by direct democratic institutions seems to be an interesting – given the growing mistrust and apathy in established democracies, perhaps even inevitable – innovation of a democratic system. It is the complementation of representative democracy with direct forms that holds the most innovative potential for a transformation of democratic systems to semi-direct democracies.

Depending on the activation, the approval, and the definition power, the inclusion of citizens' ideas into the law-making process holds great innovative potential. As a rule of thumb, the more bottom-up the direct democratic process is organized, the more responsibility is given to the citizens in terms of approval, and the higher the degree of definition power is for citizen-initiated legislation, the greater is the potential for democratic innovation as regards content. The enlargement of the scope for different arguments, the potential of taboo breaking, and the possibility of accelerating political reform is highest when citizens are allowed to directly bring in specific law proposals.

However, there are trade-offs between the innovative potential of direct legislation and the danger of unequal and undemocratic direct decision making by citizens as well as between innovation and representative control. Direct democracy has incorporated perils such as the possible "tyranny of the majority" that harms basic rights, populist demagoguery, or discriminating demands. Such jeopardy is greater the more the responsibility for direct law making is given to the citizens. Furthermore, the more the citizens have to decide, the more the elected representatives must shift responsibility, political power, and control over the political process and output.

The challenge for established democracies in the twenty-first century is the search for a political system that gives possible solutions to these trade-offs. This should be a system that is open enough to tap the innovative potential of citizen-initiated direct legislation, but that leaves enough scope for the elected representatives to limit and control the potential dangers of direct democracy. Such a system will certainly combine elements of representative and direct democracy.

Cross-References

▶ Creative Behavior
▶ Innovation and Democracy
▶ Political Leadership and Innovation

References

Altman D. Direct democracy worldwide. Cambridge: Cambridge University Press; 2011.

Barber B. Strong democracy: participatory politics for a new age. Berkeley: University of California Press; 1984.

Bernhard L. Campaign strategy in direct democracy. Basingstoke: Palgrave Macmillan; 2012.

Gallagher M, Uleri PV, editors. The referendum experience in Europe. London: Macmillan; 1996.

Lupia A, Matsusaka JC. Direct democracy: new approaches to old questions. Ann Rev Polit Sci. 2004;7:463–82.

Maduz L. Direct democracy, living reviews in democracy, vol 2; Retrieved 2012-09-05, from http://democracy.livingreviews.org/index.php/lrd/article/view/lrd-2010-1/22, 2010.

Marsilius of Padua. The defender of peace. New York: Harper Torchbooks; 1967.

Matsusaka JG. Direct democracy works. J Econ Perspect. 2005;19(2):185–206.

Mendelsohn M, Parkin A, editors. Referendum Democracy. Houndsmills: Palgrave; 2001.

Rousseau, Jean-Jacques. Du contract social ou Principe du droit politique, Elibron classique, 2006.

Scarrow SE. Direct democracy and institutional change. A comparative investigation. Comp Polit Stud. 2001;34(6):651–65.

Schumpeter JA. Capitalism, socialism, and democracy. London: Allen and Unwin, [1942] 1962.

Smith DA, Tolbert CJ. Educated by the initiative: The effects of direct democracy on citizens and political organizations in the American states. Ann Arbor: University of Michigan Press; 2004.

Vatter A (editor). Vom Schächt- zum Minarettverbot. Religiöse Minderheiten in der direkten Demokratie. Zürich: NZZ; 2011.

Innovative Activities, Creation

► Innovative Milieu as a Driving Force of Innovative Entrepreneurship

Innovative Businesses

► Knowledge Capital and Small Businesses

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Innovative Milieu as a Driving Force of Innovative Entrepreneurship

Dimitri Uzunidis[1,2], Sophie Boutillier[1,3] and Blandine Laperche[1,3]
[1]Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France
[3]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Innovation systems and individual initiative; Innovative activities, creation; Start-up and proximity relations

Introduction

The geographical proximity between science, technology, industry, and finance contributes to the emergence of innovations. Interactions are being organized through the interplay between private actors and political institutions. Today, economists (see, e.g., Acs 2001; Den Hertog et al. 2001; Feldman et al. 2005; Florida 2003) consider the regional economy as a geographical and economic platform for the organization of production and, as a consequence, as an opportunity to create new activities, goods and services, new employment, and sources of income. For almost four decades, the innovative approach based on proximity and, in particular, on the concept of the "innovative milieu" has demonstrated its pertinence as a form of modeling of decentralized economic growth and also as a source of entrepreneurship.

An analysis starting from the innovative milieu makes it possible to study the entrepreneur's economic role and function and its contribution to the innovation process. The systemic nature of the relationships that characterize an economic and social milieu (Cooke 2001) makes it possible to identify what contributes (or not) to the innovative act. Innovation and entrepreneurship (as a product of the milieu) depend to interpersonal exchanges. Are they only the result of a specific organization of economic relations? The argument here is that the systemic nature of the milieu does not exclusively relate to economic interactions but more precisely also takes into consideration the social structures that are at the origin of innovative behaviors. Moreover, institutions (states, local communities) play an important role in the organization and development of socioeconomic structures. In its turn, the innovative milieu – thanks to the relations of proximity – contributes to the entrepreneurial innovative performance through the supply of scientific, technological, and financial resources.

The first part of this entry will examine the role of synergic (spatial, organizational, and cognitive) relations – named proximity – in the innovation and entrepreneurial process. The density of these relations reinforces the capability of a local economy to generate small independent enterprises (essentially start-ups). But in the contemporary capitalism, the entrepreneur, as the owner and the manager of a small enterprise, has a specific function (second part). He is not a hero (as Schumpeter it noted), but he is a socialized entrepreneur. The former is at the origin of the development of big industries and new areas of activities; the latter is the result of the financial strategies and industrial policies of the major actors of the economy (big firms, financial institutions, central and local public administrations, etc.). In the third part, this entry will focus on the "resource potential" of the entrepreneur as a necessary condition to business creation. This potential, composed by capital, knowledge, and social relations, can give value to the entrepreneur's function. In this case, the relations of proximity, applied on the territorial level of analysis, must be characterized by the logic of collaboration, confidence, and reciprocity.

Several studies on the territorial economy based on the network analysis and the systemic relations which are developed in this case. The entrepreneur is not an actor of economic system. He is studied like a systemic relation into the network or as the result of the functioning of this network. So, the article argues to analyze how the entrepreneur builds his potential of resources in a local economy and how he uses his resources (knowledge, financial resources, social relations) to develop new relations and new economic activities.

Proximity and the Innovative Milieu

Economic Proximity and Social Relations

The concept of proximity is now widely used in both industrial economics and innovation studies (see notably Boschma 2005). A priori, proximity seems to be related to the existence of localized externalities generating phenomena of spatial concentration and regional dynamics. From this perspective, economists propose a three-dimensional approach to proximity: spatial proximity, organizational proximity, and cognitive proximity. In this approach, the issue of localization is coupled with the organizational and informational/cognitive capacity of firms.

A local economy (or a local production system) may be defined as a geographical area consisting of a set of systemic relationships among enterprises and also between enterprises, public authorities (the state), and local communities; these systemic relationships characterize the area localized for a given type of activities or final production. That economy is observed and studied as a node of productive relations which contributes to regional and local development (Uzunidis 2008).

Alfred Marshall (1919) demonstrated that the regional efficiency of such an organizational mode resides in economies in transaction costs. The concentration in a single geographical location of the main actors of the same productive system (mainly producers on one side and users on the other) not only facilitates transactions but the mutual relations of knowledge and confidence between different partners (spatial proximity). The development and accumulation of expertise will therefore create what Marshall called the "industrial atmosphere" facilitating the functioning of the local labor market. This phenomenon is related both to the workers' qualifications and experience and to the location of several enterprises in the same locality. In the meaning attributed by Marshall to the "industrial district," this environment includes a specific density of population with proven qualifications, a set of actors constituting the different links of a single production system, and finally a degree of know-how strongly resulting from acquired experience.

Before Marshall, von Thünen (1826/1850/1867/2009) in the nineteenth century underlined that the free market mechanisms are not an abstraction, but they take place in a particular territory. In this approach, the territory is defined geographically, and it is also the place where relations of proximity between individuals are developed. The von Thünen's analysis shows that the question on territory and its role for the economic dynamics is not a new phenomenon. On the other hand, Braudel (1975) had argued in the Mediterranean case that the commercial activities are developed thanks to the networks of merchant entrepreneurs.

The main characteristic is that the local organization of production is not linked to a hierarchical principle regulating an enterprise but is rather based on a principle of collaboration and cooperation between different production units. Therefore, the concept of solidarity between economic actors is of considerable importance. The local production system is mainly characterized by the proximity between productive units (individual firms, service suppliers, research centers, training institutions, etc.). The relations between these units have a variable intensity and may take on highly differentiated forms: formal or informal relations, market or nonmarket, etc. Alliances mainly relate to the flow of materials, services, labor, technologies, and knowledge. The specific nature of the activities involved in the production of new knowledge and the interactions associated with them has led economists to introduce the concept of cognitive proximity in addition to spatial-temporal proximity and organizational proximity. Cognitive proximity and knowledge exchange means the more or less formalized sharing of experiences, codes, languages, and models resulting from and facilitating the communication of information inside – and between – organizations (Nooteboom 2002; De La Mothe and Foray 2001; Foray 2003).

Proximity contributes to the coordination of the innovation process. This one, both flexible and evolutionary, imposes on the firm or on the entrepreneur the pressing need to be provided with the different types of technological and intellectual means to acquire and combine uninterrupted flows of material and immaterial resources. The "knowledge theory" applied to the company says that the ability to adapt and the efficiency of the company depends on its cognitive categories, on the interpretation codes of the information itself, and on the tacit skills and its procedures in solving the problems it encounters (Dosi et al. 1999). The scientific, technical, and industrial information as a system of knowledge (knowledge capital) which is articulated, formalized, and likely to be communicated or transferred is a means of production identifiable as such (Laperche 2007), the use of which provides innovation for the economic process and the accumulation of capital. The task of the manager or the entrepreneur consists therefore of finding the balance between managing the partnerships and developing the internal instruments of organization (see Laperche et al. 2006). To survive or grow, a company is forced to acquire new knowledge to create new competences (Penrose 1959).

Piore and Sabel (1984) integrated the proximity in a flexible system of production founded on multidirectional and horizontal relations. The dynamics of the evolution of the structures and the organization of the local system of production highlights the importance of the small enterprises. Those being more flexible and more adaptable are committed to renew the local system of production and to create new jobs since flexibility facilitates the adaptation to the new economic context. Moreover, the proximity between the large companies and the small enterprises contributes to the emergence of the innovative milieu.

Table 1 identifies the main parameters characterizing the different categories of proximity as well as the operating field and the types of stakes related to them. It is worth noting that interactions are generally multidimensional: They represent a combination of different dimensions from which a major dimension emerges. In this case, this core dimension relates to space and time.

An Innovative Milieu

Our central theoretical assumption concerning the concept of the innovative milieu, namely, the social and economic environment of a region developed over the course of history ("path dependence"), is that all innovative milieus are the product of interactions between firms, institutions, and labor. Such interactions are exclusively the result of mutual synergies (networks, partnerships, etc.) between different local agents (public or private) participating in economic and industrial development. For example, authors may refer to the different forms of cooperation between enterprises and research labs. It is firstly the surrounding socioeconomic, industrial, and scientific environment that contributes to the creation of new activities (in particular, through entrepreneurship and spin-off) and to the genesis of innovations (see also Camagni and Capello 2009). In addition, this can only develop in a "natural" form if some preconditions are respected, among which are existence at the regional level of a community of actors (enterprises, research and training centers, public administrations, professional qualifications, etc.); presence of material, human, financial, technological, and information resources in the immediate geographical neighborhood; existence of specific know-how leading to high-quality productive activity; existence of relational capital favorable to the creation of local, national, or international networks; and the existence of norms, rules, and values promoting positive behavior among economic actors.

The concept of the innovative milieu generally relates to the capacity of a local economy to generate innovations through, for example, the emergence of new enterprises. The local economy is therefore represented in the form of

Innovative Milieu as a Driving Force of Innovative Entrepreneurship, Table 1 The three categories of proximity

Proximity	Parameters	Operating field and stake
Spatial	Distance/speed	Displacement
		Flows, time
Organizational (intra- and interorganizational)	Hierarchy/market	Coordination
	Intrafirm/extrafirm	Strategy, actions, routines
	Vertical/horizontal	
	Instruction/contract	
Cognitive	Code/content	Communication
	Context/understanding (awareness and interpretation)	Concept, ideas, knowledge

Source: Authors

a spatial system valuing all kinds of capital and merchant exchange. This spatial, economic, and social system must reduce the risks related to the uncertainty of a given investment; it triggers an innovation process that includes the creation of enterprises and the incorporation of already existing technological enterprises. International competitiveness of a territory is due to the richness of its innovative capacity (Porter 2003).

The organization of the innovative milieu is ensured by two logics: The first is related to the interaction between local actors and the second to the dynamics of the collective learning (Lundvall and Johnson 1994). Interactions contribute to organize a regional economy. They make possible to bring together local actors within a production process. The dynamics of the collective learning appears in a process where the milieu initially mobilizes resources and thereafter uses them to adapt to the change which comes from outside. The capacities of innovation are the result of the cooperation between the local actors and the use of specific resources (raw materials, capital, technology, knowledge, competencies, etc.) of the milieu. By the installation of the mechanisms of coordination, the milieu is able to ensure the balance of the cooperative relations between the local actors and internal and external competition.

Spatial, organizational, and cognitive relations of proximity form an innovative milieu. The regional anchorage of the enterprise enables it to avail itself of a pool of resources (and sometimes a market) in order to amortize the costs inherent in its investments in an economy undergoing constant change. However, this regional anchorage depends on the quality of the "pool" mentioned above, compared to the entrepreneur's expectations as regards innovation, business start-up, and consolidation. Hence, it arises the necessity for governments and local authorities to create a system organizing the resources with a view to generating multiple innovation processes taking into account the competition-cooperation behaviors between the same actors in an open economy (see, in particular, Pitelis et al. 2005). This system is a supplier of those productive resources that are capable of generating innovative entrepreneurship and also attracting other enterprises with confirmed performances in the innovation field.

The Entrepreneur's Function in the Current Stage of the Capitalism

The End of the Heroic Entrepreneur

At the core of an innovation milieu, specific attention can be paid to the creation of small enterprises. In the present economic uncertainty and following the trends to decentralization, the establishment of enterprises is supposed to solve many problems linked to the rigidities resulting from institutional interventionism. Its flexible structures enable much easier reaction to consumers' expectations. Moreover, the possible bankruptcy of an enterprise does not threaten the financial and industrial fabric of the country, region, or place. Establishing a considerable number of small firms is considered as a privileged instrument of industrial policy and national planning; financing and marketing activities seek to organize the markets and the development of technologies through alliances, mergers, agreements, and political interventions; the hope for an economic renewal is concentrated on small enterprises that are in full harmony with economic needs. A small enterprise is also a formidable machine able to enrich or destroy capital. It presents itself as a sort of carrier of values to the extent that it creates bridges for the transfer of productive resources (financial capital technologies, labor force with different qualifications, and competencies) to activities, markets, and large companies able to make profits.

Entrepreneurs have been at center of economists' concerns and public policies since the beginning of the 1980s in capitalist economies (Boutillier 2008). This fact is relatively new. Since the end of the Second World War, the paradigm of the big enterprise has prevailed. The years of growth that followed the Second World War were marked by phenomena of industrial vertical concentration and the evolution of managerial capitalism. Economy was directed by a "technostructure" and, in particular, by managers being salaried workers (Chandler 1977). Entrepreneurs, as founders-owners-managers of firms, seemed to belong to an age that had gone to the heroic period to which J. A. Schumpeter often refers. The big company imposed itself and together with it mass production and salaried employment. W. J. Baumol (1969) wrote in a famous paper that the entrepreneur had disappeared from the economic literature. For a lot of economists, the main economic actor is not the entrepreneur but the enterprise.

In Schumpeter's theory of economic evolution (Schumpeter 1935), the entrepreneur is the economic agent achieving new combinations of production factors. He is the hero of the capitalism. Five combinations must be taken into account:

1. Manufacturing of a new good, in particular, unfamiliar to consumers' circles or endowed with a new quality.
2. Introduction of a new production process that is almost unknown in the specific industrial branch; it is not imperative that it is based on a new scientific discovery, and it may also be found in the new commercial process applied to a commodity.
3. Opening of a new outlet, a market in which the specific industrial branch of a specific country has not yet been penetrated, respective of the previous of the market.
4. Acquisition of a new source of raw materials or semifinished products; again, it does not matter whether this source has to be created or already existed, has been taken into consideration, or considered inaccessible.
5. Formation of new organization, for example, creation of a monopolistic situation or sudden emergence of a monopoly: the heroic entrepreneur who creates a new industry, similar to what happened at the end of the nineteenth century (movies or electricity) or at the end of the twentieth century (electronics, computer).

In his ultimate book entitled Capitalism, Socialism and Democracy, published in 1942, Schumpeter was largely pessimistic about the future of capitalism. It was because the development of capitalism led, according to him, to the disappearance of competition. Companies were becoming bigger and bigger. In addition, these were powerful organizations and bureaucratic enterprises. Schumpeter insisted on the following idea: The entrepreneur is being replaced by an organization. Entrepreneurs are no longer responsible for innovative activities, which are now performed by teams composed of expert members who have no direct link with the market or the consumer.

The vanishing of the Schumpeter entrepreneur is a metaphor used to analyze the development of managerial capitalism, the evolution of big enterprises. In the 1960s, J. K. Galbraith (1967) pursued Schumpeter's analysis of managerial capitalism and demonstrated that the economy of capitalist-industrialized countries did not fit with the paradigm of pure and perfect competition. Six distinctive elements emerged:

1. Domination of a handful of big enterprises whose ownership is split between a myriad of shareholders, a plethora of small owners of enterprise

2. Presence of a considerable number of very small firms, however, rather marginal as regards the creation of wealth
3. Disappearance of the entrepreneur replaced by a division between the owners of capital (shareholders) and capital management (managers): the "technostructure"
4. Development of planning tools in order to minimize the uncertainty resulting from the functioning of the market
5. Presence of a plethora of small entrepreneurs who do not operate in a market characterized by pure and perfect competition but in markets dominated by big firms
6. The expansion of a huge bureaucracy related to technological and not political considerations

The Socialized Form of the Entrepreneurship

But since the 1980s, the entrepreneur, as a concept, is reappearing in economics because of the positive factors that contribute to create a propitious environment for the creation of enterprises. Economists hold the idea according to which the economic, social, and political environment facilitates the development of specific economic behaviors, as for example, entrepreneurial behavior. According to the OECD, the emergence of entrepreneurship is related to the rank it holds in the scale of values and to the intensity of incentives and support it receives. However, the beginning of the 1980s was marked by a whole set of major economic and social changes that consecrate a sort of rupture from the previous period:

1. Policy of liberalization of the economy (contestable markets theory) and the development of the financial markets: The privatization of the economy releases capital in huge quantities – new investment opportunities emerge; development of investment funds and pension funds; the aging of the population; and the withdrawal of the social state from the financing of pensions stimulated their development. The major problem was to identify new investment opportunities in a context of slow economic growth. Capital becomes impatient (Harrison and Blustone 1990).
2. Development of information and communication technologies and biotechnologies generated new investments opportunities.
3. The "garage mythology" and "the legend of the entrepreneur" prevailed. As in the early days of capitalism, an idea that was already considered outdated was revived and propagated: the heroic entrepreneur. However, one trend to forget that the knowledge the new innovative entrepreneurs used to succeed is the result of the institutional and the networking (military or civilian) scientific research.
4. The crisis of welfare state: G. Gilder (1985) argued that the welfare state generates poverty because it encourages too many people to rely on social services instead of looking for a job (since the 1970s, the public choice school and the theory of bureaucracy have strongly criticized Keynesianism). According to Gilder, only the entrepreneur is capable to fight against poverty and unemployment.
5. Increase of mass unemployment and growing insecurity of salaried employees (development of part-time employment and multiemployment): Is it the "end of work" or the beginning of the "entrepreneurial society" (Audretsch 2007)?
6. New public policy: The main question is to help unemployed workers to create their enterprises (their means of existence, their job), thanks to the emergence of an institutional environment (reduction of taxation, of administrative barriers, flexibility of labor market, etc.). For Keynesian economists in the 1960–1970s, the fundamental role of the state was to sustain demand and create markets. In fact, the main objective of J. M. Keynes was social peace and political stability. In the 1980s, the economists of endogenous growth theories (Aghion et al. 2001) explain that the state has a major role to play in order to sustain the supply and support enterprises to innovate. In this turn, innovation generates wealth and employment. Through an appropriate public policy, the state tries to facilitate the transition from the situation of job worker to that of entrepreneur or from wage earner to

entrepreneur, in short to introduce more flexibility in the labor market.

7. The big managerial enterprise with its pyramidal architecture (Sennet 2006) is no longer adapted and is compelled to change: The structure of the network enterprise is flexible and decentralized (to benefit from new information and communication technologies).
8. As regards the number of salaried workers/employees, the size of enterprises has also been reduced.
9. Since the beginning of the 1990s, entrepreneurship has become an academic discipline taught in universities. Awareness programs targeted at the youth are also elaborated upon.

Thus, economic theory has a definition of new capitalism: It is a socioeconomical organization based on private property and free market. The characteristics of the managerial capitalism were the same. The fundamental differences between new capitalism and managerial capitalism are (1) the organization decentralized of industrial production (network enterprise and enterprise networks) assisted and coordinated by the ICTs and finance, (2) development of the financial markets (which generate capital funds for investment), (3) flexibility of labor market, and (4) new role of state which is to build an institutional environment to create enterprises and jobs.

In the first decade of the twenty-first century, the economy of industrialized countries is undergoing major transformations at the scientific, technological, and productive levels. The financial crisis of 2008 is also the beginning of major changes in the productive systems. If one refers to Schumpeter's theory about entrepreneurship, this situation lays a fertile ground for innovation and for business creation (Langlois 1987; Perroux 1970; Heerjte 2006), a process that fuels the ascending phase of an economic cycle.

In this context, the entrepreneur is no longer heroic but rather socialized (Boutillier et al. 2008). He is stuck between three logics: that of the big enterprise that structures and outsourcers all or a part of its activities; that of the state striving to promote the creation of new businesses, on the one hand, to fight against unemployment and, on the other, to foster the development of innovations seen in the Schumpeterian meaning of the term (product, process, organization); and that of relations of proximity on a local (spatial) but also on a interinstitutional (networks) level. The concept of the socialized entrepreneur must be distinguished from the collective entrepreneur or even from the entrepreneurial corporation (Hagedoorn 1996) that characterizes the managerial enterprise: In fact, the socialized entrepreneur may be defined in the first place by his macroeconomic function (job creation, innovation, outsourcing of the productive and service activities of big companies, localization).

In the new capitalism, the socialized entrepreneur takes place in the networks. He is an entrepreneur sitting at the interface between two logics:

1. The logic of the big industrial and financial enterprise that seeks to stimulate the creation of enterprises in order to test new markets
2. The logic of the state that seeks by these means to fight against unemployment and promote innovation

Indeed, faced with the complexity of the innovation process, M. Castels (1996, 1997, 1998) went as far as to maintain, quite cleverly, that the fundamental unit of the economic system is no longer the entrepreneur, the family, the firm, or the state but the network composed of different organizations. Thus, this network gives birth to the new entrepreneur (Table 2).

The Entrepreneur's "Resource Potential" and the Innovative Milieu

The "Resource Potential" and the Entrepreneur's Function

The entrepreneur's individual qualities and personality undoubtedly play a major role in the decision to create or buy out a small firm. Nevertheless, the action of starting up that initiative is determined by the macrosystemic dynamics of accumulation and profit. These dynamics generate barriers as well as personal enrichment opportunities that encourage an individual to become an entrepreneur who will ultimately succeed or fail. The fact is that nobody is born an

Innovative Milieu as a Driving Force of Innovative Entrepreneurship, Table 2 Big enterprises and entrepreneurs since the second half of the twentieth century

	Since the end of the Second World War	Since the 1980s
Place of the big enterprises	Development of managerial enterprises	Reorganization of big enterprises (networks)
Organization of labor and production	Assembly chain	ITCs
	Fordism	Robotization and production and services
	Taylorism	Flexible organization
	Rigid organization	
Place and role of the entrepreneur	Entrepreneur = employer = authority	Entrepreneur = innovator = creator
Form of recruitment	Mass wage earning	Increasing precariousness of salaried employment
	Mass employment	Term contract
Financing of the economy	Indebtedness (important role of banks)	Development of financial markets
	Public financing	
Role of the state	Welfare state	Privatization/deregulation
		Public policies to promote entrepreneurship and free market

Source: Authors

entrepreneur but may become one through the mobilization of a potential of resources composed of capital, knowledge, and relations. Support involves capital for investments and operations, knowledge for choices and decisions, and relations for the financing, association, and selling of products.

Economists define the entrepreneur as the founder, manager, and owner of at least a part of the enterprise. In such conditions, he may also be an innovator (Say or Schumpeter analysis); however, unemployment may as well be at the origin of his decision. Nevertheless, he always remains the economic agent who bears the risk since he is, in every case, the main financial backer of his enterprise, together with his relatives. On the other hand, the entrepreneur may be defined as a set of resources. By using the concept of potential of resources of the entrepreneur, the researcher relocates the entrepreneur and his enterprise in the general logic of the capitalist system. The potential of resources is split up in the following way:

1. A set of financial resources including all the effective financial resources (own spending, family assets, heritage) or potential (access to credit, subsides, various public aids, etc.)
2. A set of knowledge including all entrepreneurs' knowledge whether they are certificate, by a diploma, or a result from professional experience: technological, organizational, economic knowledge, etc.
3. A set of social relations: personal, family, or professional relations that the entrepreneur may mobilize in order to fulfill his project. Two social relation networks may be distinguished: on the one hand, a network of institutional relations (relations with public institutions, enterprises, banks, etc.) and, on the other, a network of informal relations with relatives, family, friends, neighbors, working relations, etc.) (Granovetter 1973). In this example, these two networks develop interdependently. Thus, it is through the information given by a friend that the observer learns about the existence of a specific type of financing. However, the individual's social background plays a fundamental role because it largely determines the network of friendly or family relations (Bourdieu 1985; Coleman 1988; Putman 1995).

Innovative Milieu as a Driving Force of Innovative Entrepreneurship, Table 3 Resource potential of the entrepreneur

Resource potential	Major characteristics
Knowledge	Tacit and various types of knowledge acquired in the family context
	Scientific and technological knowledge acquired at school
	Knowledge acquired during relations with third parties (family, professional activity, etc.)
Financial resources	Own spending
	Affective inputs: parents, relatives
	Bank credit
	Institutional financial aid (e.g., direct assistance from the state)
	Financial inputs brought in by another entrepreneur
Social relations	Informal relations (family, friends, neighbors, colleagues, etc.)
	Formal relations (stat, banks, other enterprises, research centers, etc.)

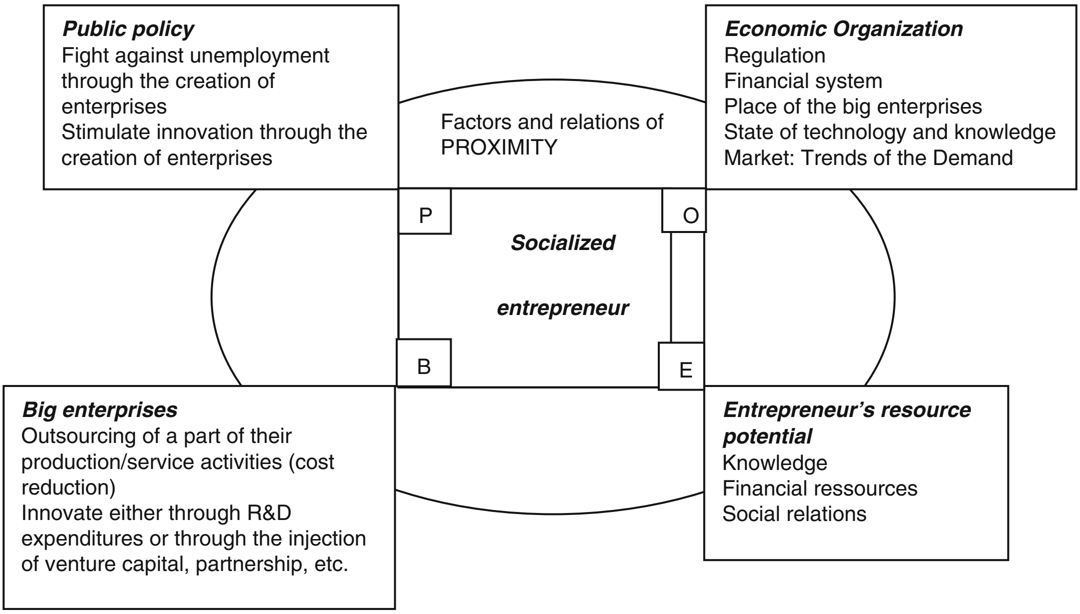
Source: Boutillier (2008), p. 80

The three components of the entrepreneur's resource potential are determined by the place he holds in the social organization chart – in spite of the increasing socialization of the economy. The elements assume a fundamental role. The family gives a taste to start a business; at the same time, it is a source of financing. This phenomenon can be observed in France, in the United States, and also in Russia where the business regulation is very new. A lot of entrepreneurs had a member of their family in business activity. In the Russian case, a lot of entrepreneurs have a member of their family in the Communist Party. It means that the Communist Party is a means to develop social relations. With the support of the family, the functions exerted by the entrepreneur draw their logic from public policies targeted at the dampening of the consequences of the crisis (employment of innovation policies) and from strategies aiming at the productive and financial reorganization of big enterprises (Table 3).

How the Relations of Proximity Increase the Resource Potential of the Entrepreneur?

The ability of the entrepreneur results from the variety and richness of the resource potential he has himself constituted. In its turn, the composition of that resource potential depends on factors that are external to the enterprise and entrepreneur. In particular, public policies of assistance for the creation of businesses (to stimulate innovation and/or to fight against unemployment) will largely determine the financial resources to which the entrepreneur will be authorized to have access in order to create his enterprise and ensure its survival. The economic and social organization has several dimensions and therefore several effects. The general level of development of knowledge and technology in the society will have an impact both on the knowledge acquired and assembled by the entrepreneur (on the basis of his education and the competences of the members of his team; activities related to economic and information watch) and the technological level of his activity. The nature of the financial system (e.g., ease or difficulty of going public, bankers' degree of "conservatism," level of development of venture capital, etc.) influences both the capacity of an individual to become an entrepreneur and the capacity of an enterprise to more or less accelerate its development.

The degree of concentration in the market, for example, the presence of big enterprises, also plays a considerable role in the dynamics of creation of small enterprises and in their type of activity (in particular subcontracting). Finally, it is necessary to underline the policy led by enterprises with a view to innovate either by their own means (R&D budget) or by implementing different types of partnership including the injection of venture capital. In conclusion, the presence and nature of the links between the "POBE" factors

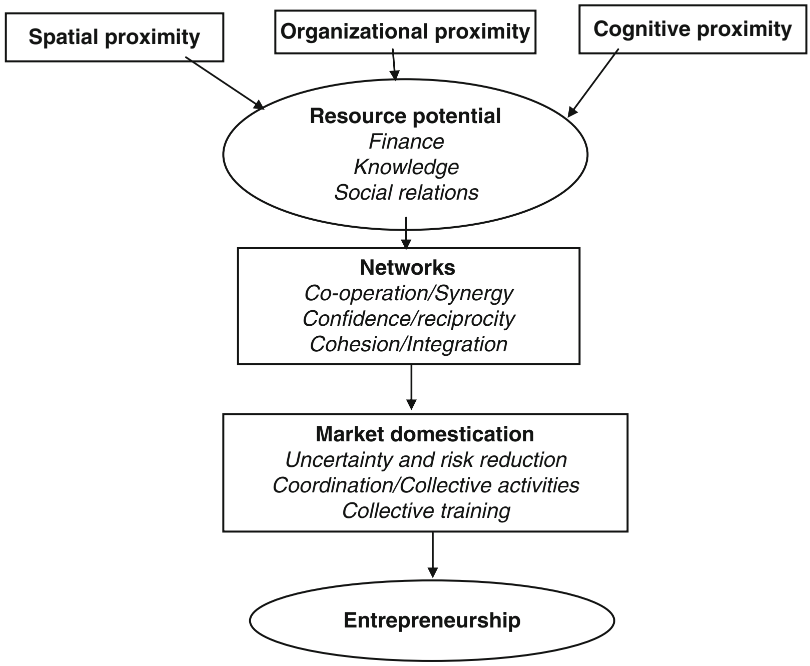


Innovative Milieu as a Driving Force of Innovative Entrepreneurship, Fig. 1 The socialized entrepreneur, the core of the organic square of business activity (Source: Authors)

(public policy, economic organization, big enterprises, entrepreneur's resource potential) lead economists to relocate the entrepreneur in his economic social, political, technological, and spatial context. This organic square provides a way to analyze the creation of enterprises at the scale of a specific local economy (Fig. 1).

The emergence of a "successful" region results from the fact that it is able to manage its own capacity to develop new products, new techniques, and new organizations. Thus, innovative milieu is the combination on a given geographical space of enterprises, training centers, and public or private research units involved in a partnership approach with the purpose of identifying synergies around common projects of an innovative nature. It combines attractiveness (agglomeration effects), diffusion (dispersion effects), and externalities: These three factors are essential for the generation and propagation of innovations. Externalities can be defined (Marshall 1891) as being positive or negative effects, which involve an activity of an economic agent outside this activity or that the agent is subjected to from outside. The most attractive for a company is to achieve, in a setting favorable to investment, substantial external savings, without having to bear the slightest cost that its activity creates for the community as a whole (pollution or various nuisances) (Krugman 1991). It is important therefore to underline that taking the enterprise will create various effects on the local community, but, in return, she will expect from the community means and opportunities to enlarge her property (assets) or where necessary to defend it.

What is favorable to an innovative entrepreneurship offering the possibility to support "network economies" is the existence of an area created, in economic and social terms, by the relations of proximity: infrastructures of transport, communication, telecommunications, education, engineering, etc.; contractual and cognitive interactions; confidence and cooperation; share same codes and business competencies, a dense network of enterprises; fiscal and financial supports and aids, etc. Figure 2 presents the links between the relations of proximity, the resource potential of the entrepreneur, and the realization of socialized



Innovative Milieu as a Driving Force of Innovative Entrepreneurship, Fig. 2 Proximity and entrepreneurship (Source: Authors)

entrepreneurship through the insertion in networks and the risk reduction.

Relations of proximity enrich the resource potential of an entrepreneur and create synergies and a large range of confidence and reciprocity links. With for consequence the reduction of the risks related to the uncertainty of a given investment (market domestication).

The entrepreneurial activities take place in a particular spatial milieu. It is in this milieu that the entrepreneur builds his potential of resources (knowledge, financial resources, and social relations). The entrepreneur develops his social relations in a particular territory, even if his objective is to develop more large-scale (and international) activities. The territory becomes a special innovative milieu by the density and the intensity of the three dimensions of the proximity: spatial, organizational, and cognitive. Enterprises (big or small) can be located in a territory for different reasons (costs reduction, demand access), and if public policy plays a nonneglect role to new business development and attractiveness, the entrepreneur, as a social agent, benefits principally from his relations to create his business. These different social relations (family, socialization, education, etc.) are also the engine of the future development of his enterprise (Ehlinger et al. 2007; Grossetti and Barthe 2008). So, economic activities are embedding (according the Polanyi's concept redefined by Granovetter) in a particular territory.

Conclusion and Future Directions

Since the 1980s, the entrepreneur has made its comeback on the forefront on the economic and political scene. In an approach combining economics and sociology, in this entry, authors tried to go deeper into the analysis of the origin of the entrepreneur's function, studying the construction of his "resource potential," that is, the set of knowledge, social relations, and financial resources gathered together by the entrepreneur in his environment. This resource potential is not stable and may be increased or reduced in different economic, political, and social contexts. According to the approach by the innovative milieu, relations of proximity reinforce the entrepreneur's potential. Business start-up becomes easier. The first meaning of physical proximity was soon supplemented by other interpretations in which the operating field of proximity (space, organization, or institution) is intertwined with the contents of the proximity relationship (information, training, knowledge, technology, etc.). The three types of proximity have made it possible to better examine the process of business creation. The systemic links between an individual and his socioeconomic environment create investment and profit opportunities. If this environment is oriented toward innovation, these opportunities will be more numerous. Thus, the innovative milieu can be studied as a major source of entrepreneurship in the current stage of the market economy.

An innovative milieu, as an innovation system, describes the relationships (scientific, technological, industrial, commercial, financial, political) between private and public institutions (enterprises, research and engineering labs, administrations, etc.). In general, the relationships consist of financial and information flows and the movement of persons. The purpose of that system is to produce innovations (new organizations, new goods and processes, new resources, new combinations of productive resources). This system facilitates business creation on the local level and contributes to define the socialized entrepreneur. This new entrepreneur is a socialized entrepreneur because he develops his activity in a particular economic environment which is structured by the business networks and by the financial, tax, and legal incentives of central or local public authorities.

In a network economy, local economies are now seeking to develop by relying on private initiatives coupled with targeted public and individual action. Investment attractiveness, the capacity to create enterprises, and the creation of jobs determine the performance of an innovative milieu. The milieu is integrated in a context resulting from the development of complex interactions between its actors. These actors and interactions constitute a system which is defined at the same time by its objectives and its composition. The analysis of the innovative milieu as a complex system leads economists and sociologists to study the whole of the local actors (enterprises, authorities, public services, etc.) in relation with the outside. Inside this system, the innovation plays a central role. The integration of the actors within the milieu contributes to the emergence of new enterprises by offering to the future entrepreneur the essential financial, relational, and cognitive resources.

Cross-References

▶ Creative Knowledge Environments

▶ Knowledge Society, Knowledge-Based Economy, and Innovation

▶ Quadruple Helix

References

Acs Z. Regional innovation, knowledge and global change. London: Continuum; 2001.

Aghion P, Harris C, Howitt P, Vickers J. Competition, imitation and growth with step-by-step innovation. Rev Econ Stud. 2001;28:467–92.

Audretsch D. The entrepreneurial Society. Oxford/New York: Oxford University Press; 2007.

Baumol W. Entrepreneurship in economic theory. Am Econ Rev. 1969;58(2):64–71.

Boschma R. Proximity and innovation: a critical assessment. Reg Stud. 2005;39(1):61–74.

Bourdieu P. The forms of capital. In: Richardson JG, editor. Handbook of theory and research for the sociology of education. New York: Greenwood; 1985. p. 241–58.

Boutillier S. Finance, state and entrepreneurship in the contemporary economy. In: Laperche B, Uzunidis D, editors. Powerful finance and innovation trends in a high-risk economy. London: Palgrave Macmillan; 2008.

Boutillier S, Laperche B, Uzunidis D. The entrepreneur's "resource potential," innovation and networks. In: Laperche B, Uzunidis D, von Tunzelmann N, editors. Genesis of innovation, systemic linkages between knowledge and market. Cheltenham: E. Elgar; 2008. p. 208–28.

Braudel F. Mediterranean and the Mediterranean world in the age of Philip II. London: Fontana; 1975.

Camagni R, Capello R. Knowledge-based economy and knowledge creation: the role of space. In: Fratesi U, Senn L, editors. Growth and innovation of competitive regions. The role of internal and external connections. Berlin: Springer; 2009. p. 145–65.

Chandler AD. The visible hand. The managerial revolution in American business. Cambridge: The Belknap Press of Harvard University Press; 1977.

Coleman JS. Social capital in the creation of human capital. Am Sociol. 1988;94:95–120.
Cooke P. Regional innovation systems, clusters, and the knowledge economy. Ind Corp Change. 2001;10(4):945–74.
De La Mothe J, Foray D, editors. Knowledge management in the innovation process. Boston: Kluwer; 2001.
Den Hertog P, Bergman E, Remoe S. Innovative clusters: drivers of national innovation systems (enterprise, industry and services). Paris: OECD; 2001.
Durkheim E. De la division du travail social. Paris: PUF; 1893/2007.
Feldman M, Francis J, Bercovitz J. Creating a cluster while building a firm: entrepreneurs and the formation of industrial clusters. Reg Stud. 2005;39(1):129–41.
Florida R. Entrepreneurship, creativity and regional economic growth. In: Hart DM, editor. The emergence of entrepreneurship policy. Cambridge: Cambridge University Press; 2003. p. 39–60.
Foray D. The economics of knowledge. Cambridge: MIT Press; 2003.
Galbraith JK. The new industrial state. Boston: Houghton Mifflin; 1967.
Gilder G. L'esprit d'entreprise. Paris: Fayard; 1985.
Granovetter M. The strength of weak ties. Am J Sociol. 1973;78:1360–80.
Hagedoorn J. Innovation and entrepreneurship: Schumpeter revisited. Ind Corp Change. 1996;5(3):883–96.
Krugman P. Increasing returns and economic geography. J Polit Econ. 1991;99(3):483–99.
Langlois RN. Schumpeter and the obsolescence of the entrepreneur. In: The history of Economics Society, annual meeting, Boston, WP 91-1503, 1987.
Laperche B. "Knowledge capital" and innovation in multinational corporations. Int J Technol Glob. 2007;3(1):24–41.
Laperche B, Galbraith JK, Uzunidis D, editors. Innovation, evolution and economic change. New ideas in the tradition of Galbraith. Cheltenham: E. Elgar; 2006.
Lundvall BA, Johnson B. The learning economy. J Ind Stud. 1994;1(2):23–42.
Marshall A. Principles of economics. London: Macmillan; 1891.
Marshall A. Industry and trade. London: Macmillan; 1919.
Nooteboom B. A cognitive theory of the firm. Paper for ESNIE workshop alternative theories of the firm, Paris, 2002.
Perroux F. Note on the concept of "growth poles". In: McKee DL, Dean RD, Leahy WH, editors. Regional economics: theory and practice. New York: The Free Press; 1970. p. 93–106.
Perroux F. La pensée économique de J. Schumpeter. Presses de Savoie; 1965.
Piore M, Sabel C. The second industrial divide: possibilities for prosperity. New York: Basic Books; 1984.
Pitelis C, Sugden R, Wilson JR. Clusters and globalisation. Cheltenham: E. Elgar; 2005.
Porter ME. The economic performance of regions. Reg Stud. 2003;37(6–7):549–78.
Putman RD. Bowling alone: America's declining social capital. J Democr. 1995;6(1):65–78.
Schumpeter JA. Capitalism, socialism and democracy. New York: Harper Perennial; 1942/1976.
Uzunidis D. The logic of the innovative milieu. In: Laperche B, Uzunidis D, von Tunzelmann N, editors. Genesis of innovation. Systemic linkages between knowledge and market. Cheltenham: E. Elgar; 2008. p. 187–207.
von Thünen JH. The isolated state in relation to agriculture and political economy. London: Palgrave Macmillan; 1826/1850/1867/2009.

Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)

Delphine Gallaud
INRA CESAER (UMR 1041), Unité Mixte de Recherche INRA-Agrosup, Dijon Cedex, France

Synonyms

Productive local system; Regional cluster; Regional innovation system

Introduction

Spatial economic theory was structured to the 1980s around two alternative thesis: the first one was called the thesis of convergence and the second approach was the thesis of divergence. For the convergence approach, income of production factor should tend to equalize all over the world. On the contrary, for the divergence approach, central and richest regions will keep on winning from their past advantages. But Aydalot (1986) brought to the fore a third way he called "reversal." In such a situation, the old industrialized regions face a persistent decline, whereas new regions, without tradition of industrialization but service-oriented, appear and become richer. The same phenomenon was observed in many European countries and in the

United States. This phenomenon challenged scholars because these regions developed on an endogenous basis. As far as development is concerned, advantages are never permanent. Winning regions can lose their competitive advantages if they do not keep them up, whereas losing regions can overcome their drawbacks to create new advantages.

To revitalize themselves, regions have to develop an important endogenous factor: entrepreneurship. Scholars are still debating on the concept of entrepreneurship. Today, two main approaches exist (Bruyat and Julien 2000). The first approach takes up the work of Turgot and Say and considers that any actor which creates a new activity is an entrepreneur. The second approach, following Schumpeter's work, considers that entrepreneurs are only the innovators. The entrepreneur is the individual who originates the dynamic of evolution in the economy. He detects new opportunities to make profit and creates a new organization to generate the innovation. In this sense, the entrepreneur has a non permanent status. As soon as he stops innovating, he is not still defined as an entrepreneur.

Entrepreneurship can be defined as the creation of a new organization in the economy. This new organization can be created ex nihilo; the owner-manager was not an "entrepreneur" before the creation. The new organization can also be a spin out of a large incumbent company (it is called corporate entrepreneurship) or from a university or a public research organism (academic entrepreneurship).

Innovative Milieux Produce Entrepreneurship

Maillat and Perrin (1992) define a "milieu" as "a geographic space without a strictly defined frontier which is characterized by a kind of unity that one can identify by behaviours. Different kind of actors such as firms, institutions, and public organism of research and formation... are located into the milieu, they own material and immaterial ressources that characterizes the milieu." To sum up, for these authors, milieu has three components: (1) a productive system including various and diversified activities, productive activities, and activities of service (as funding, transport, and consulting); (2) a local workforce market with a work time, which corresponds to the productive specialization of the milieu and a system of training and research that also contributes to the productive specialization; and (3) a dynamic of interaction and learning. Actors located into the milieu interact locally and create between them this structure of organization that allows the functioning of the milieu and the development of innovation. Learning facilitates the adaptation of the milieu to the change of the economic environment. It allows the evolution of the milieu and allows to replace specific resources that are the basis of the competitive advantage of a milieu because these resources differentiate this milieu from the others.

Most of work on entrepreneurship and on the ability to concretize the project of creation insists on the importance for the future owner-manager of two kinds of factors: from the microeconomic point of view personal characteristics of the owner manager and from the macroeconomic point of view the characteristics of the environment (Fisher and Nijkamp 2009).

Schumpeter is the first author that defines the owner-manager as the economic actor who has a peculiar ability to detect new opportunities. This ability is an important component of the entrepreneur's personal characteristics and competences. This competence is differentiated between individuals. Following Audretsch and Aldridge (2009), this ability is linked in an endogenous way to the production of knowledge during the innovation process. When an incumbent firm produces knowledge during its innovative activities, it faces what these authors call the "knowledge filter," i.e., to the gap between produced knowledge and knowledge useful to develop a marketable innovation. The valuation of produced knowledge and its ability to be converted into marketable innovation becomes a competence of actors. The commercial value of knowledge is a source of incertitude for actors. The entrepreneur becomes the actor that detects that some piece of knowledge could acquire a bigger commercial value and tries to exploit that perception, leaving the incumbent firm to set up a new organization. Doing so, the future entrepreneur becomes the actor that will be the transmitter of knowledge spillovers. The entrepreneur will assure the diffusion of knowledge and its concrete use into the new organization. To sum up, the process of innovation activities impulses the apparition of non-exploited opportunities and at the same moment allows the apparition of entrepreneurs. So, the process of knowledge creation generates entrepreneurs endogenously because of the existence of spillover phenomenon.

Initially, most of the works took into account a large environment; it is only recently that scholars took into account spatial environment set up the works on innovative milieux and regional systems of innovation.

To accomplish the setup of the new organization an entrepreneur should be able to mobilize a set of diversified resources. He can mobilize his own resources but also the resources that are located into the milieu. Therefore, the entrepreneur is embedded into the "organic square" of the economy (Uzunidis 2010). The composition of the potential of resources depends of the entrepreneur's own resources, of the economic organization of the milieu, of the relative place of large firms compared to sme's, and of the public policy.

The entrepreneur's resource includes his personal knowledge and diversified kind of capital, including social capital that allows him to access to the social network that he will use at the different stages of the funding process. The economic organization of the milieu is linked to the degree of concentration of the market, to the state of the scientific and technical potential that will get an influence on the technical development of firms, to the nature of the funding system and especially to its facility to grant credits to the firms, and lastly, to the kind of regulation that exists into the milieu (public regulation vs regulation by private operators). The relative importance of large firms plays a part too because it makes the setup of sme's easier or not. Besides, the existence of networks between small and large firms will also make the creation easier. Lastly, public policy can support the creation of new firms with public measure.

Innovative milieux favor entrepreneurship combining three kinds of proximities: geographic proximity (the distances between the actors located into the milieux are small), organized proximity (networks between actors located into the milieu make the milieux function), and cognitive proximity (actors share professional, organizational, and even cultural knowledge. Their interaction leads to the set up of norms of regulation shared among them.). These three kinds of proximities contribute to aliment the potential stock of resources that are available for the actors of the milieu. Besides, networks between local actors contribute to the "domestication of the market," favor the entrepreneurship reducing the risks linked to the creation, and protect new organization during the first stage of the start-up.

So, when the three kinds of proximities are present simultaneously, the dynamic of interaction inside the milieux induces entrepreneurship endogenously and leads to the development of the milieux.

Perrin (1992) studies three different milieux and demonstrates that they have a different capacity to create innovation and entrepreneurship. In the Nice area, the milieu has remained few industrialized for a long time. Firms have only adapted products that were not new to the market using new process neither. In this area, the milieu fails to become an innovative milieu. On the contrary, in the Marseille area, firms belong to medium- and high-tech sector. Firms located outside the region create spin-off located into the city. Public policy played an important part in developing the creation of varied areas of activity and by modifying the productive specialization of the enterprises moving from an industrial specialization to a service orientation. Doing so, public policy managed to attract any large firms interested by the amenities of living into the area. The third case concerns the scientific park of Sophia Antipolis. In fact, this area managed to become a milieu only on the third part of its development, after a long period without any internal interactions between local actors. Lastly, large groups perceived the interest of local interactions and modified the functioning of their plants to impulse local interaction and innovation. In the third case, large groups are the major set up of entrepreneurship creating spin-offs.

However the part played by large firms is ambivalent as far as entrepreneurship is concerned. In fact, large firms can favor new organizations, creating spin out, as they can destructure the industrial tissue of a milieu. Large firms can favor spin outs, but the local milieu will function well only if these large firms will allow local interaction between the new spin out and other organizations of the milieu. Besides, the innovative milieu will survive only as longer as the large firms are interested by local interactions and are convinced of the efficiency of local geographic spillovers. On the contrary, large firms that prevent their local plant from interacting locally will contribute to limit the development of the milieu. Large firms that are located outside of the milieu can also contribute to the malfunctioning by buying the local firms and by using them in a global and nonlocal strategy.

Influence of Entrepreneurship on Innovative Milieux: The Missing Relation

Effects of Entrepreneurship on Regional Growth and Regional Employment

Scholars have identified the relationship between entrepreneurship and regional growth and employment for a long time. But empirical studies have not validated this relationship for a long time. Fritsch (2008) surveyed a set of studies that corroborate the relationship. The entry of new firms on a market affects the competition's process. The first consequence of this entry is to challenge the market position of the competitors and conduce them to more efficiency. Then, the creative destruction process takes place and revitalizes industrial tissue. Public policies generally consider that entrepreneurship has a positive impact on regional growth and employment. Empirical studies that take into account the spatial level of the influence of entrepreneurship are very scarce and generally conducted at the regional level. However, any studies bring to the fore a striking result: setup of start-up would lead to a decline in total regional employment in rural areas and in areas where the birth rate of start-up is weak. On the contrary, the growth of regional employment would be higher in urban areas and areas where the birth rate of start-up is higher.

Networks of the Entrepreneurs During the Setup of the Start-up and During the First Years of the Ongoing Business

Empirical studies about the spatial location of the entrepreneurship's networks during the phase of the setup of the start-up are very scarce. In the pre-start-up phase, entrepreneurs mobilize their social networks. This social network includes member of entrepreneur's family, friends, and neighborhood relationships (Schutjens and Stam 2003). In the setup phase, the entrepreneur's network evolves to include organizations that focus more directly on the direct needs of the start-up as incubators, funders, and various kinds of professional advisors. The creation device support is generally local. Lastly, once the new organization has set up, its network includes customers and suppliers. Besides, the new entrepreneur should set up quickly if he wants the new start-up manage to stay on the market. But many start-ups have no networks at all after many years as Quevit and Bodson (1992) illustrate for the city of Liège. From a spatial viewpoint, the network's start-up does not evolve from local space to international. In fact, start-ups choose the spatial extent of their network directly linking it to their strategy. So, any start ups will choose a local network, whereas others choose directly a national or international network. In fact 39% of the start-up began with an extraregional network and not a local one (Schutjens and Stam 2003). Besides, this network has remained extraregional for a long time.

So, firms have some difficulties to create their milieu because networks are not necessarily established locally. That point limits the interaction dynamic. So, a start-up, even if it locates into a well-developed milieu, does not necessarily take part in the dynamic of local interactions. Doing so, it does not contribute to reinforce the milieu.

Besides, the local dimension of the network will also depend on the firm's sector. Therefore, service firms use more local networks than industrial firms. Besides, the size of the firm will influence the need of a local network. Small firms have a more local network than large firms.

Implications

One of the limits of the innovative milieu approach is the question of their border. Scholars of the GREMI's group have deliberately not defined the border, because they consider that the border must be defined in reference to the interaction systems and the existence of a local culture shared among the actors. But this open definition leads to consider various kinds of spaces as "milieux," e.g., cities, set of cities, or area defined in reference to geographic attributes. This lack of indicator often leads to some practical difficulties to identify a milieu, and the comparison between many case studies of milieu becomes difficult.

Quévit and Bodson (1992) demonstrate that external relationships are as frequent as interactions internal to the local milieu. In such situation, can someone consider that the object identified can be defined as an innovative milieu? In fact, these two authors hesitate to qualify their case as a milieu and prefer to speak of "a nascent dynamic."

The second limit of the approach is due to the fact that a well-functioning milieu is characterized by two dynamics: a dynamic of local interaction and a dynamic of learning. The learning dynamic favors the revitalization of the milieu. If the interaction dynamic has been well documented on various kinds of milieux, it is not the case for the learning dynamic. This dynamic is difficult to observe. Besides, the interaction dynamic should be local to allow the growth of the milieu. But at the same time, the milieu should open to the outside economic space if the milieu wants to remain efficient. So, actors of the milieu should establish both local interaction and external interaction to get some new ideas and sources of innovation and let the milieu renew over time. The way to link the two kinds of interaction is not often studied, whereas it is fundamental to understand how entrepreneurship appears in a milieu.

As far as public policy is concerned, two main points can be underlined. Firstly, Audretsch and Aldridge (2009) bring to the fore the endogenous development of entrepreneurship in the milieu because of knowledge spillovers. From this point of view, any public policy that encourages innovation and knowledge production will sustain entrepreneurship at the same time. Then the debate is to choose to encourage innovation of the public sector or of private organizations. As the social return of research is larger than the private one, public policies should encourage more innovation from the public sector to promote entrepreneurship.

However the experience of many countries, as far as entrepreneurship is concerned, does not corroborate this prediction. And it appears that many other factors can prevent the creation of start-ups. So, public policy has a very important part to play to protect nascent organizations and domesticate the market. Public policy should contribute to reduce the risks that new entrepreneurs take when they create their firm. Public policy still has many instruments to sustain entrepreneurship, but they are not all efficient. For example, incubators get a mitigated outcome. Besides, the financial system plays an important part too, in making the creation and the funding during the first years of the ongoing business easier or not. Public policy could intervene to sustain the funding or encourage financial system to give credit to small firms.

Secondly, public policy promotes entrepreneurship. But if its negative impacts have been brought to the fore by theory, with the well-known effect of Schumpeters' creative destruction, its concrete manifestations are not really taken into account by policies. In fact, today, there are no means of preventing the close down of firms in industries with important modification of competition regimes due to the innovators.

Lastly, the milieu approach can lead to competition between territories. The milieu approach focuses on the endogenous ability of a territory to create factors of development. If the milieu is not able to create these factors by itself, it can try to draw them from the outside, especially firms located in other regions by a policy of grants, for example. But doing so, one milieu can grow more rapidly than another one and become a winner region, but it is at the expense of the other territory. The milieu generates a dynamic of competition between another milieu and from the macroeconomic point of view, the total effect for a country can be negative.

Conclusion and Further Direction

One of the most promising further ways of research is to conduct more work on the missing relationship: one of the influences of the entrepreneurship on innovative milieu. GREMI's group demonstrated that the set up of new entrepreneurs could have negative effects on the future evolution of the milieu. An important change in the kind of activity in which the milieu is specialized, for example, often leads to a phase of decline before a potential recover. But the recover does not appear in all the cases studied. The part played by entrepreneurs into the milieu and their impact on the evolution of the dynamic of interaction is not yet theorized.

The milieu approach remains the most interesting approach to understand endogenous development in connection with entrepreneurship. However this will be true except the different milieu search to draw competitive advantage by drawing factors and especially firms from the outside, increasing competition between territories. In fact, milieu needs the openness to the outside to grow over time, so they should develop more cooperation with other milieux to be connected to various spaces to be able to benefit from the variety of these links.

Cross-References

▶ Entrepreneurship
▶ Entrepreneurship and Business Growth
▶ Innovative Milieu

References

Audrestsch S, Aldridge T. Knowledge spillovers entrepreneurship and regional development. In: Capello R, Nijkamp P, editors. Handbook of regional growth and development theories. Cheltenham: Edward Elgar; 2009. p. 201–11.

Aydalot P. Milieux innovateurs en Europe. 1986. http://www.unine.ch/irer/gremi/Gremi%201.pdf. Accessed June 2011.

Bruyat C, Julien PA. Defining the field of research in entrepreneurship. J Bus Ventur. 2001;16:165–80.

Fisher M, Nijkamp P. Entrepreneurship and regional development. In: Nijkamp P, Capello R, editors. Handbook of regional growth and development theories. Cheltenham: Edward Elgar; 2009. p. 182–201.

Fritsch M. How does new business formation affect regional development? Introduction to the special issue. Small Bus Econ. 2008;30:1–14.

Maillat D, Perrin J, editors. Entreprises innovatrices et développement territorial. 1992. http://www.unine.ch/irer/gremi/Gremi%202.pdf. Accessed June 2011.

Perrin J. Innovation et région en développement : 3 zones de la région PACA. In: Maillat D, Perrin J, editors. Entreprises innovatrices et dévelopement territorial. 1992. p. 65–93. http://www.unine.ch/irer/gremi/Gremi%202.pdf. Accessed June 2011.

Quevit M, Bodson S. Entreprises de haute technologie et milieu de tradition industrielle: la réion de Liège. In Maillat D, Perrin J, editors. Entreprises innovatrices et développement territorial. 1992. p. 127–149. http://www.unine.ch/irer/gremi/Gremi%202.pdf. Accessed June 2011.

Schutjens V, Stam E. The evolution and nature of young firm networks: a longitudinal perspective. Small Bus Econ. 2003;21:115–34.

Uzunidis D. Innovation et proximité. Entreprises, entrepreneurs et milieux innovateurs. La revue des scences de gestion. 2010;241:13–22.

Innovative Thinking

▶ Creativity and Innovation: What Is the Difference?

Innovativeness

▶ Creativity and Innovation: What Is the Difference?
▶ Measuring Organizational Climate for Creativity and Innovation

Innovativity

► Measuring Organizational Climate for Creativity and Innovation

Innovator

Patrice Noailles
RRI – Marne-la-Vallée University, Seillans Investissement, MemoPage.com, Paris, France

Synonyms

Entrepreneur; Inventor

The term of innovator is not specified in the economic works. Since some decades, this term has appeared in political statements or journalistic papers.

The nearest concept is entrepreneur and sometimes inventor or even growth leader. Since Cantillon, in the eighteenth century, the entrepreneur has been a man who manages its own business and takes risk. In his book "Theory of economic development" (1911), Schumpeter used this word for the "capitaines d'industrie" who innovate. So he began confusion between the two concepts of entrepreneur and innovator. Today, it appears there are two distinct words for one single concept: the nearly academic word of entrepreneur conceptualized by Schumpeter and the commonly used term of innovator.

This short study will clarify the differences between entrepreneur and innovator and will specify the characteristics and the functions of an innovator.

Definitions

Innovation

To define an innovator, one needs a clear definition of innovation, and strangely, this is not so obvious.

In this entry, an innovation is the implementation of a novel technique at the macroeconomic level, a novel tool, or a new organization in the broadest meaning of those words, in order to sustainably improve the overall economic efficiency of society as a whole.

The innovation value is the "technical rent" of the new efficiency that can be assessed as a Ricardo rent.

Innovation is the implementation of a new kind of value creation.

It should be noted that innovation is a societal phenomenon and that a social choice is required to move from the old to the new technology, organization, or process. This is a complex process that we call the "fragmentary social choice." See hereafter Section "Diffusion: The Fragmentary Social Choice".

The Innovator

The innovator is not totally an inventor or a scholar or a manager. He is not neither a "capitaine d'industrie" nor even an entrepreneur. He is a part of all and assumes the central decision-making functions in the innovation process. This complex function enables the invention (or the idea) to become an innovation through four near-simultaneous operations: financing (1), setting of technical standards (2), definition of the economic model (3), and then the first sales that confirm the previous choices (4). Thereby he initiates a process of "social choice" of innovation. He works more on the market side than on technics. A single person usually performs this complex function. Sometimes several people are needed.

The innovator is usually preceded by the inventor who has almost all the ideas, but the inventor does not know how to organize them for making them suitable for the public. Seizing the opportunity, the entrepreneur gives an industrial dimension to the innovation, follows the innovator. Sometimes, one individual supports two or three functions, mainly as an innovator and entrepreneur, and then begins the confusion between the different functions. In small-scale innovations, said incremental, this innovation function persists but in

Concepts	Kind of value creation	Recipients of value
INNOVATOR	- New kind of value, with a technical rent.	- Mainly, the society as a whole and sometimes the entrepreneur.
ENTREPRENEUR, Founder of any new company including one person company (excluding innovator)	- Value move with a new vector / often, cost cutting.	- Mainly, the founder and his company.
INTRAPRENEUR Growth leader	- Value move, but greater	- The company, and often poorly, the growth leader.
SOCIAL ENTREPRENEUR (Sometimes innovator)	- No market value but a great social value.	- The society as a whole.

Innovator, Fig. 1 Value created by entrepreneur and innovator (Source: Author)

a reduced shape, as J. Schumpeter had stressed it in 1942 (Schumpeter 1942/2008).

We have to underline that innovation is a matter of global efficiency of the society. That means that innovation may include all that has an effect on overall economic efficiency, including some laws or organizations.

Innovator and Entrepreneur

Entrepreneur is a self-ruling person with an objective of "value creation," whereas an innovator is a man who creates new kind of value.

All have a common objective of "value creation." But the nature of the value (or the quality of the opportunity) and its recipients are not the same: if there is an innovation, it is a new kind of value, with a "technical rent." Otherwise, it is only a move of the value inside the society from a recipient to another, not a creation of new kind of value. This is detailed in the Fig. 1.

The Fig. 2 shows the different kinds of innovator and entrepreneur and how these concepts are close, related, and nevertheless different.

As a consequence of the partial recovery of the two concepts of innovator and entrepreneur, we will see overlap between innovation policy and entrepreneurship policy.

Innovation Value and Innovative Company

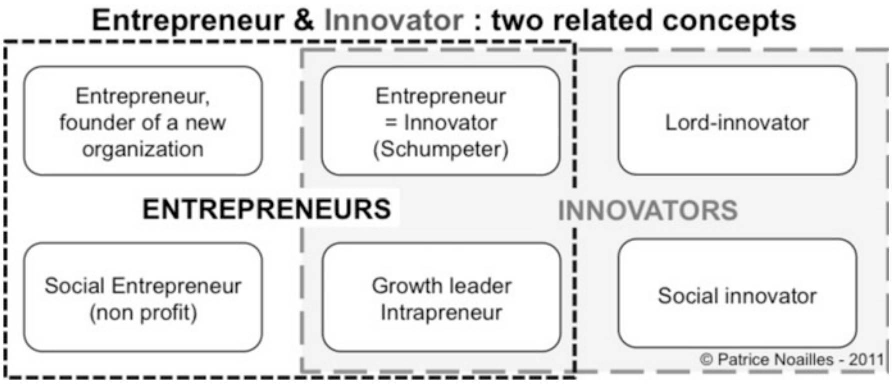
The innovation is a new kind of increase of efficiency and therefore is the source of new kind of value creation. And the value creation is the key figure of the innovation. It is the dimension of the innovation. This concept is a kind of the technical rent which is a Ricardo rent. The greatest this innovation value, the easier it will be to beat conservatism if there is any need of it.

From an economic point of view, the innovative company is the tool of the innovator to spread the innovation value among users, makers, inventors, and himself, through the price and the business model (see Fig. 3, below).

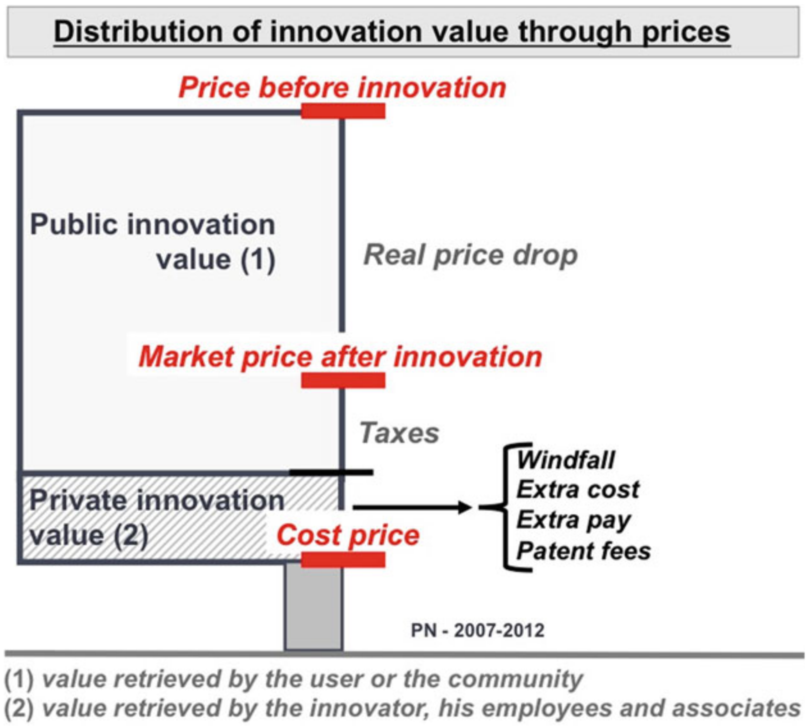
Innovator's Ecosystem

As the innovator is a living being, he has got an ecosystem for living with resources, regulation, and other people around (see Fig. 4). The capacity of innovation is therefore dependent upon environmental factors without quantity effect, except a minimum effect as for artists. But these minima are dependent upon laws, social values, or even civilization as a whole, and even unwritten social rules.

This ecosystem approach is rather new and has been developed outside classic economics by practitioners of law and venture capital. Seen in the "Rainforest" in the references section (Hwang and Horowitt 2012).



Innovator, Fig. 2 Entrepreneur and innovator (Source: Author)



Innovator, Fig. 3 Distribution of innovation value through prices (Source: Author)

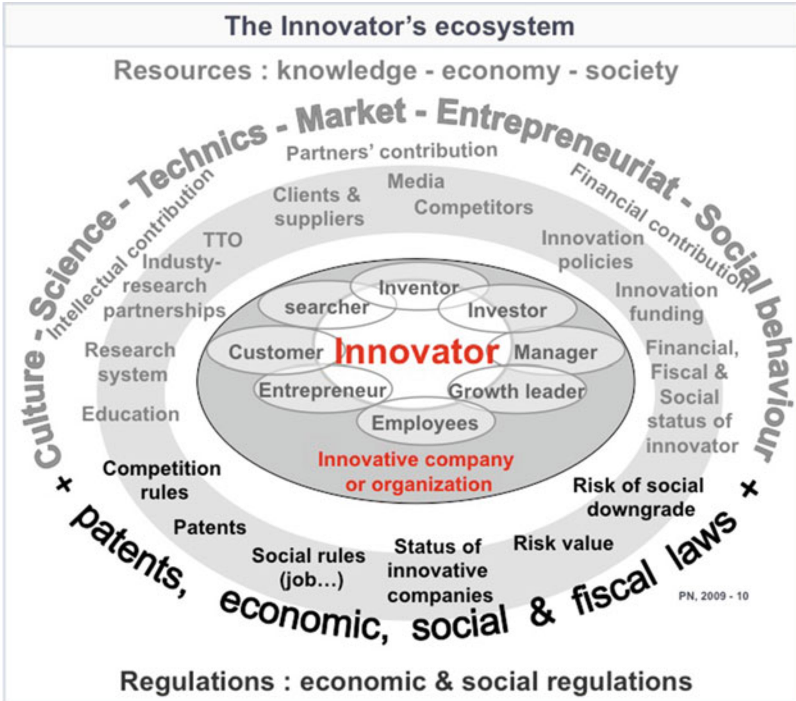
Innovators Cases

Through history, there are several examples of innovators. They may be also inventors or entrepreneurs in the same time. These examples help to understand the nature of functions and the profile of men.

Fifteenth Century: Gutenberg Created the First Innovative Company

The path of the printing invention before Gutenberg stays sketchy: some people argue that he may have got information about Chinese or even Korean tools. Nevertheless, he has to make, to finance, and to sell. History got

Innovator, Fig. 4 The innovator's ecosystem (Source: Author)



some information about the work of Gutenberg to finance and build the first printing press and complete set of movable types using metal alloy, including oil-based ink. And he did sell his product defining together the economic models of publisher and printer. At the end, he has got some big trouble with his financial partner.

He became a legend in innovation history. Please note that Gutenberg is the first innovator of the Western civilization with a name. He also is the first creator of an innovative company.

Eighteenth Century: Watt and Boulton Established the First High-Tech Venture

The story – maybe, the legend – of Watt is better known. He is not the inventor of the steam engine but (only?) an improver of the previous steam engine invented by Newcomen 60 years before (see Rolt and Allen 1997). The result was a sharp decline (75%) of coal consumption. Watt used to be an assistant at the University of Glasgow. Boulton has been the second business angel of Watt. The first one, Roebuck, went bankrupted.

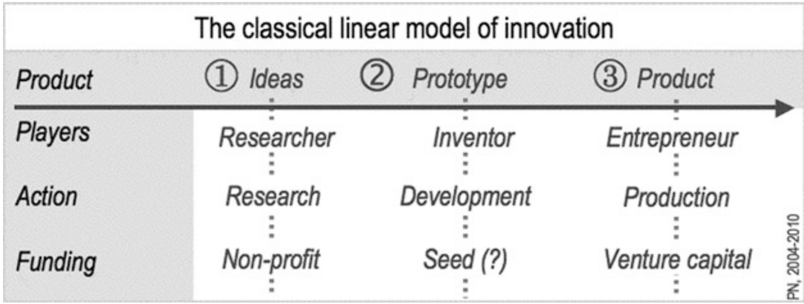
Watt has been considered as the inventor, and he was actually kind of an inventor. His partner Boulton was the main innovator. He brings the money, imagined the business model, and sold the steam machines. Nobody knows Boulton, as it is often the case for the main innovator. And nobody knows Newcomen who is the main inventor as it is also often the case for the main inventor.

Nevertheless Watt took part to the innovation by improving the technical standard of Newcomen. And for this reason, he is also an innovator.

The business model was very modern: the machines were rented (not sold), and at the beginning, the rent was half of the money saved by the leaseholder, by comparison with the Newcomen machine. Roughly, the lease ranged around 1–1.5 times the cost of the coal used by the Watt machine.

Nineteenth Century: Thomas Watson, Graham Bell, and Theodore Vail

Graham Bell is probably one of the most inventive people in the history. But few people know that he needed two more persons to reach success: an assistant (Watson) for inventing and a CEO (Vail)



Innovator, Fig. 5 The classical linear model of innovation (Source: Author)

to manage the business! Together, these three people assumed the innovator function in the Bell Company.

Twentieth Century: The Box of Malcolm Mac Lean (the "Container") Might Be the Biggest Innovation of History with Lowest Scientific Content

Malcolm Mac Lean is both a major innovator and totally unknown. He imagined the container while he was the president, owner, and driver of a "one truck" trucking company, but he developed it several years later when he became the president and owner of a shipping company. As it is explained by Levinson (2006), the Box allowed cutting cost of 90%! It is the main tool of the international trade. Without the Box, the economic development of the world would not be the same. He was an inventor, an innovator, an entrepreneur, and a "capitaine d'industrie." Although the technical side of the innovation was quite simple, the innovation was still complex due to social, legal, and business context. Perhaps the innovator function is often so complex that it requires two or three people to assume it.

Twentieth Century: Steve Wozniak and Steve Jobs

The design and the making of the first microcomputer are well known today. It required two people at least to manage this conception. One must note that neither Job nor Wozniak was CEO of the Apple Company at the beginning. There are pure innovators, but one is on the technical side and the other one on the marketing side. And there is a third one, the CEO on the management side (Gallo 2010; Isaacson 2011).

Theoretical Analysis

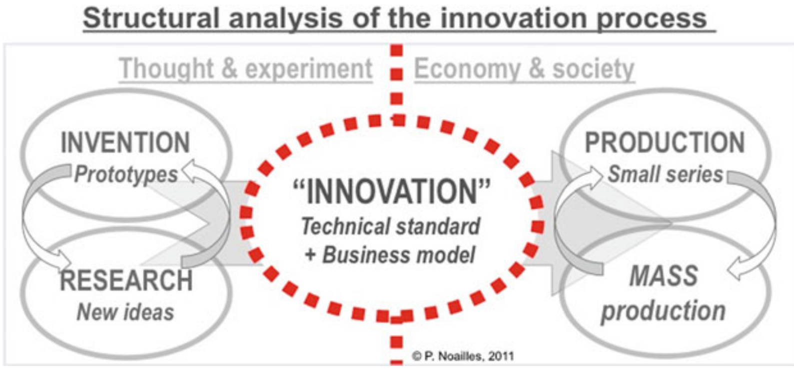
Few more details on the innovation process are needed to understand it and to specify the role of innovator.

The Process of Innovation and the Functions of Innovator

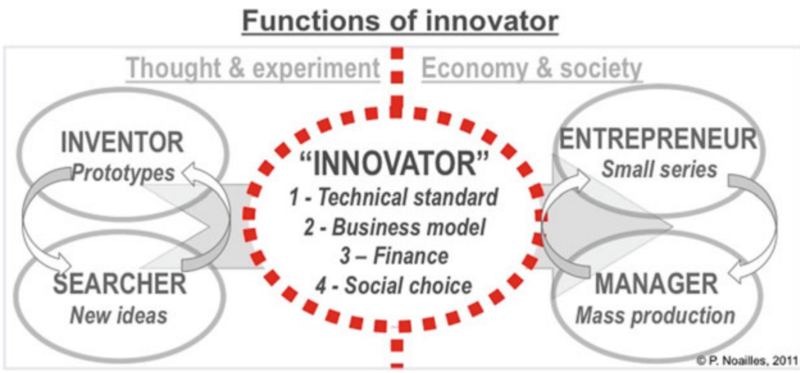
In 1911, J. Schumpeter described the innovation process for the first time. Almost always, people only memorizes a simplified diagram which can be summarized in a linear and seemingly rationale way (Fig. 5). In 1945, Vannevar Bush (inventor and director of the Office of Scientific Research and Development of President Roosevelt) has popularized this model in his report "Science, the endless frontier."

A more detailed analysis shows that there is no linear process but two kinds of complex, random, or unpredictable processes before and after the innovation, and a very complex "step" operation in the middle, named "innovation" which consists in finding in the same time the right technical standard and the good business model and then to finance and to begin to sell successfully (Fig. 6).

The history of technics often shows us that only one man holds this innovation function. We call him "Innovator" (see Fig. 7). The Innovator is the head of the innovation process: he is (or they are) the man (men) that organizes and finances the first definition of the technical standard and of the business model. Then he shows the quality of his choices by the first significant sales, thus initiating the process of fragmentary (or progressive) social choice that will transform the product "invented" into a product widely used (diffusion).



Innovator, Fig. 6 Structural (functional) analysis of innovation process (Source: Author)



Innovator, Fig. 7 The functions and the men (Source: Author)

He is not the inventor who creates and designs the object. He comes at the end of the chain of inventions. He is the man who makes the final choices, or more properly the techno-economic "arbitration" for matching the product to market. He is the man who turns ideas and prototypes into a concrete project suitable to the market and accepted by society. He is followed by the entrepreneur who expands the industrial scale of innovation. Sometimes, he is also a technician, an inventor, a marketing man, a social inventor, or an entrepreneur.

The core of innovation process with *"finance + technical standard + business model + marketing"* is a solution to a complex question. This solution is generally based on the combination of a wide range of knowledge and an extraordinary choice due to a nonrational analysis (e.g., inspired by a vision of the future). It was the case for microcomputer, later PC. The idea of IBM and other companies was a professional tool, whereas the idea of Steve Jobs, Bill Gates, and others was a home computer. The latter imagined and designed a home computer, whereas IBM designed a PC for offices. The market was the home computer concept with possibilities of professional uses. Or in other word a professional computer designed as a home computer. And more important, the business model was standard software and not specific software developments (Gundling 2000; Hargadon 2003; Wessner 2005; Christensen 2011; Goldberg et al. 2011; Cooter and Shäfer 2012).

Diffusion: The Fragmentary Social Choice

If we stay at a level of storytelling, the keywords for diffusion are the percentage of users, with a description: innovators, early adopters, early majority, late majority, laggards (Rogers 1962–2003).

If we want to go through process analysis, we may need a new concept, that is, the fragmentary social choice. This is mainly a market process.

This is a new concept and a significant part of the innovator's work. The innovator begins this process by completing the first substantial sales.

But this is just the beginning. The social choice is not over. New consumers should confirm it. During this period, the innovation (technics and economics) may be improved and sometimes significantly.

Usually, this fragmentary social choice lasts from 10 to 30 years. Among the shortest cases, there are mobile phone and compact disk, which need only few years to get a choice and 10 years to reach a high rate of diffusion over 80%. Among the longest, there is mobile steam engine for railways, which needed several decades from 1795 up to 1830 only to find the correct technical standard. The key problems are economics and technic. But as a whole, the apparent cost paid by the end user is often the main cause for delay. The real keys are the business model plus social behavior and habits.

Patent and imitation were the traditional technical keywords of the diffusion. Even if there are not the real main ones, it must be recalled that patent (invented in Venice in years 1570, to boost an imitator of Gutenberg) is often supposed to help innovators. The questions remain the existence and the length of patent. The only solid argument is history: during the last three centuries, only countries with a solid patent system were innovative.

Men and Functions, Typology of Innovators

The innovator function is different from the man (men) who assumes it. The innovator may be an entrepreneur or an inventor but also a senior corporate executive or a political leader. This typology is the first step in the way to linking man and function.

From Gods to Human People

Six thousand years ago, the ancient civilizations had imagined the "gods of innovation": the Mesopotamian Apkalus under the leadership of Enki must be seen as the distant base common to all Western technological civilizations. Closer to us, 2,000 years ago, and still more unknown, Lug dominates the Celtic pantheon, but he is on the losing side against the Romans. And that is why he has no descent. The Egyptian god Thoth and the Greek god Prometheus have a moderate significance, very far from the influence of Enki and Lug.

Now, let us go down from this pantheon toward the daily reality of innovation. Through economics and history, there are four main types of innovators. This is only a typology with overlaps between functions.

The Innovator–Entrepreneur (Sometimes Inventor)

It is the "mythical" innovator often discussed in economic literature devoted to entrepreneurship. This innovator has been characterized and named by Joseph Schumpeter as an entrepreneur. Sometimes, he is also inventor as was the case for T. Edison or even Louis Blériot. The greatest examples are Steve Jobs, Bill Gates, Thomas Edison, Henry Ford-I, Armand Peugeot, or Louis Renault.

The Lord Innovator (Who is also Often an Entrepreneur)

(Baumol et al. 2010) first used this word for history of enterprise. It refers to these gentlemen who have assumed the role of innovator during the Middle Ages and before. During the nineteenth century, there were many "lords" (rich people) who were committed to innovation from railway to water treatment. Often, they developed some key elements in the economic model as Rothschild and Pereire for French railways (Chemins de Fer du Nord et PLM, now SNCF) or Henri Siméon for the business model of water treatment in France (Compagnie Générale des Eaux, now Veolia, world leader of water treatment).

The "Intrapreneur," Growth Leader or Catalyst

The "intrapreneur" is an employee who develops new ways of working and new products as part of an existing business. He has to deal with hierarchy as well as with the market. In this field, there is no consensus on a well-defined denomination. Finally, one would add all the small players named "Kaizen." They all work on incremental innovations more than on breakthrough innovations. They are the main stakeholders of the "innovation machine" of Baumol (2002).

The Politician

The social choice is sometimes directly made by politicians, especially for the legislative innovations and for the national programs of "modernization." In these cases, the innovator will naturally be a politician. General de Gaulle in France was an archetype of this approach by launching innovative programs but focusing more on research than on innovation. His successor, Georges Pompidou, launched major innovative industrial programs (Ariane, Airbus, civil nuclear power, TGV) which are still the grounds of the industrial power in France 40 years later. Mustafa Kemal in Turkey and John Kennedy in the USA are other icons of this type of approach.

As a conclusion of this portrait gallery, we may add the copycats (Shenkar 2011), followers, and imitators who greatly help modernization, development, and even diffusion. But, of course, they are not truly innovator!

Perspectives on Economics and Sociology

The innovator is someone who not only changes economics, that is, the coefficients of the exchange board of Leontief, but even the rules of the world by finding and developing new products. This is obvious for Edison, Bell, Watt, et al. This is still almost true for small innovators (Kaïzen) who also contribute to change the economic efficiency of the world. This fact offers two prospects for development:

1. Nowadays, economics is based solely on a mathematical rationality that is expressed and summed up by the systematic search for quantitative relationships such as "cause and effect." The mathematic model is the archetype of this "school."

   The "innovator" approach proposes to fulfill the current void in innovation by introducing an element of "chance" in a world of "necessity." It deals with the everlasting question of "change" outside the rules. This question is reminiscent of the biology for the genetic mutations. Basically, it proposes that the innovator is the agent for change. He characterizes his action but does not specify causal relations.
2. The Innovator function initiates and conducts the changes of the society. This function of "innovator" seems to be the same type as that of a farmer, a warrior, or a priest detailed by Dumezil. In fact, their function is to modify the human condition.

Conclusions and Future Directions

This structuralist approach of the innovator function places the innovator at the center of the innovation process that is the Gordian knot of wealth creation. In other words, this put again the man at the center of economics, even if short-term regulation remains a mathematical science.

This approach opens three major debates on the deepening of new concepts, on innovation policies, and on rationalism and humanism.

Deepening New Concepts

All the concepts around the innovator are already known from a managerial point of view. The correlation table is rather quick to set up: the ecosystem is the environment, innovative company is often start-up company, social choice is market penetration, and breakdown of created value is business plan. But they are not the same and they have to be deepened from an economic point of view to become new economic concepts. This maybe the roadmap of innovator and innovation economic studies for the next years.

The Debates on Innovator Policy Versus Innovation Policy

This may be the most important consequence of the birth of a solid innovator concept: a new base for innovation policy.

After a long dispute over the past 20 years, it is now accepted by main *international organizations* that the key factor of development is innovation. The question remains how?

From many reports and studies on the path to success in fostering innovation and from our own experience, we can say that the following rules may avoid you the bitterest failures, but they cannot warrant any success.

Do Only Politics to Avoid the "Broken Dreams" of Traditional Innovation Policies

Through examples, Josh Lerner (2009) showed two points: in each leader regions in entrepreneurship and innovation, such as Silicon Valley, the public sector has played a significant role. However, merely every direct state intervention in the world went to failure!

This point seems to become the first part of the consensus of the policy makers around the world: be politic and not operator. Do not try to manage everything by yourselves. Stay on politics. Do influence your local leaders and establishment but do not try to manage the economy – except with public purchasing policy.

Entrepreneurship Policy is a (Major but not Unique) Part of Innovation Policy

The second part of consensus seems to be that the entrepreneurship policy is a major part of any innovation policy, meaning that innovator–entrepreneur is often the best way to transfer technology from lab to economy. Often, innovator policy is only entrepreneurship policy.

However, innovation policies have to include national innovation strategy with major projects such as the space program or the human genome program.

Take Care of innovator's Ecosystem Instead of Innovation Ecosystem

Following the innovation system during the 1990s, the current favored topic among policy makers seems to be the innovation ecosystem as a result of a systemic analysis. The word sounds well the green vocabulary but seems to be inappropriate, as the innovation is not a living animal. The right concept could be innovator ecosystem including technical, fiscal, financial rules but also social rules, including non-written rules, which may be the most important. Remember that all US states have merely the same laws, but only two small regions (Boston and Silicon valley) feature a high rate of innovation.

Tech Transfer (TT) through Start-up as a Key of Innovation Policies

At the end, the TT, by transferring ideas from laboratories to economy, is the key of the innovation capacity. But the shortest way from laboratories to the economy is not what could often be thought: from laboratories toward existing companies through tech transfer offices. On the contrary, in most cases, the shortest way is to transfer to start-up companies through people and mainly innovators.

Take Care of Local Scientific Base

On the long run, you will need a scientific base for innovation. And this scientific base needs a good education, a large university, and some large laboratories. This is the soil where innovations will grow.

Be Ambitious, Realistic

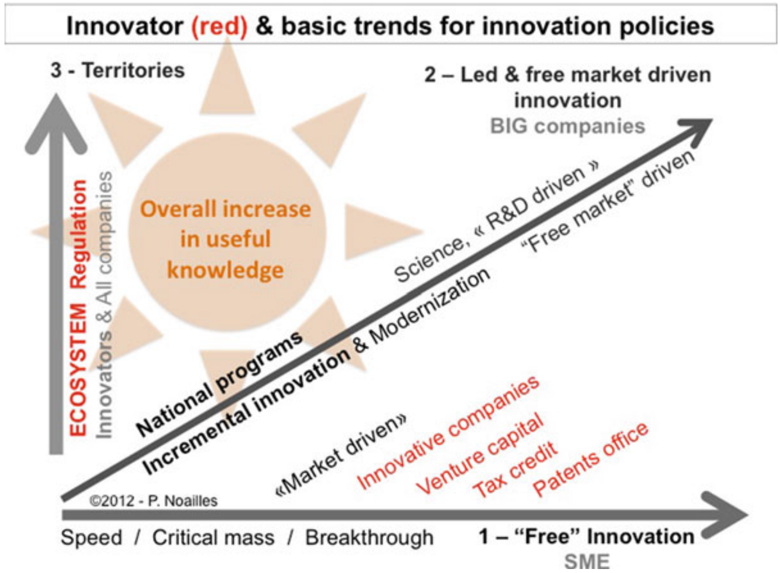
Remember that innovation is global, complex, and diverse. Innovation policies may have several levels and shapes as shown in Fig. 8.

Rationalism and Humanism

In economics, the innovator is at the center of the dispute between rationalism and humanism. Since Adam Smith, economics is mainly a matter of market (offer and demand) and organizations. On the other side, the Marxist approach ignores the market and sees only structures. Even modern statistical approach focuses on markets and sectors. The best symbol of the rationalist approach of the modern economics is the input–output matrix of Leontief. Unfortunately, this does not explain all the economic activity but only its short-term rational side due to the organization of production. On the other side (nonrationalist), we find more people than structures: this is the human side (and humanistic) of the economy. And the innovator belongs to this nonrational side.

Economics has ignored innovation for two centuries. Technology was an external factor. Until now, 50% of the growth is unexplained by

Innovator, Fig. 8 Innovation versus innovator policies (Source: Author)



rational economics. By now, scholars try to explain 50% of growth with endogenous growth based on the knowledge economy. This knowledge economy totally relies on the combination of tech transfer and the marketing capacities of people. And the idea is to find innovation factors or the best structure to increase tech transfer and marketing. Unfortunately, history shows that there is no direct or rational relationship between laboratory capacities and innovation capacities. For example, research and innovation were not linked for IBM and the home computer, for USSR globally, for the "box" which was developed without any research at all. On the rational side of economics, you only would have to put people in structures and laws to generate innovation. The main objective of this academic science is to identify innovation factors. But they do not exist.

As sociology has to take into account psychology (Moscovici 1980–1991), the "other" side of economics tries to take into account some nonrational people like innovator to overpower the complexity of the modern economy. For instance, we underline that main laws and rules are the same all over the USA and that two small territories are leaders in innovation: Silicon Valley and Road 128. Innovation relies on innovators, not only on written laws. That is why you need an ecosystem approach and not only a regulation approach. Hwang and Horowitt (2012) use the term of "rainforest" for this ecosystem. Coming back to the question of tech transfer, we have to understand that it is mainly dependent on the innovator who is nearly the obligatory go-between from knowledge to the economy. The idea of innovator policies is to find and position the right people in the right ecosystem or even to foster the right people by establishing a right ecosystem.

However, we have also to consider that at the end, conclusions of both sides may join on some decisions like education, tech transfer organizations, fiscal status. Instead of being a question of fight, the innovator could open the door between the two economics: rational and nonrational, structured and humanistic. The combination of both sides is politics. But this is still another great disputation.

Cross-References

▶ Business Model
▶ Corporate Entrepreneurship
▶ Entrepreneur
▶ Entrepreneur's "Resource Potential," Innovation and Networks

► Entrepreneurship in Creative Economy
► Entrepreneurship Policy
► Informal Venture Capital

References

Baumol W. The free market innovation machine. Princeton: Princeton University Press; 2002. ISBN 0691096155.
Baumol W, Landes DS, Mokyr J. The invention of enterprise, entrepreneurship from ancient Mesopotamia to modern times. Princeton: Princeton University Press; 2010. The Kauffman Foundation. ISBN 0691143706.
Bush V. Science, the endless frontier – a report to President, 1945, download on http://www.nsf.gov/about/history/vbush1945.htm.
Christensen C. The innovator's dilemma, Harper paperbacks. Reprint edition, 2011. ISBN-10: 0062060244.
Cooter RD, Shäfer H-B. Solomon's knot, How law can end the poverty of nations. Princeton: Princeton University Press; 2012. ISBN 978-0-691-14792-5.
Etzkowitz H. The triple Helix. New York: Routledge; 2008. ISBN 0-415-96450-4.
Gallo C. The innovation secrets of Steve jobs: insanely different principles for breakthrough success. New York: McGraw-Hill; 2010. ISBN 007174875X.
Goldberg I, Goddard JG, Kuriakose S, Racine J-L. Igniting innovation – Rethinking the role of government in emerging Europe and Central Asia. Washington, DC: The International Bank for Reconstruction and Development/The World Bank; 2011. ISBN 978-0-8213-8741-2.
Gundling E. The 3M way to innovation, balancing people and profit. Tokyo: Kodansha International; 2000. ISBN 4770024762.
Hargadon A. How breakthroughs happen. Boston: Harvard Business School Press; 2003. ISBN 978-1-57851-904-0.
Hwang VW, Horowitt G. The rainforest, the secret to building next Silicon Valley. Los Altos: Regenwald; 2012.
Isaacson W. Steve jobs. New York: Simon & Schuster; 2011. ISBN 1451648537.
Leavitt HJ. Top down, why hierarchies are here to stay and how to manage them more effectively. Boston: Havard Business School Press; 2005. ISBN 1591394988.
Lerner J. Boulevard of broken dreams: why public efforts to boost entrepreneurship and venture capital have failed – and what to do about it. Princeton: Princeton University Press; 2009. ISBN 978-0-69114219-7.
Levinson M. The box: how the shipping container made the world smaller and the world economy bigger. Princeton: Princeton University Press; 2006. ISBN 0691136408.
Moscovici S. The invention of society: psychological explanations for social phenomena. Cambridge: Polity Press; 1991. ISBN 0745618391.
Porter M. Competitive advantage: creating and sustaining superior performance. New York: Free Press; 1998. ISBN 0684841460.
Rogers EM. Diffusion of innovations. 5th ed. New York: Free Press; 1962–2003. ISBN 0743222091.
Rolt LTC, Allen JS. The steam engine of Thomas Newcomen. Ashbourne: Landmark Publishing; 1997. ISBN 0903485427.
Schumpeter J. Capitalism, socialism and democracy. New York: Harper Perennial Modern Classics; 1942/2008. ISBN 0061561614.
Schumpeter J. The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle. Transaction Publishers; 1911/1982. Piscataway; New Jersey. ISBN-10: 0878556982
Shenkar O. Copycats: how smart companies use imitation to gain a strategic edge. Boston: Harvard Business Review Press; 2011. ISBN 1422126730.
Wessner C. Local heroes in the global village: globalization and new entrepreneurship policies. With Audretsch DB et Grimm H. New York: Springer; 2005. ISBN 0387234632.
Wessner C, editor. Understanding research, science and technology parks: global best practice: report of a symposium, with committee on comparative innovation policy: best practice for the 21st century; National Research Council; 2009. ISBN: 0-309-13010-7.

Innovator, Competencies

► Knowledge Capital and Small Businesses

Insolvency

► Firm Failure and Exit

Instinct

► Effects of Intuition, Positive Affect, and Training on Creative Problem Solving

Institution – Establishment

► Institutional Entrepreneurship, Innovation Systems, and Innovation Policy

Institutional Coercion

► Planned Economy and Entrepreneurial Function

Institutional Entrepreneurship

Raghu Garud[1], Cynthia Hardy[2] and
Steve Maguire[3]
[1]Department of Management and Organization, The Pennsylvania State University, State College, PA, USA
[2]Department of Management & Marketing, University of Melbourne, Parkville, VIC, Australia
[3]Desautels Faculty of Management, McGill University, Montreal, Canada

Synonyms

Embedded agency; Paradox of agency

Introduction

The term "institutional entrepreneurship" refers to the "activities of actors who have an interest in particular institutional arrangements and who leverage resources to create new institutions or to transform existing ones" (Maguire et al. 2004, p. 657). The term is most closely associated with DiMaggio (1988, p. 14), who argued that "new institutions arise when organized actors with sufficient resources see in them an opportunity to realize interests that they value highly." These actors – institutional entrepreneurs – "create a whole new system of meaning that ties the functioning of disparate sets of institutions together" (Garud et al. 2002). Institutional entrepreneurship is therefore a concept that reintroduces agency, interests, and power into institutional analyses of organizations. It thus offers promise to researchers seeking to bridge what have come to be called the "old" and "new" institutionalisms in organizational analysis (Greenwood and Hinings 1996).

The entry begins with some observations on institutional entrepreneurship stemming from its paradoxical nature. Research on institutions has tended to emphasize how organizational processes are shaped by institutional forces that reinforce continuity and reward conformity. In contrast, the literature on entrepreneurship tends to emphasize how organizational processes and institutions themselves are shaped by creative entrepreneurial forces that bring about change. The juxtaposition of these contradictory forces into a single concept generates a promising tension – one that opens up avenues for inquiry into how processes associated with continuity and change unfold, and, how such unfolding processes can be influenced strategically. Accordingly, the entry first discusses the two core concepts underpinning the focus of this special issue, institutions and entrepreneurship, paying particular attention to how they emphasize aspects of social life that are seemingly at odds with one another. It then shows how the apparent contradictions that arise when these concepts are combined into "institutional entrepreneurship" relate to the paradox of embedded agency.

Institutions

Institutions are commonly defined as "rules, norms, and beliefs that describe reality for the organization, explaining what is and is not, what can be acted upon and what cannot" (Hoffman 1999, p. 351). As taken for granted, culturally

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embedded understandings, they specify and justify social arrangements and behaviors, both formal and informal. Institutions can thus be usefully viewed as performance scripts that provide "stable designs for chronically repeated activity sequences," deviations from which are counteracted by sanctions or are costly in some manner (Jepperson 1991, p. 145).

Organizations exist in an environment of institutions that exert some degree of pressure on them; institutional environments are "characterized by the elaboration of rules and requirements to which individual organizations must conform if they are to receive support and legitimacy" (Scott 1995, p. 132). Institutions constrain behavior as a result of processes associated with three institutional pillars: the regulative, which guides action through coercion and threat of formal sanction; the normative, which guides action through norms of acceptability, morality, and ethics; and the cognitive, which guides action through the very categories and frames by which actors know and interpret their world (Scott 1995).

Institutional arrangements are fundamental to understanding organization because of the ways in which they tend to be reproduced without much reflection in practice, become taken for granted, and create path dependencies. As a result, organizational scholars, whether adopting economic, sociological, or cognitive perspectives, have traditionally focused on the critical role that institutions play in providing continuity and stability in organizational processes.

Among institutional economists, for instance, the appearance and maintenance of institutional arrangements are explained in terms of economizing on transaction costs (Coase 1937; Williamson 1985). According to this perspective, institutional arrangements function to reduce uncertainty and to mitigate opportunistic behavior such that transaction costs associated with negotiating, monitoring, and enforcing contracts between boundedly rational actors are reduced. Institutional arrangements, in turn, tend to reproduce – rather than change – existing social arrangements.

Sociological perspectives on institutional theory emphasize how institutional arrangements confer legitimacy, which is "a generalized perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman 1995, p. 574). As a result, some actions within a particular institutional field come to be seen as legitimate (Meyer and Rowan 1977) and may even be "prescribed," making it difficult for actors to deviate from them.

Literature on cognitive processes views actors as interpreters of ambiguous symbols and constructors of meaning. Thus, mutually understood schemas, mental models, frames, and rules of typification channel the sense-making activities of individuals, who are caught in webs of significance of their own making. Actors engage in organizing as a "consensually validated grammar for reducing equivocality by means of sensible interlocked behaviors," thereby translating "ongoing interdependent actions into sensible sequences that generate sensible outcomes" (Weick 1979, p. 3). With this view, institutions – shared cognitive frames – give meaning to inherently equivocal informational inputs by directing sense-making processes. Moreover, the shared nature of these cognitive frames makes it difficult to stray far from them in either thought or deed.

In sum, the institutional literature, whether it focuses on economics, sociology, or cognition, has largely focused on explaining the stability and persistence of institutions as well as isomorphic change in fields. More recently, however, there has been interest in how non-isomorphic change can be explained using an institutional lens, as well as what is nature of the "institutional work" needed to create, maintain, transform, or disrupt institutions (Lawrence and Suddaby 2006; Hardy and Maguire 2007). Associated with this has also been a emphasis on processes of contestation and struggle within and over institutional fields (Garud and Rappa 1994; Maguire and Hardy 2006), which are viewed as political arenas in which power relations are maintained or transformed (Lounsbury and Ventresca 2003).

Entrepreneurship

To understand the critical role that entrepreneurship plays in the functioning of the modern economy, one only needs to refer to insights offered by Schumpeter (1942). For Schumpeter, entrepreneurship is an engine of economic growth with the introduction of new technologies and the consequent potential for obsolescence serving to discipline firms in their struggle to survive perennial gales of creative destruction. The disruptions generated by creative destruction are exploited by individuals who are alert enough to exploit the opportunities that arise (Shane and Venkataraman 2000).

From a sociological perspective, change associated with entrepreneurship implies deviations from some norm (Garud and Karnøe 2001). Consequently, it is unlikely that entrepreneurial outcomes and processes will be readily embraced by actors committed to existing ways of doing things in a particular field. To be successful, then, entrepreneurial efforts have to gain legitimacy, an undertaking that is made more difficult as more social groups with heterogeneous interests are involved. Indeed, as novel outcomes from entrepreneurial efforts spread, more diverse social groups will be affected and possibly mobilized, and, in the process, new legitimacy battles will be spawned.

Lachmann's work (e.g., 1986) highlights the active creation rather than the mere discovery of entrepreneurial opportunities, and it is here that literature from cognitive psychology sheds light. Cognitive psychology notes that the genesis of novelty is frequently driven by "bisociation," the intermingling of seemingly unrelated ideas from different knowledge domains (Koestler 1964), and is facilitated by metaphors and analogies (Tsoukas 1991). Indeed, just as new technological artifacts may emerge from recombination of material resources, new insights may also emerge from recombination of intellectual resources, a process in which outcomes are indeterminate. As products of recombination, new ideas have to overcome problems of legitimacy that arise when categories are crossed.

Common to all these perspectives on entrepreneurship is an appreciation that the emergence of novelty is not an easy or predictable process as it is ripe with politics and ongoing negotiation. What may appear to be new and valuable to one social group may seem threatening to another. Thus, as with institutional theory, the literature on entrepreneurship has also had to come to grips with issues of agency, interests, and power, but it has approached these from the perspective of change rather than continuity.

Work on institutions has, then, traditionally focused on continuity although it increasingly acknowledges the importance of change. In contrast, the work on entrepreneurship has focused on change even as it acknowledges that change is difficult to accomplish. The juxtaposing of institutional and entrepreneurial forces into a single concept, institutional entrepreneurship, thus offers considerable promise for understanding how and why certain novel organizing solutions – new practices or new organizational forms, for example – come into existence and become well established over time.

Separately, each body of literature faces the limitations associated with the longstanding "structure-agency" debate. Privileging structure over agency leads to causally deterministic models wherein some features of the social world become reified and "structure" others, voiding agency and creativity from humans, which in the extreme are assumed to be automaton-like processors of objective information rather than interpreters of intrinsically ambiguous symbolic inputs. In assuming that structures frustrate and, in the extreme, render agency by individual actors impossible, this work explains stasis and continuity; but it is less equipped to deal with change. Theories that privilege agency, on the other hand, often promote heroic models of actors and have been criticized for being ahistorical, decontextualized, and universalistic. Moreover, by emphasizing intentionality, such theories give little attention to unintended consequences of action, which are important components of the reproduction of institutions.

Conclusions and Future Directions

Researchers from a wide range of disciplines have attempted to address these issues by offering theoretical perspectives that combine structure and agency in some form of mutuality constitutive duality. Giddens's (1984) work on "structuration" and Bourdieu's (1977) notion of "habitus" are, perhaps, the most well known (Mutch 2007). According to these researchers, structure is both the medium and outcome of social practices: Instead of being in opposition, structure and agency presuppose each other and are mutually constitutive.

Within institutional theory, this broader structure-agency debate is often referred to the paradox of embedded agency (Seo and Creed 2002). The theoretical puzzle is as follows: If actors are embedded in an institutional field and subject to regulative, normative, and cognitive processes that structure their cognitions, define their interests, and produce their identities, how are they able to envision new practices and then subsequently get others to adopt them? Dominant actors in a given field may have the power to force change but often lack the motivation, while peripheral players may have the incentive to create and champion new practices, but often lack the power to change institutions (Maguire 2007).

One answer to this puzzle lies in conceptualizing agency as being distributed within the structures that actors themselves have created (Garud and Karnøe 2003). Consequently, embedding structures do not simply generate constraints on agency but, instead, provide a platform for the unfolding of entrepreneurial activities. According to this view, actors are knowledgeable agents with a capacity to reflect and act in ways other than those prescribed by taken-for-granted social rules and technological artifacts (Garud and Karnøe 2003). Agency is "the temporally constructed engagement by actors of different structural environments – the temporal-relational contexts of action – which, through the interplay of habit, imagination, and judgment, both reproduces and transforms those structures in interactive response to the problems posed by changing historical situations" (Emirbayer and Mische 1998, p. 970). Conceptualized in this way, institutional structures do not necessarily constrain agency but, instead, may also serve as the fabric to be used for the unfolding of entrepreneurial activities.

Institutional entrepreneurship not only involves the "capacity to imagine alternative possibilities," it also requires the ability "to contextualize past habits and future projects within the contingencies of the moment" if existing institutions are to be transformed (Emirbayer and Mische 1998, p. 963). To qualify as institutional entrepreneurs, individuals must break with existing rules and practices associated with the dominant institutional logic(s) *and* institutionalize the alternative rules, practices, or logics they are championing (Garud and Karnøe 2001; Battilana 2006). Thus, strategies must be developed to embed change in fields populated by diverse organizations, many of whom are invested in, committed to, and advantaged by existing structural arrangements. It is not surprising, therefore, that institutional entrepreneurship is viewed as an intensely political process (Garud et al. 2002).

Efforts at theorizing struggles over institutional arrangements have generated interest in the linguistic and symbolic aspects of power where the focus is on the meanings that humans attribute to a situation which, in turn, influences how they act in relation to it. Lukes (1974) focused on the power of meaning when he introduced his notion of a third dimension of power (Levy and Scully 2007), an unobtrusive form of power to create particular meanings for desired outcomes (Hardy 1985). In the context of institutional theory, the relationship between power and meaning has been addressed through the concept of "translation" (Zilber 2006), which is premised on the idea that the meaning of practices is negotiated locally (Lounsbury and Crumley 2007), with practices becoming institutionalized as meanings become shared and taken for granted across the wider field (Zilber 2007). This work challenges the idea that new practices are transmitted intact and unproblematically and, instead, emphasizes negotiations "between various parties, and the reshaping of what is finally being transmitted" (Zilber 2006, p. 283).

Efforts at shaping institutions will not go uncontested, and, therefore, these attempts can easily go awry (Garud et al. 2001). Consequently, institutional entrepreneurs must be skilled actors (Perkmann and Spicer 2007) who can draw on existing cultural and linguistic materials to narrate and theorize change in ways that give other social groups reasons to cooperate (Child et al. 2007). To this end, institutional entrepreneurs use "framing" strategically (Khan et al. 2007), articulating their change projects in particular ways to "define the grievances and interests of aggrieved constituencies, diagnose causes, assign blame, provide solutions, and enable collective attribution processes to operate" (Snow and Benford 1992, p.150). Through particular frames, new practices can be justified as indispensable, valid, and appropriate. This, in turn, can help mobilize wide-ranging coalitions of diverse groups and to generate the collective action necessary to secure support for and acceptance of institutional change (Wijen and Ansari 2007).

In conclusion, research on institutional entrepreneurship remains popular, particularly because of the paradox of embedded agency, and a range of different approaches are being employed to learn more about these dynamics (see Hardy and Maguire 2008; Battilana et al. 2009; Garud et al. 2010). Future research will, however, need to tread a fine line between putting agency back into institutional analyses of organizations and unreflexively privileging heroic "entrepreneurs" (Hardy and Maguire 2008; Garud et al. 2010).

Cross-References

▶ Entrepreneurial Opportunity
▶ Extrapreneurship
▶ Network and Entrepreneurship
▶ Social Entrepreneurship

References

Battilana JA. Agency and institutions: the enabling role of individual's social position. Organization. 2006;13(5): 653–76.

Battilana J, Leca B, Boxenbaum E. How actors change institutions: towards a theory of institutional entrepreneurship. Acad Manage Ann. 2009;3(1):65–107.

Bourdieu P. Outline of a theory of practice. Cambridge: Cambridge University Press; 1977.

Coase R. The nature of the firm. Economica. 1937;4(16): 386–405.

Child J, Lu Y, Hung S. Terence Tsai institutional entrepreneurship in building an environmental protection system for the People's Republic of China. Organ Stud. 2007;28(07):1013–34.

DiMaggio P. Interest and agency in institutional theory. In: Zucker L, editor. Institutional patterns and culture. Cambridge, MA: Ballinger; 1988. p. 3–22.

Emirbayer M, Mische A. What is agency? Am J Sociol. 1998;103:962–1023.

Garud R, Jain S, Kumaraswamy A. Institutional entrepreneurship in the sponsorship of common technological standards: the case of Sun Microsystems and Java. Acad Manage J. 2002;45:196–214.

Garud R, Karnøe P. Path creation as a process of mindful deviation. In: Garud R, Karnøe P, editors. Path dependence and creation. London: Lawrence Earlbaum; 2001. p. 1–38.

Garud R, Karnøe P. Bricolage vs. Breakthrough: distributed and embedded agency in technology entrepreneurship. Res Policy. 2003;32:277–300.

Garud R, Kumaraswamy A, Karnoe P. Path dependence or path creation? J Manage Stud. 2010;47(4):760–74.

Garud R, Rappa M. A socio-cognitive model of technology evolution. Organ Sci. 1994;5:344–62.

Giddens A. The constitution of society. Berkeley: California University Press; 1984.

Greenwood R, Hinings GR. Understanding radical organizational change: bringing together the old and the new institutionalism. Acad Manage Rev. 1996;21:1022–54.

Hardy C. The nature of unobtrusive power. J Manag Stud. 1985;22(4):384–99.

Hardy C, Maguire S. Institutional entrepreneurship. In: Greenwood R, Oliver C, Suddaby R, Sahlin-Andersen K, editors. Handbook of organizational institutionalism. London, UK: Sage; 2008. p. 198–217.

Hoffman AJ. Institutional evolution and change: environmentalism and the US chemical industry. Acad Manage J. 1999;42:351–71.

Jepperson RL. Institutions, institutional effects and institutionalism. In: Powell WW, DiMaggio PJ, editors. The new institutionalism in organizational analysis. Chicago: The University of Chicago Press; 1991. p. 143–63.

Khan F, Munir K, Willmott H. A dark side of institutional entrepreneurship: soccer balls, child labor and

postcolonial impoverishment. Organ Stud. 2007;28(7):1055–77.
Koestler A. The act of creation: a study of conscious and unconscious processes in humor, scientific discovery and act. New York: Macmillan; 1964.
Lachmann LM. The market as an economic process. Oxford: Basil Blackwell; 1986.
Lawrence T, Suddaby R. Institutional work. In: Clegg S, Hardy C, Lawrence T, editors. Handbook of organization studies. 2nd ed. London: Sage; 2006. p. 215–54.
Levy D, Scully M. The institutional entrepreneur as modern prince: the strategic face of power in contested fields. Organ Stud. 2007;28(07):971–91.
Lounsbury M, Crumley LT. New practice creation: an institutional perspective on innovation. Organ Stud. 2007;28(07):993–1012.
Lounsbury M, Ventresca M. The new structuralism in organizational theory. Organization. 2003;10(3):457–80.
Lukes S. Power: a radical view. London: Macmillan; 1974.
Maguire S. Institutional entrepreneurship. In: Clegg S, Bailey JR, editors. International encyclopedia of organization studies, vol. 2. London, UK: Sage; 2007. p. 674–8.
Maguire S, Hardy C. The emergence of new global institutions: a discursive perspective. Organ Stud. 2006;27:7–29.
Maguire S, Hardy C, Lawrence TB. Institutional entrepreneurship in emerging fields: HIV/AIDS treatment advocacy in Canada. Acad Manage J. 2004;47:657–79.
Meyer JW, Rowan B. Institutionalized organizations: formal structure as myth and ceremony. Am J Sociol. 1977;83:340–63.
Mutch A. Reflexivity and the institutional entrepreneur: a historical exploration. Organ Stud. 2007;28(7):1123–40.
Perkmann M, Spicer A. Healing the scars of history: projects, skills and field strategies in institutional entrepreneurship. Organ Stud. 2007;28(7):1101–22.
Schumpeter JA. Capitalism, socialism, and democracy. New York: Harper and Brothers; 1942.
Scott R. Institutions and organizations. Thousand Oaks: Sage; 1995.
Seo M, Creed D. Institutional contradictions, praxis and institutional change: a dialectic perspective. Acad Manage Rev. 2002;27:222–48.
Shane S, Venkataraman S. The promise of entrepreneurship as a field of research. Acad Manage Rev. 2000;25:217–26.
Snow DA, Benford RD. Master frames and cycles of protest. In: Morris AD, Mueller CM, editors. Frontiers in social movement theory. New Haven: Yale University Press; 1992. p. 133–55.
Suchman MC. Managing legitimacy – strategic and institutional approaches. Acad Manage Rev. 1995;20:571–610.
Tsoukas H. The missing link: a transformational view of metaphors in organizational science. Acad Manage Rev. 1991;16:566–85.
Weick K. The social psychology of organizing. New York: Random House; 1979.
Wijen F, Ansari S. Overcoming inaction through collective institutional entrepreneurship: insights from regime theory. Organ Stud. 2007;28(7):1079–100.
Williamson O. The economic institutions of capitalism. New York: Free Press; 1985.
Zilber TB. The work of the symbolic in institutional processes: translations of rational myths in Israeli hi-tech. Acad Manage J. 2006;49(2):281–303.
Zilber TB. Stories and the discursive dynamics of institutional entrepreneurship: the case of Israeli high-tech after the bubble. Organ Stud. 2007;28(7):1035–54.

Institutional Entrepreneurship, Innovation Systems, and Innovation Policy

Markku Sotarauta
School of Management, University of Tampere, Tampere, Finland

Synonyms

Entrepreneur – change agent, promoter, broker; Innovation – deviation, alteration, implemented novelty; Institution – establishment; Policy – line, program; System – arrangement

Key Concepts and Definitions

Institutional Entrepreneurship

Institutional entrepreneurs are actors who initiate changes that contribute to transformation of existing institutions and/or creating new ones (Battilana et al. 2009). Institutional entrepreneurs can be organizations or groups of organizations or individuals or groups of individuals who act as change agents. They are actors who initiate divergent changes and actively participate in the implementation of them (Battilana et al. 2009, p. 67).

The concept of institutional entrepreneurship was first introduced by Paul DiMaggio in 1988, and it is based on his observation that organized actors do not only comply with institutions but consciously aim to create institutions or to transform existing ones, and for this purpose, they mobilize resources, competences, and powers (DiMaggio 1988).

Institution

Different schools of thought define *institutions* differently. Scott's (2001) three-dimensional view cuts cross many schools. According to Scott, institutions are composed of regulative, normative, and cultural-cognitive pillars. The regulative pillar highlights institutions as constraining forces that regularize behavior. It frames individual actions and choices by rule setting, monitoring, rewarding, and sanctioning activities. The normative pillar includes values and norms that by prescription, evaluation, and obligations frame individual actions and choices. Normative pillar consists of factors that influence actors' choices and actions by informing what is preferred and/or desirable. It also informs about the standards on which existing structures are based (Scott 2001, pp. 51–54). For its part, the cultural-cognitive pillar stresses those external frameworks that shape actors' internal interpretation processes (Scott 2001, p. 57) and, therefore, demolished, renewed, and/or totally new institutions change the ways actors see, interpret, and understand themselves, their actions, and positions in wider structures (Sotarauta and Pulkkinen 2011).

Innovation System and Innovation

The dynamic and continuously expanding body of research shows how industries, firms, and the public sector actors, in their efforts to create new innovations, are embedded in national, sectoral, and/or regional *innovation systems* (Lundvall 1992; Braczyk et al. 1998; Malerba 2002) and how innovation systems are constructed on knowledge-creating and knowledge-utilizing subsystems (Autio 1998).

An innovation system consists all the relevant economic, social, political, organizational, and other institutional factors that influence the development, diffusion, and use of new knowledge (Edquist 2008, p. 5) and have an influence on individuals', firms', and organizations' learning capacity and hence on their ability to innovate (Lundvall 1992; Lundvall et al. 2002). All this is supposed to produce new creations of economic and/or societal significance, i.e., *innovations* that are widely accepted as primary sources of renewal in a global economy (e.g., Edquist 2005).

The various approaches on innovation systems stress, according to a narrow definition, "interacting private and public firms, universities, and government agencies aiming at the production of science and technology" (Niosi et al. 1993) and "networks of institutions that in interaction initiate, import, modify, and diffuse new technologies" (Freeman 1987). Additionally, according to a broader view, innovation systems consist of organizations and institutions affecting and supporting learning and innovation (not only focusing on science and technology), and thus, according to this view, innovation system embraces also such actors that earlier were not seen influencing innovation (Asheim and Gertler 2005, p. 300).

In the literature on innovation systems, such factors as intellectual property right laws; other laws; various standards; environment, safety, and ethical regulations; organization-specific rules; industry specialization and structure; governance structure; financial system; structure of the research and development; R&D investment routines; and training and competence building system as well as operational cultural factors are raised as institutions (see, e.g., Autio 1998; Braczyk et al. 1998; Edquist 2005, 2008).

Institutional entrepreneurs are here seen as those actors who consciously work to change the institutional environment to better support the many functions of an innovation system and hence creation of innovations.

Innovation Policy

In innovation studies, innovation policy is fairly generally seen as actions by public organizations that influence innovation processes (Edquist 2008). Innovation policy is usually seen to consist of explicit measures to promote the generation, diffusion, and efficient use of new products, services, and processes in markets or more widely in a society. Innovation policy often has wider objectives than those focusing only on science and technology even though it more often than not incorporates elements of these. Consequently, broad-based innovation policy may cover a wide range of initiatives that are linked to science, technology, user needs, societal demand, and education.

Recent studies emphasize that contemporary innovation policies are designed and implemented in multi-actor innovation arenas and related networks (state–region–municipality–firm–university–polytechnic) (Kuhlmann 2001; Sotarauta and Kosonen 2013). Consequently, multi-actor forms of innovation policy challenge the straightforward definitions of innovation policy that see it as something only the public sector performs alone. Innovation policy is one arena among many through which institutional entrepreneurs may work to change institutions, and on the other hand, changes in innovation policy may be a consequence of institutional changes.

Open-Ended Issues and a Selection of Main Challenges

Agency: What Actors Do to Change Institutions for Innovation?

Institutions being central in promotion of innovation following generic questions guide studies focusing on institutional entrepreneurship in the context of innovation systems: (a) how to promote institutional change for better innovation systems and, consequently, (b) how to create, demolish, and change something that is stable and a source of order and a product of emergent properties (Sotarauta and Pulkkinen 2011). Indeed, there are calls for explicit efforts to change institutions for innovation. For example, Lundvall et al. (2002, p. 255) call for deeper understanding of transformation processes of innovation systems at an institutional level. They also see that the institutions as such are not as important targets of study as the processes of institutionalization are.

Institutions by definition imply permanence and stability, and one of their key characteristics is that they are resistant to change. This kind of restrictive perspective reminds that actions deviating from what is framed as appropriate by institutions are often sanctioned, one way or another. In the literature, restrictive view has recently been actively complemented, and also the enabling role of institutions is being acknowledged (Hage and Meeus 2006). Therefore, an institution can be interpreted both as an object of change itself and as a constraining as well as an enabling and incentivizing structure for change (Soskice 1999, p. 102). Institutional approach has been criticized for its inability to explain transformation and institutional change and more generally for predicating compliance and conformity. This critique, for its part, has generated increasing interest in the role of agency in institutional change and thus also institutional entrepreneurship (Tracey et al. 2010).

Of course, in the literature that focuses on national, regional, and sectoral systems of innovation, there already are several notable examples of the efforts to understand how institutional systems affect innovation and how innovation may also affect institutional change. However, policy process and agency as well as institutional change still are black boxes for students of innovation system. Innovation systems are often treated as if they function well or transform themselves without conscious efforts to change them (Uyarra 2010). Additionally, as Uyarra (2010) also states, innovation scholars often do not peep into policy processes but assume that they progress step-by-step from analysis to policy design to implementation and action. For these reasons, institutional entrepreneurship is gaining more ground as it aims to add knowledge in how social actors work to change the institutions that govern their own activity. Indeed, it improves understanding of the ways power is exercised in these efforts and how actors strategize and mobilize tangible and intangible resources for institutional change (Garud et al. 2007).

The point of departure here is that by taking institutional entrepreneurship as a key organizing device also in studies focusing on innovation systems, an analytical leverage could be added and thus to better understand institutional change, agency, and policy processes.

Complex Social Process: What Is Going on in Innovation Systems?

DiMaggio and Powell (1991) maintain that when adopting institutional entrepreneurship as theoretical lens, institutions can be studied as outcomes of complex social processes and as products of human agency. Institutional entrepreneurship provides an analytical framework to study what various agents do in cooperation and/or competition with each other to change institutions; how they interact, relate, and evolve with wider institutional constellations; and importantly, what kinds of risks they take and what they invest personally in the change efforts. Consequently, this kind of approach highlights the importance of studying interests, legitimacy, strategy, and power (Levy and Scully 2007), while the more conventional approaches on innovation systems highlight the presence or absence of actors, institutions, and interaction patterns (Uyarra and Flanagan 2010, p. 683).

By definition, an actor needs to be intentional in action to be recognized as an institutional entrepreneur. In studies on institutional entrepreneurship, it is important to distinguish forms of institutional change that are relatively spontaneous and emergent from those that take shape with considerable strategizing, organizing, and coordination (Sotarauta and Pulkkinen 2011). This distinction may help in the efforts to understand what institutions can be shaped and how. Additionally, there is a need to ask to what extent and under what circumstances institutions can be directed. Clearly, conscious efforts to change institutions and emergent development patterns are in many ways intertwined. Intentionality of purposive change agents needs, more or less, to be adjusted to emergent properties, those being outside the reach of institutional entrepreneurs. For these reasons, it is not suggested here that there might be some kind of predestined causality between institutional entrepreneurs' actions and institutional change.

At best, institutional entrepreneurship studies are a form of process-oriented inquiry where the role of actors is fleshed out by analyzing the change processes in which the institutional structure coevolves with actors; thus, the interaction between structure and actors needs to be seen as bidirectional.

Embedded Agency: How Actors Aim to Change Something That Frames Their Own Actions?

Hall and Thelen (2009) divide the role of agency to institutional change into three main types: (a) reform (institutional change explicitly directed or endorsed by the actors), (b) defection (key actors cease behaving according to the rules and practices prescribed by a preexisting institution), and (c) reinterpretation (the actors learn new ways of thinking and consciously create new interpretations of themselves, rules as well as practices without abolishing the institution itself).

Institutional entrepreneurs may possess a formal position to attack institutional arrangements by applying above-mentioned generic strategies, but some of them may not have it. It would be tempting to assume that mayors, leading policy makers, CEOs of main firms, vice chancellors, and other authorities with formal positions would somehow automatically be institutional entrepreneurs. There is a need for both conceptual development and more fine-grained empirical analyses before it would be possible to reliably answer to the question who institutional entrepreneurs in different situations actually are (Sotarauta and Pulkkinen 2011). Of course, whoever institutional entrepreneurs are and whatever their change strategies may be, their freedom to push for institutional change is limited in situations of fragmented power and authority. Interestingly, institutional entrepreneurs are constrained by the very same institutions they aim to change, and therefore, their work is a form of "embedded agency" (see more, in Battilana 2006; Leca and Naccache 2006; Seo and Creed 2002).

A core belief underlying in the approach suggested here is the importance of understanding interactions between actors and their institutional settings. It is more or less impossible to understand institutional entrepreneurship without understanding how actors shape institutions they are embedded into and how institutions shape their actions. This calls for relational, contextual, and systemic understanding. This kind of *process and system-oriented approach locates institutional entrepreneurship not in the attributes of individuals but in the relationships connecting actors in an innovation system and institutional change*. To understand these kinds of institutional change processes, it is important to ask the following: How do institutional entrepreneurs deal with change? What kind of change strategies do they launch? What is the combination of change strategies they adopt in specific situations at specific times? How can actors innovate and renew institutional settings if the very institutional environment they wish to change determines their beliefs and actions? How do they resolve the paradoxical situation in which they aim to change those institutions that frame their very actions? How do they earn/take their positions? Who are the institutional entrepreneurs in different institutional contexts? (Sotarauta and Pulkkinen 2011).

Institutional Change: How Institutions Governing Innovation Change?

When studying institutional change, there is a danger to fall into a "radical change trap" and focus mainly on those changes that are easy to detect and observe and thus to see change as a discontinuous period between periods of stability and continuity. This kind of view on change might lead to simplified accounts on institutional entrepreneurs' roles in institutional change. It is suggested here, inspired by Streeck and Thelen (2005), that there is a need to be more sensitive to gradual transformations. Incremental changes are not only reactive and adaptive for the protection of institutional continuity, as often assumed. Accumulation of subtle, seemingly minor changes in longer periods of time can lead to considerable discontinuity that may surface beneath the apparent stability. Indeed, "creeping change" (gradual transformation) suggests that there are no optimum states but a constant search is a core in institutional change processes (Streeck and Thelen 2005) and thus also in the strategies adopted by institutional entrepreneurs. All this suggests that when studying institutional entrepreneurship, there is a need to be sensitive to continuity and discontinuity as well as incremental and abrupt changes and their combinations.

Broader View on Institutions Called for: What Are They?

In spite of the fairly generally shared understanding that institutions mediate in subtle but pervasive ways evolutionary trajectories of economies. Their specific roles in the innovation puzzle are still poorly understood and perhaps even underappreciated. While innovation system literature highlights the role of institutions, they have been conceptualized and empirically studied with fairly narrow lenses. In innovation studies, institutions are often conceptualized as rules of the game, while organizations are seen as players (e.g., Edquist 2005). Hodgson, however, argues that also an organization can be, but not always is, an institution in itself (Hodgson 2006). Some of the organizations may evolve so that they end up framing the actions and choices of other actors and thus become institutions by themselves (e.g., universities in their own countries and regions and Nokia in Finland).

All in all, the ultimate question is why and how certain institutional arrangements facilitate economic development and innovation while others seem to hinder them, and to answer this question, the fairly clear-cut distinction between institutions and organizations need to be reconsidered and the notoriously complex and context-sensitive nature of the concept appreciated. It is suggested here that institutions governing innovation systems ought to be approached as a context-specific and open empirical question. It is also suggested that by focusing on what actors actually do to change the conditions for innovation might enable us to learn more about the true nature of institutions.

Implications for Policy and Practice

Innovation policy has been stressed throughout the world as a way to renew economies and cope with challenges of globalizing world. Simultaneously, there is a growing understanding that there are no one-size-fits-all innovation systems or policies in circulation (Tödling and Trippl 2005). This suggests that institutions framing both innovation systems and policies differ significantly between many different types of regions and countries. For example, as shown by Asheim et al. (2011), even in relatively small countries like the Nordic countries, which in many ways are fairly similar to each other, innovation policies indeed differ from each other.

The Nordic countries are only one example among many how institutions mediate economic development paths and how historically rooted national institutions frame the choices of both individuals, firms, and policy makers. More explicit focus on institutional entrepreneurship might enable policy makers to better understand the nature of both institutional obstacles and ways to cross them, instead of searching for ways to adapt to latest buzzwords in global circulation. Additionally, by explicit focus on institutional entrepreneurship, it might be possible to identify the true roles of policy making in different situations, and thus, it might be possible to design more sophisticated policy approaches and policies.

Conclusions and Future Directions

The main challenge in studies aiming to understand innovation systems by an explicit view on how institutions change and on what actors do to change them is to understand the dynamics of institutional change with a microlevel analytical lens. This calls for (a) identification of institutions that are locking industries, countries, and/or regions into the past development path or slowing their transformation down; (b) analysis of the ways actors aim to demolish and/or renew these institutions; and (c) identification of strategies different actors adopt when aiming to create new institutions to support the emergence of a new development path (see also Sotarauta and Pulkkinen 2011). The concept of institutional entrepreneurship might offer a conceptual lens in these efforts by seeking for a balance between structure and actor.

Institutional entrepreneurship provides an analytical framework of how various agents aim to change institutions as well as how they interact, relate, and evolve with wider institutional constellations. Especially important for this line of study is the notion that micro-agent change leads to macro system evolution, i.e., before change at a macro level can be seen, it is taking place at many microlevels simultaneously.

Institutional entrepreneurship needs to be studied with three perspectives in mind: (a) the *process* perspective that informs a study on the dynamism of innovation systems and secures a temporally conscious approach; (b) the *network* perspective that informs about the social relationships of the actors in and beyond a innovation system; and (c) the *governance* perspective that informs about the wider systemic issues framing and molding both the actual systems and change processes as well as forms of institutional entrepreneurship.

Ultimately, to repeat and conclude, the aim of taking institutional entrepreneurship under close scrutiny is to add analytical leverage to endogenous innovation processes and systems and find a fresh lens that enables studies operating in between macro and micro issues.

Cross-References

▶ Academic Entrepreneur, Academic Entrepreneurship
▶ Co-conception and Entrepreneurial Strategies
▶ Corporate Entrepreneurship
▶ Creative Knowledge Environments
▶ Entrepreneurial Capability and Leadership
▶ Entrepreneurial Opportunity
▶ Entrepreneurial Organizations
▶ Entrepreneurship in Creative Economy
▶ Entrepreneurship in International Context
▶ Innovation and Democracy
▶ Innovation Policies (vis-à-vis Practice and Theory)
▶ Innovation Policy Learning
▶ Innovation Systems and Entrepreneurship
▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)

- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Multi-level Systems of Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Political Leadership and Innovation
- ▶ Social Entrepreneurship
- ▶ Social Networks and Entrepreneurship
- ▶ Triple Helix of University-Industry-Government Relations

References

Asheim BT, Gertler M. The geography of innovation: regional innovation systems. In: Fagerberg J, Mowery D, Nelson R, editors. The Oxford handbook of innovation. Oxford: Oxford University Press; 2005. p. 291–317.

Asheim B, Isaksen A, Moodysson J, Sotarauta M. Knowledge bases, modes of innovation and regional innovation policy: a theoretical re-examination with illustrations from the Nordic countries. In: Bathelt H, Feldman MP, Koegler DF, editors. Beyond territory: dynamic geographies of knowledge creation, diffusion and innovation. London/New York: Routledge; 2011. p. 227–49.

Autio E. Evaluation of RTD in regional system of innovation. Eur Plan Stud. 1998;6(2):131–40.

Battilana J. Agency and institutions: the enabling role of individuals' social position. Organization. 2006;13(5):653–76.

Battilana J, Leca B, Boxenbaum E. How actors change institutions: towards a theory of institutional entrepreneurship. Acad Manage Ann. 2009;3(1):65–107.

Braczyk H-J, Cooke P, Heidenreich M. Regional innovation systems: the role of governances in a globalized world. London: UCL Press; 1998.

DiMaggio PJ. Interest and agency in institutional theory. In: Zucker LG, editor. Institutional patterns and organizations. Cambridge, MA: Ballinger; 1988. p. 3–22.

DiMaggio P, Powell W. Introduction. In: Powell W, DiMaggio PD, editors. The new institutionalism in organizational analysis. Chicago: Chicago University Press; 1991. p. 1–38.

Edquist C. Systems of innovation. In: Fagerberg J, Mowery DC, Nelson RR, editors. The Oxford handbook of innovation. Oxford: Oxford University Press; 2005. p. 181–208.

Edquist C. Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). Circle working paper 2008/06. Lund: Lund University; 2008.

Freeman C. Technology policy and economic performance: lesson from Japan. London/New York: Printer; 1987.

Garud R, Hardy C, Maguire S. Institutional entrepreneurship as embedded agency: an introduction to the special issue. Organ Stud. 2007;28(7):957–69.

Hage J, Meeus M, editors. Innovation, science and institutional change: a handbook of research. Oxford: Oxford University Press; 2006.

Hodgson GM. What are institutions? J Econ Issues. 2006; XL(1):1–25.

Hall PA, Thelen K. Institutional change in varieties of capitalism. Socio-Economic Review. 2009;7(1): 7–34.

Kuhlmann S. Future governance of innovation policy in Europe—Three scenarios. Res Policy. 2001;30(6): 953–76.

Leca B, Naccache P. A critical realist approach to institutional entrepreneurship. Organization. 2006;13(5): 627–51.

Levy D, Scully M. The institutional entrepreneur as modern prince: the strategic face of power in contested fields. Organ Stud. 2007;28(7):1–21.

Lundvall B-Å. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992.

Lundvall B-Å, Johnson B, Andersen ES, Dalum B. National systems of production, innovation and competence building. Res Policy. 2002;31(2):213–31.

Malerba F. Sectoral systems of innovation and production. Research Policy. 2002;(31)2:247–264.

Niosi J, Saviotti P, Bellon B, Crow M. National systems of innovation: In search of workable concepts. Technol Soc. 1993;15(2): 207–227.

Scott WR. Institutions and organizations. 2nd ed. Thousand Oaks: Sage; 2001.

Seo M, Creed WED. Institutional contradictions, praxis and institutional change: a dialectical perspective. Acad Manage Rev. 2002;27(3):222–47.

Soskice D. Divergent production regimes: coordinated and uncoordinated market economies in the 1980s and 1990s. In: Kitschelt H, Lange P, Marks G, Stephens JD, editors. Continuity and change in contemporary capitalism. Cambridge: Cambridge University Press; 1999.

Sotarauta M, Kosonen K-J. Customized innovation policies and the regions: digital content services and intelligent machinery in Finland. Accepted for publication in the *European Urban and Regional Studies* in 2013 (2013).

Sotarauta M, Pulkkinen R. Institutional entrepreneurship for knowledge regions: in search of a fresh set of questions for regional innovation studies. Environ Plann C Govern Policy. 2011;29(1):96–112.

Streeck W, Thelen K. Introduction: institutional change in advanced political economies. In: Streeck W, Thelen K, editors. Beyond continuity: institutional change in advanced political economies. Oxford: Oxford University Press; 2005.

Tödling F, Trippl M. One size fits all? Towards a differentiated regional innovation policy approach. Res Policy. 2005;34(8):1203–19.

Tracey P, Phillips N, Jarvis O. Bridging institutional entrepreneurship and the creation of new organizational forms: a multilevel model. Organ Sci. 2010;22(1):60–80.
Uyarra E. What is evolutionary about 'regional systems of innovation'? Implications for regional policy. J Evol Econ. 2010;20(1):115–37.
Uyarra E, Flanagan K. From regional systems of innovation to regions as innovation policy spaces. Environ Plan C Govern Policy. 2010;28(4):681–95.

Instructional Design

► Teaching as Invention

Intellectual Property Rights

► Intellectual Property, Creative Industries, and Entrepreneurial Strategies
► Patent System
► Patents and Entrepreneurship

Intellectual Property, Creative Industries, and Entrepreneurial Strategies

Julien Pénin
University of Strasbourg – BETA (UMR 7522 CNRS-UdS), Strasbourg Cedex, France

Synonyms

Creativity management; Incentive-diffusion dilemma; Intellectual property rights; Open business model; Open source

The expression "knowledge-based economy" is one of the most used in the economic and managerial literature. This expression refers to the fact that, roughly since the mid-1970s, knowledge and, more broadly, intellectual capital is the most important input in the production process of the economy (as compared to other inputs such as tangible capital, land, and low-skilled labor). A tangible manifestation of the critical role of knowledge in the production process is provided by the raise of firms which are specialized in knowledge production, be it consulting companies specialized in supply chain management or quality management, technological start-up, and/or university spin-offs. The common point between those firms is that, since they produce only knowledge, they must be able to valorize it, i.e., to sell it on markets.

In other words, the prominent place of intellectual capital in the knowledge economy directly shed light on the importance of intellectual property, i.e., on the means for entrepreneurs to protect their intellectual creations. Entrepreneurs usually seek to secure their intellectual capital by relying on intellectual property rights (IPR in the following). Most used IPR are (the list is not exhaustive) patents, trade secrets, brands, copyrights, models and drawings, etc. From an entrepreneurial point of view, IPR are keys to secure intellectual capital and hence to provide incentives to continuously develop novelties and innovation. And obviously, needless to say that the more important intellectual capital in the value creation process, the more important the place granted to IPR and, most of all, the more important it is to adapt a coherent strategy to use them (Teece 2002).

The issue of intellectual property is therefore critical today in almost all inventive and creative sectors, be it in traditional industries, in art or in creative industries. In particular, since creative industries are at the intersect of art and industry (Caves 2002), the issue linked to intellectual property in those sectors is likely to be different than in more traditional sectors (and also more complex). According to Bach *et al.* (2010): "Creative industries typically include industries that focus on: Creating and exploiting intellectual property products such as music, books, film and games; or providing business-to-business creative services including advertising, public relations and direct marketing. To a large extent, these creative industries integrate artistic as well as industrial dimensions, thus narrowing the gap between the use of patents (traditionally used in industry) and copyrights (traditionally used in art)." For instance, in the case of the movie industry, the music industry or the video-game industry, to cite only some of the most famous creative sectors, firms must today be able to combine and to handle a multiplicity of IPR and a multiplicity of valorization strategies.

From a social perspective, at the era of Internet, the role of IPR is vividly debated in the economic literature (Andersen et al. 2007). In a sense, technologies of information and communication (TIC in the following) exacerbate the Arrovian dilemma between incentive and diffusion (Arrow 1962). In its seminal paper, Arrow described the problem faced by entrepreneurs who seek to sell informational goods, i.e., goods which are hardly appropriable and nonrival. He explained that no buyer would accept to pay for something that he has no clue about. Thus, sellers must disclose the information in order to be able to sell it. But as soon as they do so, buyers do not need to pay to acquire the information since they already have it. This dilemma explains why IPR are fundamental in markets for informational goods and in creative industries.

Now, with the advent of TIC, this dilemma is still made more relevant. On the one hand, it becomes more and more important to prevent imitation and to secure intellectual property since in many sectors the Internet makes it easier and easier to duplicate and to copy new creation, thus undermining the incentives of inventors and creators. But on the other hand, TIC also increase the value of the dissemination of those new creation, which reinforce the importance of a wide diffusion of new creations at a low (if not zero) cost. For instance, in the music industry, for incentives sake, it is nowadays critical to protect new songs via strong copyrights and to prevent as much as possible free download on the Internet. But on the other hand, since TIC make it possible to disseminate new songs within the economy very fast and almost for free, the value of the diffusion of new songs has also increased, which calls for a minimum of protection.

However, if on the one hand the emergence of the Internet modifies the equilibrium of IPR policies, on the other hand, it also changes firms' entrepreneurial strategies. Because it potentially generates new source of value and affects the mechanism of repartition of this value, the emergence of the Internet and improvements in TIC indeed triggers the adoption of new business models by entrepreneurial firms, often more open than more traditional ones.

The standard view of IPR focuses on their role to prevent copy and to secure monopoly power and thus to restore incentives to create. For instance, in traditional industries such as pharmaceutical or chemical industries, firms often rely on patents to protect new chemical compounds and therefore increase incentives of biotech start-ups to invest in R&D. Or, in the music sector, copyrights prevent consumers to copy new songs for free, thus increasing incentives of artists to produce new pieces of music. Here, in line with traditional thinking in management, the ability to exclude and to enjoy monopoly power is at the heart of entrepreneurs' business models.

Yet, the link between IPR and entrepreneurial strategies is not straightforward. In reality, there is a large spectrum of possible utilization of IPR and entrepreneurs might not always want to use IPR in order to exclude imitators. In particular, openness and diffusion may become interesting for firms in order to benefit network effects, to ease compatibility, or to develop business in complementary assets. Hence, the valorization of creations and inventions may not always require exclusion and full appropriation strategies. This is all the more relevant in the Internet economy, where network effects tend to be large, thus increasing the value of openness and information sharing.

Consequently, encouraged by the huge progresses of TIC, new business models have emerged recently. For instance, in software, the open-source movement demonstrates the possibility for entrepreneurs to become profitable without strong right of exclusion. Open-source software typically relies on copyleft, i.e., on a peculiar use of copyright which ensures not the exclusion but the maximal dissemination of produced lines of codes (Raymond 1999; Lerner and Tirole 2001; Dalle and Jullien 2003; Benkler 2006). Thus, in open-source communities, participants who produce lines of code cannot appropriate them and control their use. Yet, many firms do devote times and resources to contribute to open-source project although they know they will not be able to appropriate the produced software. This clearly illustrates that open business model can sometimes be profitable.

The success of open-source software has triggered many scholars to explore how and when to export this model in other sectors. In the field of arts, for instance, licenses based on creative commons' principles are now deeply rooted in the practices of many actors. Similarly, Lakhani and Panetta (2007, p. 98) explain that: "The achievements of open-source software communities have brought the distributed innovation model to general attention so that it is rapidly taking hold in industries as diverse as apparel and clothing, encyclopedias, biotechnology and pharmaceuticals, and music and entertainment."

If the example of open source is quite extreme, it suggests that, for entrepreneurs, IPR strategies based on strong exclusive rights may not be optimal. In many cases, it might pay for an innovative firm to weaken its IPR and to adopt open business model. For instance, in the case of open source, it must be noted that, technically, software "protected" by a copyleft is not automatically free. It can be sold. Yet, the copyleft means that nobody can prevent someone from distributing it for free, which seriously undermines the incentives to sell it. In practice, therefore, copylefted pieces of art are usually distributed for free.

Second, creators by opening their invention or creation do not usually abandon all their rights over it. Very often, they keep at least their name associated to their creation. It is the case, for instance, under the label of *creative commons*, which proposes some more or less permissive licences, but under which it is always very important to mention the name of the creator.

Third and more important, new business models can be designed around free and open invention and creation. For instance, in industries with strong network effect (where the value of the good largely increases with the number of users), it may pay for firms to open their technology, to favor its diffusion and wide use in order to benefit from network effects. Network effects indeed introduce the issue of standard and compatibility. And, needless to say that exclusive strategy is seldom relevant in order to favor compatibility. More generally, any times a market is multisided, the issue of openness, at least on one side of the market, must be addressed by firms who operate on those markets. It may indeed pay to offer the good for free (or almost for free) on one side of the market in order to increase the value of the good for customers on other sides, thus increasing their willingness to pay and the firm's potential of revenue.

Similarly, as illustrated by the case of software, weakening its IPR might lead to maximize sales of complementary assets (Teece 2002). Indeed, if complementary assets are exclusively controlled by the firm, providing a free good might enable entrepreneurs to increase their profits on those complementary assets. In other words, it is possible for artists not to sell directly their copylefted work but to make money out of complementary services that are combined with the open resource. This explains why, for instance, firms as Google or Amazon are strong contributors of open-source software. They do not sell the software but they combine it with assets that they hold exclusively (reputation, networks) in order to maximize their revenue.

Finally, open environment is critical in order to lever the work of creative communities. Bach et al. (2010) emphasize indeed that in creative industries, the process of creation is generally a collective effort that necessitates the interaction and coordination of a multitude of heterogeneous economic actors. Basically, Bach et al. argue that stakeholders of the creative process are talented individuals, firms, and creative communities. In particular, they stress the critical role of the latter. According to them: "the locus of creation is rooted within the diverse informal communities with which firms and individuals must somehow maintain links in order to keep introducing novelties. *Creative communities* refer here to informal groups of individuals who accept to exchange voluntarily and on a regular basis in order to create knowledge in a given field. As the knowledge-based economy expands, such communities take in charge some significant parts of the *sunk costs* associated with the process of generation or accumulation of specialized parcels of knowledge." This is, for instance, clearly the case in the video-game industry in which dominant firms must rely on the production of underground creative communities of artists (Cohendet and Simon 2007).

However, the point which is important to make here is that, with respect to IPR, creative communities have radically different needs than firms. Communities need openness and knowledge exchanges while firms need exclusion and knowledge retention. This is what Bach et al. (2010) call "the IPR dilemma in creative industries." Communities can only flourish under weak IPR. Creative projects entail integrating, cutting, and pasting, assembling creative elements dispersed among a vast array of technical and cultural activities carried out by diverse and distinct actors. Thus, in order to foster the production of novelty, firms, individuals, and communities must rely on some kind of open spaces. In particular, it is important for firms to moderate their use of exclusive IPR in order to preserve privileged links with creative communities. Lessig (2001, 2004), for instance, insists on the fact that creation is a collective process involving communities and that, for those creative communities, the issue of access is more important than the issue of incentives. According to him, creativity can hardly occur in a world of permission and the production of novelty requires the preservation of a free platform on which creators can freely draw to feed their creativity.

In order to reconcile those two opposed positions and to preserve the delicate balance between appropriation and creation, firms might therefore develop specific arrangements, which often means to behave less aggressively in order to be able to lever the work of the masses. These new strategies of intellectual property are clearly in line with all the recent literature on open innovation which stresses new innovative strategies based on user communities, crowdsourcing, etc.

Conclusion and Future Directions

In creative industries, the issue of intellectual property (and in particular intellectual property rights) and entrepreneurial strategy is critical. In many situations, it is important for new ventures to be able to prevent imitation. But, on the other hand, in some cases, it may also pay to adopt more open business models. Indeed, in creative industries, building an ongoing creative dynamics requires the preservation of a fragile equilibrium between exclusion and openness, which ensures the coevolution of individuals, firms, and a creative underground. In this sense, firms must accept to some extent new uses of IPR, in particular those based on copyleft strategies and creative commons in order to favor links with underground communities.

This discussion on the role of intellectual property and new entrepreneurial strategies is essential because it contributes to introducing new dimensions to comprehend the debate on intellectual protection in creative industries. Yet, future research will have to complete it at least with respect to two issues.

First, future research will have to improve the understanding of the business models that allows firms to exploit and use the strength of open strategies. In particular, it will be important to explore whether or not it is possible for firms to elaborate hybrid strategies in between exclusive and open access in order to reconcile their need of appropriation and of creation. If yes, under which conditions? For instance, crowdsourcing is often presented as such hybrid strategy (a mix of strong appropriability and peer production). Yet, it is well known that crowdsourcing in the case of inventive and complex activities raises many problems and is likely to work only in limited contexts (Burger-Helmchen and Pénin 2011).

Second, future research will have to understand the functioning and evolution of creative communities and their interactions with the business sphere. The dynamics of creative industries indeed strongly depends on the creation and development of local creative communities that are in charge of elaborating and diffusing the norms and rules which help to regulate the behavior of all the different actors. How those communities evolve, how they change and interact with other actors of the innovation process, is a fundamental research question that needs further investigation.

Cross-References

- ▶ Creativity Management
- ▶ Entrepreneurship in Creative Economy
- ▶ Knowledge Capital and Small Businesses
- ▶ Patents and Entrepreneurship

References

Andersen B, Kozul-Wright R, Kozul-Wright Z. Rents, rights'n'rhythm: cooperation and conflict in the music industry. Ind Innov. 2007;14(5):513–40.

Arrow KJ. Economic welfare and the allocation of resources for invention. In: The rate and direction of inventive activity: economic and social factors. Princeton: Princeton University Press; 1962. p. 609–25.

Bach L, Cohendet P, Pénin J, Simon L. Creative industries and the IPR dilemma between appropriation and creation: some insights from the videogame and music industries. Manag Int. 2010;14(3):59–72.

Benkler Y. Freedom in the commons: a political economy of information. New Haven: Yale University Press; 2006.

Burger-Helmchen T, Pénin J. Crowdsourcing of inventive activities: definition and limits. Int J Innov Sustain Dev. 2011;5(2/3):246–63.

Caves RE. Creative industries: contracts between arts and commerce. Cambridge: Harvard University Press; 2002.

Cohendet P, Simon S. Playing across the playground: paradoxes of knowledge creation in the videogame firm. J Org Behav. 2007;28(5):587–605.

Dalle JM, Jullien N. "Libre" software: turning fads into institutions. Res Policy. 2003;32:1–11.

Lakhani K, Panetta JA. The principles of distributed innovation. Innovations: Technology, Governance, Globalization. 2007;2(3):97–112.

Lerner J, Tirole J. The open source movement: key research questions. Eur Econ Rev. 2001;45:819–26.

Lessig L. The future of ideas. New York: Vintage Books; 2001.

Lessig L. Free culture: the nature and future of creativity. New York: Penguin books; 2004.

Raymond E. The Cathedral and the bazaar: musings on Linux and open source by an accidental revolutionary. Sebastopol: O,Reilly; 1999.

Teece D. Managing intellectual capital: organizational, strategic and policy dimensions. Oxford: Oxford University Press; 2002.

Intelligence

▶ Speaking Pictures: Innovation in Fine Arts

Intelligent Cities

▶ Entrepreneurship in Creative Economy

Interaction, Simulation, and Invention

Jonathan Impett
School of Media and Performing Arts, Middlesex University, London, UK

Synonyms

Creativity; Human-computer interaction; Simulacrum

The information age, we still call it. Since postwar revolutions in technology (and above all in communications, we must remember), it has become commonplace to see the world and its events as information, as data. The processes of storing, accessing, and processing information are accepted culturally as central roles of contemporary technology, the central pillar of the trio of sensing, computation, and communication that characterizes and enables technologized life. The notion of "interactivity" is one of the foundational, defining concepts of the technological age. The idea that technology can respond to, appear to adapt itself to human actions or transpose those actions to other contexts transforms the scope of behavior of both human and machine. Over a generation, two developments have brought this relationship to a point where the interface often seems transparently thin: cultural practice and the common imagination have assimilated many of the implications, and technology has become faster, smaller, adaptable, and ubiquitous. This entry will explore the shape of the liminal space within this interface.

From Ubiquitous Concepts to Ubiquitous Reality

Interaction

Interaction is inevitably one of the broadest terms within technological culture. It is used to refer to all levels and modes of causal relationship between human and machine, however, conscious, intentional, or otherwise. The idea of interaction in a social sense or in dealing with the working together of machines, systems, or models is also relevant here. Interaction generally has a social context, and the modularity or complexity of systems means that intra-system relationships are equally important. Feedback is an important component in any interactive (rather than reactive) context.

Simulation

In its simplest sense, we might seem to be dealing with machine imitation of some behavior in the material or cultural world. In fact, the design and interpretation of such systems produces potentially complex and interesting meaning-generating relationships. More fundamentally, most systems designed for any kind of interaction can be seen as embodying a model. This might take the form of a set of simple assumptions, or of a population of dynamical systems designed to model complex behavior in the material or virtual world. Most crucially, the idea of simulation suggests an act of interpretation by a subject – a designer, observer, or user. It implies that the machine-embodied system is understood as a model or parallel of another system in a material or imagined world.

Invention

Invention tends to be understood as innovative application of science or technology – a new way to do something or something new to do. Here we will use a broader definition also encompassing means of producing new knowledge or understanding and aesthetic creation.

Interaction, Simulation, and Invention: A Reflexive Relationship

Invention, Creativity, and Cognition

Theories of creativity tend to emphasize the role of interaction rather than miracle birth. Indeed, the latter – the genius moment – we would now explain in terms of the process of emergence, as will be discussed below. Most such theories suggest that invention is the product of a more or less consciously observed encounter between internally modeled spaces or behaviors. The spontaneous reflexive process of the mind's generation of maps of its own conceptual spaces is at the root of such interpretations. Creative thought can be seen as the drawing of analogy between different mental spaces within interacting constraints of similarity, structure, and purpose. More recently, researchers have proposed an evolutionary explanation; that genius typically explores a wide range of potential behaviors, often in parallel, searching for complexity, novelty, and emergent structure. These explanations have in common an understanding that invention is the fruit of interacting simulations, of material of conceptual models. The action of imagination is the projecting of this interaction onto a new plane. Such a plane may be visual, aural, or temporal, for example, or it may be a new space of possibilities with its own potentialities, constraints, and dynamics.

In this respect, simulation must be considered an integral component of consciousness; every human behavior implies a model and projection on some level, and most involve some kind of interaction with the material or social world. In dealing with technology, external models and instrumentalities come into play, and in understanding this we must bear in mind that humans are optimized for engaging with humans. Indeed, we are disposed to understand behaviors in general (from the mythological actions of the gods to those of Disney cartoon animals) as human. This tendency is fundamental to our design of and interaction with machine behaviors. Interaction thus depends on a degree of credibility, an act of faith, or investment on the part of the "user" – the subject. The three key technologies are well tried; most advances in design and production transform practicality rather than concept. It is the capacity of the potential subject – the human – to imagine themselves into new technology-mediated contexts that carry such change forward. The special property of the technologies of interaction and simulation is that they create the very reflexive environment by means of which such vision becomes possible. They are the very instruments of invention.

Contexts for Action

Interaction with models is not exclusive to computational processes, of course. Maps, tools, pen, and paper and notational systems all function as extensions of human behavior. Heidegger's example of the hammer is a much-discussed theoretical reference in this respect. More generally, cognitive functions and individual and social behavior are mediated by tools, technology, representations, and social structures. External memory, representation and devices for manipulating the material world all become part of a feedback system that incorporates not only internal and external modeling, but also projections of how things might develop – simulation. In considering the prospect of digital craft, the *symbolic* nature of digital technology is crucial. This is how it is able to relate real and virtual actions and information. It also means that every relationship is mediated by a symbolic layer; technology is a medium. The computer provides a network of representational contexts for action. The power and flexibility of these contexts lies precisely in their symbolic nature, in their capacity to map representational spaces onto one another. The symbolic layer also facilitates and requires cross-disciplinary research and creation – invention that is the product of the interaction of different areas of thought and practice.

Representation, Modeling, and Emergence

Representation itself is thus a vital issue. Interaction and simulation both rely on symbolic models of a material, virtual, or informational space. Model making depends on reducing the number of parameters (degrees of freedom) to a non-infinite number tractable in the particular technological context and representing those parameters symbolically. Explicitly or otherwise, in identifying the system to be modeled a designer constructs a quasi-autonomous model of a situated system the behavior of which has enough overlap with that of an experienced, imagined, or comprehensible system for the user to engage with it meaningfully. The art of modeling is itself one of invention, of perceiving and defining as a quasi-autonomous system with limited links to its environment one which in the material world has a potentially intractable number of such relationships. The power of such an approach lies not only in its calculability, but also in its modularity and generalizability. More complex systems can be constructed of such models, to simulate and test the nature of relationships, and patterns if behavior and interaction can be abstracted.

Representation remains at the heart, however, complex, responsive, or contingent a system appears. Any difference between information and control systems lies in their use and design, in their mode of output rather than in their abstract structure. The nature of interaction (as opposed to remote or complex control) has tended until recently to continue such an information-based understanding of human behavior. Even beyond the confines of AI research, there has been an implicit assumption that an adequately rich and navigable knowledge base could form the basis of machine behavior with which humans are content to interact. While many interactive systems still effectively work on the basis of what is known as "good old-fashioned artificial intelligence" – "top-down" models, such as expert systems – most thought on machine intelligence over the last 20 years has moved toward an embodied, situated, distributed “bottom-up” approach. Interaction thus becomes one of the primary aspects of the model to be designed and observed. Most importantly, the knowledge potentially generated or revealed by such a system is not explicitly embodied in its structure and rules. Knowledge becomes a function of time and context; it is *emergent*. Definitions of emergence vary by context (Clayton and Davies 2008), but there is a general division those of weak emergence – emergence in the eye of the beholder – and strong emergence – new structure or behavior that has a causal impact on the behavior of the system itself.

Modes of Interaction

Similarly, many issues that are often connected with interaction are inseparable from questions of what used to be referred to as human-computer interaction. The parameters of interface design for interaction are well rehearsed: mode and degree of physicality, degrees of intuitiveness or necessary learning, analogy with other objects, systems, or models, and – crucially – feedback. Research in interaction design tends to focus on the individual; the concept of *joint cognitive systems* considers at the broader interaction of social and technological systems. The more recent notion of “experience design” acknowledges the dynamic nature of the relationship. Questions of the design of physical objects have become integrated with those of interfacing. Recent work points to the important role of skill acquisition in satisfactory and engaging interaction; successful design is the product of a partnership between designer and use. The design of interaction can enable the user to navigate complexity through structure, effective communication, and a learnable, sociable interaction, but the user must also seek to understand, engage, and learn. Interaction is thus not limited to the confines of the standard personal computer interface. Indeed, many screen-based exchanges might better be classed as iteratively reactive rather than interactive.

Developments in sensing technologies and data processing have greatly enhanced the potential of interactive environments. This might take the form of sophisticated multimodal interaction, such as immersive environments, or the intelligent processing of data that embodies complex actions, such as the abstraction of human forms from visual input. In both cases, the range of interacting behavior is vastly expanded from, say, a switch or dial. With this broadened palette of range and mode of input must come a thicker layer of software mediation between subject and response. This creates richer potential for learning on the part of the system; multimodal learning is also a more intuitive process for the subject.

Prosthetic Culture

Technological evolution drives the cultural understanding of human-machine relationships to another paradigm. If subject and computer are integrated such that the subject no longer perceives a distinction, then the situation is no longer one of interaction. Instead, we are dealing with a form of prosthesis, but one that is cognitive and experiential as well as physical. Theorizing of this situation generally pursues two lines: notions of the “posthuman,” as state in which informational dynamics are no longer entirely constrained by material life, and the balancing view of human knowledge and understanding as being essentially and evolutionarily embodied. Both are vital lines to consider. The new situation will likely afford the emergence of concepts that could not form in the “raw” human situation, constructs which require the extended context for their formation. However, as with previous technological innovation – writing, communications, computing, for example – this will doubtless also add to the conceptual repertoire of raw human thought and culture. Theorists refer to such a dynamically mind-technology coupled process as *enactive systems*, within which technology becomes an integral part of human sense-making. The extension of the individual through simulation and interaction could lead to its dissolution into a dynamical pattern of evolving cultural constructs. In this reading, interaction is no longer an intentional exchange but rather an evolutionary, emergent process of continual invention in which the boundaries between individuals become dynamical and multiple.

The Crucial Role of Time

Temporality introduces an infinitely greater richness to interaction. Dynamical models represent the evolution of a system over time. They may be characterized by the mode and degree of interaction they afford:

– Autonomous systems (e.g., meteorological, social, or economic models, generative graphics or music)
– Systems that are quasi autonomous but allow or require data from outside (simple computer games, continuously evolving information systems such as finance)
– Systems that allow multiple or complex intentional relationships with the subject(s) (flight simulators, interactive performance systems)
– Systems that inhabit a real world environment (installations, immersive environments)

This might be better understood in terms of the *distribution* of interaction – the points in the cycle of imagination, design, and use at which imagination might intervene. Fully autonomous systems play an equally important part in the emergence of new modes of thought; the creative influence of concepts of chaos and complexity are obvious examples.

State variables within the system evolve over time. In a digital context, dynamical systems must be discrete time models (i.e., they proceed in steps, however small), which themselves are integrations of continuous time systems the behavior of which is represented by differential equations. In this respect, computational systems are themselves models of mathematical systems. Recursivity is an important characteristic of such systems; the state at time $t + 1$ is calculated from the state at time t on the basis of the equations of the model incorporating any changes to state variables from external sources. This property allows for relationships and feedback loops between variables that are generally the source of perceived nonlinear behavior or emergent structure – that is, behavior or structure over time that is not predictable from the initial state without running the system in time. We might posit interaction and invention in the observation of nonlinear behavior in a dynamical system. The design of modes of intervention in that system implicitly assumes a dynamical model on the part of the subject. Similarly, intervention by the subject is structurally equivalent to an evolving parameter or feedback loop within the system; the subject becomes part of the environment of a complex system, and vice versa. New knowledge and invention are two sides of the same coin. Given that no simulation can be absolute, the difference between simulation and interactive systems is largely one of design and use, of cultural convention.

Invention and Complex Systems

The modularity of modeling allows for complex simulations such as the massively multi-point calculations of contemporary weather forecasting – a vast number of interacting localized systems. It also affords the possibility of agent-based modeling, in which the global system behavior is the product of interactions between internal autonomous systems, each modifying the environment of the others. The paradigm of *Artificial Life* is based on the coevolution of such structures. Taking its cue from the "non-intelligent" design of nature, it views life as the organization of matter and explores life-as-it-could-be through the self-organization of complex systems. As a research tool, A-life models have been used to explore phenomena from the evolutionary to social to cosmological levels. They are naturally suited to the modeling of adaptive and emergent behaviors, and for the exploration of virtual worlds. The different modes of operation of A-life models and their artifacts provide a good example of how design at different levels generates different kinds of interaction and invention. A system might allow subject interaction simply in the setting of parameters before a particular system run, perhaps generating output graphically or as sound. It might permit intervention during its operation, such that the subject effectively becomes an agent participating in the evolutionary process, or it might be formed about the subject in a more complex set of relationships to effectively become an extension of the subject. Artists have also used A-life approaches to "growing" carbon-based life forms, by intervening in the genetic and environmental processes.

If, hypothetically, a simulation were absolute, that would itself transform our mode of knowledge and thus constitute invention. Baudrillard presents the canonical argument for the dangers of simulation; not by coincidence is his *Simulacra and Simulation* the book in which Neo hides his contraband in *The Matrix* (itself hollowed out to become an empty self-representation). In such an interpretation, wars are fought primarily on screen, other times and places are known through a distant lens, edited and manipulated. The here and now, represented in the same way, becomes at best undistinguishable, at worst less-than-real. In fact, of course, such factual-historical and anthropological misrepresentation is far from new; one might even interpret aspects of religious dogma as the manipulation of cosmological self-image. What is interesting is that the technologies of apparent immediacy are no more an absolute guarantee of objectivity than the mythologized reports of ancient battles, received months after the event. Baudrillard sees three levels of simulacrum: physical copy, mass production, and our present state of hyper-reality in which a reference "reality" ceases to be relevant; concepts of real and virtual dissolve. Recent theorists pursue the implications of this "desert of the real" in respect of the interpenetrations of cultural and political behaviors.

Simulation becomes simulacrum at the point when the subject no longer questions the material reality of experience. In William Gibson's novel *Neuromancer* such experience is likened to hallucination, for example. Such a metaphor points to the crucial role of consciousness. The simulacrum only really obtains when consciousness cannot or does not distinguish. Science fiction is replete with borderline cases. Yet crucial aspects of simulation function appropriately outside this state. Flight simulators present an example. Faced with an emergency, the subject's physical emotional responses reflect those of an actual situation sufficiently for the exercise to be meaningful without the pretence of "reality." The relationship with a simulation known *not* to be real is fascinating, and points to the crucial role of the relationship of the simulation with the subject – that is, the relationship is always interactive to a degree, regardless of apparent physical intervention. The simulation model of certain computer games would appear to present an authentically new paradigm – one deriving from the cultural diffusion of concepts from ecology – in that an environment has to be maintained in balance. This contrasts with the drive to imbalance of earlier games using metaphors from war (chess) or economics (*Monopoly*). Additional levels of cultural simulation can be seen in computer games that seek to recreate not the apparent reference experience but the depiction of that experience in another form – for example, wargames that simulate not the experience of war but its representation in film. This points an interesting cultural phenomenon: it seems that engagement with virtual environments relies to some extent on prior experience and conceptual models. As with film (or any other art form), interaction with virtual worlds can serve to reify preconceptions as much as to engender invention.

Interactive Aesthetics

Material and virtual realities are mixed the aesthetic concept of *critical fusion*. It has been called a "telegraphic art," an art produced by action-at-a-distance in space or time. One defining behavior of telegraphic art is its relationship with memory: rather than searching or indexing, telegraphic art can produce emergent memory or *anamnesis*. New media are by their nature programmable. Generative art produced by autonomous machine behavior might appear to stand in opposition to interactive art, an aesthetic mode in which the viewer develops an instrumental and changing relationship with the work. However, the distinction is not so clear; the process of invention is still fundamental at the stage of design (and perhaps of perception), and an interactive work based on some form of simulation or model also displays a degree of autonomous behavior. Key issues in interactive art include kind of experience, mode of engagement, phase of involvement, and viewpoint of evaluation. The engagement process can be articulated in terms of stages of adaptation, learning, anticipation, and deeper understanding. The concept of play is frequently used to understand the nature of involvement. In all cases, the machine behavior has to engage on some level with human behavior, perception, and models; it is clear that technological art must develop together with research in cognition. The close relationship between artistic and scientific research and the role of collaborative work have transformed the nature of artistic practice.

Conclusion and Future Directions

We should consider the understanding produced through simulation as a new kind of knowledge. This is another example of the reflexive nature of the situation. Both the artifacts and behaviors observed and the resultant new concepts are emergent; ontology and epistemology are in a double bind. DeLanda proposes that we see a simulated system as of a space of possibilities with a defined structure.

What simulation and interaction afford above all is an extension in complexity, contingency, and time of the reflexive process that makes us human, that is at the root of human invention. As a medium and a context for symbolic representation, simulation represents both a means for the externalization and exploration of ideas and a mirror reflecting their potential and consequences. Invention – whether of a global grand design or of a spark of personal meaning – is the product of cycles of interaction between model and subject. To return to our starting point of creativity, it is most likely to occur in a moment of perceived resonance with *another* model.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Cognition of Creativity
▶ Creativity from Design and Innovation Perspectives
▶ Creativity in Invention, Theories
▶ Creativity, Intelligence, and Culture
▶ Imagery and Creativity
▶ Models for Creative Inventions

References

Casti J. Would-be worlds: how simulation is changing the frontiers of science. New York: Wiley; 1996.
Clayton P, Davies P. The re-emergence of emergence: the emergentist hypothesis from science to religion. Oxford: OUP; 2008.
Delanda M. Philosophy and simulation: the emergence of synthetic reason. New York: Continuum; 2011.
Edmonds E. The art of interaction. Digi Creat. 2010;291(4):257–264.
Kauffman J, Sternberg R. The Cambridge handbook of creativity. Cambridge: Cambridge University Press; 2010.
Leonardo Electronic Almanac http://leoalmanac.org/
Moggridge B. Designing interactions. Cambridge: MIT Press; 2006.
Norman D. Living with complexity. Cambridge: MIT Press; 2010.
Popper F. From technological to virtual art. Cambridge: MIT Press; 2007.
Simon H. Sciences of the artificial. Cambridge: MIT Press; 1996.

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Interactive Processes in the Form of Creative Cooperation

Anne-Laure Saives[1], Robert H. Desmarteau[2] and W. David Holford[1]
[1]Department of Management and Technology, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada
[2]Department of Strategy, Social and Environmental Responsabilities, School of Management Sciences (ESG), University of Quebec at Montreal (UQAM), Montreal, QC, Canada

Definitions

Creative cooperation: “The term creative cooperation captures the use of extensive cooperation between incumbents and new entrants initiated (‘created’) by an innovation that leads to a search for mutually complementary assets. Complementary assets such as marketing, manufacturing, and after-sale service are often needed to ensure the successful commercialization of an innovation.

Therefore, a 'complementary innovation' destroys the existing industry structure, but instead of destroying the incumbent firms with it as in the Schumpeterian model, it results in an industry structure of extensive cooperation between incumbents and new entrants firms that allows for a symbiotic coexistence in a newly defined industry" (Rothaermel 2000, p. 150).

Cooperation: Cooperation implies a relational system of organizations working together toward a common purpose. "A continuum moving from cooperation to coordination to collaboration moves generally from low to high formality" relationships between stakeholders of the system (Reilly 2001, p. 55).

Creative response: One can speak of "adaptive" responses when firms, in the face of major changes within their environments, respond by simply readjusting their existing practices. Conversely, "creative" responses (a) mobilize practices which are situated "outside of existing managerial practices" (McCraw 2007, p. 474), (b) cannot be planned or possess a nondeterministic trait, (c) depend on the specific leadership of individuals, (d) permanently change economic and social situations so as to create new environments, that is, affect the behaviors of other companies or a whole industry at large, independent of the size of the innovating firm in question.

Creative cooperation practices: Creative strategic management practices of firms (i.e., dynamic capabilities) resulting in creative cooperation and complementary innovation.

Knowledge-based economy: An economy in which knowledge and human cognition take a central role in the production process (Castells 1996; Rifkin 2000). According to Foray (2000), today's knowledge-based economy is characterized by a *marked increase* in knowledge externalities as well as by a *growth in the arena for change* (in the sense of activities dedicated toward innovation) within economic activity. During the past three decades, this new economy has imposed itself across massive investments in both production and knowledge transmission (research and development, education systems, patent acquisition and patent development systems, etc.), as well as by the advent of new information and communication technologies (Foray 2000).

Network-firm: Within the context of the knowledge-based society, organizations are comprised of internal networks, often non-hierarchical in nature, with a multitude of individuals, groups, teams, and communities which are dynamic and interconnected across formal and informal mechanisms. These organizations are, in turn, interconnected with other organizations within alliance networks and industrial, geographical, or sectorial clusters of activities. Hence, the network-firm (Sérieyx and Azoulay 1996) is particularly well adapted to a global and complex environment characterized by the interdependence and dynamism of technologies, products, or services. Such an environment calls for collaboration throughout the organization as well as around it.

Defining Creative Cooperation Through Creative Collaboration Practices

High-technology-intensive industries involve high degrees of collaborative practices whereby interfirm relationships, as well as the cooperative innovation management practices that accompany these, are constantly changing. The evolution of the biopharmaceutical industry is an emblematic case in point of how science-driven industries in this age of the knowledge-based society are continuously transforming. Here, with the acknowledged consecration on the necessity of biological sciences within the drug discovery process (Cooke 2003), biotech firms have become indispensible partners with the pharmaceutical industry. This entry aims to define and characterize these creative collaborative practices across an organizational re-reading on the concept of "creative cooperation" as proposed by Rothaermel (2000). This will be conducted in three steps: (a) a review on the notion of "creative response" to change as first explained by Schumpeter, (b) a synthetic review of the literature on contemporary "network-firms" within the knowledge society, and (c) an operational definition of "creative cooperation," and the specific management practices associated with this, based on theoretical and empirical literature covering the case of the life sciences sector.

The Disruptiveness of Practices Within an Innovating Context

Schumpeter (1942) used the term "creative destruction" to describe the now-classical idea of how innovation drives or stimulates capitalism. Furthermore, the firm's capacity to survive depends on its capacity to internalize this ability to innovate so as to render it as an organizational routine. In his 1939 work entitled *Business Cycles*, Schumpeter specifies that not all change within their environment engenders the same types of responses on the part of existing firms. He distinguishes "adaptive" responses from "creative" ones. Can these teachings on the art of change and the practice of innovation serve as a springboard toward describing and understanding the context of today's biopharmaceutical industry (and eventually, of science-driven industries in general)? An abundant literature on biotech SMEs shows how the dynamics of cooperation, via alliances and collaborations, is central within the industry's response to technological change (e.g., the advent of biological drugs) (Koput et al. 1996; Fetterhoff and Voelkel 2006). Rothaermel (2000) considers that the case for biopharmaceutical innovation does not engender a wave of "creative destruction" but rather entrains a "specific creative response" at the level of the industry's structure: "creative cooperation," as a symbiotic-like cooperation between incumbent firms (pharmaceutical companies) and new entrants (biotech companies), occurs with the ultimate aim of commercializing an innovation. Such cooperation is essentially motivated by the complementary assets and resources that can be achieved, which are necessary toward the industrialization process of life science inventions and innovations. Interfirm cooperation is, therefore, the preferred reconfiguration mechanism in response to a changing context. The following section of this entry aims toward helping us understand and decode this hybrid of "creative cooperation" at the organizational level.

A Look at the Evolution of "Creative Cooperation" Practices Within the Network Age

Throughout the past three decades, the conjugation of stakes related to the "knowledge-based economy" with those of the "network age" have helped lead toward the emergence of new organizational realities, and most notably, toward the multiplication of alliances and collaborations. More specifically, a number of authors have identified the network-firm (or the firm within a network) as the archetypal organizational form within biotech firms (Powell et al. 1996; Powell 1998; Baum et al. 2000; Cooke 2003; Patzelt and Audretsch 2008; Chiaroni et al. 2009). "Creative cooperation" inscribes itself within an emergent stream of theorization on network-firms and the open business model (Chesbrough 2006) within the age of the knowledge-based economy. As such, the specific literature on biotech sectors considers the locus of innovation to reside within both the internal and external knowledge exchanges by means of value networks (interconnectivity). This involves dealing with (a) uncertainties and risks related to the difficulties in measuring the feasibility of scientific projects in biosciences involving multiple research paths and multi-disciplines in required fundamental knowledge, (b) of creating new capacities for integrating the evermore tacit knowledge of scientific experts (or of that contained in patent portfolios and other intellectual properties) (Owen-Smith et al. 2002), and finally, (c) to forge long-term learning capacities for the transmission of knowledge developed over long periods by means of long-term partnerships (rather than by opportunistic "deals") (Pisano 2006). Along these lines, Baker (2003) argues that new distinctive capacities of biotech firms are to henceforth stem from the articulation of internal innovation capacities as well as from reticular capacities to detect knowledge which can stimulate innovation.

Toward an Operational Definition of "Creative Cooperation"

Based on a systemic and dynamic definition of the strategic firm, "creative cooperation" within the biotech sector, thus, involves at the organizational level (also refer to Table 1):

- A *creative strategy (and governance)*, which constantly re-questions the business model of the firm and the pertinence of its portfolio of products (or intellectual property), services, competencies, technologies, and relationships in regard to the evolution of its capacities (and of those of its partners) for transforming knowledge into assets (Durand et al. 2008).
- A *creative organization* which implies *organizational innovation* toward new partnership forms; toward the positioning of the firm within its value chain and value network; and toward transforming the ways of coordinating knowledge creation (scientific and technical) within networks by means of openness (e.g., Chesbrough's (2003) "*Open Innovation*"; or Leonard-Barton's (1998, p. 155) "*Fight the not-invented here syndrome*").

In the case of biotechs, at least four creative cooperation practices (or dynamic capabilities (Teece 2007)) have been mentioned within the literature of the past two decades, and were also described by managers of biotech firms in the Quebec case study (Saives and Desmarteau 2010; Bréchet et al. 2012):

1. *Thinking and acting in networks*: The building up of an open network of expertise and high-caliber experts so as to construct a credibility of developed knowledge by varying the locations of intervention where these independent experts bring forth the benefits of distanciation. In support of this thinking is Venkatraman and Subramaniam's (2002) argument that firms are just as much portfolios of relations as they are portfolios of capacities and activities, whereby factors toward their competitive advantage reside in economies of scale, of scope, and of expertise. Here, their key resources are tied to their position within a network of expertise such that the strategic unit of analysis shifts away from the firm itself toward a *network* of internal and external relations where the objective becomes a matter of profiting from intellectual capital. The strategic focus, therefore, aims toward transforming new *knowledge* into *products* or *services* across a *network of specialized entities* involved in a variety of innovating activities; and toward maintaining strong ties so as to coevolve with various sources of knowledge and ideas, such as universities, regional start-up clusters, companies providing risk capital, and other co-specialized firms (Floricel and Miller 2003, p. 50–506). For the firm itself, the issue is much less a matter of rendering its processes and routines inimitable than to ensure its *centrality* within the network. And if one were to pursue a research agenda on this theme, it should be noted that Biotech SMEs have relied heavily on networking with star scientists, star CEOs, or high-profile venture capitalists on their advisory boards in an attempt to signal the underlying quality of their competences and their business models, as well as to gain status and credibility. One possible research avenue would be to understand the comparative effectiveness of the different ways in which biotech firms attempt to gain such credibility.
2. *The construction of symbiotic and equitable partnerships* toward the valorization of joint intellectual assets of the firm throughout all stages of scientific discovery; and this, across the manifestation of an original organization of bidding-up the value of its knowledge and project portfolio. This new way of progressively negotiating payments and deposits reminds us of Kalamas et al. (2002) who predicted a shifting of contractual discussions between biotechs and pharmas toward much earlier in the discovery process on the basis that biotech firms have increased their power of negotiations as a result of maturing technical and administrative competencies. As such, biotech firms have become better negotiators for license and expertise networks by concluding business contracts that are based on a more equitable sharing of value spaced over time,

Interactive Processes in the Form of Creative Cooperation, Table 1 Operational dimensions of "creative cooperation" within the biopharmaceutical industry: a synthesis of creative cooperation practices

	Creative Cooperation Practices			
Dimensions	Thinking and acting in networks	Constructing equitable partnerships	Arbitrating in-house and outsourced activities	Engaging the academic toward the market
Strategy	Emphasizing external expertise to achieve credibility	Establishing lasting and reciprocally profitable partnerships (*New deal making*)	Systematically arbitrating all links within the logistics chain	Valorizing translational research *(from science to business)*
Organization (Structure, culture)	Establishing independent and varied governance instruments	Honesty and frankness within communication mechanisms based on long-term visions	Flexibility within all structural and cultural components (e.g., *the bidding-up of ideas*)	Proliferation of bridges (physical, cultural, cognitive) between science and the market

thus leading to more durable and reciprocal relationships. Furthermore, Chesbrough (2007) asserts that innovation practices are evermore conducted within an "open" mode whereby the arbitrage between in-house and outsourced activities is conducted by embracing more fully a partnership perspective. An example of such innovating practices (Chesbrough and Appleyard 2007) shows how pharmaceutical giant Merck finances and implements a research partnership network whereby the value and wealth created is more equitably redistributed. In short, Chesbrough's fundamental message is that the strategic evolution of innovating practices within today's organizational environments is (and must be) transcended across a reticular openness. Both biotech and large incumbent firms have come to realize that their respective skills are largely complementary and are engaged in a series of different symbiotic partnerships. Further research would be needed on documenting the best microlevel practices and interactions which facilitate successful interorganizational relationships.

3. *The systematic arbitrage between in-house and outsourced activities across every link of the value chain*, and this, as a result of a "knowledge on outsourcing" made possible across the control of pharmaceutical research and clinical production quality standards.
4. *The proliferation of bridges (physical, cultural, cognitive) between science and market* so as to better enable, track, orient, and valorize scientific creativity and invention carried out within universities. The fact that the collaboration between universities and companies is an important key toward biopharmaceutical innovation is not new within the literature on national innovation systems. However, how does one render it more effective and efficient? Pisano coined the term "translational research" as a form of research that "translates" discoveries and fundamental scientific concepts into specific product opportunities. It connects in a much more systematic fashion fundamental research with clinical tests, including activities such as the identification and validation of targets, the screening of in vitro and in vivo candidates, and certain first-stage clinical tests.

In this sense, companies build creative organizations across a prolific bridging between the fundamental and the applied. Several levers are effective toward this end, which include (1) the hiring of liaison agents or "knowledge translators" (better known as Leonard-Barton's (1998, p. 155) *boundary spanners*), often being biopharmaceutical managers that were formerly researchers or vice versa, who support and ensure a cultural proximity between actors so as to enable the translation of science and assure the proper circulation of knowledge between the academic and economic spheres, (2) multipartied cooperation toward the bringing together of science and the market, and finally (3) the proliferation of opportunities toward the creation of knowledge across numerous technology platform

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applications within firms which also favor this science/market reconciliation.

Further research and studies, again at the micro-organizational level, could be conducted with regard to which types of bridges with academia have been the most effective toward inducing technological returns for the bridging firms; or again, on how different firms have interfaced with academia.

Conclusion and Future Directions

Creative cooperation is a new force toward the reconfiguration of innovating industries. It involves cooperative practices within the context of change and for which it possesses all the characteristics of "creative response" as defined by Schumpeter.

In today's age of open innovation, the biopharmaceutical sector is a probative example. In practice, the biopharmaceutical industry put forth creative responses to major technological changes and to increasing complexities which the life sciences have introduced within the drug discovery process. Starting from the "research workshop," a number of biotech VSE/SMEs have become partners in "creative symbiosis" with their peers, and more importantly with large pharmaceutical companies. The age of the bio-pharmacy is in full expansion whereby four creative practices have brought forward real signs of renewal within the art of cooperating, that is, of "creative cooperation": network-based credibility; equitable and symbiotic partnerships; network flexibility or arbitrage between in-house and outsourced activities; and finally, the proliferation of bridging between academia and market.

These four creative practices are based on new management principles, in part inspired by the Japanese approach (Nonaka and Takeuchi 1995) as well as more recent theory on governance. Indeed, *selective openness* (toward a network of expertise, toward commercial, production, or academic research partnerships), *complementarity and redundancy* (of information for decision-making across various governance instruments; of commercial partnerships for the proliferation of opportunities in innovation; of knowledge belonging to the committed parties involved in "translational" research), and *autonomy and equity* (of information belonging to independent experts; of control mechanisms for logistic chains; of knowledge sharing within "translational" research) seem to be the master words of future academic research and firms' practices of "creative cooperation" within the age of *open* innovation.

Cross-References

- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Network and Entrepreneurship
- ▶ Open Innovation

References

Baker A. Biotechnology's growth-innovation paradox and the new model for success. J Commerc Biotechnol. 2003;9(4):286–8.

Baum JAC, Calabrese T, Silverman BS. Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology. Strateg Manag J. 2000;21(3):267–95.

Bréchet J-P, Desmarteau RH, Saives A-L. Gouvernance, incertitude et expertise. Le cas des industries fondées sur la science. Manag Int. 2012;16(2):11–24.

Castells M. La société en réseaux. Paris: Fayard; 1996.

Chesbrough HW. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003.

Chesbrough HW. Open business models: how to thrive in the new innovation landscape. Boston: Harvard Business School Press; 2006.

Chesbrough HW. Why companies should have open business models. MIT Sloan Manag Rev. 2007;48(2):22–8.

Chesbrough HW, Appleyard MM. Open innovation and strategy. Calif Manage Rev. 2007;50(1):57–76.

Chiaroni D, Chiesa V, Frattini F. Investigating the adoption of open innovation in the bio-pharmaceutical industry; A framework and an empirical analysis. Eur J Innov Manag Bradf. 2009;12(3):285–305.

Cooke P. The evolution of biotechnology in three continents: Schumpeterian or Penrosian? Eur Plan Stud. 2003;11(7):757–63.

Durand R, Bruyaka O, Mangematin V. Do science and money go together? The case of the french biotech industry. Strateg Manag J. 2008;29:1281–99.

Fetterhoff TJ, Voelkel D. Managing open innovation in biotechnology. Res Technol Manag. 2006;49(3):14–8.
Floricel S, Miller R. An exploratory comparison of the management of innovation in the New and Old economies. R&D Manag. 2003;33(5):501–25.
Foray D. L'économie de la connaissance. Paris: La Découverte; 2000.
Kalamas J, Pinkus GS, Sachs K. The new math for drug licensing. McKinsey Q. 2002;4:9–12.
Koput KW, Powell WW, Smith-Doerr L. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. Adm Sci Q. 1996;41(1):116–45.
Leonard-Barton D. Wellsprings of knowledge, New ed. Boston: Harvard Business School Press; 1998.
McCraw TK. Prophet of innovation, Joseph Schumpeter and creative destruction. Cambridge, MA: Belknap Press of Harvard University Press; 2007.
Nonaka I, Takeuchi H. The knowledge-creating company: how Japanese Companies create the dynamics of innovation. Oxford: Oxford University Press; 1995.
Owen-Smith J, Riccaboni M, Pammolli F, Powell WW. A comparison of US and European university-industry relations in the life sciences. Manag Sci. 2002;48(1):24–43.
Patzelt H, Audretsch D. The evolution of biotechnology in hostile financing environments. J Organ Change Manag. 2008;21(6):773–85.
Pisano GP. Can science be a business? Lessons from biotech. Harv Bus Rev. 2006;84(10):114–25.
Powell W. Learning from collaboration: knowledge and networks in the biotechnology and pharmaceutical industries. Calif Manage Rev. 1998;40(3):228–40.
Powell WW, Koput KW, Smith-Doerr L. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. Adm Sci Q. 1996;41:116–45.
Reilly T. Collaboration in action: an uncertain process. Adm Soc Work. 2001;25(1):53–74.
Rifkin J. L'Âge de l'accès, Survivre à l'hyper capitalisme. Québec: Boréal; 2000.
Rothaermel FT. Technological discontinuities and the nature of competition. Technol Anal Strateg Manag. 2000;12(2):149–60.
Saives A-L, Desmarteau RH. Les pratiques de 'coopération créatrice' des PME de biotechnologies dans la turbulence de la chaîne des médicaments au Québec. In: Garnier C, Saives A-L (dir.). Turbulences dans la chaîne des médicaments. Montréal: Liber; 2010. p. 253–279.
Schumpeter JA. Capitalism, socialism, and democracy. New York/London: Harper & Brothers; 1942.
Sérieyx H, Azoulay H. Mettez du réseau dans vos pyramides. Paris: Éditions Village Mondial; 1996.
Teece DJ. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strateg Manag J. 2007;28(13):1319–50.
Venkatraman N, Subramaniam M. Theorizing the future of strategy: questions for shaping strategy research in the knowledge economy. In: Pettigrew A, Thomas H, Whittington R, editors. Handbook of strategy and management. London: Sage; 2002. p. 461–73.

Interdisciplinarity and Innovation

Lee Wilson[1] and Alan F. Blackwell[2]
[1]Division of Social Anthropology, Department of Archeology and Anthropology, University of Cambridge, Cambridge, UK
[2]Computer Laboratory, Crucible Network for Research in Interdisciplinary Design, University of Cambridge, Cambridge, UK

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Synonyms

Multidisciplinarity; Transdisciplinarity

Introduction

This entry is based on findings obtained from a cross-sector analysis of successful interdisciplinary innovation in the UK, sponsored by NESTA, the UK National Endowment for Science, Technology and the Arts, and conducted at the Centre for Research in the Arts, Social Science and Humanities (CRASSH) at Cambridge University.

Public policy for scientific investment emphasizes the need to support interdisciplinary research. The Royal Society report (2009) "The scientific century: securing our future prosperity" is typical, recommending that science and innovation can become "better aligned with global challenges" by reforming the UK research funding and assessment to support and reward interdisciplinary work: "Connections with and between the natural sciences and the social sciences, arts and humanities will be increasingly vital for innovation" (Royal Society 2010: 40). However, documents such as these are unclear with regard to the precise processes and mechanisms, or even the personal dynamics, through which such collaborative innovation occurs.

While the notion of interdisciplinarity has gained popularity due to a general association of innovation with processes of boundary crossing, collaboration, and the integration of different kinds of knowledge in general policy literature (e.g., in the UK see Council for Science and Technology 2001; Cox 2005; HM Treasury 2004), there is scant attention paid in this literature to what interdisciplinary research might consist of in practice. In academic accounts, epistemologically grounded frameworks for identifying and categorizing interdisciplinary research have been useful for the purpose of measuring interdisciplinarity in practice (e.g., Huutoniemi et al. 2009). However, they are limited in what they can tell us about the social aspects of collaboration between people to produce knowledge (Lattuca 2002) and, importantly, the critical role of the leadership of interdisciplinary teams (Brewer 1999). There is then a need to improve understandings of the actual processes of knowledge production as they occur on a day-to-day basis in order to avoid abstracting interdisciplinarity as an index of innovation and end in itself (Strathern 2004).

Definition: Family Resemblances in Collaborative Experience

The following analysis is informed by an anthropological perspective – that forms of knowledge do not exist outside of the specific social relationships in which they are constituted and reproduced (e.g., Brown and Duguid 2000; Chaiklin and Lave 1993; Engeström 1999; Latour and Woolgar 1979). Rather than reviewing policy recommendations and epistemological accounts of interdisciplinarity (of which there are many), the objective here is to describe interdisciplinary innovation in terms of the experiences of those who are recognized as achieving it.

The scope of the analysis was determined by a reputational survey of those considered by their peers in the UK to be exemplary practitioners of interdisciplinary innovation. Several rounds of "snowball sampling" asked leading practitioners which of their peers should be considered as exemplars, eventually making contact with 473 nominees from a wide range of disciplines. A second research phase involved a series of in-depth reflective workshops, to which a sample of these exemplary practitioners was invited as "expert witnesses." This phase was phenomenological in the sense that it focused on comparing personal reports of the experience of collaboration within the context of a professional career (Blackwell et al. 2009). The survey and workshop phases were supplemented with further site visits and interviews, and informed by reflection on the work of the Crucible network for research in interdisciplinary design, which has supported participants in more than 100 interdisciplinary projects over a period of 10 years.

The goal then here is not to construct a typology of interdisciplinarity or even a catalogue of what might be considered innovative practices. Rather, the purpose is to elicit the experiential aspects of working across perceived boundaries in the production of knowledge. Participants for the study were recruited from academia, the corporate, and public sectors. Workshop transcripts and survey responses were finally analyzed by a research team that was itself interdisciplinary and cross sectoral, comprised of both academic researchers and commercial strategy consultants with backgrounds in design, social anthropology, engineering, and economics. The result has been to treat the notion of interdisciplinarity as a "family resemblance" (Wittgenstein 1958). That is, not to assume practices categorized as "interdisciplinary" necessarily share a common set of properties, but rather are characterized by overlapping similarities in appearance.

In the remainder of this entry, these similarities are discussed in order to provide an introduction to the effective practices of interdisciplinary innovation identified here.

The Importance of Individual Leadership

While this analysis confirms previous studies of interdisciplinarity that emphasize the value of teams, of collaboration between different disciplines, and the ability to cross boundaries between different kinds of knowledge (e.g., National Academies 2005), it has also highlighted the essential role of the leaders of these enterprises. The majority of individuals that were identified from the reputational survey as exemplary interdisciplinary practitioners were managers and facilitators of projects. In this respect, the importance of key individuals to innovations arising from interdisciplinary collaboration cannot be underestimated. These individuals cannot be seen simply as charismatic leaders whose authority rests on their personal qualities, although the success of the projects they led was certainly reliant on the relationships they engendered between project members. What they worked to achieve was a personal engagement with the aims and goals of the project itself. In the sense that this does not involve normative values propagated through commitment to or faith in the leader, the authority of their leadership, while not impersonal, was depersonalized.

Narrative Construction of Events

Many individuals recognized as innovative interdisciplinary practitioners share an ability to narrate their projects to different audiences in ways that spoke to the relative value placed on the enterprise by interlocutors, negotiating differing needs and demands, and communicating in different registers to a variety of stakeholders. Whether this was representing the importance of research to funders, speaking to clients, or presenting arguments for policy, these leaders framed the narrative construction of the value and benefit of project goals to best communicate their goals and ideals to a variety of audiences. To be able to inspire and motivate diverse groups of disciplinary practitioners required framing project goals in ways that could appeal to all according to their own personal values and ideals. Researchers might, for example, be involved in a project because of the relative value placed on research outcomes – whether profit or the greater good, for career advancement, or the desire to broaden one's own intellectual horizons.

For some individuals, project goals might be subordinate to their personal aims, but the broader project narrative was able to accommodate and provide direction to various modes of personal and professional engagement. Meanwhile, project leaders might have to articulate the wider societal value of a project to a research funding body, framing arguments for its value within institutional and governmental funding priorities.

Shared Values

The importance of developing a sense of shared values and commitment to the research agenda was a theme frequently emphasized by expert witnesses. In some cases, this was a long-term commitment to an ideal, as in the work of the "Equator" consortium, a 6-year technology design initiative supported across eight UK universities to cultivate a community with diverse skill sets based in fundamental, curiosity-driven research. Consortium managers sought to create an environment in which teams could work together such that individuals derived their own value from the project while working within the framework of the consortium's research agenda. Mechanisms of appraisal were not merely measures of performance but placed key emphasis on critical reflection. This was a shared process of introspection that was seen to be a vital aspect of the management of the project, an egalitarian management style that allowed for people to engage with the project on their own terms and, importantly, implied a relationship of trust between all parties.

Commercial organizations are more typically concerned with incremental innovation that builds on existing products and business models. However, the egalitarian management ethos of commercial consultancy TTP bears a remarkable resemblance to that of successful interdisciplinary academic projects. TTP does not sell interdisciplinarity to its clients – clients already have a generalist understanding of their own business and come to TTP for specialist skills, not skill in interdisciplinarity. The core business of TTP relies on their being able to "sell" currently available staff as universal specialists – specialists in any problem that might present itself. The business cards of TTP staff do not reveal any specialization but present the holder as a representative of the TTP ethos. It is therefore essential that the company be managed in an egalitarian way, emphasizing social networks, collaborative personal styles, and matrix structure rather than strict disciplinary boundaries. There is then a strong sense of individual autonomy and flexibility in bringing people together in problem-solving teams in which knowledge and expertise might be combined in an ad hoc basis.

Polestar Leadership

The director of an interdisciplinary university research center for nanophotonics had consistently found that despite shared objectives, the most exciting discoveries from his work were not those expected at the start of a project. He gave highly skilled staff the freedom to pursue questions that interested them and noted the importance of motivating such a team through shared purpose. However, the tension between this leadership "from behind," and conventional expectations of leadership by vision and example, led him to describe his management style as neither from in front or behind but rather "sideways management," developing the metaphor of the "polestar," a long-term vision or goal that served as a common motivator to which multiple ideals and values might be oriented as a desired, ultimate research outcome.

Polestar leadership extends beyond the common notions of either intellectual leadership within an established tradition or of managerial coordination of activities within a project. It entails being able to recognize opportunities for alternative outcomes and being skilled at harnessing excitement among members of a team as it arises. This approach to innovation presents a number of challenges and paradoxes for managers and research sponsors. Few organizational structures are able to accommodate radical changes in the goals of a project, and it is hard for investment decisions to be made without articulating explicit outcomes that can be evaluated in advance. Although funding review and assessment procedures often distinguish between these intellectual ("scientific") and practical ("management") aspects of a research enterprise, the leadership of an interdisciplinary enterprise is not well characterized by either. Instead, leadership is manifest in the promotion of shared values and commitment to a community who share them. That community draws in, not only those directly employed in an enterprise but a wide variety of stakeholders, sponsors, and publics. The "polestar" vision that the interdisciplinary leader promotes and exemplifies does not rely on the knowledge structures of an established field (that would be a disciplinary research project) but on the potential to develop new knowledge and practices within a community that will value them.

Unanticipated Outcomes

The most valuable innovations arising from interdisciplinary research are often not anticipated at the outset, because successful interdisciplinary outcomes involve not only new answers but also new questions. Whether in contexts of professional problem-solving or open-ended curiosity-driven research, innovations arise in ways that cannot be foreseen at the outset of a new interdisciplinary enterprise, whether assembling a commercial team or commencing a research project. Most professional disciplines, or kinds of academic knowledge, bring with them ways of approaching a problem. This often involves restating the problem in a way that is compatible with the knowledge of the discipline – for example, the problem of obesity might be described by a physicist as being essentially one of "energy balance" – the result of people consuming more calories than they expend in exercise. However, the definition of a problem in disciplinary terms immediately excludes insights of other disciplines. Obesity might alternatively be described as a problem of social structure, to be addressed by investigating the fact that it is the wealthy and powerful who are obese in some cultures, but the poor and excluded in others. Neither formulation of the problem offers any direct assistance to the other.

Questions arise from the particular values of a discipline (in the obesity example, physicists are primarily interested in closed systems, while anthropologists are primarily interested in societies). It is only after significant periods of time or with specific attention and focus that collaborators from different disciplines are able to adopt each other's values to an extent that problems can be reformulated in radically different ways. Once this has been achieved, the ecology of interdisciplinary knowledge provides the context in which newly discovered problem formulations can be developed and exploited.

Ontology Versus Epistemology

It is often suggested that the main barrier to interdisciplinary collaboration is that disciplines develop their own jargon, such that those from outside cannot understand terminology. To a somewhat trivial extent, this may be true, although most experts are well aware of the technical terms and acronyms used in their field, and are easily able to adjust their discourse when speaking to nonspecialists. However, on the basis of findings of the study, it can be seen that the main obstacle to interdisciplinary innovation is not the need to find a "translator" or to develop a shared vocabulary. On the contrary, people from different disciplines seem to talk at cross-purposes because they are trying to achieve different things. They have difficulty understanding statements not because the words are unfamiliar but because the intention presumes different core values. In this respect, the issue of commensurability can be perceived as one of the ontological grounding of particular positions and perspectives rather than misunderstanding as a consequence of epistemological differences.

Many of the expert witnesses took the opportunity to reflect on their own personal histories and compare those histories to the attributes that they valued in collaborators, students, and employees. Individuals often seem to become "imprinted" with particular disciplinary styles as a result of early life experiences, especially first professional experiences and (for academics) early experience of higher education. This is not so much a matter of specific knowledge or disciplinary vocabulary (although vocabulary remains a consideration). Rather, it is a difference in ways of thinking, manner of approaching a problem, or the way in which goals are conceived. Expert witnesses referred to this obliquely or in passing as their "home discipline" or "native discipline," somewhat as though it were a first language, perceived ethnicity, or a country of origin. The literature on interdisciplinarity tends to assume that disciplinary knowledge is explicit rather than tacit, can be imparted via formal education, and can be articulated when necessary for comparison to other disciplines. It was found that those who work in interdisciplinary contexts, including among people who themselves have moved among many disciplines, suspect that their first academic training has left permanent traces that influence their intellectual style, wherever they have subsequently found themselves. The existence of personal and tacit disciplinary styles may form a natural limit on pace of disciplinary change, which could only be generational, if it is primarily the result of early career experiences. Interdisciplinary enterprises construct new communities that are composed of individuals who share willingness to step outside the knowledge boundaries within which they are trained. It is the diversity of the individuals that provides opportunities for unanticipated insight and innovation.

The Public Value of Interdisciplinary Innovation

While there are many components of innovation, encompassing both creativity and exploitation, this cross-sector analysis clearly brought to light the diverse targets for innovative activity in different sectors, encompassing the development of products or services for commercial exploitation, curiosity-driven academic research, problem solving of various scope, and the creation of social value through specific intervention. These may be summarized as follows:

- Commercial exploitation of new ideas, technologies, and processes is a primary concern of innovation, enshrined in definitions from business and economic policy bodies. The objective is to create, develop, implement, and sell products or services. To this end, commercial innovation is likely to be purposeful and managed. The result may be incremental – a minor enhancement of an already marketed or used product, service, or process. More spectacularly, commercial innovation may be radical, characterized by a greater degree of novelty, perhaps with a capacity to disrupt previous business.
- Curiosity-driven research is most often found in the academic sector. It seeks knowledge and new insights, creating unifying theories and models that describe a new understanding of perceived phenomena. Those phenomena might be equally well in the domains of science, of humanities, of arts and creative industries, of sociology, or of politics and policy. The aim is insight, not necessarily with the intention of action or intervention.
- Problem-solving activity is directed toward identifying some new approach that solves a situated problem. Here, there may be a problem of agreed boundaries – what is the scope of the problem and what kind of solutions are expected. The objective is an explicit intervention to solve or ameliorate the problem. In this context, success can be characterized by the extent to which the problem is resolved. New knowledge or new insights are a convenient but nonessential by-product.
- The enhancement of social value is another form of innovation, whether the health of a population or the social cohesiveness of a community. Here, the development may lie in the creation of a new intervention, or it may lie in the process by which change was exercised, for example, in an artistic endeavor that engages with marginalized parts of society.

So what is the value proposition of interdisciplinarity in these examples?

In the areas of problem solving or of the commercial development of a new product, service, or process, the objectives may be tightly defined. Here, the explicit intention of interdisciplinarity is the use of different skills or analytic perspectives – to frame the problem or opportunity, to bring to bear different repositories of knowledge, and to use the insights so gained to achieve a richer solution. It is believed that interdisciplinarity increases the likelihood of a radical solution to the problem or realizing the commercial opportunity. This requires more than the simple combination of professional skills to carry out routine business (as when a nurse, an anesthetist, and a surgeon work together in an operating theater). Radical innovations combine people and skills in unexpected ways, leading to results of different kinds to those that professional training is focused on.

In academic, curiosity-driven research, there may be new insights created by the new conjunction of differing interests and perspectives. In such cases, the different disciplines combine in ways that serendipitously stimulate breakthroughs. Indeed, in the pure research area, there is increasing enthusiasm for the unpredictable novelty and potentially radical nature of the results of interdisciplinary teams. Such research can also result in breakthrough opportunities for later commercial application or as foundations for innovative cultural and social action. However, such forms of exploitation often occur at a distance or a long time after the initial research investment. In these cases, it is not usually the goals of the original research project that result in long-term benefits. Instead, it is the creation of an "ecology" within which such exploitation can happen, where there is an intellectual and skills capacity of highly trained people, and these people have experience of working within other disciplinary contexts as well as networks of contacts giving them rapid access to other disciplinary knowledge.

A key policy concern at present is how one can prioritize and evaluate research activity that is supported with public funds. It is essential that value be demonstrated to the public and that those receiving public funds be held accountable for their use of funds. However, a paradox for responsible stewardship is that, while public funds should be directed toward known outcomes of public benefit, interdisciplinary research has essentially unknown outcomes. "Safe" or "incremental" research is considered less deserving of public support, yet it continues to be prioritized by mechanisms that assess performance within established categories. In order to maintain quality of academic enquiry, it is necessary to establish mechanisms that recognize and reward determined curiosity, willingness to step outside boundaries, and reflective development of personal and community practices.

Conclusion and Recommendations

Interdisciplinary innovation is primarily a social phenomenon, associated with the processes and experiences of crossing social boundaries, rather than an epistemological phenomenon as often implied by metaphors of "cross-fertilization" or "filling gaps" in human knowledge. Social structures are certainly associated with knowledge structures – every social group acquires and organizes its own characteristic body of knowledge. However, there is no reason to believe that academic disciplines as custodians of knowledge are any different from other social groups. Individual departments within large public organizations and corporations are equally likely to acquire, structure, and preserve special bodies of knowledge within which to define relative expertise, seniority, or originality among colleagues.

The instrumental agenda for policy advocates of interdisciplinary innovation is that new problems faced by organizations may need to be addressed by using knowledge from elsewhere. Of course, many routines and conventionally applied problems also include aspects that are well-defined as requiring a variety of specialist expertise (e.g., the design of a house may involve an architect, structural engineer, quantity surveyor, construction lawyer, etc.). Problems of this kind are ubiquitous but are not regarded as being "interdisciplinary" because of their conventional nature. The term "multidisciplinary" is often suggested as a means of distinguishing between routine collaboration and the innovative problem solving associated with interdisciplinarity.

When addressing a new kind of problem – one that requires an innovative solution – it may be clear from the outset that more than one kind of knowledge will be necessary to construct a solution. However, because the appropriate relations between disciplines have not yet been formulated, it will be necessary for collaborators to cross boundaries when negotiating a solution. Furthermore, even large organizations are unlikely to accurately forecast the problems they will face in future; in which case, the formulation of responses to future problems will require knowledge resources from outside the organization boundaries. The social need for crossing boundaries in interdisciplinary innovation is therefore a natural consequence of organizational life. Interdisciplinary boundary-crossing experiences are associated with innovation because they arise from novelty and from the need to prepare for the future.

This entry focused specifically on the personal experiences of those people who have gained a reputation for effective work in interdisciplinary innovation. These findings should be seen as being complementary to studies of organizational structure and to studies of the business and economic consequences that result from innovation.

The essence of interdisciplinary innovation is the experience of teamwork, where each member encounters people with different skills and perspectives to their own. However, those different kinds of knowledge are associated with boundaries. As noted above, knowledge is maintained within organizations – usually by the group of experts who are at the core of any organization and who maintain and develop its core knowledge. In many organizations, and especially academic disciplines, recruitment, induction, and advancement within the organization are often managed in terms of the extent to which an individual has acquired its core knowledge. Within traditional career structures (and again, academic disciplines are archetypal), the ultimate benchmark of expertise is the amount of knowledge that a person might reasonably acquire in a lifetime. Organizational knowledge boundaries, whether government departments or academic disciplines, are likely to be set in accordance with the lifetime capacity of the experts at the center of the organization.

Policy rhetoric advocating interdisciplinarity often denigrates the "silo," employing a metaphor that suggests knowledge would be better released into locations where it can be applied. However, the findings do not suggest that boundaries can simply be ignored or removed. Boundaries are essential to the social construction and maintenance of expert knowledge. The challenge of interdisciplinary teamwork is to find effective ways of working across those boundaries without disrupting them. In this respect, incommensurability might be perceived potentially as an enabler or driver for interdisciplinary engagement. The aim here is the facilitation of cross-disciplinary engagement – not to establish the ultimate veracity of a particular truth, model, or account of events but to generate the possibilities for new insights via engaging with those oriented practically in and perceiving the world differently.

There are, of course, obstacles facing those who wish to work outside their established organizational boundaries. Many disciplines have grown together as social groups precisely because of a set of shared values that motivated the creation of the discipline. It takes a wide range of skills, including substantial personal leadership ability, to manage a team of people who hold different values. In order to be effective interdisciplinary innovators, the team must develop shared values and culture, probably over a period of many months, leading to years. The leader of an interdisciplinary enterprise must create conditions to enable, encourage, and inspire that process. Furthermore, the leader must be able to recruit resources sufficient to maintain the team within an inherently uncertain environment.

The most valuable outcomes from an interdisciplinary enterprise were not anticipated at the outset. This is unsurprising, because future problems, or even novel problems that cross today's boundaries, are problematic because of the way they defy description in disciplinary terms. It is in the nature of such problems that they cannot be described or characterized in established terms. The leader must therefore be able to attract resources, maintain them over a considerable period of time, and be a competent manager of uncertainty and risk, while also being a skilled enabler of serendipity – providing the capacity to recognize and profit from unexpected events.

Cross-References

▶ Interdisciplinary Research (Interdisciplinarity)
▶ Knowledge Society, Knowledge-Based Economy, and Innovation

References

Blackwell AF, Eckert CM, Bucciarelli LL, Earl CF. Witnesses to design: a phenomenology of comparative design. Des Issue. 2009;25(1):36–47.

Brewer G. The challenges of interdisciplinarity. Policy Sci. 1999;32:327–37.

Brown JS, Duguid P. The social life of information. Boston: Harvard Business School Press; 2000.

Chaiklin S, Lave J. Understanding practice: perspectives on activity and context, learning in doing. Cambridge: University Press; 1993.

Council for Science and Technology. Imagination and understanding: a report on arts and humanities in relation to science and technology. London: Department of Trade and Industry; 2001. www2.cst.gov.uk/cst/reports/files/imagination-and-understanding/imagination-understanding.pdf

Cox G. Cox review of creativity in business: building on the UK's strengths. Norwich: TSO; 2005. www.hm-treasury.gov.uk/independent_reviews/cox_review_index.cfm

Engeström Y. Expansive visibilization of work: an activity – theoretical perspective. Comput Support Coop Work. 1999;8:63–93.

HM Treasury. Science and innovation investment framework 2004–2014: next steps. Norwich: Stationery Office; 2004. www.hm-treasury.gov.uk

Huutoniemi K, Klein JT, Bruun H, Hukkinen J. Analyzing interdisciplinarity: typology and indicators. Res Policy. 2009;39:79–88.

Latour B, Woolgar S. Laboratory life: the social construction of scientific facts. Beverly Hills: Sage; 1979.
Lattuca L. Learning interdisciplinarity: sociocultural perspectives on academic work. J High Educ. 2002;73:711–39.
National Academies (U.S.) Committee on Facilitating Interdisciplinary Research, Committee on Science, Engineering, and Public Policy (U.S.), National Academy of Sciences (U.S.), National Academy of Engineering, Institute of Medicine (U.S.). Facilitating interdisciplinary research. Washington, DC: National Academies Press; 2005.
Royal Society. Hidden wealth: the contribution of science to service sector innovation. RS Policy document 09/09. London: Royal Society; 2009.
Royal Society. The scientific century: securing our future prosperity. RS Policy document 02/10. London: Royal Society; 2010.
Strathern M. Accountability across disciplines, commons and borderlands: working papers on interdisciplinarity, accountability and the flow of knowledge. Wantage: Sean Kingston; 2004.
Wittgenstein L. Philosophical investigations. 2nd ed. Oxford: Blackwell; 1958.

Interdisciplinary Groups

► Creative Collaboration

Interdisciplinary Research (Interdisciplinarity)

Markus Arnold
Faculty of Interdisciplinary Studies (IFF), Institute for Science Communication & Higher Education Research (WIHO), Alpen-Adria University of Klagenfurt, Vienna, Austria

Synonyms

Cross-disciplinarity; Multidisciplinarity

Introduction

From the beginning the discourse on interdisciplinarity (ID) was "a discourse on innovation in knowledge production" (Weingart 2000: 30). Its basic objective has been to make science and higher education more responsive to the complexity of life-world problems and more relevant for the public good and the legitimate needs of the society. The criticism leveled in the name of ID against the disciplinary organization of the traditional universities was summarized under the oft-cited catchphrase "Communities have problems, universities departments" (CERI 1982: 127).

The term interdisciplinarity or interdisciplinary research (ID) can be defined in two distinct but intersecting ways: interdisciplinarity means either the collaboration of researchers trained in different fields of knowledge or the integration of different concepts, methods, and data from two or more different disciplines, no matter if this interdisciplinary integration is achieved by an interdisciplinary research group or by a single researcher.

However, an interdisciplinary *integration* of different knowledge fields requires at the same time new *divisions* of knowledge, since the definition of specialized topics between disciplinary knowledge fields is essential as interdisciplinary foci for any collaborative research across disciplinary boundaries (Weingart 2000: 36). The dream of an all-encompassing unity of knowledge belongs to the past, an ID integration of different knowledge claims can be reached only in a variety of local syntheses between research findings of carefully selected disciplines.

History of the Concept

The Organization for Economic Co-operation and Development (OECD) was in the 1970s one of the first organizations promoting interdisciplinarity with the aim to strengthen universities "which in the future ought not be the servant but the conscience, the analytical mind and the driving force in society" (Briggs et al. 1972: 288). Scientific research should become more relevant for the economic as well as the societal development of modern societies. It was the time of the starting discourse about "knowledge societies," which found 1973 its prominent advocate in

Daniel Bell's book "The Coming of Post-Industrial Society: A Venture in Social Forecasting" (Bell 1973).

Nevertheless, the concept of interdisciplinarity itself was from the beginning about the nuts and bolts of the day-to-day research in industrial laboratories and at universities. In contrast to the discourses on knowledge societies (Bell 1973), Mode-2 research (Gibbons et al. 1994; Nowotny et al. 2001), the Triple Helix Model (Etzkowitz and Leydesdorff 2000), and on Quadruple Helix Innovation Systems (Carayannis and Campbell 2012), the discourse on ID research does not presuppose any macro theories about societal developments or all-encompassing speculations about historical developments. Although to make a well-founded case for doing ID research, ID supporters are often relying on one of these theoretical forecasts and analyses of modern society. The concept of ID itself just asserts that for the solving of certain societal problems, researchers have to transgress disciplinary boundaries and engage in ID collaborations. The competence to engage in ID research is seen as an indispensable craft for modern societies: if someone wants to cope with the complexity of the modern world, the competence for ID research is a vital skill to be learned. Therefore, ID is basically a discourse on the how-to-do of successful disciplinary-boundaries-transcending scientific research (Arnold 2009).

As a matter of fact the term interdisciplinarity became since the 1980s a prominent key tender term in many newly established research funds aiming at more social or environmentally relevant scientific research (cf. Hackett 2000; Krull and Krull 2000). Soon ID was implemented in university curricula as well, teaching students – with an eye to their prospective field of work and to their role as responsible citizens in a modern democracy – to tackle with complex life-problems by the use of different scientific methodologies in a professional way (Kockelmans 1979; Frodeman et al. 2010: 345–403).

In 2004, the EU research Advisory Board circulated recommendations for interdisciplinarity in research (EU Research Advisory Board 2004), in 2005 the Finnish Academy of Science followed with a study promoting ID (Bruun et al. 2005), whereas in the USA the National Academy of Sciences together with the National Academy of Engineering issued a report evaluating past achievements of ID research and recommending ID as an important and successful way for innovations, stating that:

> "many of the great research triumphs are products of interdisciplinary inquiry and collaboration: discovery of the structure of DNA, magnetic resonance imaging, the Manhattan Project, laser eye surgery, radar, human genome sequencing, the 'green revolution,' and manned space flight." (Committee on Facilitating Interdisciplinary Research et al. 2005: 17)

Furthermore – as the report adds (ibidem) – many of today's "hot" research topics are interdisciplinary like nanotechnology, genomics, bioinformatics, neuroscience, conflict, and terrorism, as well as research in areas like disease prevention, economic development, social inequality, and global climate change.

Aims and Limits of Disciplinary Research

The First Obstacle for ID: The Disciplinary Organization of Science

Although the term *disciplina* was used as early as in the Middle Ages for the ordering of knowledge within universities, the invention of the modern scientific discipline (here and in that which follows including humanities and the social sciences) dates back to the nineteenth century and the invention of the modern research university in Berlin. Since then, disciplines are the basic units of differentiation within the system of science and the higher education system as well. They were established together with the emergence of modern scientific communities and the first scientific journals with their standardized ways of scientific communication with colleagues and specialized readers only. Amateur scientists, which were in the eighteenth century as educated public still an accepted part of the scientific community, became now excluded (Stichweh 1984, 1992). It was the arrival of what Thomas Kuhn later famously called "normal science." Its chief characteristic is its close alignment to approved "paradigms" (or what Kuhn later called "disciplinary matrix"), setting narrow limits for new methods and research questions:

> "Perhaps the most striking feature of the normal research problems [. . .] is how little they aim to produce major novelties, conceptual or phenomenal. [. . .] To scientists, at least, the results gained in normal research are significant because they add to the scope and precision with which the paradigm can be applied." (Kuhn 1970: 35 f.)

"Normal science" is nothing more or less than a kind of "puzzle-solving," since each paradigm identifies perplexing puzzles, suggests paths to their solution, and reassures that not scientific genius but the hard work of scientific practitioners will be sufficient for success (Kuhn 1970: 179). In other words, paradigm-led normal science is aiming at perfection, that is, incremental innovations, to find better answers to existing questions. Radical innovations, like paradigm shifts, are within the disciplinary organization of the sciences the exception and not the rule.

The Second Obstacle for ID: The Variety of Epistemic Cultures

However, it is not merely the disciplinary orientation of normal science which impedes ID collaborations. Even, should the need for an ID collaboration be acknowledged by scientists, cooperation may become difficult since different epistemic cultures are often in conflict when it comes to questions like: What are sound methods? How to measure quality, but also more subtle differences like differences in social values making day-to-day collaboration within interdisciplinary teams again and again vulnerable to conflict and fundamental misunderstandings (Arnold 2004; Becher 1993; Knorr-Cetina 1999)? Furthermore, different disciplines are often not considered as of equal rank and status within the disciplinary system:

> "[T]he interdisciplinary team is an open rather than a closed system. [. . .] Interdisciplinary teams in this respect are status systems that reflect external hierarchies and disciplinary chauvinism. [. . .] [T]he status system of a team will tend to follow the status system of the world outside the team if there is no strong alternative organization, though even a strong organization cannot eliminate status ambiguity and clashes in career goals, professional styles, and epistemologies." (Klein 1990: 127, cf. Lamont 2009)

The different disciplinary contributions by themselves, therefore, often do not add up to a coherent whole, that is, to an integrated research result, since they adhere to quite different epistemological principles or are the product of diverse research routines.

The Third Obstacle for ID: The Claims of Professional Jurisdiction

For experts (inside and outside the universities) to accept that other experts can contribute with their methods and disciplinary knowledge as much as oneself to the solution of a problem implies in the end to give up one's own disciplinary claim for exclusive professional jurisdiction over this problem field. Hence, interdisciplinary cooperation can conflict with professional aspirations to prevent competing scientific communities and professions from interfering in one's own field of expertise:

> "A jurisdictional claim made before the public is generally a claim for the legitimate control of a particular kind of work. This control means first and foremost a right to perform the work as professionals see fit. Along with the right to perform the work as it wishes, a profession normally also claims rights to exclude other workers as deemed necessary, to dominate public definitions of the tasks concerned, and indeed to impose professional definitions of the tasks on competing professions. Public jurisdiction, in short, is a claim of both social and cultural authority." (Abbott 1988: 60)

For that reason the demand for ID cooperation is seen especially by dominant disciplines and professions as infringement of their jurisdictional claims for exclusive responsibility; to admit the relevance of the expertise of other disciplines for a particular research project is like accepting a kind of defeat inevitably undermining the social and cultural authority of one's own disciplinary knowledge and expertise. The authority of jurisdictional claims is important for disciplines not least because jurisdictional claims, when acknowledged as legitimate, are directly translatable in further research funding and job opportunities on the labor market for their graduates (Turner 2000).

Innovations: Crossing Disciplinary Boundaries

Trading Zones: The Value of Multidisciplinary Perspectives

Although multidisciplinarity is not ID as such, since a multidisciplinary perspective on an issue is per definition not aiming at an ID *integration* of the different perspectives, multidisciplinarity can become an important, if only preliminary stage in the process of designing ID projects and research programs. Putting a multiplicity of disciplinary approaches together can provide a multifaceted outlook revealing the complexity of real-world problems pointing out the need for a truly interdisciplinary solution.

Peter Galison developed the concept of disciplinary "trading zones" in his attempt to describe the requirements of a difficult, but in the end successful multidisciplinary collaboration between engineers and physicists with different theoretical background in the development of particle detectors and radars (Galison 1997: 781–844; Gorman 2002). These different groups had not only to find an agreement over those objectives, the design of the particle detector had to achieve: to communicate their ideas they had to invent a common ("creole") language transcending their disciplinary idioms to explain their research programs and to share their disciplinary expertise commonly.

> "The point is that these distinct groups, with their different approaches to instruments and their characteristic forms of argumentation, can nonetheless coordinate their approaches around specific practices. [. . .] Note that here, as in any exchange, the two subcultures may altogether disagree about the implications of the equivalences established, the nature of the information exchanged, or the epistemic status of the coordination." (Galison 1997: 806)

Unlike ID, which aims at a comprehensive integration of disciplinary knowledge domains and shared epistemological models, *multidisciplinary* co-operations can differ about theories and their understanding of the collaboration, since they do not necessarily need unanimity and a common perspective.

Such "trading zones" between different scientific and societal groups are public spaces where the need for certain interdisciplinary co-operations and projects can become pressing and where innovations through brokering of ideas, methods, and theories are becoming more likely to emerge. Therefore, as Lester and Priore have argued, certain institutional and organizational arrangements to encourage this kind of brokering and trading of multidisciplinary information with the help of public domains have to be established and maintained within an innovation system. Particularly the modern research university with its diversity of scientific disciplines under one organizational roof is well-designed for this special purpose: to provide a kind of "sheltered space" that can sustain public conversations between a variety of scientific specialists and societal stakeholders:

> "To a much greater degree than in business firms, the disciplines dominate [within the university] the conversations; but the diversity of perspectives is greater than in firms because academic discussions draw in a broader range of participants [. . .]. Even accounting for the restrictive influence of the disciplines, a university, far more than a firm, is a public space." (Lester and Priore 2004: 166 f.)

These multidisciplinary public conversations within the universities (and at other places) give rise to "interpretative communities" enabling actors with different backgrounds to establish common definitions of societal problems and research questions, which are the indispensable precondition for the design of ID research programs and research co-operations.

Interactional Expertise: Communicating Across Disciplinary Boundaries

The competence necessary to build ID research co-operations within these "trading zones" is what Collins and Evans have called "interactional expertise" (in contrast to "contributory expertise"), that is, an expertise in understanding and communicating knowledge across the boundaries of disciplinary communities and specialized fields of expertise:

> "mastery of interactional expertise [. . .] is the medium of interchange within large-scale science projects, where [. . .] not everyone can be a contributor to everyone else's narrow specialism; it is, *a forteriori*, the medium of interchange in

properly *interdisciplinary*, as opposed to multidisciplinary, research." (Collins and Evans 2007: 31 f.; cf. Collins and Evans 2002)

To cooperate successfully with other disciplines it is necessary to understand their problems, methods, and results, so one can talk with members of this scientific community about their research questions and findings on a certain level of expertise without becoming a member of this community by oneself. Obtaining this level of understanding is possible only with the help of insiders, who are willing to explain their work. Cultivating interactional expertise for an interdisciplinary cooperation requires an ongoing effort to make disciplinary knowledge accessible to a wider public, in other words by participating in efforts of "popularization" which itself is usually aligned with innovation and interdisciplinarity:

> "In modern science innovation, especially radical or revolutionary innovation is regularly coupled to interdisciplinarity as a mechanism of hybridization of scientific knowledge. And popularization is often based on interdisciplinary combinations of knowledge which sometimes are audacious. Therefore, there is a significant innovation potential in popularization [. . .]. Doing popularization is [. . .] an opportunity for experimenting with a level of intellectual risk which is not readily accepted in everyday scientific practice." (Stichweh 2003: 215)

Communicating scientific knowledge successfully beyond the confines of its disciplinary community is only possible if this knowledge is placed within a wider context: its relations to other sources of knowledge – how they match or mismatch with one another – as well as its societal relevance have to be explained, helping to understand the significance of this knowledge and why it should be considered as relevant in the context of certain research questions. Furthermore, concentrating on the relevance of scientific knowledge for societal problems is an effective way to connect disciplinary expertise to the expertise of other disciplines, to relate scientific findings to everyday knowledge and to widely hold cultural beliefs – in preparation for the development of ID epistemological models.

Interdisciplinary Epistemology: The Need for ID Models

For the integration of different disciplinary knowledge fields one is in need of a theory or an epistemological model of the relations between these different knowledge claims. For example, how can someone best analyze a historical period or – more generally – the "cultural" practices of a societal group: the evidence of social sciences based on statistical numbers is different from the evidence of historical scholarship based on archival sources. And both are different from the evidence of literary and media studies based on an interpretation of a novel or a film. However, each of these knowledge domains can provide a substantial contribution for the understanding of someone's "culture." Only a combination of these different disciplinary results, governed by a theoretical model of the epistemological relations between their methods and sources, can give an interdisciplinary perspective on the distinctive cultural features of someone's way of life, that is, a detailed explanation of one's culture.

Therefore, when the French historian Fernand Braudel proposed (together with the members of the so-called Annales School) a research program aiming to show how geography and economy have shaped societies and historical events in particular, he had to integrate findings from disciplines as diverse as geography, economy, and history within a theoretical model. Since these

> "systems of explanation vary infinitely according to the temperament, calculations, and aims of those using them: simple or complex, qualitative or quantitative, static or dynamic, mechanical or statistical. [. . .] In my opinion, before establishing a common program for the social sciences, the crucial thing is to define the function and limits of models, the scope of which some undertakings seem to be in danger of enlarging inordinately." (Braudel 1980: 40)

Braudel's epistemological reflections on the different disciplinary systems of explanations made him aware of what he called the *longue durée* (the long term) in contrast to the short-term events which lie in the traditional focus of the historians. To integrate these different levels of explanations, he established his famous distinction between three levels of time: (1) the geographical time of the natural environment, where change is very slow and almost imperceptible for human actors, (2) the long-term developments of the economic, social, and cultural history, and (3) the time of the historians dominated by short-term events and the actions of individuals, including those of politicians and soldiers. Only then could Braudel begin to integrate the diverse disciplinary findings within a methodological sound historical framework, as he did, for example, in his influential *The Mediterranean and the Mediterranean World in the Age of Philip II* (1949).

Another example is an ID model developed by the interdisciplinary Birmingham School of Cultural Studies to understand innovation in the "culture industry" analyzing, as an example, the invention of the Sony Walkman. Introducing the model of the "circuit of culture" they have tried to understand the interactions between five different cultural processes: the production of goods, the consumption, different kinds of regulations, the cultural representations within mass media, and the construction of social identities. In other words, how an electronic device "is represented, what social identities are associated with it, how it is produced and consumed, and what mechanisms regulate its distribution and use." (Gay et al. 1997: 3). The ID model is necessary to combine diverse types of knowledge about an electronic device such as the Sony Walkman. Only then is it possible to understand how every product is participating in various economic, social, and cultural processes: why success and failure of an innovation are always depending on the interaction of these processes, which are often mistakenly seen as autonomous and for that reason usually analyzed by separate scientific disciplines.

A theoretical model of the ID relations between different knowledge domains helps to understand how someone can integrate different disciplinary findings in a methodological sound way.

Organizing Interdisciplinary Research Teams

Each discipline or research area has to develop and care for its own epistemic culture. Therefore, it is important, which scientific disciplines should be integrated within an interdisciplinary project. Different methods, different kinds of argumentation and evidence, as well as different social arrangements of inner-disciplinary co-operations require customized solutions for every single ID-research project (cf. Piaget et al. 1972; Piaget 1973; Becher 1993; Klein 1996; Arnold 2009). But also the host institutions can differ regarding the type of ID research that they are supporting. There are on the one hand ID institutions with changing research topics and temporary research groups, such as the German Center for Interdisciplinary Research (ZiF, *Zentrum für interdisziplinäre Forschung*, University of Bielefeld), founded in 1968 (Frodeman et al. 2010: 292 f.), or on the other hand institutions with long-lasting ID research teams institutionalized in departments staffed with both permanent and temporary researchers, such as at the Austrian Faculty for Interdisciplinary Studies (IFF, *Fakultät für interdisziplinäre Forschung und Fortbildung*, Alpen-Adria-Universität Klagenfurt), with predecessor organizations dating back to its first formation in 1979 (Arnold and Dressel 2009). In the former case ID is seen as driven by changing scientific interests, in the latter ID is organized around societal problems, which require steadfast attention over many years if they ever should be solved.

Nevertheless, there are also some characteristics, which most ID research projects have in common. For example, to create an ID research team out of a multidisciplinary group of researchers, where at least one of the research participants has to think interdisciplinarily, working deliberately on the integration of the different methods and research findings (Parthey 1999). Much time has to be designated for periodic team meetings (not least at the beginning, but during the project as well), to elaborate not only a common understanding, but also to address personal irritations and conflicts between team members face-to-face. Since learning from other disciplines is an important element of ID projects, a successful ID research process can be seen as fostering a type of societal learning, where scientists share their different knowledge and expertise aiming to create a common understanding of the problems and the solutions, with the result that every team member has to acquire and adopt this knowledge during the research process (Arnold 2009).

However, ID depends on the individual researcher's competence and personal ability to cooperate with others in ID research teams. Studies suggest that there are certain character traits which many effective ID researchers have in common like "a high degree of ego strength, a tolerance for ambiguity, considerable initiative and assertiveness, a broad education, and a sense of dissatisfaction with monodisciplinary constraints" (Klein 1990: 183).

Evaluating Interdisciplinary Research

As Heinrich Parthey showed, a good indicator for ID is the percentage of researchers within a research group who formulate their own guiding research problem in concepts spanning across disciplinary boundaries. Because thinking from an ID perspective means to formulate and justify the guiding research problem on a different theoretical level and with different theoretical concepts than the methods with which these interdisciplinary problems are approached afterward by the participating disciplines. In addition, a second important indicator for ID research is the interdisciplinary character of the methods applied to the problem: when scientists borrow methods across disciplinary boundaries, for example, by transfer of methods from other specialist fields of research (Parthey 2011). Both traits have to be encouraged within research teams and both are valuable indicators for the evaluation of the "interdisciplinarity" of an ID research project.

But one main problem in evaluating the quality of ID remains: Who is able to judge about the quality of ID research? Disciplines have their standards and their peers, but ID projects are by definition transcending disciplinary boundaries:

> "Since interdisciplinary research is a new synthesis of expertise, peers in the strong sense of the word do not exist. When new combinations of knowledge are tried in interdisciplinary projects, no one but those conducting the work are competent in all aspects of that combination." (Laudel 2006: 57)

Furthermore, empirical research suggests a bias against ID in peer review since peers tend to favor proposals belonging to their own field of study (Laudel 2006) and are falling back on traditional disciplinary standards of the disciplines involved so that in the aggregate all too often an ID research proposal has to meet more quality criteria than disciplinary proposals, increasing the likelihood of getting rejected by research funds (Lamont 2009: 208–211, Mansilla 2006: 25, Huutoniemi 2010: 312 f.).

As already said above (Sect. The First Obstacle for ID: The Disciplinary Organization of Science), paradigm-led disciplinary science is aiming at perfection, that is, incremental innovations, to find better answers to existing questions. Disciplinary evaluations, therefore, endorse those projects which are "sound" and "mature" according to the existing disciplinary standards, they are looking for inaccuracies. However, innovations are per definition not "mature" and in the beginning not "sound" (as defined by disciplinary-oriented evaluators) as well. Since competing quality standards of different disciplines are often one of the reasons why disciplines cannot agree to cooperate in a common research project, ID research has often to develop and justify its own methodological standards, which are appropriate for its special research questions and its carefully selected new research objectives.

Conclusion and Future Directions

Creating an innovation and ID-friendly research environment will remain an important objective for the near future. Since despite critics who are still claiming that ID is nothing but a passing science policy fad: as long as modern research and teaching is primarily organized within disciplinary boundaries, ID research will assert its rank as one of the most important paths to innovation. Its major aim will remain to counterbalance the conservative and inward-looking character of strictly disciplinary research organizations, of their research questions and evaluations. For that reason the distinct quality of ID has to be recognized for the funding of research and the management of research organizations as well. Traditional quality indicators like publications in disciplinary journals can contradict the very intentions of ID-research: stipulating that the results should be published in different (disciplinary) journals forces research teams at the end of their project to dissolve the already achieved level of ID knowledge integration again into its disciplinary parts. By insinuating that disciplinary audiences are the only legitimate judges about the outcomes of ID research, ID is against its principal objective treated as nothing but a loosely connected "multidisciplinary" synopsis of disciplinary research questions and findings.

Hence, the assessment of ID should not solely consist of a post hoc addition of individual expert opinions, but of the deliberate attempt to integrate different disciplinary perspectives with the help of the consolidated judgment of an ID expert group, amenable to reason and time-consuming deliberations. Only a disciplinary-boundaries-bridging group of experts is able to appreciate the specific merits of ID research such as developing new research questions and research programs beyond well-trodden disciplinary paths.

Furthermore, since ID is not only aiming for innovations but also on social relevance, combining interdisciplinary research with participatory transdisciplinary research (TD) is a highly successful method to ensure within an ID research project both the non-disciplinary character and the social relevance of the research questions. Thus, proceeding from life-world problems and integrating not only knowledge of different scientific disciplines, but in addition also non-scientific expertise as well, can be seen as one of the most promising research strategies for the future of ID.

Cross-References

- ▶ Mode 1, Mode 2, and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)

References

Abbott A. The system of professions: an essay on the division of expert labor. Chicago/London: University of Chicago; 1988.

Arnold M. Disziplin und Initiation. Die kulturellen Praktiken der Wissenschaft. In: Arnold M, Fischer R, editors. Disziplinierungen. Kulturen der Wissenschaft im Vergleich. Wien: Turia & Kant; 2004. p. 18–52.

Arnold M. Interdisziplinarität: theorie und praxis eines forschungskonzepts. In: Arnold M, editor. iff – Interdisziplinäre Wissenschaft im Wandel. Wien-Münster: Peter Lang; 2009. p. 65–97.

Arnold M, Dressel G. iff – Geschichte einer interdisziplinären Institution. In: Arnold M, editor. iff – Interdisziplinäre Wissenschaft im Wandel. Wien-Münster: Peter Lang; 2009. p. 17–56.

Becher T. Academic tribes and territories. Intellectual enquiry and the cultures of disciplines. Buckingham: Open University Press; 1993.

Bell D. The coming of post-industrial society: a venture in social forecasting. New York: Basic Books; 1973.

Braudel F. History and the social sciences. The Longue Durée. In: Braudel F, editor. On history. Chicago: University of Chicago Press; 1980. p. 25–54.

Briggs A, et al., editors. Interdisciplinarity. Problems of teaching and research in Universities. Paris: OECD; 1972.

Bruun H, Hukkinen J, Huutoniemi K, Klein JT. Promoting interdisciplinary research: the case of the Academy of Finland. Helsinki: Publications of the Academy of Finland; 2005.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems: 21st-century democracy, innovation, and entrepreneurship for development. New York/London: Springer; 2012.

CERI. The university and the community. The problems of changing relationships. Paris: OECD; 1982.

Collins HM, Evans R. The third wave of science studies: studies of expertise and experience. Soc Stud Sci. 2002;32(2):235–96.

Collins HM, Evans R. Rethinking expertise. Chicago/London: University of Chicago Press; 2007.

Committee on Facilitating Interdisciplinary Research et al. Facilitating interdisciplinary research 2005. Washington, D.C.: National Academies Press: National Academy of Sciences, and National Academy of Engineering, and Institute of Medicine; 2005.
de Gay P, et al. Doing cultural studies. The story of the Sony Walkman. London/Thousand Oaks/New Delhi: Sage; 1997.
Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and 'mode 2' to a triple helix of university-industry-government relations. Research Policy. 2000;29(2):109–23.
EU Research Advisory Board. Interdisciplinarity in research. EURAB http://ec.europa.eu/research/eurab/pdf/eurab_04_009_interdisciplinarity_research_final.pdf. Accessed 10 Aug 2012; 2004.
Frodeman R, et al., editors. The Oxford handbook of interdisciplinary. Oxford/New York: Oxford University Press; 2010.
Galison P. Image and logic: a material culture of microphysics. Chicago/London: University of Chicago Press; 1997.
Gibbons M, Limoges C, Nowotny H, Schwartzmann S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary Societies. London: Sage; 1994.
Gorman ME. Levels of expertise and trading zones: a framework for multidisciplinary collaboration. Soc Stud Sci. 2002;32(5–6):933–8.
Hackett EJ. Interdisciplinary research initiatives at the U.S. National Science Foundation. In: Weingart P, Stehr N, editors. Practising interdisciplinarity. Toronto/Buffalo/London: University of Toronto Press; 2000. p. 248–59.
Huutoniemi K. Evaluating interdisciplinary research. In: Frodemann R et al., editors. The Oxford handbook of interdisciplinarity. Oxford/New York: Oxford University Press; 2010. p. 309–20.
Klein JT. Interdisciplinarity: history, theory, and practice. Detroit: Wayne State University Press; 1990.
Klein JT. Crossing boundaries: knowledge, disciplinarities, and interdisciplinarities. Charlottville/London: University Press of Virginia; 1996.
Knorr-Cetina K. Epistemic cultures: how the sciences make knowledge. Cambridge/London: Harvard University Press; 1999.
Kockelmans JJ, editor. Interdisciplinarity and higher education. University Park/London: Pennsylvania State University Press; 1979.
Krull W, Krull W. Beyond the ivory tower. Some observations on external funding of interdisciplinary research in universities. In: Weingart P, Stehr N, editors. Practising interdisciplinarity. Toronto/Buffalo/London: University of Toronto Press; 2000. p. 260–9.
Kuhn TS. The structure of scientific revolutions. 2nd ed. Chicago/London: University of Chicago Press; 1970.
Lamont M. How professors think: inside the curious world of academic judgment. Cambridge-London: Harvard University Press; 2009.
Laudel G. Conclave in the tower of Babel: how peers review interdisciplinary research proposals. Research Evaluation. 2006;15(1):57–68.
Lester RK, Priore MJ. Innovation. The missing dimension. Cambridge/London: Harvard University Press; 2004.
Mansilla VB. Assessing expert interdisciplinary work at the frontier: an empirical exploration. Research Evaluation. 2006;15(1):17–29.
Nowotny H, Scott P, Gibbons M. Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge: Polity Press; 2001.
Parthey H. Persönliche Interdisziplinarität in der Wissenschaft. In: Umstätter W, Wessel K-F, editors. Interdisziplinarität – Herausforderungen an die Wissenschaftlerinnen und Wissenschaftler. Bielefeld: Kleine Verlag; 1999. p. 243–54.
Parthey H. Institutionalisierung disziplinärer und interdisziplinärer Forschungssituationen. Wissenschaftsforschung Jahrbuch 2010. In: Fischer K, Laitko H, Parthey H, editors. Interdisziplinarität und Institutionalisierung der Wissenschaft. Berlin: Wissenschaftlicher Verlag Berlin; 2011. p. 9–36.
Piaget J. Main trends in interdisciplinary research. London: G. Allen; 1973.
Piaget J, et al. The epistemology of interdisciplinary relationships. In: Briggs A, editor. Interdisciplinarity. Problems of teaching and research in universities. Paris: OECD; 1972. p. 127–39.
Stichweh R. Zur Entstehung des modernen Systems wissenschaftlicher Disziplinen – Physik in Deutschland 1740–1890. Suhrkamp: Frankfurt/M; 1984.
Stichweh R. The sociology of scientific disciplines: on the genesis and stability of the disciplinary structure of modern science. Sci Context. 1992;5:3–15.
Stichweh R. The multiple publics of science: inclusion and popularization. Soziale Systeme. 2003;9:210–22.
Turner S. What are disciplines? And how is interdisciplinarity different. In: Weingart P, Stehr N, editors. Practising interdisciplinarity. Toronto/Buffalo/London: University of Toronto Press; 2000. p. 46–65.
Weingart P. Interdisciplinarity. A paradoxical discourse. In: Weingart P, Stehr N, editors. Practising interdisciplinarity. Toronto/Buffalo/London: University of Toronto Press; 2000. p. 25–41.

Interest and Creativity

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Intrapreneurship

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Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity

James Berry
Kenan-Flagler Business School, University of North Carolina at Chapel Hill, Chapel Hill, NC, USA

Synonyms

Empathy; Interest and enjoyment; Motivational components of creativity

Key Concepts and Definition of Terms

Creativity is a complex construct often defined as requiring the components of both novelty and usefulness. So how can organizations and managers activate both novelty and usefulness in encouraging creativity in the workplace? Broadly defined, motivation is a set of psychological processes that directs, energizes, and sustains action (Mitchell and Daniels 2003). People may be moved to action by several different kinds of motivations. Researchers have explored the effects of extrinsic, intrinsic, and prosocial motivations on creativity often with inconsistent findings. Perhaps alone, these motivational drivers encourage a focus on only one of the two main components of creativity, but activated together, different motivations may more consistently encourage creativity through increasing both novelty and usefulness considerations.

Intrinsic Motivation

The most common definition of intrinsic motivation can be stated as a desire to expend effort based on an individual's positive reaction to the task itself, primarily founded in a personal interest in and enjoyment of the activity that is being performed (Amabile 1996; Ryan and Deci 2000). Intrinsically motivated people often find themselves lost in their driven activity for the pure enjoyment of it. The need to explore this activity often leads one to focus on new experiences with little regard for their value outside of the pleasure derived from engagement in these activities.

Prosocial Motivation

The desire to expend effort based on a concern for others is a common definition of prosocial motivation (Batson 1987; Grant 2007). The target of prosocial motivation can be a single individual, group, or other people in general. Thus, this motivation directs one to act in a way that is intended to benefit others. This focus on helping others encourages one to have an understanding of what might contribute to others needs or wants.

Perspective Taking

The cognitive process of adopting another viewpoint in an effort to understand their needs, positions, and interests is often defined as perspective taking (Parker and Axtell 2001). Trying to view a situation through another's eyes can help one recognize what that other person is thinking, feeling, or interpreting from a given scenario.

Creativity

J.P. Guilford (1897–1987) is often considered the father of modern creativity research. He defined creativity as novelty bounded by some degree of evaluation that the novelty fits the needs of the particular situation. More recently, creativity has been broadly defined as a contextually based social judgment that an idea, process, product, or person is both novel and useful (Amabile 1996). The two factors of novelty and usefulness are contextually bound in that they are essentially comparative considerations. Novelty is compared to what is currently known or done. Usefulness is estimated with respect to a need, intent, or problem.

Theoretical Background and Open-Ended Issues

Positive Motivational Influences on Creativity

Creativity can be found in almost every aspect of human endeavors from art to science, from one's personal life to business interactions. The outcomes of creative efforts are often seen as important drivers of economic value and human achievement. Yet as creativity requires some component of differentiation from what is already present or currently accepted, there is a note of risk involved with being creative. In presenting a creative product or approach, one opens oneself to failure or rejection. Thus, this type of activity is not naturally a default but requires a motivational force to counterbalance the perceived risks of being different that are so integral to being creative. Even as creativity requires some amount of novelty, it also requires a second component: usefulness. Driving one without the other may leave an effort short of achieving an improvement in creativity.

Novelty and usefulness are the two main criteria for something to be considered creative. Novelty is the extent to which something is new or unlikely to have been considered by others. Usefulness is the appropriateness or value of a thing in a given situation. If one was asked to generate a creative new product to replace glass as a car windshield, corrugated aluminum might be a novel response, as it would be different and probably unlikely to have been considered by others. However, this response would probably not be considered useful as a key need in car windshields is transparency. This idea would thus not be considered creative as it only possesses one and not both components required for creativity. Just the same, a response of clear plastic might be useful but not novel. Creativity requires the presence of both novelty and usefulness factors.

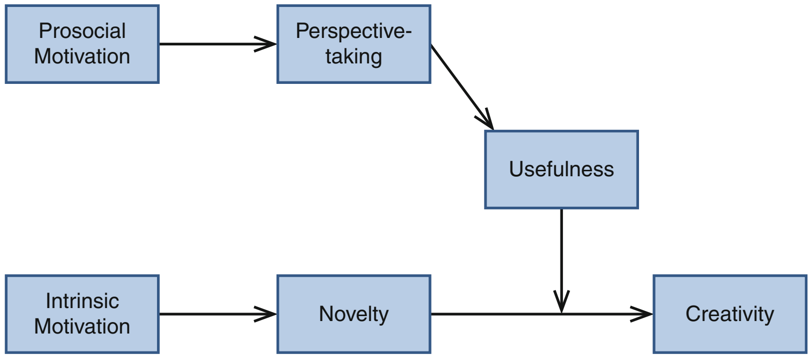
It is this dual componential nature of creativity that makes single focused approaches to driving its attainment inconsistently effectual. If one motivates a focus on novelty without consideration for usefulness, creativity may be increased via more novelty, but those gains may be offset by a loss of focus on usefulness. This could happen with a drive toward usefulness crowding out novelty, as well. To consistently motivate people to higher creative achievement, both components must be activated.

Amabile (1996) has tied intrinsic motivation to creativity as a central factor essential to developing creative ideas or products. When one is driven by intrinsic motivation, the engagement of the activity is the end, and the activity is not undertaken as a means to some external goal. Individuals so motivated experience a desire to explore their curiosities, to learn, and to continue the activity. This individually driven focus on the enjoyment of the task at hand leads to a feeling of freedom and escape from control that allows an individual to explore novel concepts. This feeling of freedom and intense immersion in an activity is well described by Mihaly Csikszentmihalyi in his book Creativity (1996).

This type of activation encourages creativity through cognitive exploration, positive affect, and persistence. On the cognitive side, the desire to learn often stimulated when one is intrinsically motivated by a task, encourages one to expand one's understanding of the activity and explore new avenues of the task. Positive affect has a similar influence on creativity in that positive affect has been linked to an increase in cognitive flexibility and a broadening of the information available to an individual. Additionally, persistence in the activity allows a longer time to explore new ideas and generate options, thus maximizing the effects of cognitive and affective benefits. This increase in flexibility and information increases the likelihood that combinations of ideas and solutions will be unique. Donald T. Campbell argued in 1960 that the more information available and the more combinations one can generate will logically lead to more novel options being developed.

When one is so engaged in an activity, the development of novelty can often be seen as an end in itself. Oftentimes, one can get so absorbed in the intrinsically motivated activity that other considerations are ignored. It is this aspect of intrinsic motivation that encourages a drive for novelty at the expense of external considerations beyond the activity. Sometimes, the results of these intrinsically motivated activities coincide with external demands. Organizational efforts at matching individual's personal interests with work duties, allowances for job crafting, or encouraging autonomy are several ways of encouraging alignment of novelty generation with organizational utility. However, these efforts may encourage a chance congruence of novelty and usefulness; they do not put a direct focus on the utility of generated ideas or solutions.

A focus on utility is often encouraged by motivation efforts imposed from external sources, particularly within organizations. Externally determined rewards for completing certain tasks or reaching milestones can be very effective at driving certain behaviors, but these rewards encourage activity in a task for an externally justified end. Often, these extrinsic motivational approaches are seen as efforts to control an individual and as such are often detrimental to intrinsic motivation and the resultant gains in novelty. This being the case, extrinsically focusing a person on an externally determined goal (usefulness to the organization) may come at the expense of novelty. If extrinsic motivation can be applied in a noncontrolling fashion, then there may be an opportunity for creative synergy between these motivational sources (see Hennessey and Amabile 2010 for a broader discussion).



Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity, Fig. 1 Relations between intrinsic motivation, prosocial motivation, perspective taking, and the components of novelty and usefulness driving creativity

Creative synergy or a maximization of both novelty and usefulness can be engendered when intrinsic motivation is paired with an internal drive to be productive for others. Prosocial motivation encourages individuals to be concerned for and act in ways that contribute to the welfare of others. This is an internally generated desire and thus avoids the negative effects related to feelings of being externally compelled to engage. However, acting on a desire to help others necessitates at least an attempt at understanding of what may be helpful to them. This type of other-focused motivation may benefit creative efforts by providing a desire to focus on the usefulness of these efforts.

Being motivated to help someone may provide the intent for usefulness. Moving this intent to effective improvement in creativity requires understanding of what might be helpful to the target of one's prosocial motivation. This intent to help others encourages one to build an understanding of what might be beneficial to those one seeks to help. In this way, prosocial motivation promotes an attempt to understand issues from another's perspective. This perspective taking can help provide an external reference of what ideas or products may be ultimately useful to others.

Combining both intrinsic and prosocial motivations may be an effective way to maximize creativity. By activating increased focus on both novelty and usefulness, the motivational effects may be more powerful together than alone. This model as shown in Fig. 1 posits that intrinsic motivation influences creativity through increasing novelty and prosocial motivation influences creativity through perspective taking increasing usefulness.

Conclusion and Future Directions

This model of how motivation relates to creativity through its components of novelty and usefulness can be valuable in conceptualizing how different motivations may influence creativity to generate synergistic effects. Research in this area (Grant and Berry 2011) has supported this general model, finding a strengthening of the link between intrinsic motivation and creativity when perspective taking is encouraged through prosocial motivation. The inclusion of the novelty and usefulness components in this model is at this point theoretical. How these motivations and perspective taking exactly influence creativity efforts is an area for future exploration. Additionally, perspective taking may be engendered by different means other than prosocial motivation; thus, there are opportunities to explore the independent effects of perspective taking on usefulness and creativity.

These findings suggest that organizations might want to broaden their attempts to motivate employees for creativity through multiple avenues simultaneously to encourage a focus on both novelty and usefulness. By considering how different motivations influence creativity through the individual components of novelty and usefulness, this work attempts to explain inconsistent results often found when studying single motivations and their relation to creativity. Hopefully, this approach to expand the precision of how motivation relates to creativity can be applied to other areas of investigation into this complex concept we call creativity.

Cross-References

▶ Cognition of Creativity
▶ Creativity and Emotion
▶ Creative Mind: Myths and Facts
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
▶ Promoting Student Creativity and Inventiveness in Science and Engineering

References

Amabile TM. Creativity in context. Boulder: Westview Press; 1996.
Batson CD. Prosocial motivation: is it ever truly altruistic? In: Berkowitz L, editor. Advances in experimental social psychology, vol. 20. New York: Academic; 1987. p. 65–122.
Campbell DT. Blind variation and selective retention in creative thought as in other knowledge processes. Psychol Rev. 1960;67:380–400.
Csikszentmihalyi M. Creativity: flow and the psychology of discovery and invention. New York: HarperCollins Publishers; 1996.
Grant AM. Relational job design and the motivation to make a prosocial difference. Acad Manage Rev. 2007;32:393–417.
Grant AM, Berry J. The necessity of others is the mother of invention: intrinsic and prosocial motivations, perspective taking, and creativity. Acad Manage J. 2011;54:73–96.
Guilford JP. Creativity. Am Psychol. 1950;5:444–54.
Hennessey BA, Amabile TM. Creativity. Annu Rev Psychol. 2010;61:569–98.
Mitchell TR, Daniels D. Motivation. In: Borman WC, Ilgen DR, Klimoski RJ, editors. Handbook of psychology, Industrial and organizational psychology, vol. 12. New York: Wiley; 2003. p. 225–54.
Parker SK, Axtell CM. Seeing another viewpoint: antecedents and outcomes of employee perspective taking. Acad Manage J. 2001;44:1085–100.
Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol. 2000;55:68–78.

Intuitive Thinking Versus Logic Thinking

▶ Divergent Versus Convergent Thinking

Invent

▶ Invention Versus Discovery

Invention

▶ Analogies and Analogical Reasoning in Invention
▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Creativity and Innovation: What Is the Difference?
▶ In Search of Cognitive Foundations of Creativity

Invention and Innovation as Creative Problem-Solving Activities

Frank Beckenbach and Maria Daskalakis
University of Kassel, FB Wirtschaftswissenschaften, Kassel, Germany

Synonyms

Creativity; Novelty creation

Background: Microeconomics of Novelty Creation and Problem Solving

Obviously, invention and innovation can be hardly analyzed from the usual cost/benefit perspective of economics. These processes are conjectural by their very nature:

- Because ex ante results of the search endeavor cannot reasonably be anticipated (or even expected)
- Because there is no guarantee for the social acceptance of a possible result
- Because there is the risk that an accepted result cannot be used as a source of (additional) private yield (Nelson 1959a, b, 1982)

Due to these intricacies, invention and innovation have previously been either considered as coming "out of the blue" (Kirzner 1979; Vromen 2001) or have been simply postulated as an outcome of mesopatterns in terms of paradigms, routines, and institutions (Dosi 1988; Lundvall 1992).

Notwithstanding these caveats and provisos, various attempts to conceptualize the novelty creating process from a microeconomic perspective have been made (Kline and Rosenberg 1986; Noteboom 2000; Witt 2009). The common denominator of these attempts is that these novelty creating processes have essential features which can be dealt with analytically: (a) there are boundary conditions or triggers making the occurrence of these processes highly probable; (b) these processes can be divided in different phases, each of which is characterized by specificities in terms of cognitive resources, uncertainty, and economic constraints; (c) time matters not only in terms of succession and path dependency but also in terms of feedback loops with different range; (d) multiple types of behavior are included in these processes (especially deliberation and intuition); and finally (e) their social embedding has to be taken into account (especially related to the issues of acceptability and appropriation).

The concept of problem solving initially figured out in Gestalt psychology (e.g., Wertheimer 1922) and afterward imported and specified for economic contexts by Herbert Simon (e.g., Simon 1965). According to Simon, problem solving is a cognitive device which allows bounded rational agents to make decisions in a complex environment. Simon especially proposes his approach as a more realistically conception of human (and organizational) behavior than the standard approach of economics, namely, the expected utility concept. Nevertheless, there is an ongoing controversy about the question if the former concept is suitable for analyzing novelty creating processes (including invention and innovation) in terms of the features (a–e) mentioned above. This might be partially due to the fact that the core of the problem-solving concept was developed by supposing simple problems or rather abstract themes (e.g., the "Tower of Hanoi" – problem and chess).

The Core Concept of Problem Solving and Its Restrictions

The starting point of the problem-solving procedure is the perception of a "problem." "A person is confronted with a *problem*, when he wants something and does not know immediately what series of actions he can perform to get it . . . . . To have a problem implies (at least) that certain information is given to the problem solver: information about what is desired, under what conditions, by means of what tools and operations, starting with what initial information and with access to what resources" (Newell and Simon 1972, p. 72; Cyert and March 1992, p. 121). Hence, the essential feature of a problem is a divergence between the given and the desired state of affairs. The conditions for eliminating this divergence are on one side the initial constraints of the agent (in terms of money, time, and knowledge) and on the other side the (virtual and real) transformation devices (in terms of heuristics and operators) for the given state of affairs. Yet, the applicability of these transformation devices is uncertain in that there is only a rough idea about the appropriateness of these devices.

"Problem solving" is the process of finding out a sequence of states between the initial and the desired final state under the given constraints. This process is based on a "mental representation, a mental scheme for holding information in memory and operating on it"

(Simon 1999, p. 674; Newell and Simon 1972). The elements of the mental representation are:

- An interpretation of the given situation
- A listing of the transformation devices (operators derived from heuristics) according to this interpretation
- A test and evaluation mechanism for the results of operator application.

Hence, selecting a cognitive activity under the constraint of available knowledge and the experience about the problem domain marks the starting point of the problem-solving process.

The listing of the transformation procedures within the mental representation is not complete because not all the procedures contained in the knowledge stock are activated. This would easily lead to a combinatorial explosion of transformation possibilities which, due to cognitive constraints, would have to be dealt with on a trial and error base. Therefore, the problem solver applies only a part of the available search procedures (heuristics) to reduce the size of the problem space, i.e., the space which is defined by applying all available transformation possibilities to all possible states. These heuristics might be either explicit in that they are explicable and even programmable or they might be implicit in that a given situation includes cues about what to do for the experienced problem solver.

However, only under ideal conditions problem solving will be a linear sequence of representation, operation, and realization. Normally, it will be a feedback process between the steps "operation" and "representation" as well as within the "operation" step. Furthermore, if several attempts to reach a given goal are not successful, the goal itself might be modified (in quantitative or qualitative terms).

This sketch of the seminal contribution of Simon and Newell to the analysis of the elements and process of problem solving shows that this is a pathbreaking alternative to the standard model of the deliberate decision process (a) in that it focuses an open-ended search behavior divided in the statement of the given situation, the figuring out of the problem space, and finally the solution of the problem and (b) in that it integrates the assumption of bounded rationality in terms of knowledge-dependent problem representation and in terms of limited capabilities of problem manipulation (by heuristics and operators). Due to these cognitive constraints, the process of problem solving might become sticky and path-dependent.

Nevertheless – at least in its original form – the concept has a rather narrow scope. *First*, it takes only the goal-related outcome into account which abstracts from basic abilities of the agents as well as from individual specificities. *Second*, according to the computer-oriented context in which this concept of problem solving was developed, it was mainly confined to clear cut ("well-defined") problems. This means that the goals of the agent as well as the heuristics used for reaching this goal are specified in such a way that the results of the application of these heuristics can be unambiguously evaluated with respect to their goal-reaching capability. Furthermore, it is assumed that this capability is even measurable in terms of a larger or smaller distance to the goal. *Third*, it is assumed that the definition of the problem and the finding of the problem-solving devices are two separable elements and that the problem-solving devices are merely instrumental for the problem itself. Thus, only these solution advices are varied during the problem-solving process. Taking these limitations into account, one might become skeptical about the essential difference between this problem-solving approach and the decision approach in standard economics. Furthermore, this simplistic problem-solving approach has been criticized due to its affinity to what computers can do (instead to what humans used to do; cf. Dreyfus and Dreyfus 1986).

Enhancing the Concept of Problem Solving: Ill-Defined Problems and "Creative Problem Solving"

Ill-Defined Problems and Creativity Research

Not all problems in the economic world are well defined in the sense of the standard approach of problem solving. Sometimes, even the understanding of the initial situation is not in such a way clear that it can be transformed into a mental representation. Consequently, it remains vague in which way such a situation can be influenced by any kind of operator and which goals are appropriate for it. However, even if the situation is well understood, it might be difficult to solve a problem because there are multiple incommensurable problem spaces and/or a lack of appropriate operators/heuristics making it intricate to find a sequence of reasonable operations. Finally, it is possible that the goal is not defined in a unanimous manner. These caveats are the background for admitting "ill-defined problems" (Simon 1973) and thereby broadening the scope of the concept of problem solving.

The inconveniences arising with ill-defined problems – which do normally occur in an uncertain world – change the character of the problem-solving process. *First*, it is not any longer "directed" insofar it successively reduces the gap between initial and final (goal-reaching) state; rather, it might circle around or even be regressive by broadening the gap. This is due to the lack of appropriate operators/heuristics and/or the goal ambiguity. *Second*, the instrumental role of problem-solving devices does not hold anymore if the problems are ill defined. Under this condition, heuristics and operators as emanations of the stock of knowledge are themselves influencing the way the problem is posed at every time step. Problem solving then becomes an iterative and simultaneous exploration of problems and solutions.

Solving ill-defined problems makes great demands upon the actors involved. At the core of the individual ability to look for new situations and to deal with them is the human creativity. Referring to the research on human creativity therefore helps to understand how ill-defined problems can be solved. This research has a long tradition starting when the ability to create something new is no longer considered as a divine inspiration but rather an individual capacity of the human being. However, even in the professional treatment of creativity in psychology, it took some time before single hypothesis approaches (such as the psychodynamic, associationist, and Gestaltist treatment) to this human ability have been overcome in favor of a broad treatment including all resources and processes known in modern cognitive psychology (Guilford 1950; Weisberg 2006).

The modern creativity research defines creativity as "the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (Amabile 1996; Sternberg and Lubart 1999). Hence, what is meant by creativity in the sense of modern creativity research are the individual creative traits and processes. Creativity research does not primarily deal with the wide range of tacit everyday creativity. Rather, creativity here implies that the individual creative output (product) is being assessed and accepted by the environment. Following this definition, three different – although interdependent – aspects of creativity are emphasized in the modern creativity research: the individual qualities, the process analysis, and the environment. All these aspects are relevant for solving ill-defined problems and thereby broadening the scope of the original concept of problem solving (Weisberg 2006).

- The *individual qualities* can be subdivided in knowledge and skill endowment, motivation, and personality features. For being creative, knowledge is required about the domain specificities (Weisberg 1999). This knowledge should be well organized giving the possibility for switching flexibly between different levels of generalization. Whereas this kind of knowledge is "declarative," also "procedural" knowledge is required in terms of knowing how to use available heuristics. These different levels of knowledge are accomplished by skills in terms of finding new heuristics and capabilities for recombination and association of given elements of knowledge (Chand and Runco 1992; Policastro and Gardner 1999). However, knowledge and skills are not sufficient for being creative: Additionally, a strong motivation for fulfilling a task is required. This strong motivation can either come from inside in that an individual views such an engagement as an end in itself (intrinsic motivation) or in that this motivation comes from outside following from external information or expectations without restricting the autonomy of the person under consideration (informational or enabling extrinsic motivation; Amabile 1996). Finally, some personal qualities are required for a creative activity. Among the most important ones are curiosity, the steadfastness of purpose, patience, and a fundamental willingness to bear risks (Csikszentmihalyi 1999b). Knowledge, skills, motivation, and personality are combined in two overarching features of creativity: *deliberate cognitive style* and *divergent thinking*. A deliberate cognitive style is a stable preference for using extensively deliberate (conscious) resources in sorting out the possibilities of action (Kirton 1989). Divergent thinking is a specific way to use these cognitive resources. Convergent thinking has only one direction; one conventionally correct answer is searched for. Contrary to that, divergent thinking proceeds in different directions (Guilford 1959). Hence, the approach of creative individuals to problems is original in that they are breaking with traditional formulation and solution of problems, and it is flexible in that many ideas about formulation and solution are held for a long time simultaneously in mind until a switch to one of these options occurs (Amabile 1996).

- The *process analysis* of creativity was initially heavily influenced by the idea that the creation of something new is a rather unexplainable operation in terms of rational process analysis. This gap in explanation was either filled by referring to mysterious abilities of the human genius or it was assumed that creative ideas emerge from a largely uncontrollable Darwinian process of random variation and natural selection. This gap is well documented in one of the first process models of creativity by Wallas (1946). In this model, four phases are distinguished: (a) the definition of the issue and the observation of the starting conditions in the phase of preparation, (b) then the phase of incubation in which the issue is laid aside, (c) the phase of illumination in which the new idea is born by picking up the issue after a while, and finally (d) the phase of verification. How this illumination can happen remained unexplained at that time. Furthermore, it seems dubious to separate this act of illumination from all conscious endeavors to analyze the issue. This lack of explanation was reflected in the process model of Rossman (1964). In this model, the preparation phase is composed of observation of need, analysis of need, a survey of all available information, and a formulation of all possible solutions. The incubation/illumination phases are replaced with a critical analysis of these possible solutions and a birth of the new idea out of this analysis. The last phase is analogous to Wallas (here based mainly on experimentation). How this "birth" of the new idea happens still remains mysterious. Meanwhile, these traditional conceptions have been challenged by at least two relevant approaches: On the one hand, the incubation/illumination paradox is explained as a cognitive process, relying on cognitive operations and not on mystical insights. Thereby, the features of the four-stage model are either updated (Amabile 1996; Cszikszentmihalyi 1999b) or rejected (Weisberg 1993). On the other hand, very promising endeavors have been made to propose new models to overcome the traditional perspective (Finke et al. 1992). Additionally, a lot of empirical and experimental work has been done to explain problem-solving (and problem-finding) processes (Runco and Sakamoto 1999; Lubart 2001).
- Creative operations do not happen in an empty space; they have an *environment*. This environment is relevant for the generation of a creative act as well as for the evaluation of the result of this creative act. According to the difference between the outcome of creativity (an idea, a concept, a physical product, etc.) and the creative person, the environment is seen to consist of a "domain" to which the product refers and a "field" to which the person refers (Csikszentmihalyi 1999a, b; Weisberg 2006). Unresolved problems in the domain as well as the way the experts in the

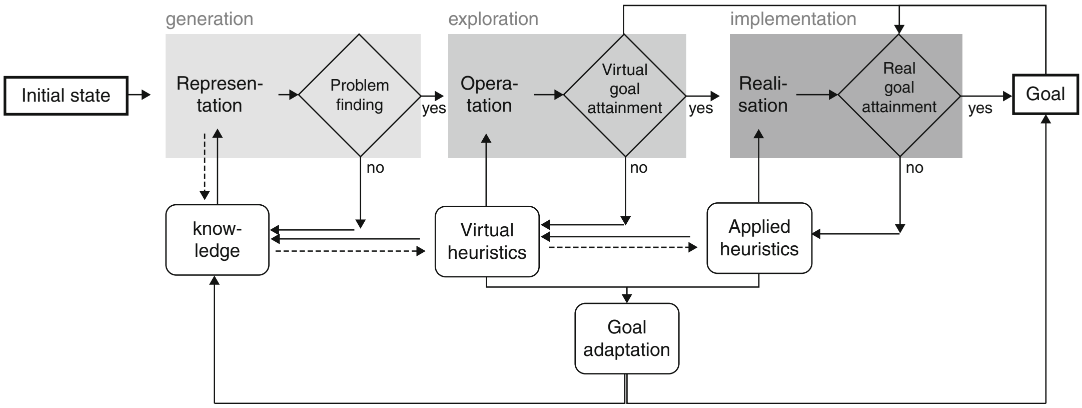
field deal with these problems determine the act of creativity: on one side, by the accessibility to the (incomplete) knowledge of the domain and, on the other side, by the degree of the open-mindedness of the experts in the field. This is related to the knowledge base and the motivation of the creative person and to the preparatory stage of the creative process mentioned above. But the domain and the field are also important "test beds" of the results of a creative act. It will become manifest how much the domain is altered by this creative result (To what degree hitherto unsolved problems are pretended to be solved?), and the experts in the field will have to evaluate this change in the domain (Is the solution accepted? How far reaching is it?).

What conclusion can be drawn from this sketch of creativity research for dealing with ill-defined problems? (a) Before problems of this kind can be solved, a creative specification of these problems in preparatory steps is necessary. (b) Unconscious illumination, imagination, and the like are not sufficient for explaining the creative process because a necessary condition for creativity is conscious endeavors. At the core of creating something new, there is a twofold process of synthesizing ideas, facts, etc., on one side and a transfer and transformation of these ideas, facts, etc., on the other side. (c) Insofar, as the solution of ill-defined problems requires acts of creativity, individual qualities as well as a creativity friendly environment are necessary for the problem-solving process. (d) Finally, the role of a variety of cognitive elements like knowledge, motivation, and memory is emphasized.

Creative Cognition and Creative Problem Solving

The separation of personal qualities, process analysis, and environmental conditions is a useful starting point for systematizing the insights of creativity research. But from the perspective of modern cognitive psychology, this separation seems arbitrary, and therefore, attempts have been undertaken to broaden the process analysis of creativity to include at least some aspects of personal qualities and environmental conditions. Such an attempt is "creative cognition," developed by T. Ward, S. Smith, and R. Finke. In this approach, a new model of the cognitive process and structure of creativity is proposed, incorporating thereby the aspects of individual qualities and – though at a different level – aspects of environment (Finke et al. 1992, 1999). The main feature of this approach to creativity is a heuristic model called "Geneplore" (Finke et al. 1992; Ward et al. 1999). According to this model, the creative process is a sequence of generative and exploratory processes (hence the name).

The *generative processes* take place in the initial phase. Here, mental manipulations of knowledge elements (retrieval, association, synthesis, transformation, transfer) lead to new mental representations, e.g., to a new interpretation of the initial situation, new (virtual) operators, new evaluation mechanisms, and/or new combinations of these elements. Such new representations may consist of discovered patterns, mental models, and the like. These results of the generative processes are not simply novel. Rather, they have some inherent ambiguity, incongruity, and divergence and therefore encourage the investigation of these results in the second phase, the *exploratory processes*. Because the problem definition is incomplete in that no definite goal is given, the applicability and usefulness of the new representations are now tested, and if necessary, the goal is adapted. What kinds of problems can be tackled with such new representations? Are new attributes of a problem at stake accessible? What kind of operators can be used to manipulate the initial context and what will be the result of such a manipulation? This can be summarized as a figuring out of appropriate virtual heuristics. Finding answers to these questions might include a modification (focus or expand) of the preinventive structures (new mental representations) which are the result of the generative process. Hence, multiple feedback cycles between generative and exploratory processes might be necessary until a useful novelty has been discovered.



Invention and Innovation as Creative Problem-Solving Activities, Fig. 1 Enhanced concept of problem solving

What kind of insights for a problem-solving process under the condition of an ill-defined problem can be gained from the creative cognition approach? Insights from creative cognition for the concept of problem solving are threefold: *First*, a specification of what is meant by "ill defined" is provided. By bringing in new cognitive devices (like mental models, analogy building, context shifting, and divergent thinking; Finke et al. 1992), it is possible to specify what generative/explorative method is used. Furthermore, the following questions can be answered: Is the "illness" of the definition due to not having a new representation or is it due to the unexplored usefulness of a new representation? Or is it due to both? *Second*, the generative processes constitute a specific determining stage of the whole problem-related process: the problem finding. This is tantamount to finding representations or heuristics by using the "Geneplore" approach. *Third*, the problem solving itself changes character in that it becomes creative. It deals with new heuristics/operators and makes of problem-solving proper a temporary operation in an overarching problem-finding/problem-solving feedback process. Given that, the focus of the core concept of problem solving (cf. section "The Core Concept of Problem Solving and Its Restrictions") can be enhanced by including the phases of generation and exploitation. Figure 1 shows the main features of such an enhanced problem-solving concept.

Applying the Problem-Solving Concept to the Microeconomics of Invention and Innovation

Invention as a Problem-Finding/Problem-Solving Activity

Invention means the creation of a conceptual novelty. It denotes the creation of an idea or a concept, waiting for being applied in a practical context. Such a new idea or concept might be based on new knowledge which is simultaneously created with the invention ("primary inventions" in the sense of Usher 1971, p. 50), or the invention is the result of new applications of a given set of knowledge ("secondary invention," Usher 1971, p. 54).

Considering invention as an act of creative problem solving means to specify the endowment of the inventor in terms of cognitive resources (cf. above section "Ill-defined Problems and Creativity Research"). A profound declarative knowledge about the domain, the ability to flexibly combine the elements of this knowledge, and knowing how to search in a given domain for new insights (procedural knowledge) is the *first* cognitive prerequisite for the creative act of invention. *Second*, the motivation for inventive activity is intrinsic in that this activity is seen (by the inventor) as an end in itself. Any environmental expectation about the result of the invention is either ignored or transformed in the inventor's individual motivation. This means that on one side there is no person who is directly forcing the inventor to follow a predetermined action pattern; on the other side, this does not exclude that the inventor has an open mind for scientific, technical, social, or economic needs in his environment. A *third* momentum of the inventor is a combination of all personal qualities which have been attributed to the creative personality (cf. section "Ill-defined Problems and Creativity Research") with a special emphasis on a deliberate cognitive style and divergent thinking.

For invention, the environment hence has the double role to be (a more or less) stimulating background and to be an evaluating context. The stimulation is given in terms of scientific, technological, social, and economic "driving forces" (i.e., strategic and/or global needs in these domains). This background for the invention process may be given by identifying "reverse salients" (Hughes 1978, pp. 172, 179), i.e., the bottlenecks of a global system development in the domains mentioned before. The focus on these reverse salients is determined (a) by education and expertise of the inventor, (b) by the prior activities of the inventor in the same or a similar domain, and (c) by anticipating some feasibility constraints in terms of funding, accessible R&D facilities and perhaps by referring to the expectation of an entrepreneur (Schumpeter 1983). The evaluation of the invention is one important function of the entrepreneur. This function can be incorporated in a special group of entrepreneurs, or it may be a temporary feature of actors, which have also other roles to play (as it is often the case in small- and medium-size firms). This entrepreneurial evaluation process of invented products may be influenced by the hostility of those vested scientific, technological, social, and economic interests for which the innovative development of the invention might be a threat (Nelson 1959a; Gilfillan 1970; Hughes 1978; Amabile 1998).

Given this background, the process of invention can be characterized (in a stylized manner) by referring to the features of an enhanced problem-solving concept: (a) it deals with ill-defined problems, (b) it includes a stage of problem finding, and (c) it solves problems in a creative manner.

ad (a): Taking "problem space," "goals," "heuristics," and "operators" as attributes of a problem definition, all these attributes can be in the state "none," "one," "multiple," and "vague." A vague problem space is given if there is a high uncertainty about the dimensions of the problem to deal with. The goals are vague if a goal is not known in a positive sense but only in a negative sense in knowing what is not intended. The heuristics and operators are vague if the appropriateness of both for any given goal is ambiguous. Then there are 4^4 possibilities to characterize the problem situation. The problem situation for an inventive activity lies somewhere between a situation which is well defined (all attributes are in the state "one") and a situation of total ignorance in which all attributes are in the state "none." The typical situation of inventive problem solving is defined, *firstly*, by a vague problem space and a vague fixing of the goals. This corresponds to the incomplete knowledge of the inventor about possible directions for transforming an initial situation and to a loose binding to the "driving forces" of the environment mentioned above. *Secondly*, heuristics are vague and possible operators are unknown (state "none") when the invention process starts. Hence, when the invention starts, the string of the attributes (problem space, goals, heuristics, and operators) is:

$$I_{\text{vent}} = \{\text{vague}, \text{vague}, \text{vague}, \text{none}\}.$$

This specific type of an ill-defined situation is called here a "strong ill-defined problem."

ad (b): Given such a strong ill-defined problem, the first stage of the inventive process is the solution of the "problem" of problem finding. This problem is coped with by the above mentioned generative processes (section "Creative Cognition and Creative Problem Solving") leading to preinventive structures in terms of a specification of the problem space, mental models about this problem space, and a discovery of new (virtual) heuristics and operators for "walking through" this problem space. Thereby, it is specified where this walk

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could go to, i.e., hopefully the vagueness of the goals is reduced by these generative processes. Ideally, at the end of this stage of invention, at least the problem space should be specified, and a couple of heuristics (e.g., heuristics for decomposing and for recomposing a problem space) as well as operators should wait for being explored.

ad (c): In the next stage of the inventive process, the heuristics and operators are explored. In this process, a feedback to the understanding of the problem space as well as to the goals of the whole operation takes place. One way to specify such a process more closely, is to assume that the inventor may use one of the available decomposition heuristics to discern the weakest point of a problem at stake, then he/she may solve this weakness by using an heuristic of analogy to a similar (better known) problem, and finally, this abstract solution is adapted to the real-world problem by using a recomposing heuristic (Hughes 1978, p. 173).

Invention as an economic activity is confronted with strong uncertainty. This uncertainty is twofold: *Firstly*, there is no clear relationship between input and output (Arrow 1971, p. 172). Hence, there is a high risk of either not finding any new idea or concept at all or to find something which is not applicable, i.e., something that cannot be used as a source of innovation (output uncertainty). This side of the uncertainty can be expressed as the problem of determining the direction and amount of search activities. *Secondly*, if the invention is successful, there is no guarantee that those who are not willing to pay for the use of it can be successfully excluded (exclusion uncertainty). Partially, this uncertainty can be reduced by juridical protection (e.g., application for patent). Especially the output uncertainty confines the applicability of the usual economic calculation framework in terms of costs and (expected) yields. Invention takes place due to a strategic orientation because only in the long run a pay off can be expected. In the short and medium term, the output uncertainty as well as the motivational requirements for the inventors imply the paradox that inventive activities are the more successful, the more this activity is delinked from the normal organization of economic activities and from the efficiency criteria coupled with this normal organization (Nelson 1959).

To resume, dealing with invention in a (broadened) problem-solving framework has several specificities. It shows that invention consists of a sequence of knowledge-using and knowledge-generating stages and their feedbacks:

- It integrates modern creativity research by demystifying the “act of insight” in that the latter is seen as a combined effect of cognitive resources, environmental conditions, and personality features. Thus, the inventive insight is not a sudden recombination or synthesis of given elements of knowledge; rather, it is a result of a – socially shaped – process of finding, defining, and treating a problem.
- The definition of this problem is influenced by a “supply push” in terms of new knowledge and a “demand pull” in terms of global needs. Hence, there is an “. . .interplay of moving frontiers of knowledge and growing need upon the direction and likelihood of success of individual ‘acts of novelty’” (Nelson 1959, p. 107).
- Finally, in this approach, it is possible to pick up the results of those case studies related to technological inventions which are not part of the creativity research and to interpret them in a problem-solving procedure.

Innovation as a Problem-Solving Activity

Innovation means the creation of an instrumental novelty. In many cases, it is the process of applying and thereby figuring out the result of the invention process. Generally, this figuring out has to meet two requirements: The feasibility of applying the inventive idea/concept has to be shown in technical, institutional, and behavioral terms. Furthermore, a path to the marketability of this feasible application has to be demonstrated. To deal with these challenges is at the core of the entrepreneur function.

The cognitive resources involved in innovation as a specific stage in the overarching creative problem-solving process are in most parts different from the cognitive prerequisites for invention. Whereas both processes have in common that a profound knowledge of the domain is necessary (declarative knowledge), the requirement for the procedural knowledge shifts in the case of innovation toward knowing how to solve a given problem. Due to an increasing focus on applicability and solution requirements, the motivation is no more intrinsic in that the innovation is seen as an end in itself. Rather, the innovator is – at least partly – animated by strong incentives in terms of either "motivational slack" or deficits in realizing some aspiration level as regards a given goal (March 1994).

The environment of the innovator is set by the ideas/concepts "offered" by the inventor, the given solutions to past problems in terms of products, processes, organizations, and behaviors as well as the competitors. Compared with the inventor, the stimulation for the innovator coming from this environment is more visible (in case it is there), and the driving forces for his activity become less global and less far reaching. In such an environment, the innovator has his role as entrepreneur to play: After assessing the opportunities given by the products of the inventive process, he has to focus on one option and implement it as a midrange improvement of his market performance. This implies that there is some acceptance for what he is doing on the side of producers or consumers.

Compared with the process of invention, the process of innovation differs in the way it poses and solves problems: (a) It still deals with ill-defined problems, but the "illness" is weaker than in the case of invention. (b) There is no stage of problem finding anymore. (c) Solving the problems at stake requires less creativity.

ad (a): The definition of the problem is shaped by picking up the results of the invention stage. The mental representation of the problem space as well as the goals are to a certain degree specified (turning from the "vague" to the "multiple" state) by the invented option the innovator wants to implement and by the triggering market conditions for such an innovative activity. Hence, the following questions arise: What are the technical feasibility problems of a given concept? What qualities of the product innovation promise what kind of advantage in the market performance of the innovator? Additionally, the innovator has to deal with remaining uncertainties as regards heuristics and even more as regards operators. Although these heuristics and operators are to a large degree determined by the invented option, at least a multiplicity of these heuristics and operators have to be checked. Furthermore, the implementation of the invented option may necessitate to find out and experiment with unknown (sub)heuristics and unknown (sub)operators. Hence, the string of attributes (problem space, goals, heuristics, and operators) at the beginning of the innovation switches now to:

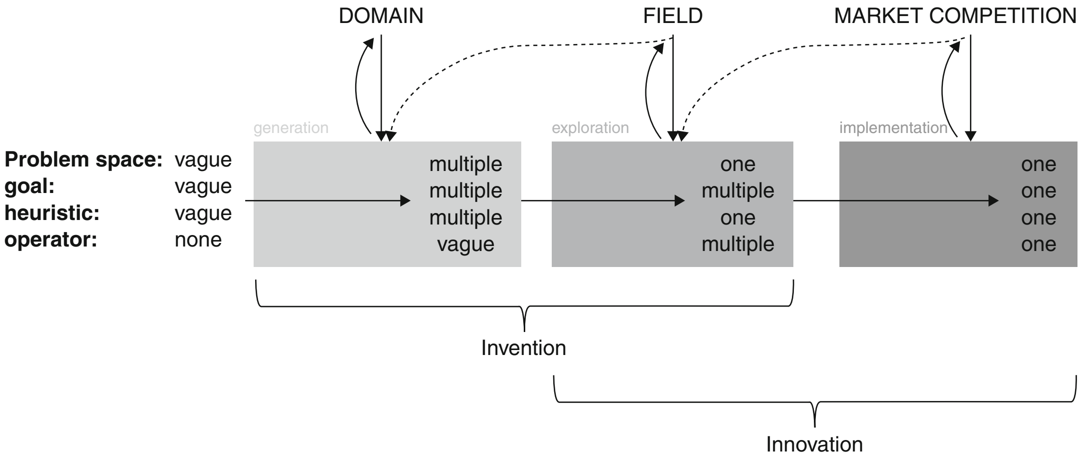
$$I_{vat} = \{\text{multiple}, \text{multiple}, \text{multiple}, \text{vague}\}.$$

This specific type of an ill-defined situation is called here "weak ill-defined problem."

ad (b): Assuming that the initial condition for the innovative process is the application of an outcome of invention for improving the economic performance and given a weak ill-defined problem, no problem finding is necessary – the finding problem is solved!

ad (c): Solving the weak ill-defined problem of innovation still requires some creative resources. Even if heuristics and operators are determined by the option picked up by the inventor, the outcomes of these transformation procedures are uncertain. For example, which of the heuristics and operators discovered during the invention process may be appropriate for generating a desired product quality? Additionally – as already mentioned – new subproblems will arise and hence a need for new subheuristics and suboperators. Exploratory processes with respect to the whole problem at stake as well as regards the subproblems are still necessary.

Compared with the invention process, the overall degree of uncertainty is reduced. Although the implementation of an idea or a concept may be a source of additional



Invention and Innovation as Creative Problem-Solving Activities, Fig. 2 Features of problem solving during invention and innovation

uncertainty, the output uncertainty is reduced because the amount and direction of the search activities are much clearer now. Contrary to that, the exclusion uncertainty is increased because competitors may use the same invented option and similar heuristics and operators. Last but not least, the great challenge for the innovator is to transpose the figuring out of the invented option into a context which is determined by normal organizational procedures and economic evaluation criteria.

The Novelty Creating Process as a Whole and Its Embeddedness

Invention and innovation are stages of the novelty creating process as a whole (which also includes the diffusion phase (Rogers 1995)). They are distinct in terms of general definition, cognitive resources, environmental conditions, process elements, and economic character. Taking into consideration these differences, the whole novelty creating process can be deciphered by referring to the dimensions of problem solving and the social embeddedness of the latter (cf. Fig. 2). This is a process in which the state of the string of the problem representation (consisting of the components problem space, goal, heuristic, and operator) changes according to a process of "generation," "exploration," and "implementation." Starting with a situation slightly better than total ignorance in which at least some rough ideas exist about problem space, goals, and possible heuristics, the generation process leads to a reduction in the search space. It identifies different dimensions of the problem space and creates a finite number of heuristics and operators. This still very large search space is further reduced in the exploration process in which ideally a unique problem space should be found (being one condition for a switch to a well-defined problem) and possible goals of the process should be specified. The task of the final implementation stage is to find unique states for all the components of the problem representation. This means there should be definite answers to the following questions: What is the novelty about? What is it good for? What are the steps from an initial situation with a problem to be solved and a final situation, where the problem is solved?

The novelty creating process is not unidirectional (cf. Fig. 1). Because it is a process of search, discovery, and learning, there are feedbacks between the successive stages of this process (Nelson 1959; Heuss 1965; Usher 1971). In terms of the suggested process analysis, this means that the findings of the exploration stage stimulate new generation activities. This may be the case, either if the exploration shows that the generative activities went in the wrong direction (substitutive feedback) or if a further specification of the invention or a complementary invention is necessary (adaptive feedback). Correspondingly, it was observed in the research about innovation that "...often an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers 1995, p. 174). In terms of the process analysis above, this is tantamount to a feedback from the implementation stage to the exploration stage. The reasons for this feedback are analogous to the feedback mentioned before.

Invention and innovation are not disjunctive stages in the novelty creating process. Rather, there is a fuzzy border between these two processes in that they overlap. The final stage of the invention process in which an idea or concept is explored thereby reducing the ambiguity of a problem representation (or discovering potential problem representations) may be the first stage of an innovation process. In this process an understanding of the invention is obtained (specifying the problem space) and the range of goals is defined to which the invention can be related.

According to the analysis of the social embeddedness of creative activities given in the systemic approach of creativity research (Csikszentmihalyi 1999a, b), these different stages of the novelty generating process are influenced by different environmental conditions. The generation phase depends on the socially available knowledge about the domain at stake (apart from the individual tacit knowledge). On the other side, this domain knowledge is influenced by the new knowledge produced during the invention process in case that this new knowledge is communicated. When the generated ideas or concepts are explored and thereby related to existing ideas and concepts in the domain (including an assessment by the people in the given domain), the influence of a "field" comes in. This is the way the inventor is affected by needs articulated in the public. Furthermore, if the field is dominated by some order parameters, there might even be an influence of the field on the direction of the generating processes of invention. As in the case of the domain, the field is influenced by the results of the inventive exploration. Finally, the implementation stage is shaped by the embedding of the innovator in the economic competition which strongly determines his goals. If a strategic deficiency in his/her competitive performance is observable for the innovator, this will have an impact on his exploration activities.

Conclusions and Future Research

The skepticism against the suitability of the concept of problem solving in the context of explaining invention and innovation can be relativized if this concept is enriched by integrating the insights of creativity research and modern cognitive psychology. Most of the generic features of novelty creating processes mentioned in section "Background: Microeconomics of Novelty Creation and Problem Solving" can be explained in such a conceptual setup:

- "Generation," "exploitation," and "implementation" can be identified as specific phases each of which combines peculiar personal, economic, and environmental conditions and gives the dimensions of problem solving different expressions.
- The successive occurrence of these phases (including path-dependence) as well as the multiranged feedback loops between them specifies the critical role of time for the novelty creating process.
- The behavior involved in such processes is not monistic; rather, it includes different modes of action especially skills, intuition, deliberation, and choice.
- Finally, the issues of acceptability and appropriation are dealt with in taking into account the "domain," the "field," and the market competition as environmental conditions.

But, by simply postulating a problem to be solved as the starting point, the boundary or trigger conditions making the occurrence of the novelty creating processes highly probable remain rather void in the concept of problem solving. To meet this explanatory requirement necessitates a broader perspective of the agency under consideration especially including the social and organizational form in which invention and innovation take place (Dosi et al. 2011; Runco 2007; Nickerson and Zenger 2004; Bijker 1987). Given this, it should be possible to elaborate the conditions favorable for the temporary passing of the agency into the ambitious and costly mode of invention/innovation (Beckenbach et al. 2012).

Cross-References

- ▶ Convergent Versus Divergent Thinking
- ▶ Corporate Creativity
- ▶ Creative Behavior
- ▶ Creative Personality
- ▶ Creative Problem Solving
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity, Experiential Theories
- ▶ Creativity from Design and Innovation Perspectives
- ▶ Creativity in Invention, Theories
- ▶ Divergent Thinking
- ▶ Divergent Versus Convergent Thinking
- ▶ Entrepreneur
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Innovation and Entrepreneurship
- ▶ Innovator
- ▶ Invention Versus Discovery
- ▶ Inventive Problem Solving (TRIZ), Theory
- ▶ Mental Models and Creative Invention
- ▶ Nature of Creativity
- ▶ Psychology of Creativity
- ▶ Radical invention
- ▶ Research on Creativity

References

Amabile TM. Creativity in context. Boulder/Oxford: Westview Press; 1996.

Amabile TM. How to kill creativity. Havard Bus Rev. 1998;76(5):77–87.

Arrow K. Economic welfare and the allocation of resources for invention. In: Rosenberg N, editor. The economics of technological change. Harmondsworth: Penguin; 1971. p. 43–72.

Beckenbach F, Daskalakis M, Hofmann D. Agent-based modelling of novelty creating behavior and sectoral growth effects—Linking the creative and the destructive side of innovation. J Evolut Econ. 2012;22(3):513–542.

Bijker WE. The social construction of bakelite: towards a theory of invention. In: Hughes TP, Bijker WE, Pinch T, editors. The social construction of technological systems: new directions in the sociology and history of technology. Cambridge: MIT Press; 1987. p. 159–87.

Chand I, Runco M. Problem finding skills as components in the creative process. Personal Individ Differ. 1992;14(1):155–62.

Csikszentmihalyi M. Implications of a systems perspective for the study of creativity. In: Sternberg RJ, editor. Handbook of creativity. New York/Cambridge: Cambridge University Press; 1999a. p. 313–38.

Csikszentmihalyi M. The creative person. In: Wilson RA, Keil FC, Editors. New York/Melbourne: Cambridge University Press; 1999b.

Cyert RM, March JG. A behavioral theory of the firm. Malden/Oxford: Blackwell; 1992.

Dosi G. Sources, procedures and microeconomic effects of innovation. J Econ Lit. 1988;26:1120–71.

Dosi G, Faillo M, Marengo M, Moschella D. Toward formal representations of search processes and routines in organizational problem solving: an assessment of the state of the art. Seoul Journal of Economics. 2011;24(3):247–86.

Dreyfus HL, Dreyfus SE. Mind over machine – the power of human intuition and expertise in the era of the computer. New York: The Free Press; 1986.

Finke A, Ward T, Smith S. Creative cognition. Theory, research and applications. Cambridge/London: MIT Press; 1992.

Gilfillan SC. The sociology of invention. Cambrige, MA: MIT Press; 1970.

Guilford J. Creativity. Am Psychol. 1950;5:444–54.

Guilford J. Personality. New York: McGraw-Hill Book Company; 1959.

Heuss E. Allgemeine Markttheorie. Tubingen: J. C. B. Mohr; 1965.

Hughes T. Inventors: the problems they choose, the ideas they have, and the inventions they make. In: Kelly P, Kransberg M, editors. Technological innovation: a critical review of current knowledge. San Francisco: San Francisco Press; 1978. p. 166–82.

Kirton M. Adaptors and innovators: styles of creativity and problem solving. London: Routledge; 1989.

Kirzner I. Perception, opportunity and profit. Studies in the theory of entrepreneurship. Chicago/London: The University of Chicago Press; 1979.

Kline SJ, Rosenberg N. An overview of innovation, the positive sum strategy. Washington, DC: National Academy Press; 1986.

Lubart TI. Models of the creative process: past, present and future. Creat Res J. 2001;13(3/4):295–308.
Lundvall B-Â. National systems of innovation. Towards a theory of innovation and interactive learning. London/New York: Pinter; 1992.
March JG. A primer on decision making. New York: The Free Press; 1994.
Nelson RR. The economics of invention: a survey of the literature. J Bus. 1959a;32(2):101–27.
Nelson RR. The simple economics of basic scientific research. J Political Econ. 1959b;67(3):297–306.
Nelson RR. The role of knowledge in r&d efficiency. Q J Econ. 1982;96:453–70.
Newell A, Simon HA. Human problem solving. Englewood Cliffs: Prentice- Hall; 1972.
Nickerson JA, Zenger TR. A knowledge-based theory of the firm – the problem solving perspective. Organ Sci. 2004;16(6):617–32.
Noteboom B. Learning and innovation in organizations and economies. Oxford: Oxford University Press; 2000.
Policastro E, Gardner H. From case studies to robust generalizations: an approach to the study of creativity. In: Sternberg HRJ, editor. Handbook of creativity. New York/Melbourne: Cambridge University Press; 1999. p. 213–25.
Rogers EM. Diffusion of innovations. New York: The Free Press; 1995.
Rossman J. Industrial creativity: the psychology of the inventor. New York: University Books; 1964.
Runco MA. Creativity – theory and themes: research, development, and practice. Amsterdam: Elsevier; 2007.
Runco MA, Sakamoto SO. Experimental studies of creativity. In: Sternberg RJ, editor. Handbook of creativity. New York/Melbourne: Cambridge University Press; 1999. p. 62–92.
Schumpeter JA. The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle. New Brunswick: Transaction Publishers; 1983.
Simon HA. Administrative decision making. Public Adm Rev. 1965;25(1):31–7.
Simon HA. The structure of ill structured problems. Artif Intell. 1973;4(3–4):181–201.
Simon HA. Problem solving. In: Wilson RA, Keil FC, editors. The MIT encyclopedia of the cognitive sciences. Cambridge/London: The MIT Press; 1999. p. 674–6.
Sternberg RJ, Lubart TI. The concept of creativity: prospects and paradigms. In: Sternberg RJ, editor. Handbook of creativity. New York/Melbourne: Cambridge University Press; 1999. p. 3–15.
Usher AP. Technical change and capital formation. In: Rosenberg N, editor. The economics of technological change. Harmondsworth: Penguin; 1971. p. 43–72.
Vromen JJ. The human agent in evolutionary economics. In: Laurent NJ, Nightingale J, editors. Darwinism and evolutionary economics. Cheltenham: Edward Elgar; 2001. p. 184–208.
Wallas G. The art of thought. London: Watts; 1946.
Ward TB, Smith SM, Finke RA. Creative cognition. In: Sternberg HRJ, editor. Handbook of creativity. New York/Melbourne: Cambridge University Press; 1999. p. 189–212.
Weisberg R. Creativity: beyond the myth of genius. New York: Freeman; 1993.
Weisberg RW. Creativity and knowledge. In: Sternberg HRJ, editor. Handbook of creativity. New York/Melbourn: Cambridge University Press; 1999. p. 226–50.
Weisberg RW. Creativity: understanding innovation in problem solving, science, invention, and the arts. Hobocken: Wiley; 2006.
Wertheimer M. Untersuchungen zur Lehre von der Gestalt. Prinzipielle Bemerkungen. Psychol Forsch. 1922;1(1):47–58.
Witt U. Propositions about novelty. J Econ Behav Organ. 2009;70(1–2):311–20.

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Invention and Modification of New Tool-Use Behavior

Shinya Yamamoto
Primate Research Institute, Kyoto University, Inuyama City, Aichi Prefecture, Japan

Synonyms

Creativity; Evolution; Material culture, emergence; Technological innovation

Introduction

The invention and modification of new tool-use behavior is the essence of technological innovation. Although tool use can be found in both humans and nonhuman animals, humans are distinguished by the variety of their tool use and their invention of new tool-use behaviors by modifying previous types. Humans are also unique in their customary use of metatools, that is, tools used to gain or modify a second (primary) tool, which is then used to achieve the goal.

Human technology has been pervaded by metatool use, from the construction of stone tools by our Oldowan ancestors of 2.5 million years ago, achieved by knapping one stone with another, to the most sophisticated computer-controlled machines consisting of some tens of thousands of components (or sometimes more) in the twenty-first century. This entry discusses the invention and modification not only of the tool itself but also of tool-use behavior, which incorporates several aspects such as technique, function, target, and so on.

Tool Use

Background and Definition

Complex tool-use behavior is a hallmark of human beings. Until Jane Goodall observed a chimpanzee at Gombe in Tanzania using a twig to extract termites from their impregnable shelter in 1960, researchers had believed that tool use was a uniquely human trait. Even now that there is accumulating evidence that nonhuman animals also demonstrate tool-use behavior, some might say that the history of the invention of tools parallels the history of humanity. It is true that there are considerable differences in the variety and complexity of tool-use behaviors between humans and nonhuman animals. The mechanism of generating these differences has recently been one of the most controversial research topics. The invention and modification of new tool-use behavior is central to this question.

Several researchers have provided definitions of tool use. One of the earliest explicit definitions, proposed by van Lawick-Goodall (1970), focused on the abstract properties of this behavior: "the use of an external object as a functional extension of mouth or beak, hand or claw, in the attainment of an immediate goal." Beck (1980) offers a more detailed definition, one that has been used widely in the animal tool-use literature: "the external employment of an unattached environmental object to alter more efficiently the form, position, or condition of another object, another organism, or the user itself when the user holds or carries the tool during or just prior to use and is responsible for the proper and effective orientation of the tool." Matsuzawa's (2001) definition is simpler and makes the point clearly: "a set of behaviors utilizing a detached object to obtain a goal that is adaptive in the biological sense."

Tool Use in Humans and Nonhuman Animals

Nonhuman animals, especially some primates, dolphins, elephants, and birds, also demonstrate tool-use behaviors. They are known to use and make tools and also to demonstrate multiple tool uses. For example, chimpanzees, which are known as the most prominent tool users besides humans, demonstrate a rich variety of tool use with divergent tool materials and techniques aimed at various targets: fishing termites and ants from a nest with a twig or a stalk, dipping for ants on the ground with a rigid wand, scooping up algae floating on a pond with a stick, drinking water with a leaf sponge, cracking open nuts with a stone hammer and an anvil (Fig. 1), clipping a leaf for a courtship display, and so on. The most complex form of tool use found in chimpanzees is the use of a wedge in cracking nuts. Chimpanzees at Bossou in Guinea have been observed to insert a third stone underneath an anvil to serve as a wedge, thereby keeping the anvil stable and flat. While almost all other examples of tool use in nonhuman animals contain only a single relationship between a single tool and a single target (level 1-type tool use), nut cracking with a hammer and an anvil entails two relationships between objects (level 2-type tool use), and three relationships can be discerned in the instances of wedge use (level 3-type tool use): (1) a chimpanzee uses a stone as a hammer to hit a nut, where (2) the nut is placed on an anvil stone, and (3) the anvil stone itself is supported by a wedge stone (Matsuzawa 2001). There is no evidence that nonhuman animals can use tools at level 4 or higher.

Besides the chimpanzees' infrequent wedge stone use, there is no clear evidence in the wild that nonhuman animals use metatools, that is, using one tool to make or gain a second (primary) tool. This is considered to be because of the animals' cognitive inability to do so. Metatool

Invention and Modification of New Tool-Use Behavior, Fig. 1 Chimpanzees' use of stone tools for cracking open nuts at Bossou in Guinea (Source: Photograph by Nogami Etsuko)

use is very cognitively demanding because the relationship between a metatool and the goal object is not direct but rather mediated via the primary tool. Another possible explanation from an ecological viewpoint is that the animal can select or manufacture the appropriate type of primary tool in the first place, and consequently there is no need to use a metatool. The lack of metatool use might be one of the restrictions preventing technological innovation and expansion in nonhuman animals.

Because tools are used extensively by both humans and wild chimpanzees, it is widely assumed that the first routine use of tools took place prior to the divergence between the two species. These early tools, however, were likely made of perishable materials such as sticks or consisted of unmodified stones that cannot be distinguished from other natural stones as tools. The first evidence of stone tool industry that can be found in fossil records dates as far back as 2.5 million years: Oldowan chopper tools. *Homo habilis*, an ancestor of *Homo sapiens*, is considered to have started manufacturing Oldowan tools. Oldowan technology is typified by what are known as "choppers." Choppers are stone cores with flakes removed from part of the surface, creating a sharpened edge that was used for cutting, chopping, and scraping.

Thereafter, humans invented numerous kinds of tools that can be used in a variety of contexts such as feeding, clothing, housing, traveling, and social interactions. After the long Stone Age, around the fourth millennium BC, humans started to use metal instead of stones as the material for their tools. In the Middle Ages and thereafter, the incorporation of new energy sources such as water, wind, heat, and nuclear power caused major technological innovations. Humans evolved an opposable thumb, which is useful in holding and manipulating tools, and our brain size increased, which led to our understanding of the physical principles and causal regularities of how tools work. These features are considered to have contributed to the invention and modification of new tool-use behaviors in humans.

Origins of Material Culture

Not only for humans but also for some nonhuman animals, especially chimpanzees (Whiten et al. 1999), recent studies have revealed geographic variations in tool-use behavior among communities. For example, chimpanzees at Bossou in Guinea crack open oil-palm nuts, whereas chimpanzees at Gombe and Mahale in Tanzania do not demonstrate such stone tool use or hammering techniques even though nuts and suitable stones are readily available at these sites. This is interpreted as evidence of material culture in these species, and it proves that tool use is not totally inherent but rather acquired by invention and modification. These cultural variations are considered to be maintained and passed on from generation to generation through social learning and transmission. This social learning and transmission mechanism enables an individual to learn a novel behavior from others; however, this cannot explain the mechanism of the emergence of the novel behavior in the first place. The mechanism of emergence, that is, invention and modification, of a new tool-use behavior is a key to understanding the origins of material culture.

Invention and Modification of New Tool-Use Behavior

"Invention" and "Modification"

In many cases, it is difficult to clearly distinguish "invention" from "modification" because these two types of change are often continuous, and the difference is merely a matter of degree. For example, de Beaune (2004) examined changes in tools in early humans and suggested that new tools were the result of combining preexisting elements rather than creations *ex nihilo* (Fig. 2). That is, changes can be seen as the "invention" or as "modification" of tools, materials worked, techniques, or other elements.

There are very few records of the invention and modification of new tool-use behavior in nonhuman animals. At Bossou in Guinea, where "ant dipping on the ground" by chimpanzees is customary, a chimpanzee was observed to demonstrate a new tool-use behavior, "ant fishing in trees," which had never been observed over the past 27 years. In 2003, a 5-year-old juvenile chimpanzee was observed to be engaged in ant fishing in trees by employing wands of similar length to those used for ant dipping on the ground, which is a customary tool-use behavior of this community (Fig. 3a). Two years later, at the age of seven, his tools for ant fishing were shorter and more suitable for capturing carpenter ants living in a tree hollow (Fig. 3b). In this process, two steps can be recognized: the first is the change of the target ants from safari ants on the ground to arboreal ants, and the second is the change in the tool length. This can be considered an example of emergence of a new tool-use behavior in which it is difficult to clarify exactly whether the new tool-use behavior was "invented" at the first or second step.

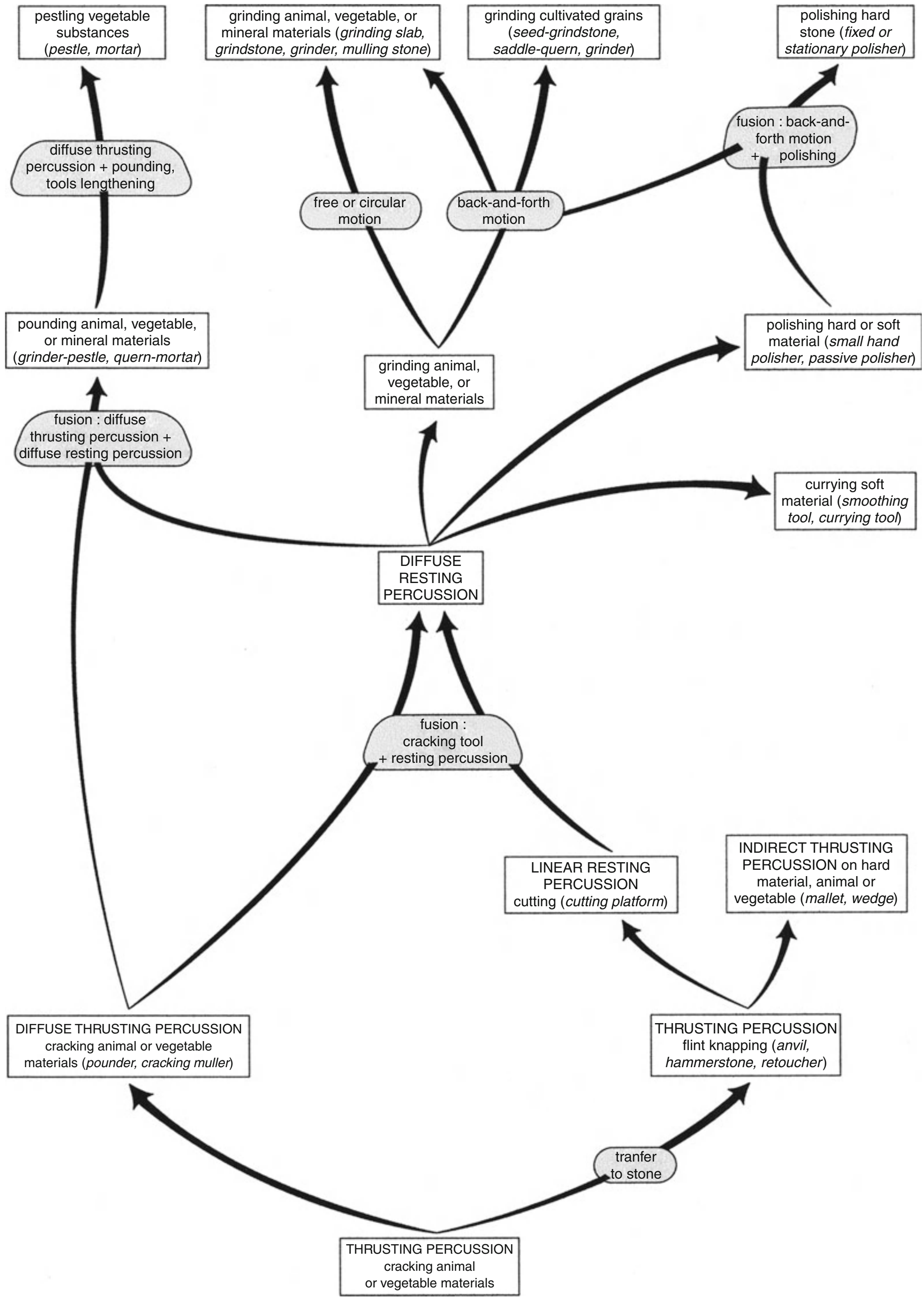
Elements that Could Have Been Newly Invented and Modified

As seen in the above example of the emergence of "ant fishing in trees" by a chimpanzee, there are several elements that could be invented or modified in the process of the emergence of a new tool-use behavior: tool shape, tool material, technique, target, function, and a combination of these.

Tool Shape: In Stone Age tool innovation, 2.5 million years ago, *Homo habilis* first made tools (Oldowan chopper tool, Fig. 4) by hitting one stone against another. About 1.5 million years ago, *Homo erectus* started to shape stone tools more carefully by flint knapping, so that they had long straight cutting edges, like a knife (Acheulean hand axe, Fig. 5). In nonhuman tool use, chimpanzees make fishing and dipping tools from natural plants by stripping off unnecessary leaves and biting off some of the plant to obtain the appropriate length. In the above example, the chimpanzee was observed to adopt tools of different length 2 years after he started to target the different ant species. Some captive corvids (*Corvus moneduloides* and *Corvus frugilegus*) are known to have invented a hook tool to retrieve an out-of-reach bucket containing a worm.

Tool Material: Nonhuman animals mainly use plant materials such as sticks and leaves. Plant tools are easily worked and shaped but are perishable and disposable. Stone tools are hard and tough but are difficult to process. Metal tools have the advantages of both plant and stone tools: they are hard, tough, and also easy to shape. The invention of metal tools stimulated the expansion of technological innovation in humans.

Technique: With the same tool, several different techniques can be employed. For example, when chimpanzees dip for safari ants with a wand tool, some chimpanzees dip for ants



Invention and Modification of New Tool-Use Behavior, Fig. 2 Tool-invention processes (Source: de Beaune (2004))

Invention and Modification of New Tool-Use Behavior, Fig. 3 Invention and modification of a new tool-use behavior by a juvenile chimpanzee at Bossou in Guinea. (**a**) Ant fishing in trees first observed when the chimpanzee was 5 years and 4 months old in 2003. He used a long and rigid tool that is similar to tools used for ant dipping on the ground. (**b**) Ant fishing with a short tool when he was 7 years and 2 months old in 2005 (Source: Photograph by (**a**) Gen Yamakoshi and (**b**) Shinya Yamamoto. Reference to Yamamoto et al. (2008))

Invention and Modification of New Tool-Use Behavior, Fig. 4 Oldowan chopper tool (7.2 × 6.5 cm) found in Swaziland, Southern Africa (Source: Museum of Anthropology, University of Missouri)

Invention and Modification of New Tool-Use Behavior, Fig. 5 Acheulean hand axe (10.7 × 6.5 cm) found in the Sahara Desert, North Africa (Source: Museum of Anthropology, University of Missouri)

with one hand and then sweep the wand directly with their lips (one-handed technique), while others hold the wand in one hand, sweep the ants with the other hand, and hastily put the mass of ants into their mouth (two-handed technique). Different efficiency levels among techniques may drive behavioral changes in tool use, although chimpanzees are known to considerably stick to an acquired technique.

Target: It is sometimes possible to use the same tool for a target that is different from its original target. For example, in the above case of the chimpanzee's invention of ant fishing in trees, the chimpanzee seemed to first apply a tool and technique originally used for dipping for ants on the ground to ants in trees. Different targets normally have different characteristics and may require tool users to modify their tools accordingly. In this case, the chimpanzee changed the length of the tool 2 years later.

Function: Early stone tools in humans are considered to have had several different functions. For example, Oldowan chopper tools, the earliest stone tools, were used to cut meat off the bone, to crush bones to eat the marrow, to crack open nuts, to skin an animal for its hide, and to fashion wood and bone into other kinds of tools. Thereafter, according to their sophistication in stone-processing techniques, early humans invented tools shaped for specific purposes, such as sharper knifelike tools.

Combination: Combinations of two or more tools sometimes generate a new tool use, enabling an individual to achieve a goal that is otherwise difficult or impossible to accomplish. Three categorical types of combinations can be considered: sequential multiple tool use (tool set), metatool use, and fusion of multiple tools of different functions. As an example of the first category, chimpanzees are known to use a tool set, that is, the sequential use of a digging tool and a dipping tool and sometimes even more (up to five different tools) for obtaining food that is difficult to access, such as termites in a hard shelter and honey in an underground hive. Wedge stone use in Bossou chimpanzees can be interpreted as metatool use (see section "Tool Use in Humans and Nonhuman Animals"). An alarm clock in our modern life is an example of the fusion of a measuring tool (clock) and a perception tool (alarm).

Mechanisms of Invention and Modification

How can the invention and modification of a new tool-use behavior be achieved? Ernst Mach (1838–1916), an Austrian physicist and philosopher, noted: "The majority of the inventions made in the early stages of civilization, including language, writing, money, and the rest, could not have been the product of deliberate methodical reflection for the simple reason that no idea of their value and significance could have been had except from their practical use." On the other hand, Thomas Edison (1847–1931), an American inventor, stated, "None of my inventions came by accident. I see a worthwhile need to be met and I make trial after trial until it comes. What it boils down to is one per cent inspiration and ninety-nine per cent perspiration."

Despite the apparently contradictory remarks by Mach and Edison, both of these suggest an important issue: when we say "a tool-use behavior is invented," we have to recognize its significance and/or necessity. As clearly described in Matsuzawa's definition (see section "Background and Definition"), a tool has to be used "to obtain a goal," and therefore it should be "adaptive in the biological sense." In other words, without any significance or necessity of use, an object cannot be a tool. For example, a stone can be a tool only for animals that are able to use the stone for a specific purpose, such as cracking open nuts. For Mahale and Gombe chimpanzees who do not demonstrate nut cracking, a stone exists as an object, but not as a tool. Consider another example. A stone anvil (or a hammer) can be broken when a chimpanzee cracks open nuts on (or with) it. The shape of the broken stone with sharp edges is similar to that of an Oldowan stone tool. The chimpanzee sometimes reuses the broken stone as a hummer (Matsuzawa 2011); however, it is not used in a newly invented way like Oldowan chopper tool by the chimpanzee, which does not notice its significance or does not have any necessity for using it in this way. In short, we can say that necessity is the mother of invention of new tool-use behavior.

In the process of the invention of a new tool-use behavior, it is possible to consider three types of mechanisms: by accident, by trial and error, and by insight.

By Accident: An individual notices that an object (or objects), whether it has already existed or has newly appeared, serves as a useful tool for solving an overt or potential problem when the individual is not aiming to invent a tool for a specific purpose.

By Trial and Error: An individual, when struggling to solve a problem, finds out a way of using an object (or objects) to reach a correct solution or satisfactory result by trying out one or more ways or means until the errors are sufficiently reduced or eliminated. In this process, at least at the first trial, the individual does not fully understand the causal relationship between the tool use and solving the problem.

By Insight: An individual, when struggling to solve a problem, finds out a way of using an object (or objects) to reach a correct solution or satisfactory result with a full understanding of the causal relationship between the tool use and solving the problem. This is achieved without learning based on trial and error.

It is difficult to clarify which of these three mechanisms takes place in each process of

Invention and Modification of New Tool-Use Behavior, Fig. 6 Invention and modification of hook tools by captive non-tool-using rooks. The rook in this photo extracted the bucket containing a worm using a piece of wire she had just bent (Source: Bird and Emery (2009))

invention and modification. This has continued to be a matter of debate. In nonhuman animals, most tool-use behaviors are considered to have been invented by accident or by trial and error. There are few reports that indicate the insightful invention of tool-use behavior in nonhuman animals. Bird and Emery (2009) reported that captive rooks, which are not tool users in the wild, spontaneously used appropriate tools and modified the tool shape to solve several problem-solving tasks (Fig. 6). In most cases, the rooks did so without trial and error. The authors suggested that this provides evidence for insight in the problem-solving abilities of rooks, referring to Thorpe's (1964) definition of insight: "sudden production of new adaptive responses not arrived at by trial behavior . . . or the solution of a problem by the sudden adaptive reorganization of experience." However, controversy remains as to whether the rooks' invention of tool-use behavior can qualify as insightful because other possibilities such as learning and shaping during previous experiments could not be excluded.

Even in humans, insightful invention is probably not as dominant as we naively suppose. The term "insightful" is often used for behaviors for which we cannot fully explain the information-processing mechanism. People often attribute their own behavior to what they perceive as insight, but in many cases, they can be shown to be wrong, whereas in others the label simply reflects ignorance of the origin of inspiration (Kacelnik 2009). In the above remarks, Thomas Edison also emphasized the trial-and-error processes of his inventions. Nevertheless, it is also true that humans can accumulate their knowledge through their own experience, by social learning, and from shared knowledge passed on from generation to generation. With this capacity, humans may invent a new tool-use behavior through analogical reasoning: new problems and their solutions are stored in their long-term memory and later, if necessary, serve as a source of analogous situations from which to draw inferences about the current one (de Beaune 2004).

Conclusion and Future Directions

In conclusion, there is no doubt that humans and some species of nonhuman animals have invented and modified a variety of tool-use behaviors and have passed them on from generation to generation. So what is the difference between humans and nonhuman animals? What enabled humans to achieve considerable technological innovations in such an evolutionarily short period? One plausible explanation is cumulative cultural evolution, which is considered to be unique in humans. Humans have a capacity to recognize that a modification of a known behavior being used by another individual is more productive or effective in obtaining results than one's own and have the flexibility to switch to this alternative behavior. This is the core of the "ratchet effect" (Tomasello 1994), whereby incremental improvements in behavior occur in succeeding generations. So far, evidence of cumulative cultural evolution in nonhuman animals remains minimal and controversial. This is probably because nonhuman animals lack some of the essential abilities such as imitation, evaluation and comparison of efficiencies, and behavioral flexibility or just because they have not experienced any necessity to achieve such an evolution in their natural environments.

At this moment, the cognitive processes that lead to the invention and modification of new tool-use behavior remain for further investigation. Since the first observation of wild chimpanzees was achieved by Jane Goodall in 1960, the study of nonhuman animals' tool use does not have a long history, and we have not accumulated enough examples of invention and modification of new tool-use behaviors. It is difficult to clarify the mechanism even in human cases and much more difficult for human cases involving fossils because it is impossible to identify the "first" appearance from fossil records. Despite these difficulties, however, investigation of the cognitive processes underlying the invention and modification of tool-use behavior is worthwhile, as it deepens our understanding of how we can reach the production of a new idea, the origins of creativity.

Cross-References

- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Analogies and Analogical Reasoning in Invention
- ▶ Cognition of Creativity
- ▶ How does Material Culture Extend the Mind?
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Invention Versus Discovery
- ▶ Patterns of Technological Evolution
- ▶ Psychology of creativity
- ▶ Radical invention

References

Beck BB. Animal tool behaviour. New York: Garland; 1980.

Bird CD, Emery NJ. Insightful problem solving and creative tool modification by captive nontool-using rooks. Proc Natl Acad Sci. 2009;106(25):10370–5.

de Beaune SA. The invention of technology. Curr Anthropol. 2004;45(2):139–62.

Kacelnik A. Tools for thought or thought for tools? Proc Natl Acad Sci. 2009;106(25):10071–2.

Matsuzawa T. Primate foundations of human intelligence: a view of tool use in nonhuman primates and fossil hominids. In: Matsuzawa T, editor. Primate origins of human cognition and behavior. Tokyo: Springer; 2001. p. 3–25.

Matsuzawa T. Stone tools for nut-cracking. In: Matsuzawa T, Humle T, Sugiyama Y, editors. The chimpanzees in Bossou and Nimba. Tokyo: Springer; 2011. p. 73–83.

Thorpe WH. Learning and instinct in animals. London: Methuen; 1964.

Tomasello M. The question of chimpanzee culture. In: Wrangham R, McGrew W, de Waal FBM, Heltne P, editors. Chimpanzee cultures. Cambridge: Harvard University Press; 1994.

van Lawick-Goodall J. Tool-using in primates and other vertebrates. Adv Study Behav. 1970;3:195–249.

Whiten A, Goodall J, McGrew WC, Nishida T, Reynolds V, Sugiyama Y, Tutin CEG, Wrangham RW, Boesch C. Cultures in chimpanzees. Nature. 1999;399:682–685.

Yamamoto S, Yamakoshi G, Humle T, Matsuzawa T. Invention and modification of a new tool use behavior: ant-fishing in trees by a wild chimpanzee (*Pan troglodytes verus*) at Bossou, Guinea. Am J Primatol. 2008;70(7):699–702.

I

Invention Versus Discovery

Carlotta Piscopo and Mauro Birattari
IRIDIA, Université Libre de Bruxelles, Bruxelles, Belgium

Synonyms

Discover: Observe, Find, Unveil; Invent: Devise, Create, Innovate

The concept of discovery indicates the process of finding something that exists but that is not known or recognized yet. The concept of invention, on the other hand, indicates the process of devising something that does not exist.

The two concepts of discovery and invention form a dichotomy that portrays a central tension in epistemology. They highlight two different angles from which one can look at the relation between theory and experience.

Introduction

The relation between theory and experience has always been an issue of paramount importance in both philosophy and science. The first modern stand on this issue traces back to Francis Bacon, the father of the experimental method. According to Bacon, scientific theories are obtained directly by induction from observation: Scientific theories exist in nature and scientists limit themselves to discover them through observation. According to Bacon, science is a process that consists in a gradual and linear accumulation of truths about nature. This epistemological position can be conveniently indicated as the *discoverist* position.

The discoverist position has been challenged by a major breakthrough in physics: the refutation of classical mechanics. For more than 200 years, the Newtonian description of nature allowed scientists to obtain predictions that matched accurately empirical results both in the terrestrial and in the celestial domain. The crisis of Newton's theory came as a shock for all scientific disciplines. This shock affected also the epistemological foundations of science. In particular, the fact that classical mechanics, which had been considered for centuries as the true description of the universe, was superseded by relativistic and quantum mechanics challenged the very idea that science is about the accumulation of truths about nature.

The shift from classical to relativistic and quantum mechanics determined a major *epistemological shift*: the shift from the discoverist position to what can be named the *inventionist* position. This shift moves from the idea that science is made of truths that are discovered by induction from observation to the idea that science is about the construction of conjectures that are not obtained directly through experience and that cannot be definitively verified on the basis of experience itself. The dichotomy *inventionism/discoverism* can be used to highlight the tension between the two positions on the status of science that have characterized the scientific debate after the crisis of classical mechanics.

The Discoverist Position

The discoverist position has its roots in the ancient and medieval philosophy and relies on the idea that the ultimate structure of nature can be eventually known beneath the fallacious appearances. As already mentioned above, Bacon embodies such an epistemological position. Bacon's picture of science rests upon the idea that natural laws are obtained by induction from simple observation. Coherently, Bacon (1610) insists that the experimenter should avoid all theoretical anticipations that Bacon calls *idola*. The term *idolum* comes from the Greek *eidolon*, meaning image or phantom. Bacon uses this term to convey the idea that scientists should not observe reality through theoretical constructs: Scientists should simply stick to the data obtained from experience, which Bacon regards as completely objective and as the only source of knowledge. In the proper experimental phase, the experimenter should collect data and organize them in what he calls *tabulae*, which can be regarded as the forerunners of the contemporary databases. The experimenter should eventually derive by induction general laws from the *tabulae*. Two centuries after Bacon, John Stuart Mill (1843) further elaborated the discoverist view of science. Mill stated that induction is a necessary tool to acquire knowledge: It is the only genuine method that allows us to obtain general theories and to justify them. In a way, the discoverist view can be epitomized by the idea that science can eventually remove Schopenhauer's *veil of Maya* and reveal the truth about reality.

The idea that laws truly representing nature can be extracted simply and immediately from experimental data stands on the assumption that these laws are isomorphic to the reality to which they refer. Translated in more contemporary terms (see, e.g., Hastie et al. 2003), this assumption equates to the idea that the real system under observation belongs to the model space. This assumption is necessary if a scientific model is deemed to converge, when sufficient experimental data are available, to the real system itself.

The idea that it is possible to obtain a perfect account of nature underlies the development of modern science. Immanuel Kant's philosophy of science can be seen as the first modern attempt to articulate this idea. Though Kant cannot be seen as a discoverist thinker, he believed that the laws of natural science are indubitably correct because they are based on the a priori categories of cognition, which are applied to phenomena and to which phenomena conform perfectly. Clearly, the significant successes obtained by classical mechanics through the centuries strongly supported the conviction that the correct representation of the universe had been obtained and that science had reached the final truth.

The Crisis of Classical Mechanics and the Problem of Induction

The crisis of such a solid theory as classical mechanics undermined the key assumption on which the discoverist position rests: It undermined the idea that, on the basis of observation, it is possible to derive models that coincide with reality. The inadequacy of classical mechanics suggested that models are, at best, approximations of reality and that they remain ontologically distinct from it.

The crisis of classical mechanics revived one of the most controversial issues in epistemology: The Humean problem of induction according to which no matter how much evidence is accumulated in favor of a theory, the theory can be, at any moment, disconfirmed by further observations. The reemergence of the issues raised by Hume is testified by the fact that a significant number of critical works on induction are coeval to the crisis of the Newtonian paradigm.

In the early twentieth century, Henri Poincaré (1902) argued that scientific theories are not inductive generalizations of experience but are *conventions* that science uses because they yield to useful predictions. Just few years later, Pierre Duhem (1906) criticized Newton's contention that the theory of the universal gravitation was obtained by observation and generalized by induction. Through the well-known example of the "inductivist chicken," Bertrand Russell (1957) stressed the idea that the principle of induction cannot be either proved or disproved on the basis of experience and that it should be accepted as an a priori principle. Karl Popper (1935) firmly rejected the idea that science is characterized by the use of inductive methods. According to Popper, scientific theories are bold speculations that are not obtained by induction from experience nor are definitively verified by it. Following Kant, Popper held that scientists do not draw scientific laws from nature, but they rather apply them to nature. Yet, Popper opposed Kant's view that scientists must necessarily succeed in applying scientific laws to nature, and he insisted on the idea that scientific theories have a temporary status and that they are kept as long as they resist to the test of experience. Thomas Kuhn (1962) questioned, in his turn, the idea that science grows linearly by accumulating truths about nature, and he portrayed science as a process composed of irreconcilable steps. According to Kuhn, science is made of stipulations that the scientific community decides by agreement to use and eventually to replace with alternative ones, which typically lead to an innovative and often incompatible account of reality.

The Inventionist Position

The critical concerns raised in the twentieth century about the discoverist conception of science can be conveniently gathered under the above-mentioned heading of inventionism. Notwithstanding none of the thinkers mentioned in the preceding section, except Popper, explicitly uses the term *invention* to characterize the nature of scientific models, these thinkers share the idea that observation does not directly lead to theories and that it cannot be used to finally prove that theories correspond truly to reality.

Popper delineates the core idea of the inventionist epistemology through the thesis of the asymmetry between verification and falsification. With this thesis, Popper subverts the inductivist presumption that there is a positive relation between observation and theory: He puts forward the idea that the relation is rather in the *negative*. Though scientific theories can never be definitively verified by empirical observation, they can be definitively falsified by it. Coherently, Popper characterizes scientific theories as inventions of the human mind rather than as discoveries of the ontological properties of nature. It should be noted that, in this respect, the title "The Logic of Scientific Discovery" of the English translation of the original German "Logic der Forschung" appears contradictory and seems to suggest the opposite idea. Yet, at a closer look, there is no contradiction between Popper's inventionist view and the original title of the book as *Forschung* means literally *research* rather than *discovery*.

By delineating a composite inventionist and falsificationist conception of science, Popper aimed at forsaking the then mainstream logical positivist stance according to which *verifiability* is what distinguishes science from metaphysics. Popper's argumentation is that, since scientific statements cannot be definitively verified by induction from experience, verifiability cannot be used as a solid criterion to demarcate science from metaphysics. Popper found in the possibility of being tested, and potentially falsified by experience, the appropriate criterion of demarcation between scientific and metaphysical statements. Following Poincaré (1902), Popper considered the *predictive adequacy*, rather than the *ontological adequacy*, as the criterion to be used to justify a scientific theory. The predictive adequacy can be assessed on the basis of empirical tests and therefore pertains to science. On the contrary, assessing the ontological adequacy or, in other terms, the adherence to reality goes beyond the limits of the empirical method and therefore concerns metaphysics. A contemporary formulation of the idea that science should limit itself to what can be empirically assessed is Van Fraassen's *constructive empiricism* (1980). Constructive empiricism rests upon the assumption that the goal of science is to obtain theories that are empirically adequate and not to discover the truth about the unobservable aspects of nature.

By drawing a clear line of demarcation between science and metaphysics, Popper wished to preclude metaphysics from playing a role in the justification of empirical theories. Yet, Popper admitted that some speculative ideas, and he cited the example of ancient Greek atomism, had been of value for science as they have been subsequently turned into scientific theories. In acknowledging the value of metaphysics, Popper echoed Whitehead's idea that modern science owes much to metaphysics. As stressed by Whitehead (1926), science eventually rests upon the faith into the deterministic order of nature that should be seen as the reinterpretation of the medieval belief in a rational God. In particular, it can be noticed that classical mechanics relies upon the idea of an "intelligent and powerful Being" that is ultimately responsible of the order of nature (Newton 1713). Further, it can be observed that Leibnizian mechanics supposes that the world that an observer experiences is nothing but the one that God chooses as the best among many possible others (Leibniz 1710). Through the *principle of least action*, this idea carries on to the Euler-Lagrange theory, to the Hamilton-Jacobi theory, and ultimately to all contemporary formulations of classical mechanics (Lanczos 1986). Nevertheless, as far as Popper reasoning is concerned, the idea is that scientific theories should be justified only on the basis of their predictive ability. As explicitly argued by Popper (1963), metaphysical assumptions, like the one of the perfect adherence to reality, can drive scientists toward interesting research directions. Yet, the theories that are devised along these research directions are to be regarded as conjectures that can be justified only on the basis of the fact that they lead to reliable predictions.

By arguing that science does not rest upon truths derived by induction from experience but rather on bold conjectures that precede observation and that are then checked against it, Popper claimed that he had skipped the problem of induction. Yet, by emphasizing the inventionist character of science, Popper raised a central epistemological issue: the *objectivity* of science. Indeed, stating that science invents laws *about nature* and does not discover laws *in nature* amounts to abandon the idea that scientific knowledge is obtained from, and justified on the basis of the observation of, a reality that exists independently from our mental representations. Popper (1935) provided an answer to this issue by introducing the idea of the *intersubjectivity* of science: Though scientific theories are inventions, they are not arbitrary because the predictions derived from them are "intersubjectively tested" by the scientific community according to well-defined experimental protocols.

The very idea that science is about prediction rather than about the discovery of final truths traces back to concerns raised in the late nineteenth century. This idea is paramount to Mach's epistemology. Before the crisis of classical mechanics, Mach (1883) developed an *instrumentalist* conception of science according to which scientific theories have not to be intended as referring to real entities. According to Mach, scientific theories are rather useful instruments for making predictions. Mach's epistemology, in its turn, may be traced back (Popper 1953) to the one of Berkeley (1710). With his composite empiricist-instrumentalist position, Berkeley anticipated Mach in delineating the idea that scientific theories are justified by their practical utility and in denying that science can discover the intimate nature of reality.

The instrumentalist view of science remained marginal until the end of the nineteenth century. It became mainstream in the early twentieth century, as it appeared the adequate epistemological background for the then-newborn paradigms of relativistic and quantum mechanics. The discussion that confronted Niels Bohr (1949) to Albert Einstein on the interpretation of quantum mechanics shows that the Berkeleian and Machian views of science deeply influenced the epochal turning point that characterizes physics in the twentieth century. Although Einstein is typically presented as an advocate of a realist interpretation of the quantum theory, he agreed with the inventionist thinkers that scientists do not draw from observation theories that correspond perfectly to reality. As put by Einstein (1949), reality "is mentally constructed," and the constructs that are used by scientists to account for the sensory experiences must not be regarded, as Kant did, "as unalterable (conditioned by the nature of understanding) but as (in the logical sense) free conventions": These conventions are justified by their ability to provide a "logical representation" of sensory experiences.

Contemporary Incarnations of the Discoverist Position and the Current Debate

Notwithstanding the idea that science is about discovering the truth has undergone serious criticisms in the first half of the twentieth century, starting from the 1960s, a discoverist stream of thinking reemerged in the literature. This stream of thinking goes under the name of *scientific realism* (Smart 1963; Boyd 1973; Putnam 1975). This new version of the discoverist view revised significantly the notion of truth. Notwithstanding it considers truth as the final goal of science, it acknowledges that science cannot deliver absolute truths. This fundamental change of view emerged from the fact that the notion of truth was replaced by the notion of *truthlikeness* (Oddie 1986; Niiniluoto 1987). The idea behind this revised notion of truth is that science does not state absolute truths but only approximates truths by eliminating false theories and by devising more accurate descriptions of reality.

The notion of truthlikeness is formulated and analyzed within the *similarity approach* (Oddie 1986; Niiniluoto 1987) where it is adopted to provide an explanation of the predictive success of scientific theories. Scientific realists acknowledge, in line with the inventionist view, that scientific theories are selected on the basis of their predictive success. Yet, they claim that it is necessary to recur to the notion of truthlikeness in order to both decide which theory to select among competing ones that are equally predictively successful and to explain why the selected theory is more successful than its rivals: Through the so-called *no miracle argument* (Putnam 1975), a number of realist thinkers argued that the amazing success of science would be miraculous if scientific theories were not, at least approximately, true of the world.

The scientific realist strategy to move from an absolute to a softened conception of truth is motivated by the need to respond to the issue of falsification. Yet, accepting that science is about approximating truth rather than discovering it constitutes a breakthrough in the scientific realist epistemology. It heads the realist epistemology toward an *asymptotic discoverist* conception of truth. This asymptotic conception amounts to renounce the key realist assumption that scientific theories correspond to reality. It nonetheless implies the hope that eventually, and possibly in infinite time, theories converge to truth.

The realist attempt to revive the notion of truth has been seriously challenged in the 1980s by Larry Laudan (1981). Laudan questioned the very idea that the predictive success of a theory is an indication of the fact that the theory is a true account of reality. Laudan pointed out that the history of science indicates that the empirical success of scientific theories does not guarantee either their genuine reference to reality or their truthlikeness. Classical mechanics is a representative example in this sense. Recently, it has been argued that the reasons why the notion of truthlikeness has been perceived as unsatisfactory are related to the double role that this notion plays in the similarity approach: Using Kant terminology, Piscopo and Birattari (2010) clarified that the dissatisfaction derives from the fact that the notion of truthlikeness plays a *constitutive role* in the selection of empirical theories while it should play only a *regulative role* in their conception. Within the similarity approach, truthlikeness performs, on the one hand, the regulative function of a stimulus to continuously search for a more complete account of reality. On the other hand, it plays a regulative role while deciding which theory to select among competing ones: The conclusive criterion for preferring a theory to a rival one is the better correspondence to reality.

The problematic issue with the regulative use of the notion of truthlikeness is that the crisis of classical mechanics has definitively ruled out the idea that a scientific theory can be shown to truly correspond to reality. It is therefore hard to see how the criterion of truthlikeness can act as a regulative principle for the selection and the justification of scientific theories.

Notwithstanding the challenge posed by the crisis of classical mechanics to the idea that science is about discovering the truth, there is nowadays a propension in epistemology toward a discoverist position as it is testified by the reemergence of realist perspectives. This propension has a deep motivation. It should be seen as an attempt to preserve the objectivity of science: It is aimed at defending the idea that there is a reality independent from the observer and that this reality can eventually be discovered through observation.

At a closer look, the tension between the discoverist and the inventionist views of science is not a prerogative of epistemology. This tension emerges, for instance, clearly in the artificial intelligence and machine learning field that goes under the name of *knowledge discovery in databases*. As its name suggests, the field of knowledge discovery in databases rests upon the idea that it is possible to build programs that can discover general laws from data sets. The expert system BACON.1 (Langley et al. 1987) is a milestone in machine learning and should be regarded as a realization of the inductivist and discoverist idea. As it is made clear by its name, the assumption behind the implementation of BACON.1 is that this system is built to *extract* theories *from* nature rather to *construct* theories *about* nature. In other words, the very assumption that is made is that since BACON.1 does not devise theories but discovers them in nature, these theories are necessarily a true representation of nature itself.

It must be noted, yet, that though the discoverist view has pervaded the machine learning field for decades, some sectors of the community seem to have eventually switched to an inventionist position. In particular, nonparametric statistical methods such as bootstrap (Efron and Tibshirani 1993) and cross-validation (Stone 1974) do not rest on the hypothesis that the real system under observation belongs to the model space: If the system does not belong to the model space, the learned model cannot coincide with the system itself, and therefore, no discovery is possible. In such a case, the learned model can be at best an approximation of the system. The learned model can be therefore considered only as a useful invention.

Concerning the possibility of building inductive machines, just few years before BACON.1 was built, Popper raised doubts about the idea that a machine could discover scientific laws by induction from simple observation:

> [. . .] *we may consider the idea of building an inductive machine. Placed in a "simplified world" (for example, one of sequences of coloured counters), such a machine may through repetition "learn", or even formulate, laws of succession which hold in "its" world. If such a machine can be constructed (and I have no doubt that it can) then, it might be argued, my theory* [here Popper means the theory that science does not rely on induction] *must be wrong; for if a machine is capable of performing inductions on the basis of repetition, there can be no logical reasons preventing us from doing the same. The argument sounds convincing, but it is mistaken. In constructing an induction machines we, the architects of the machine, must decide* a priori *what constitutes its "world"; what things are to be taken as similar or equal; and what* kind *of "laws" we wish the machine to "discover" in "its" world. In other words we must build into the machine a framework determining what is relevant or interesting in its world: the machine will have its "inborn" selection principles. The problems of similarity will have been solved for it by its makers who thus have interpreted the "world" for the machine*. (Popper 1963)

Conclusions and Future Directions

A tension between the *discoverist* and the *inventionist* views can be seen both in science and in epistemology. The discoverist view is motivated by the need to preserve the objectivity of science, but this view has to deal with the problem of induction. The inventionist view skips the problem of induction, but it has to renounce the idea that scientific knowledge has an objective character.

The tension between the discoverist and the inventionist views appears unavoidable in future discussions about the nature of science. On the one hand, the discoverist view responds to the philosophical concern of ensuring that science is not an artifice but a rational and objective enterprise. On the other hand, the inventionist view is enforced by the pragmatic acknowledgement that even the best confirmed theories are simply conjectures that can be eventually abandoned and substituted by alternative ones that are expected, in their turn, to face the same destiny as their predecessors.

Further research is needed in order to solve the above-mentioned tension. Popper's falsificationist view and the related conception that science does not produce truths but rather builds intersubjectively testable theories appears to be a viable solution: Falsificationism describes scientific theories as not arbitrary though it accounts for their fallible character.

I

Cross-References

▶ Convergent Versus Divergent Thinking
▶ Creativity and Innovation: What Is the Difference?
▶ Ideas and Ideation
▶ Imagination

References

Bacon F. Novum organum. In: Montagu B, editor. The works of Francis Bacon. Philadelphia, PA: Parry & MacMillan; 1610, 1854.

Berkeley G. A treatise concerning the principles of human knowledge. In: Luce AA, Jessop TE, editors. The works of George Berkeley Bishop of Cloyne. London, UK: Thomas Nelson and Sons Ltd; 1710. p. 1948–1957.

Bohr N. Discussion with Einstein on epistemological problems in atomic physics. In: Schilpp PA, editor. Albert Einstein: philosopher-scientist. The library of living philosophers, vol. 7. La Salle, IL: Open Court; 1949.

Boyd RN. Realism, underdetermination, and a causal theory of evidence. Noûs. 1973;7(1):1–12.

Duhem P. La théorie physique: son object et sa structure; 1906. Available as: Wiener PP (transl). The aim and structure of physical theory. Princeton, NJ: Princeton University Press; 1991.

Efron B, Tibshirani RJ. An introduction to the bootstrap. New York: Chapman and Hall; 1993.

Einstein A. Remarks to the essays appearing in this collective volume. In: Schilpp PA, editor. Albert

Einstein: philosopher-scientist. The library of living philosophers, vol. 7. La Salle, IL: Open Court; 1949.
Hastie T, Tibshirani R, Friedman J. The elements of statistical learning. Data mining, inference, and prediction. 2nd ed. Berlin, Germany: Springer Verlag; 2003.
Kuhn T. The structure of scientific revolutions. Chicago, IL: University of Chicago Press; 1962.
Lanczos C. The variational principles of mechanics. New York: Dover Publications; 1986.
Langley P, Simon HA, Bradshaw GL, Zytkov JM. Scientific discovery. Computational explorations of the creative processes. Cambridge, MA: MIT Press; 1987.
Laudan L. A confutation of convergent realism. Philosophy of Science. 1981;48:19–49.
Leibniz GW. Essais de Théodicée sur la bonté de Dieu, la liberté de l'homme et l'orgine du mal; 1710. Available in: Huggard EM (transl). Theodicy essays on the goodness of god, the freedom on man and the origin of evil. La Salle, IL: Open Court; 1985.
Mach E. Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt; 1883. Available as: McCormack TJ (transl). The science of mechanics: a critical and historical account of its development. Chicago, IL: Open Court Classics; 1988.
Mill JS. System of logic; 1843. Available in: Robson JM editor. Collected works of John Stuart Mill. Toronto, Canada: University of Toronto Press; 1963.
Newton I. Mathematical principles; 1713. Available as: Cajori F editor. Berkeley, CA: University of California Press; 1946.
Niiniluoto I. Truthlikeness. Dordrecht, The Netherlands: D. Reidel Publishing; 1987.
Oddie G. Likeness to truth. Dordrecht, The Netherlands: D. Reidel Publishing; 1986.
Piscopo C, Birattari M. A critique of the constitutive role of truthlikeness in the similarity approach. Erkenntnis. 2010;72:379–386.
Poincaré H. La Science et l'Hypothèse; 1902. Available as: Greenstreet WJ (transl). Science and hypothesis. New York: Dover Publications; 1952.
Popper K. A note on Berkeley as a precursor of Mach and Einstein. The British Journal for the Philosophy of Science. 1953;4:26–36.
Popper K. Conjectures and refutations. London, UK: Routledge and Kegan Paul; 1963.
Popper K. Logik der Forschung; 1935. Available as: The logic of scientific discovery. London, UK: Routledge; 1999.
Putnam H. Philosophical papers, Vol. 1: Mathematics, matter and method. Cambridge, UK: Cambridge University Press; 1975.
Russell B. The problems of philosophy. London, UK: Williams and Nogate; 1957.
Smart JJC. Philosophy and scientific realism. London, UK: Routledge and Kegan Paul; 1963.
Stone M. Cross-validatory choice and assessment of statistical predictions. Journal of the Royal Statistical Society B. 1974;36(1):111–147.
van Fraassen BC. The scientific image. Oxford, UK: Clarendon; 1980.
Whitehead AN. Science and the modern world. Cambridge, UK: Cambridge University Press; 1926.

Inventive Creativity

► Creative Mind: Myths and Facts

Inventive Problem Solving (TRIZ), Theory

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Synonyms

Systematic innovation

Introduction

How people invent? Famous scientists and engineers sharing their memories, as well as psychologists studying the creativity process, describe similar situations: An individual facing a difficult problem is mentally exploring various approaches, persistently trying and rejecting ideas until the right one comes. Psychologists call this process trial-and-error method (T&EM).

T&EM has a great history. It was used to create first stone knives, bows, guns, windmills, building, ships, and almost everything we can see around. Some results are astonishing: Polynesian catamarans, old Chinese, Norwegian, or Russian boats are practically perfect. Each element has the best shape. However, archeological research has shown that even 500 years ago, these vessels were rather far from perfect. One hundred years after another of repeating practically the same shapes, the builders yet were introducing slight changes into design. Some of them were unsuccessful, causing fatal accidents, and have been forgotten; the others, successful ones, were becoming a standard. It was a long evolutionary way similar to the evolution of life with similar consequences including fatalities and victims.

With the acceleration of technological evolution, T&EM became less and less acceptable as a method of design. It is absolutely unreasonable today to build thousands of samples to select the best design of a modern aircraft or a steam machine. Engineering science has stepped in offering various means, allowing identifying the best design with the help of scientific research, calculations, modeling, computer simulations, etc. As a result, engineering design today is rather systematic, structured, and well-controlled process, while searching for new ideas is still lacking all these necessary features.

In the typical creative process, people start from exploring apparent conventional solutions, usually governed by their *psychological inertia* slowly moving to the area of "wild" ideas. After hundreds of unsuccessful attempts, luck becomes a king: Someone occasionally can notice a café-maker in the room and wonder if steam could help to solve the problem.

The T&EM effectiveness depends on how difficult the problem is. It could be measured by a number of trials that have to be made to guarantee successful results. This number can vary within wide range – from dozens for simple problems to hundreds of thousand for difficult ones. T&EM is rather sufficient for the problems that do not require more than 10–20 trials; however, for difficult problems that require out-of-the-box thinking, it leads to an unacceptable waste of time and efforts.

In addition to low efficiency, T&EM contributes in poor problem statements. Often a problem is stated in occasional and incorrect format with a lot of unnecessary information while needed information is absent.

Until recently, the T&EM deficiency has been compensated via increasing number of people working on the same difficult problem. At the same time, since the mid-1950s, it had become obvious that even the most adequate utilization of human resources could not satisfy the required pace of invention production. Accelerating technological evolution demanded simple and affordable creative methods. So, the demand has originated the supply. To date, over hundred of various creative techniques and methods are available with different efficiency, area of application, and practical importance (Higgins 1994). At the same time, because it seemed fairly obvious that creativity was a product of the human brain, the main approach to creativity was focused on attempts to enhance the creative process by facilitating an individual's mental processes, that is, *psychology-based approach* to creativity. In summary, these efforts were aimed at the following:

- Unleashing natural creativity and eliminating mental blocks
- Stimulation and mobilization of resources helpful for generating ideas by a group or individual

Later, a fundamentally different, knowledge-*based approach* has been introduced including various analytical steps aiming to manage (organize, restructure, etc.) and utilize available internal knowledge and experience; eventually this approach led to utilization of specially developed and structured external knowledge (innovation knowledge bases).

The basic advantages of the innovation knowledge-base techniques are the following:

- Accumulation of the best practices in creative problem solving is possible.
- Proved knowledge can be assessed.
- Results are repeatable and do not depend on personal (psychological) issues.

The most significant result of the knowledge-based approach is the Theory of Inventive Problem Solving (TRIZ – a Russian acronym for the Theory of Inventive Problem Solving, pronounced as "trees" (Altshuller 1984).

TRIZ Origination and Early Discoveries

TRIZ was founded by Genrich Altshuller, who was born in former Soviet Union in 1926. He has made his first invention at age of 14 and was later educated as a mechanical and chemical engineer.

He also has a military education as a pilot. In 1946, he was employed as a patent agent in Soviet navy with the main responsibilities to assist inventors in filing their patents. However, because of his background, he was frequently approached by engineers stragling with difficult problems. While trying to help them, Altshuller began questioning if a certain systematic or even scientific approach to innovation is possible. After conducting preliminary studies in this area, he decided to embark on his own quest to develop such approach.

While traditional studies on creativity were focusing on psychological aspects of the innovation process, Altshuller chose studying thousands of patents looking for common threads, repetitive trends, and patterns related to innovation activities. The early results of this research brought discovery of *patterns of inventions* (inventive principles) and *patterns of technological evolution*. Other results included *definition of an inventive problem* and *levels of invention*.

In the history of TRIZ, two distinct periods could be identified: *classical TRIZ* and *contemporary TRIZ* characterized as follows:

Classical TRIZ	TRIZ as it underwent development led by Genrich Altshuller in the former Soviet Union (from the mid-1940s to the mid-1980s).
Contemporary TRIZ. Phase 1	TRIZ during *perestroika* in the former Soviet Union, when first commercial application started (from the mid-1980s to the early 1990s).
Contemporary TRIZ. Phase 2	TRIZ as it penetrated the Western world (beginning in the early 1990s to present).

TRIZ Fundamentals

Among the basic discoveries of TRIZ, the most important are:

- Any technical system develops according to certain patterns.
- The patterns of evolution for different systems have much in common.
- The patterns of evolution can be unveiled through researching the evolutionary history of a system (for the area of technology, this evolutionary history is contained in the patent library and other sources of technical information).
- Via application of these patterns, one could accelerate the evolution of that system to its next generation.
- Based on these discovered patterns of evolution, universal methods for searching for new ideas can be developed.

Patterns of Invention

Altshuller's analysis of patents showed that the same fundamental solutions had been used over and over again for different problems, often separated by many years.

Invention #1. Sweet Pepper Canning Method

To prepare green peppers for canning, the stalk and seeds must be removed. This is done manually in the kitchen, but automating the process for large-scale production is difficult because the pods are nonuniform in shape and size.

The following method was invented to core green peppers: The peppers are placed in an air-tight container, in which the pressure is gradually increased to 8 atm. The pods shrink and, as they do so, fracture at the weakest point, where the stalk joins the pepper. Compressed air penetrates the pepper at the fractures, and the pressure inside and outside the pepper eventually equalizes. The pressure in the container is then quickly reduced, causing the pepper to burst at its weakest point (which has been further weakened by fractures). The top is "ejected" from the rest of the pepper, taking the seeds with it.

Invention #2. Husking Sunflower Seeds

One method of husking sunflower seeds is to load them into a bunker, increase the pressure inside the bunker, and then decrease the pressure sharply. The air that penetrates the husks under high pressure expands as the pressure drops, thereby splitting the husks.

Invention #3. Filter Cleaning Method

A filter used to treat fine-grained sand consists of a tube whose walls are coated with a porous, felt-like material. When air passes through the tube, the sand particles are trapped in the pores. Cleaning such a filter is difficult.

The filter can be cleaned by exposing it to a pressure of 5–10 atm and then quickly dropping the pressure to normal. The sudden change in pressure forces air out of the pores, along with the sand. The sand particles are carried to the surface, where they can be easily removed.

Invention #4. Splitting Imperfect Crystals

When manufacturing tools made of artificial diamonds, crystals that contain fractures cannot be used. Splitting the crystals at the fracture yields useable diamonds, but efforts to do so often produce new fractures.

As an alternative, the crystals can be placed in a thick-walled, air-tight vessel. The pressure in the vessel is increased to several thousand atmospheres and then quickly returned to normal. This sudden change in pressure causes the air in the fractures to break the crystals.

Invention #5. Producing Sugar Powder

A technique similar to those described above is employed, at much lower pressure, to break sugar crystals into powder.

The inventions above span different areas of technology and appear at different times, yet they are clearly similar. Moreover, the problems addressed by these inventions are similar. Undoubtedly, had the later inventors known of the earlier solutions, their problem-solving tasks would have been straightforward. Unfortunately, the barriers that exist between different industries made this practically impossible.

We can imagine that a problem solver trying to devise a way to remove the shells from walnuts will know (or be able to find out) how sunflower seeds are shelled, and solving the problem will therefore be relatively simple. Let's imagine, however, that this solution did not yet exist in the food industry. In this case, it is very unlikely that our problem solver will look for a solution in the metallurgy or diamond production industries, and he therefore will be unable to apply a "ready-made" solution and instead must spend time and money reinventing it.

Altshuller realized that knowledge about inventions could be extracted, compiled, and generalized so that it would be useful to inventors in any technological domain. For example, all five of the above inventions can be described as follows:

Problem: Breaking Apart an Object *Solution:* Apply a gradually increasing pressure for some period of time, and then abruptly drop the pressure. The pressure differential will create an "explosion" that breaks the object apart.

This generalized knowledge can be organized and made available so that, when faced with a problem, an inventor needs to only match the problem with the generalized problem, then refer to the corresponding solution(s).

In this way, TRIZ provides problem solvers with access to the most effective solutions over a broad range of industries, based on the accumulated innovative experience of inventors throughout history. In TRIZ, these generalized solutions are called *inventive principles*.

Patterns of Technological Evolution

The first set of patterns of technological evolution was distributed by Altshuller among TRIZ schools in the mid-1970s. This seven-page manuscript became the most valuable component of TRIZ and established the foundation for TRIZ as a science.

The set of patterns included three groups named after the laws of theoretical mechanics as follows (Altshuller 1984):

Group 1 – Statics – determines the beginning of a system's life cycle, including:

1. Completeness of an engineered system
2. Energy flow in an engineered system
3. Harmonization of the synchronization rhythms or parts in an engineered system

Group 2 – Kinematics – determines the general evolution of a system, including:

4. Increasing ideality of an engineered system
5. Nonuniform evolution of subsystems comprising an engineered system
6. Transition to the overall system

Group 3 – Dynamics – reflects evolution in contemporary conditions involving certain physical and technical factors, including:

7. Transition from macro- to microlevel in an engineered system
8. Increasing substance-field involvement

Later, various modifications to the set above were introduced, including numerous lines of evolution (more detail step-by-step descriptions of evolution within the patterns).

Contradictions

One of Altshuller's key findings was that *nearly all great inventions* (*except serendipitous discoveries or inventions resulting from accidents or mistakes*) *are the result of the resolution of one or more contradictions* (*paradoxes*). This common thread – the relationship between contradictions and inventions – provided invaluable insight about problem solving that had previously been unavailable (Altshuller 1984).

A ***contradiction*** exists when attempts to improve one feature of a system cause another feature to degrade.

Altshuller identified two types of contradictions. The first is called a *technical contradiction*. A technical contradiction exists when an improvement to one characteristic of a system is associated with the deterioration of another characteristic. Indeed, engineers often talk in terms of such "dilemmas":

- If we add more functional capabilities to this machine, it will become more complicated and difficult to maintain.
- By increasing the speed of our process, we end up with more errors.

The second, more fundamental type is called a *physical contradiction*, when a characteristic must exist in two opposite states:

- A pen tip should be sharp to draw legible lines but blunt to avoid tearing the paper.
- Aircraft landing gear is necessary for landing but is undesirable during flight.

The conventional way to deal with a contradiction is to look for a compromise or trade-off. Revealed in the patent fund, however, are many examples of solutions that resolve contradictions. This means that *methods for satisfying contradictory requirements exist and can be applied.*

The discovery of the relationship between contradictions and inventions led to significant findings that were soon to simplify the process of solving inventive problems. Altshuller realized that the key to attacking an inventive problem was to reveal the contradiction that lies at its core. For recognized and formulated contradictions, tools for their resolution were created.

Ideality and Inventive Resources

Another Altshuller's important fundamental discovery was that *as technological systems evolve, they become more ideal*. By his definition, a completely ideal system would just perform its function without having side effects, cost, or any other undesired factors. Further, he concluded that all these negative factors that make the system less ideal are associated not with its function but rather with the system that performs this function. Based on this conclusion, *in an ideal system, the function is performed without the existence of the system* (Altshuller 1999). Accordingly, the best solution to a problem will be the one closest to the ideation ultimate result (IUR) that could be defined as follows:

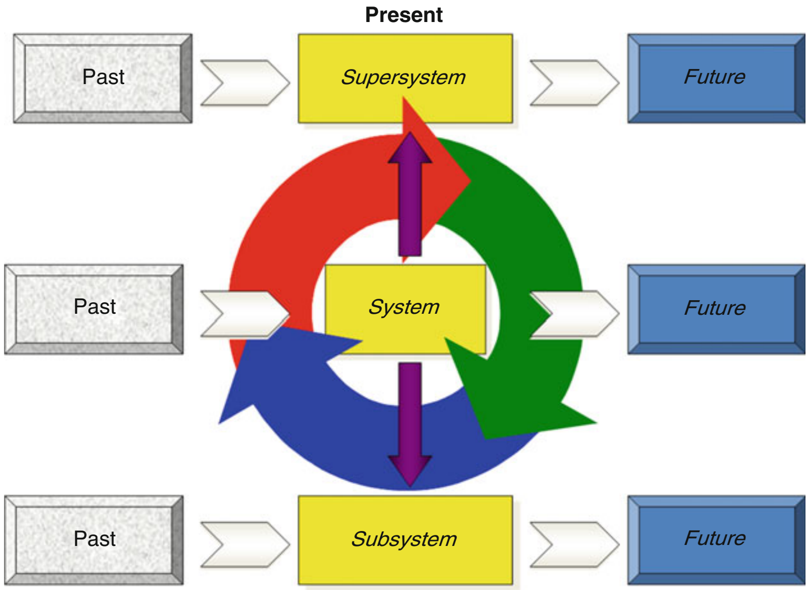
- Produces the desired improvement
- Does not make the system more complex and/or costlier
- Does not cause any side effects/consequent problems

These statements are obviously extreme and are never actually attainable, yet it is important to keep them in mind as we look for inventive solutions to difficult problems.

In real systems, *ideality* for a given system can be defined as the ratio of the sum of its useful features (benefits) to the sum of harmful (or undesired) factors. Given that, the way to increase system's ideality could be one of the following (or both):

- Increasing system benefits
- Reducing harmful factors

The general approach to achieving near-ideal solutions is using *inventive resources*. An inventive resource can be defined as an attribute of a system or its surroundings that could be utilized for system



Inventive Problem Solving (TRIZ), Theory, Fig. 1 9-screen model of creative thinking (Altshuller 1984; Ideation International 1995)

improvement instead of introducing (adding) external means. These attributes could be:

- Any substance or anything made of a substance (including waste) that is available in the system or its environment
- An energy reserve, free time, unoccupied space, information, etc.
- The functional and technological ability to perform additional functions, including properties of substances as well as physical, chemical, geometric, and other effects

Example

At egg farms, instead of using special devices for date stamping, workers use gloves with date-stamp on one of the fingers. The eggs get stamped as they are placed by workers into cartons.

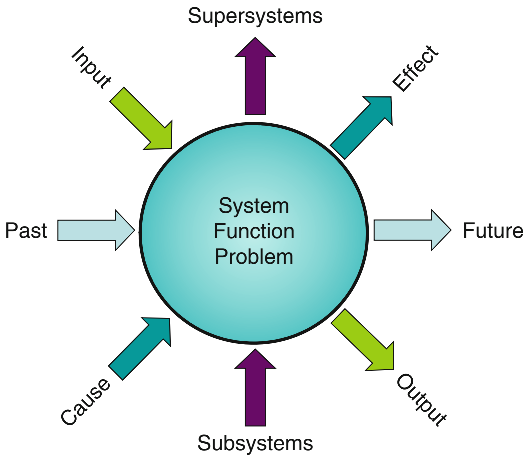
System Approach

Typically, when a problem arises in a system (or in its certain part, for this matter), problem solvers try to solve the problem by focusing on the *system*. But experienced inventors think differently. They understand that the system elements and the elements of the close environment are interconnected; because of that, changes in one part of the system produce sequential changes (both positive and negative) to other parts of the system and its environment. Given that, they simultaneously think about the system, the supersystem, and all associated subsystems and how they could be useful in problem resolution. For example, the system "airplane" is a part of the supersystem "transportation." Switching from the "airplane" to "transportation" changes our point of view for how to deal with a problem associated with an airplane.

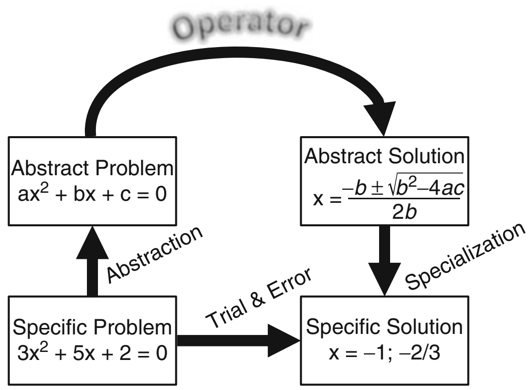
Example

If we are looking for ways to reduce the time it takes to fly from Los Angeles to Tokyo, and we are targeting a system called "airplane," then our focus for solving the problem would be centered on making the airplane move faster. On the other hand, if we focused on the supersystem "business trip," we might consider *all* aspects associated with moving a person through the entire process, from the time he/she leaves the house until he/she arrives at the desired destination. This more expansive look at the problem now includes driving, parking, ticketing, security check-ups, baggage handling, entering and exiting the plane, directional signage in the terminal, and so forth.

Altshuller suggested that the thinking process of the most talented natural inventors could be illustrated with the diagram shown below (Fig. 1).



Inventive Problem Solving (TRIZ), Theory, Fig. 2 8-angle system approach (Ideation International 2004)



Inventive Problem Solving (TRIZ), Theory, Fig. 3 Principle of solution by abstraction applied to quadratic equation (Ideation International 1995)

Because thinking about numerous aspects of the situation is extremely hard for normal human being, he recommended transforming this complex picture in a linear sequence of "boxes," allowing considering one direction at a time.

Later, the schematic above was convoluted in two axes, system axis and time axis, and two additional axes were introduced, suggesting eight angles to the problem situation (Fig. 2).

Main Approach to Inventive Problem Solving

Humans possess an innate approach to problem solving: When faced with a problem we do not know how to solve, we try to think of a similar, *analogous* problem for which we know a solution. Then, with this known solution in mind, we try to devise an analogous solution to the problem we are trying to solve. The chances that we will succeed using this approach are determined by:

- Our knowledge of problems with known solutions, accumulated through education and experience. This knowledge is needed to make the analogical "leap" from our new problem to the analogous problem.
- Our ability to devise a solution to a new problem from the analogous solution.

If one's experience and/or ability to see analogies is limited, principle of abstraction can help (Fig. 3).

The example above is a well-established approach in math. TRIZ suggests that the same approach could be applied to inventive problem solving (Fig. 4).

Similar to math, each transition described above is supported with well-defined tools (Fig. 5).

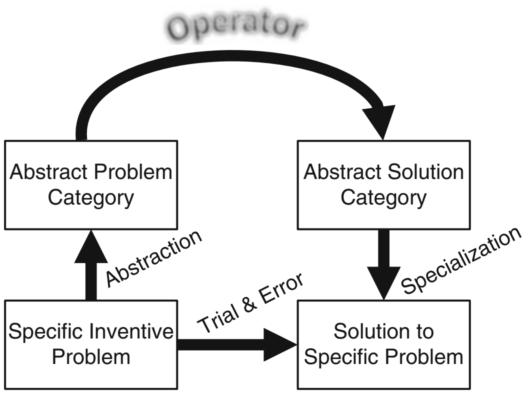
TRIZ Way of Thinking Versus Conventional Thinking

The main concepts of TRIZ, especially ideality, resources, contradictions, and system approach, constitute TRIZ way of thinking, which is different from conventional thinking of the majority of human individuals. The Table 1 below shows the difference.

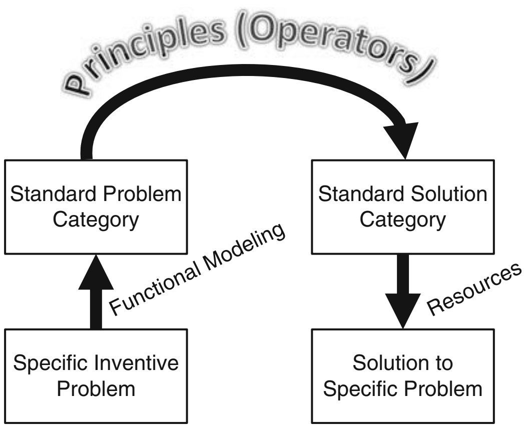
Simple algorithms and several well-formulated recommendations can help master TRIZ way of thinking, making it an inherent part of an individual's mentality.

TRIZ Tools

TRIZ tools for systematic innovation include *analytical tools* that help understand if it is necessary to reformulate the problem and



Inventive Problem Solving (TRIZ), Theory, Fig. 4 Principle of solution by abstraction applied to inventive problems (Kaplan 1996)



Inventive Problem Solving (TRIZ), Theory, Fig. 5 How TRIZ works (Ideation International 2004)

knowledge-based tools that represent the best innovation and problem-solving practices extracted from patents and other sources of information.

Analytical Tools

Analytical tools of classical TRIZ include:

- Algorithm for Inventive Problem Solving (ARIZ)
- Substance-Field Analysis

Later, two additional analytical tools have been developed to ensure complete support of all steps in the problem-solving process, including problem definition and formulation (Terninko et al. 1998):

- Innovation Situation Questionnaire®
- Problem Formulator®

ARIZ

ARIZ (Russian acronym for the *Algorithm of Inventive Problem Solving*) is an analytical tool organized as a set of sequential steps helping reveal contradictions and create a set of models of the problem that serve as pointers to apply appropriate knowledge-base tools. The first version of ARIZ was introduced by G. Altshuller in 1959. Since then, numerous modifications have been developed based on feedback and suggestions provided by TRIZ theoreticians and numerous TRIZ practitioners. The last standard version introduced by Altshuller was ARIZ-85C (1985) including over 60 steps. Since then, several modifications have been compiled by various TRIZ providers (mostly simplifications), but none of them has become a standard.

Substance-Field (SF) Analysis

Substance-Field (SF) Analysis is an analytical tool introduced by G. Altshuller in the mid-1970s with the following assumptions (Altshuller 1984; Terninko et al. 1998):

- The minimal model of a functioning technological system includes two objects or substances interacting through a field or force (energy).
- The system can be graphically modeled by a triangle relating the substances and the field.
- Depending on completeness of the given model (all three elements are present or some are missing) or the nature of interaction (useful or harmful), certain standard solutions are recommended.

The Innovation Situation Questionnaire®

(Innovation Situation Questionnaire®, Problem Formulator®, and Directed Evolution® are trademarks of Ideation International Inc.)

The Innovation Situation Questionnaire (ISQ) is a set of questions helping collect and organize available knowledge about a problem situation for the purpose of supporting the problem-

Inventive Problem Solving (TRIZ), Theory, Table 1 TRIZ way of thinking versus conventional thinking

Concept	Conventional thinking (attitude)	TRIZ thinking (attitude)
Ideality	Looking for incremental obviously feasible solutions	Envisioning the most desirable solution in assumption that anything is possible and, once it is envisioned, looking to realize it or the closest possible
Resources	Means for system improvement should be brought from the outside. To add a function or a feature, one should introduce additional element, energy, money, etc.	First, look for an unused resource (internal or from the close environment) that can perform an additional function or provide an additional feature
Contradiction	Avoiding; when confronted, looking for a trade-off or a compromise	Understanding that any difficult situation has an underlined contradiction. Formulating (verbalizing) this contradiction(s) and applying appropriate operators for its resolution
System approach	Limiting solution space within the area in which a problem has occurred	Understanding that elements of the given system and its environment are interconnected; changes in one part of the system produce sequential changes (both positive and negative) to other parts of the system and its environment; every problem should be considered as a problem situation with multiple angles to address the issue

solving process (Terninko et al. 1998; Kaplan 1996). Although typically subject matter experts for a given system know their system well, this knowledge is usually focused on performance and/or production. While this is helpful and even necessary, knowledge of this type can produce strong psychological inertia factors that hinder the creative process. ISQ questions have been carefully selected based on extensive TRIZ experience of leading TRIZ specialists; as a result, they help look into the problem situation from TRIZ point of view and allow for generating the first inventive ideas.

Problem Formulator®

The Problem Formulator is an analytical tool for transferring knowledge about a particular problem situation from the user's mind into a comprehensive set of Directions for Innovation (problem statements) (Terninko et al. 1998). Problem Formulation process included two steps:

- Building a diagram (visual model) that describes the problem (innovation) situation in terms of cause-effect relationships
- Converting the diagram into an exhaustive set of Directions for Innovation

Each computer-generated Direction for Innovation serves as a "pointer" to a relevant portion of the knowledge base.

Knowledge-Based Tools

Besides patterns/lines of evolution, knowledge-based tools of classical TRIZ include (Altshuller 1984):

- 40 Principles and Contradiction Matrix
- Separation Principles
- The System of (76) Standard Solutions
- Selected Innovation Examples
- Effects (Phenomena)

Historically, various TRIZ knowledge-based tools were developed with the expectation that older tools would eventually be replaced or absorbed by more advanced and effective tools (Zlotin 1999). As a result, by 1980s many TRIZ schools practically stopped teaching the 40 Innovation Principles providing only brief information about this tool and instead put emphasis on the System of (76) Standard Solutions. However, later it became apparent that excluding the 40 Innovation Principles from a practitioner's "toolbox" had a negative impact on one's practical problem-solving abilities, primarily due to the fact that the older tool had its own advantages, like simplicity. Also, several very effective recommendations from the 40 Innovation Principles were not included in the System of Standard Solutions (e.g., "transformation of harm into a benefit"). On the other hand, tools multiplicity led to duplication and confusion which tool to use in various practical cases.

Later attempts to resolve the issues above and to further enhancement of TRIZ knowledge-based tools went in two main directions (Zlotin et al. 2010):

- Development of an integrated operational knowledge-based tool (System of Operators) that included all recommendations contained in the 40 Innovation Principles, System of Standard Solutions, Utilization of Resources, etc. This new system allowed working with any problem model known in TRIZ: technical contradictions, physical contradictions, substance-field models, etc.
- Development of simplified sets of principles (operators).

TRIZ Applications

The first TRIZ application (reflected in the name of the methodology) – solving inventive problems in technological areas. However, inventive problem solving (IPS) is only one of the existing innovation needs. To address all needs and develop a complete innovation and problem-solving platform, the following steps have been taken:

1. Identifying all needs related to problem solving and innovation and development of a comprehensive set of applications that will address these needs.
2. Development of computer-aided processes for each application.

This approach resulted in the development of the following additional applications supported by the family of TRIZ-based software (TRIZSoft®) (Zlotin et al. 2010):

- *Anticipatory failure determination* (*AFD*) – proactive process for analyzing, predicting, and eliminating failures in systems, products, and processes
- *Directed evolution*® (*DE*) – predicting next generations of products, services, and technologies via inventing them and developing a comprehensive set of scenarios describing future generations of a system
- *Control* (*Management*) *of Intellectual Property* (*CIP*) – evaluation and enhancement of intellectual property (IP) related to proprietary technologies, inventions, patents, and patent portfolios

Furthermore, contemporary TRIZ possesses tools and processes developed for addressing various issues beyond technology, including problem solving and innovation in areas of business, management, logistics, organizational development, social aspects, and more (Zlotin et al. 2000). Together with inventive problem solving (IPS), the applications above could be considered as contemporary *office of innovation*.

TRIZ Education

Learning how to apply TRIZ concepts and tools takes time. In various ways, TRIZ could be counterintuitive to many people. Psychological inertia, fear of contradictions, lack of open mind, and other reasons make it difficult to learn and accept TRIZ concepts for adult professionals often overwhelmed with their everyday tasks.

Original typical TRIZ courses developed during the era without computers and support from academia were rather long (at least 240 h). The long learning curve was necessitated by the large amount of knowledge that must be acquired from various sources and through substantial practice before becoming a self-sufficient practitioner. Over the years, TRIZ has accumulated many tools of various degrees of complexity, yet there were no clear rules as to which tools should be applied to a particular practical case. Typical TRIZ knowledge included numerous examples and illustrations (learned from instructors and accumulated from one's own experience) and other (mostly tacit) knowledge about how to successfully utilize TRIZ methods and tools. There was no doubt that this issue could become a serious obstacle in wide dissemination of TRIZ.

TRIZ for Professionals

Since the mid-1980s, the need to accelerate TRIZ learning for professionals became quite critical. One (rather obvious) way was to simplify TRIZ learning via focusing on the easy-to-learn TRIZ concepts. Unfortunately, the downside of this approach was substantial reducing of TRIZ problem-solving power. The other approach was development of TRIZ-based software tools. This approach also could be realized in two ways – (a) computerization of existing TRIZ tools and (b) restructuring TRIZ knowledge, making it more suitable for computerization (and thus more effective) (Zlotin et al. 2010).

Today, various TRIZ courses are offered (with or without software) for professionals, from 4–8-h orientations to extended ones. The most cost-efficient proved to be 3–5-day workshops during which the participants learn TRIZ fundamentals and use TRIZ software to simultaneously work on their project. The best results are achieved when these workshops are followed with coaching/mentoring for 30–60 days to ensure successful completion of the project.

At the same time, short TRIZ courses (even with the utilization of software helping achieve good practical results) cannot accomplish one very important objective – development of TRIZ mentality necessary to become a TRIZ professional (similar to the fact that one cannot learn math in a 3-day workshop to become an engineer). Naturally, it should be different if the main TRIZ concepts were learned at early age, like math.

TRIZ for Students and Children

Given the main difficulties with teaching TRIZ to professionals, it became obvious that most of the difficulties could be overcome if TRIZ were taught to college students and even school children of various ages. The first attempts to engage children audiences were made in 1970s in the Soviet Union, when G. Altshuller had a special page in the all-union paper, publishing basic TRIZ concepts and holding a contest for them to participate. Later, Altshuller summarized this 10-year experience in one of his books (Altshuller 1996). Since then, various TRIZ courses have been taught to school children and even in kindergartens.

Since the mid-1990s, some elements of TRIZ have been taught at various colleges and universities in USA and other countries. Lately, fully credited courses for undergraduate students and for continuous education have been offered.

Conclusion and Further Directions

Over 65 years of TRIZ development could be illustrated below (Fig. 6).

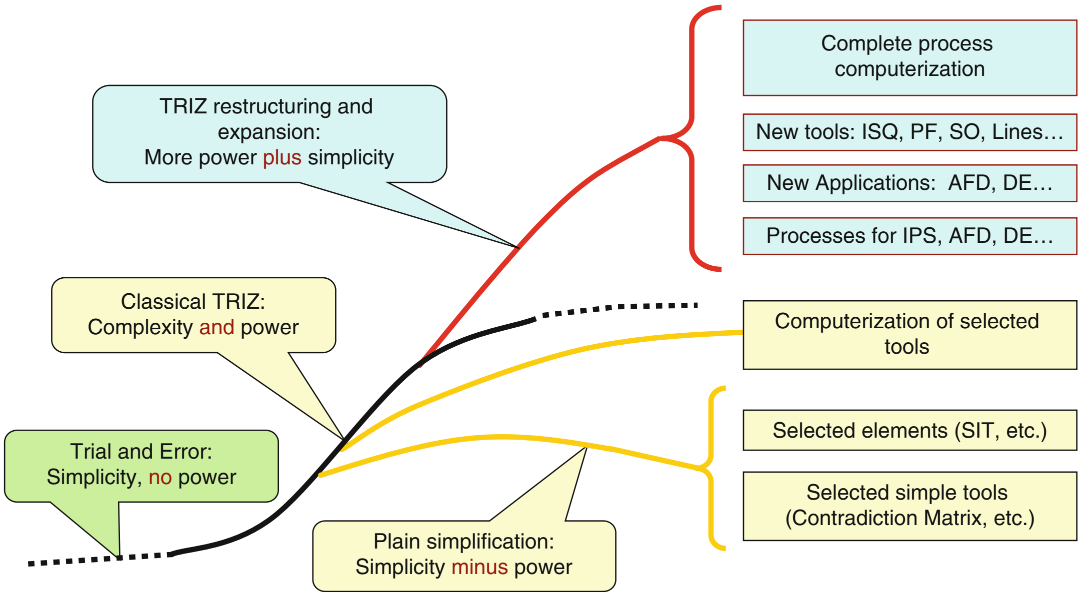
Started from revolutionary discoveries, it has resulted in creation of numerous tools and applications to satisfy all innovation needs and problem solving in practically all areas of human activities (Figs. 7 and 8).

The benefits from learning TRIZ for an individual are quite obvious – one can become a strong critical thinker, innovator, and problem solver.

For an enterprise, the main benefits of TRIZ utilization could be illustrated as shown below (Fig. 9).

When a project manager is about to start a project (starting point), he/she has to analyze possible directions and make a decision which way to go. Typically, the options to consider are few; theoretically, an exhaustive set of all possible options could have many more; however, it may take decades to find all of them if one relies on gradual accumulation of practical knowledge. Therefore, the manager has to make a “forced” decision within reasonable time in the situation of insufficient knowledge relying on his/her intuition, “gut feeling,” etc. Utilization of TRIZ with its powerful analytical tools and extensive knowledge base that accumulated the best innovation practices could significantly shrink this time – a typical problem-solving project can take 4–8 weeks.

The majority of more or less successful techniques introduced to the industry in the twentieth



Inventive Problem Solving (TRIZ), Theory, Fig. 6 Evolution and transformation of methods for innovation (Ideation International 2001)

Four Original Key Findings • Definition of the Inventive Problem • Levels of Inventions • Patterns of Inventions • Patterns of Evolution ***Three Main Premises*** • **Contradictions** • **Ideality & Resources** • **System Approach** ***Four Analytical Tools*** • **Innovation Situation Questionnaire® (ISQ)** • **Problem Formulator®** • **Algorithm for Inventive Problem Solving (ARIZ)** • **Substance-Field Analysis (Su-Field)**	***Ten Knowledge-based Tools*** • 40 Inventive Principle & Contradiction Matrix • Separation Principles • 75 Standard Solutions • Effects • **Patterns /Lines of Evolution** • **Selected Innovation examples** • **System of Operators** • **Bank of evolutionary Alternatives™** • **AFD Checklists** • **IP checklists** ***Four Main Applications*** • **Inventive Problem Solving (IPS)** • **Anticipatory failure Determination (AFD)** • **Directed Evolution® (DE)** • **Management of Intellectual Property**

Inventive Problem Solving (TRIZ), Theory, Fig. 7 Office of innovation: summary of key findings, tools, and applications (Ideation International 2001, 2010). Legend: Classical TRIZ (*in black*); Advanced (*in blue*); Newly developed (*in red*)

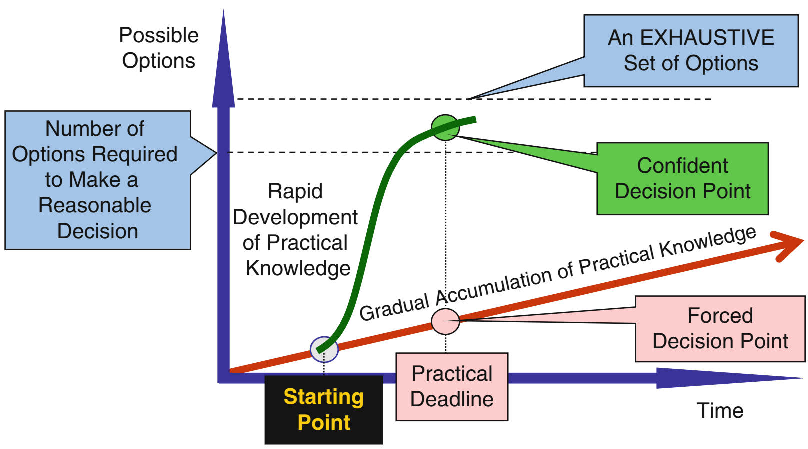
century (value engineering, quality function deployment, lean manufacturing, six sigma, etc.) have a weak link – luck of tools to produce creative solutions. Because the latter is the strongest point of TRIZ, it makes it greatly compatible with practically all other techniques and methods for quality improvement and cost reduction.

At the same time, TRIZ is neither a magic wand nor a silver bullet. If one would like to "calculate" the result of implementing TRIZ within an enterprise, the formula could look as follows (Fig. 10).

From the formula above, one can see that if such critical factors like subject knowledge, personal capability, motivation, and/or management support is missing, the overall results will be zero (with or without TRIZ). However, if all these necessary components are in place, TRIZ could be a tremendous multiplication of efforts and acceleration factor to the innovation process.

I-TRIZ Application/process	Education	Software	Publications	Analytical Services	Age of Application
Inventive Problem Solving	☆	☆	Multiple books and paper	☆	65 yrs
Failure Analysis	☆	☆	Two books multiple papers	☆	30 yrs
Failure Prediction	☆	☆	Two books multiple papers	☆	30 yrs
Directed Evolution	☆	Internal use	One book multiple papers	☆	20 yrs
Enhancement of Intellectual Property	☆	Internal use	Multiple papers	☆	10 yrs

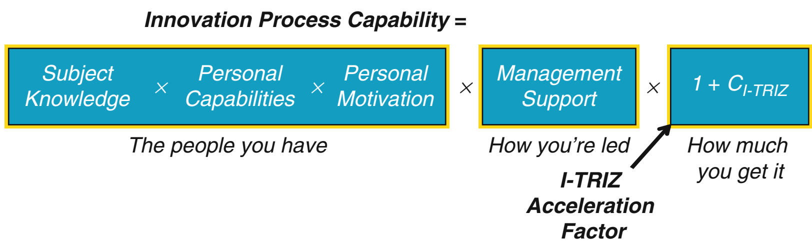
Inventive Problem Solving (TRIZ), Theory, Fig. 8 Commercial offerings of TRIZ education, software, and analytical services (Ideation International 2010)



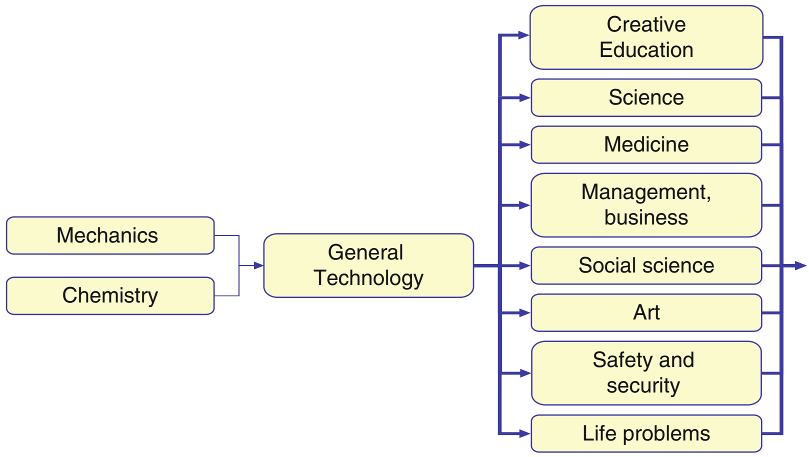
Inventive Problem Solving (TRIZ), Theory, Fig. 9 Accelerating innovation with TRIZ: more solutions, better, and faster (Ideation International 2001)

In spite of 65 years of development, research, and utilization and close to 5 M of search results on Google, TRIZ is still a very young science and technology. The strongest challenges are:

- Absence of Industrial Standards. Many companies tried some TRIZ products, services, and/or education from various providers with inconsistent results. While power of TRIZ methodology is quite visible to technical people, it is not so for the top executives who are focusing on bottom line rather than on technical issues. Although innovation has become a "buzz" word for the twentieth century, very few companies have the strategy and culture to embrace it and unleash its full potential. Because of many organizational and cultural factors affecting TRIZ implementation (see Fig. 9 above), there are not enough success stories to start TRIZ "tornado."
- Lack of Academic Research. Although being created using empirical approach, TRIZ was built as a science, with assumptions, definitions, and fundamental knowledge (patterns of evolution); however, during "Russian period" of TRIZ (1946–1992), most of the TRIZ research was done by individual enthusiasts, without sponsors or academia involvement. Even today, serious TRIZ studies are limited. Few commercial companies are



Inventive Problem Solving (TRIZ), Theory, Fig. 10 Innovation process with TRIZ (Ideation International 2004; John Dubuc 2010)



Inventive Problem Solving (TRIZ), Theory, Fig. 11 Evolution of TRIZ applications (Ideation International 2001)

more focused on sales and marketing strategies than research.

- Lack of Benchmark. Although there is a lot of offering of TRIZ products, services, and education on the market, potential clients have a hard time to evaluate the supply. As a result, certain negative experiences hinder wide TRIZ dissemination.

From the future direction's point of view, there are several aspects of TRIZ further evolution. As a methodology, it has gone through several transformations as follows:

- Way of thinking
- Set of tools
- Set of processes
- Complete system (office of innovation)

From application's point of view, TRIZ evolution could be considered as follows (Fig. 11):

Given the above, further directions in TRIZ development should be as follows:

- Theoretical base of TRIZ (TRIZ as a science)
  - Axiomatic foundation of TRIZ
  - Revised and extended system of patterns/lines of evolution
- Development of new and enhancing existing tools and applications, including productivity software tools
- Continue expanding TRIZ in new areas, for example:
  - Validation and enhancement of intellectual property
  - Solving scientific problems
  - TRIZ for nontechnical systems (business, management, politics, marketing, etc.).
- Integrating TRIZ with other creative techniques and business, quality, and knowledge management systems like six sigma, stage gate, etc.

At the same time, TRIZ has far overgrown its name. Solving inventive problems was a strong necessity of industrial era. There is still room for further development, including honing analytical tools, upgrading and extending knowledge base, finding new applications, etc. However, today, a problem in a certain system can be compared to a sickness; problem solving is equal to looking for a cure. This health care analogy shows us a better way – healthy lifestyle allowing avoiding problems in the first place. Similarly, the next step in evolution of TRIZ is transition to directed (managed, guided) evolution of technology and beyond that will eventually allow any individual or entity to be able to plan and control their destiny, including formulating goals and timely unveiling (anticipating) and solving problems that could arise on the way to a destination.

Cross-References

- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Directed Evolution® Technology
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Inventive Resources
- ▶ Patterns of Technological Evolution
- ▶ TRIZ Software for Creativity and Innovation Support

References

Altshuller G. Creativity as an exact science. New York: Gordon and Breach; 1984 (Russian edition 1979).

Altshuller G. And suddenly the inventor appeared: TRIZ, the theory of inventive problem solving. Worchester: Technical Innovation Center; 1996 (Translated by Lev Shulyak).

Altshuller G. The innovation algorithm. Worcester: Technical Innovation Center; 1999 (First Russian edition 1969).

ARIZ-85c: Altshuller G, Zlotin B, Philatov V. The Profession of Searching for New Ideas. Kishinev: Kartya Moldovenyaska Publishing House; 1985 (In Russian).

Higgins JM. 101 Creative problem solving techniques. Winter Park: New Management Publishing Company; 1994.

Ideation International (1995, 2001, 2004): Ideation Methodology course material: Introduction to the Ideation Methodology. Ideation International Inc., 1995–2005.

John Dubuc. Ideation International 2010, Dubuc J. Accelerating Continuous Innovation. Presented in Orlando, Florida; 2010.

Kaplan S. An introduction to TRIZ, the Russian theory of inventive problem solving. Southfield: Ideation International; 1996.

Terninko J, Zlotin B, Zusman A. Systematic innovation: an introduction to TRIZ. Boca Raton: St. Lucie Press; 1998.

Zlotin B, Zusman A. An integrated operational knowledge base. In: TRIZ in progress. Southfield: Ideation International; 1999a. p. 114–122.

Zlotin B, Zusman A. Managing innovation knowledge. In: TRIZ in progress. Southfield: Ideation International; 1999b. p. 123–140.

Zlotin B, Zusman A, Kaplan L, Visnepolschi S, Proseanic V, Malkin S. TRIZ beyond technology. The theory and practice of applying TRIZ to non-technical areas. Proceedings of TRIZCON 2000; 2000. p. 135–176.

Zlotin B, Zusman A, Fulbright R. Knowledge based tools for software supported innovation and problem solving. Altshuller's TRIZ Institute Conference TRIZCON 2010, Detroit; 2010 Nov. 29–30.

Inventive Resources

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Synonyms

Substance-field resources

Definition

An inventive resource can be defined as:

- Any substance or anything made of a substance (including waste) that is available in the system or its environment
- An energy reserve, free time, unoccupied space, information, etc.
- The functional and technological ability to perform additional functions, including properties of substances as well as physical, chemical, geometric, and other effects

The term "resources" is widely used within many contexts to refer to natural resources, financial resources, human resources, etc. In TRIZ, the creative utilization of the resources available in a system to increase the system's *ideality* is a cornerstone of *inventive problem solving*.

The concept was introduced in 1982 by Vladimir Petrov in the form of *excessiveness in technological systems* that could be utilized to increase the system's ideality. In 1985, Genrich Altshuller introduced "substance-field resources" as a component of the *Algorithm for Inventive Problem Solving* (*ARIZ*). These resources were grouped based on accessibility (internal, external, and from the supersystem(s)), readiness for utilization (readily available and derived (modified readily available resources) and cost (free, inexpensive, cheap). Later, this concept was expanded to include other types of resources such as functions, information, space, and time (Zlotin, Visnepolschi, Zusman). Other types of resources suggested were *differential resources* (Vertkin), resources produced by differing attributes or parameters; *change resources* (Royzen), resources produced by a change to the system; and *super-effect* (Gerasimov, Litvin), an additional benefit resulting from innovation that often goes unrecognized.

Until recently, the utilization of physical, chemical, geometric, and other *effects* has been regarded in TRIZ as another way to increase a system's ideality, as these effects often permit the substitution of a relatively complex system with a much simpler one. However, because an effect can be defined as a predictable (i.e., predetermined or statistical) response to a specific influence based on certain properties of participating elements and these properties (e.g., substance properties) can themselves be considered resources, one can suggest that the utilization of effects is yet another type of resource.

The concept of inventive resources is closely connected with a system emergence and its evolution along an *S-curve*. Typically, there are plenty of resources in the system in the beginning; fast growth is associated with intensive consumption of available resources; the amount of remaining resources is becoming scarce in the vicinity of maturity; the system's decline starts when initial resources are practically exhausted.

An abundance or lack of resources in the existing system can determine the success of problem solving; one can find multiple acceptable solutions in the system rich with resources. On the contrary, finding a solution to a problem in a system with nearly exhausted resources always represents a serious challenge; in certain cases, the solution could be provided only by transition to the next generation of the given system (new S-curve). In other words, certain resources should exist to enable invention. At the same time, every invention creates new resources that could be utilized for its further development and new applications (super-effect).

The most important issue associated with inventive resources is that they are usually unobvious or hidden (the easily apparent resources having already been utilized). A significant step in the formalization of the concept of resources and their utilization was the creation of checklists of typical resources (both readily available and derived) embedded in various TRIZ software products.

Cross-References

- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Inventive Problem Solving (TRIZ), Theory

Inventive Thinking Skills, Development

Alexander Sokol, Edgar Lasevich, Renata Jonina and Marija Dobrovolska-Stoian
Thinking Approach Group (TA Group),
Riga, Latvia

Synonyms

Teaching problem solving; Teaching thinking; Thinking skills, development

Background

Development of inventive thinking skills should be considered in the context of the so-called thinking skills approaches. Although hardly anyone disputes the need for teaching thinking, the actual approaches and programs can vary significantly as there are different theories and pedagogical traditions that underlie them. When analyzing the situation in the field of teaching thinking, it is useful to distinguish between specific programs for teaching this or that aspect of thinking, approaches to teaching thinking, and theoretical frameworks which constitute the basis for various approaches.

Teaching Thinking

Programs

There are numerous programs for teaching thinking. Traditionally, they can be divided into two types: stand-alone and infusion. The former offers a general training in this or that aspect of thinking as a separate subject in the curriculum, while the latter offers thinking instruction as an integrated part of a subject matter course. Thinking programs are usually developed within some approach to teaching thinking: numerous programs for teaching elements of critical thinking (Baumfield et al. 2004), programs developed within Teaching for Understanding approach (Wiske 1998), a large variety of developmental education programs (Davydov 1996), and many others. When such programs are developed by the authors of approaches or people close to them, they tend to become the programs – the ones mostly known and quoted, for example, Feurstein's (1990) Instrumental Enrichment program, de Bono's (de Bono 1973–1975) CORT Lessons, Lipman's (1985) (Lipman et al. 1984) novels and accompanying manuals, etc. As a result, they may often be situated somewhere between programs and approaches, as more specific programs can be developed on their basis when adapting them to peculiarities of a particular situation.

Approaches

While most programs are primarily aimed at solving a local problem, approaches are developed to solve a much more global problem. Contribution to solving this problem is the reason for the development of the approach. An approach should also follow a certain theoretical framework(s). Due to various reasons, approaches can be developed with a different degree of precision – compare, for instance, a very elaborate description of Teaching for Understanding approach developed within the Project Zero and rather general and fragmented data on educational approach to teaching lateral thinking developed by Edward de Bono. An approach gives a possibility to develop various programs for teaching thinking. Lipman's Philosophy for Children, Elkonyn and Davydov's Developmental Education, and what is known as the Montessori Method are examples of approaches. It is necessary to mention that in time, some approaches develop to a degree when just a name remains and there already exist many, often quite different smaller approaches developed within the umbrella one. Critical thinking is the most well-known example.

Theoretical Frameworks

Theoretical framework is a theory, or a set of theories, which constitutes the basis of a given approach. This theory should not necessarily be a pedagogical theory – it can come from a different field of studies. Moreover, the theory should not be pedagogical in most cases, as the scope of problems it is supposed to solve should lie beyond the field of education. For instance, formal and informal logic are the underlying basis of critical thinking approaches to teaching thinking, while dialectical logic (Ilyenkov 1984) and a number of theories developed by Russian psychologists (Leontyev 1974; Vygotsky 1982) constitute the basis for developmental education approach. Note that the understanding of a framework proposed here places some widely quoted "theories" of thinking, Baron's (1987) theory of intelligence, or Sternberg's theory of rationality (Sternberg 1985) to the group of approaches.

Development of Inventive Thinking Skills in Approaches to Teaching Thinking

Inventive thinking skills are required to effectively solve nontypical (creative) problems in various domains avoiding a large number of trials and errors, where nontypical problem is the one for which no solution exists or is not known to the problem solver (Sokol et al. 2008). Thus, education for inventive thinking should aim at helping one acquire skills for coping with the new and the unknown. It is often assumed that this aim is catered for by widely spread thinking skills approaches such as critical thinking, Teaching for Understanding, Philosophy for Children, etc. As indicated in the next section, despite numerous useful features of the approaches, their main focus is different from what is required for the development of inventive thinking skills.

Critical Thinking

General Description

Critical thinking is an umbrella term for quite a few different approaches. The content of a critical thinking skills instruction is not so easy to identify as practically each more or less distinguished author has come with his/her list of critical thinking skills. Paul describes 35 dimensions of critical thought (Paul et al. 1990). Facione (1990: 13) proposes six groups of critical thinking skills: interpretation, analysis, evaluation, inference, explanation, self-regulation, and two groups of dispositions, approaches to life and living in general and approaches to specific issues, questions, or problems. Robert Ennis (2002) suggests three main dispositions: (1) Care that their beliefs be true and that their decisions be justified, that is, care to "get it right" to the extent possible; (2) care to present a position honestly and clearly, theirs as well as others'; and (3) care about the dignity and worth of every person (a correlative disposition) and 15 abilities.

Critical thinking approaches stand out from the rest of approaches due to the most developed assessment tradition. In addition to a number of various critical thinking tests developed largely in the United States, there is an A and AS Level Thinking Skills exam administered by the University of Cambridge International Examinations where critical thinking takes a major role. Yet the range of skills tested appears fairly limited and includes largely various aspects of mathematical problem solving.

Aims and Theoretical Basis

Aims of critical thinking–based courses can be formulated on the basis of definitions of critical thinking. Ennis (1997) defines critical thinking as "reasonable reflective thinking that is focused on deciding what to believe or do." Bailin (1998: 3) says that critical thinking should be conceptualized in terms of things necessary for making reasoned judgments. Paul (Scriven and Paul undated) says that "critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action."

Ennis's definition leads to a very general aim that might sound as follows: educate a learner who is able to think reasonably and reflectively and as a result make decisions on what to believe or do. A part about reasonable thinking would probably be the aim if formulated by Bailin's followers while Paul's approach would be generally the same but giving a more explicit understanding of "reasonable and reflective."

Constructivism is the educational theory that lies at the basis of critical thinking. At the same time, it is necessary to note that due to a large number of various kinds of critical thinking currently taught around the world, the degree of constructivism in this or that approach may differ. Even working with materials that presuppose a constructivist approach, the teacher may often keep very close to the traditional teacher-centered model of teaching. This can often be seen in language classrooms when the teacher exemplifies a classical authoritative pedagogy using a "communicative" course book. Yet, if it is teaching for critical thinking rather than teaching critical thinking, it is a constructivism approach that is essential for successful learning.

Conclusions

Instruments of critical thinking work best when applied to dealing with today's knowledge. They can be extremely useful for analysis, evaluation, and interpretation of this knowledge, making inferences and explaining, but they have not been created for dealing with situations when no knowledge is available. Critical thinking is a tool for today and to a lesser degree a tool for tomorrow. Its focus is not so much on solving inventive problems (and thus developing inventive thinking) as finding a place in the ocean of solutions, as Ennis puts it, "deciding what to believe or do."

Teaching for Understanding

General Description

The authors of the approach distinguish between knowledge, skills, and understanding. Knowledge is seen as "information on tap." Skills are "routine performances on tap." "Understanding is the ability to think and act flexibly with what one knows' (Wiske 1998: 40) and is recognized through flexible performance criterion (Wiske 1998: 42). It is stressed that the performance view of understanding should not be seen as just attaining a representation, a matter of "getting it." "Developing understanding should be thought of as attaining a repertoire of complex performances. Attaining understanding is less like acquiring something and more like learning to act flexibly" (Wiske 1998: 52).

There are four guiding questions underlying Teaching for Understanding Framework (TfU):

- What topics are worth understanding?
- What about these topics needs to be understood?
- How can we foster understanding?
- How can we tell what students understand? (Wiske 1998: 61–62)

These four questions are the basis for four elements of the TfU: generative topics, understanding goals, performances of understanding, and ongoing assessment. The authors speak about four dimensions of the TfU: knowledge, methods, purposes, and forms. The authors also describe the features that characterize the master level of understanding (Wiske 1998: 199–200).

Although it is not explicitly stated, a list of dispositions proposed by Perkins et al. (1993: 7–8) can also be considered a part of TfU-based syllabus. It would mean that there are seven main dispositions that are aimed to be developed in the TfU classrooms: to be broad and adventurous toward sustained intellectual curiosity, to clarify and seek understanding, to be planful and strategic, to be intellectually careful, to seek and evaluate reasons, and to be metacognitive.

Aim and Theoretical Basis

The view that "what students learn needs to be internalized, able to be used in many different circumstances in and out of classrooms, serving as a base for ongoing and extended learning, always alive with possibilities" can be considered the aim of the TfU framework (Wiske 1998: 13).

As well as with most thinking approaches, the theoretical basis of the TfU framework is constructivism, or as Perkins puts it, a brand of constructivism that might be called performance constructivism because of its emphasis on building learners' repertoire of understanding performances more than on cultivating the construction of representations (Wiske 1998: 57). The difference, according to the authors, lies in what gets constructed: representations or performance capability. "Learning a topic with understanding is not so much constructing a representation to fit the topic as developing a flexible performance capability around the topic" (Wiske 1998: 55).

Conclusions

Generative topics that lie at the heart of the approach are based on today's understanding. Thus, they cannot be either new or unknown. The same holds true about methods and forms. TfU is grounded in what we see as good performance today rather than what will be a good performance tomorrow. It is useful for the development of various thinking skills; however, it is not designed for working with inventive thinking skills.

Philosophy for Children

General Description

Although Philosophy for Children is sometimes seen as a critical thinking approach, its author Mathew Lipman (2003) says that critical thinking is only a part of the program. According to Lipman, there are deficiencies of critical thinking programs that "doomed it from the start" (Lipman 2003: 5–6). Philosophy for Children is offered as an alternative educational approach to improvement of thinking in schools. Its curriculum "is composed of novels for the students and manuals for the teachers. The novels are age-differentiated, and they aim to stimulate in children patterns of questioning and discussion that are first modelled by the fictional characters in the novels and subsequently continued, by internalization and appropriation, by the live children in the classroom, as they talk about what they have learned" (Lipman 2003: 156). Children are learning to become the community of inquiry which is seen as the only fully appropriate pedagogy for improvement of thinking (Lipman 2003: 5). "The community of inquiry wants to build a system of thought" (Lipman 2003: 103). In Lipman's novels, fictional characters serve as role models to children. Children are expected to gradually internalize the behavior of the characters (Lipman 2003: 102) and then demonstrate a similar behavior in the classroom.

Aim and Theoretical Basis

Philosophy for Children is aimed to develop three dimensions of thinking: critical, creative, and caring which collectively produce multidimensional thinking (Lipman 2003: 197). The ultimate aim of the program is to provide education for "an inquiry-driven society" (Lipman 2003: 204). Thus, the aim of the program may be formulated as follows: educate a learner who is able and wishes to think in a multidimensional way and is a part of "an inquiry driven society."

It is not surprising that Philosophy for Children is also based on the constructivist tradition in education. At the same time, Lipman's constructivism is much closer to the Russian school of psychology and it shares many commonalities with such an approach as developing education (Davydov 1996) which is largely based on the Vygotskian Cultural-Historical theory (Vygotsky 1982). At the same time, it is necessary to note that a number of important differences exist between the two approaches, such as different conceptualization of thinking, various objects of study, models of educational process, etc. (see Margolis (1996) for more details).

Conclusions

Constructive (creative thinking) and value (caring thinking) dimensions are important in the context of the development of inventive thinking. At the same time, the focus in the program is more on "protective" tools rather than "constructing" tools, as critical component seems to prevail over the other two. This is also reflected in the role given to the formal logic in the process of development of thinking skills. For the development of inventive thinking, Philosophy for Children novels should contain characters that face and resolve nonstandard (creative) problems rather than deal with the typical ones.

Specific Approaches to the Development of Inventive Thinking

An effective approach for teaching thinking should be based on a sound theory. The drawback of most current approaches and programs lies in the absence of a theory for inventive thinking that would underlie them (Baron 1993: 191; McGuinness and Nisbet 1991: 176; Moseley et al. 2004: 24). At present, the only widely recognized theory dealing with the inventive thinking is the Theory of Inventive Problem Solving (TRIZ) (Altshuller 1979). A number of simplified versions of TRIZ (e.g., SIT, ASIT, USIT) and its modifications (e.g., OTSM-TRIZ, ATRIZ) also underlie approaches to the development of inventive thinking.

Problem-Centered Education

Problem-centered education (PCE) (Nesterenko and Belova 2010) comprises interdisciplinary tools that allow to structure and transform information with the aim of analyzing and solving problems in various fields. Its basis is the General Theory of Powerful Thinking based on the Theory of Inventive Problem Solving (OTSM-TRIZ) (Khomenko and Ashtiani 2007).

The system of PCE didactic tools includes a system of models and procedures for organization of inquiry-based research activity of students. The system of models includes information and contextual blocks. The former comprises three levels of models for different types of descriptions of objects studied: the empirical description for mastering ways of researching and describing objects via their features, the systemic description where objects are considered as systems with a specific function, and the problem description where both material and immaterial objects are considered through the demands set to them by people. The levels are organized in such a way that each consecutive level is based on the previous one. The latter block allows to consider objects in three different "worlds": the real world, the world of images, and the fantasy world.

The PCE didactic tools include training for introducing and acquisition of thinking models, tasks construction sets, and diagnostic materials. Models are interdisciplinary and are applicable across subjects. Models are the basis for the procedures that provide for the organization of the inquiry-based research activity of learners. Among others, the procedures include research based on the bank of objects aimed at finding patters and developing rules, research based on the system operator that helps learners pose questions and develop a systemic description of an object, problem solving procedures that contain contradictions of various levels of complexity, etc.

Thoughtivity for Kids

Khomenko and Sidorchuk coined the term "thoughtivity" for the approach for the development of inventive thinking of children starting from the age of 3 (Khomenko and Sidorchuk 2006). The approach is the result of almost 20 years of research and approbation in over 30 kindergartens. There are three underlying principles: nonlinearity of teaching and learning, the use of both hemispheres in the learning process, and the demonstration of the way of thinking by the adult. The principles are implemented through three technologies: the Analogous Solution Technology aimed at helping children acquire the skills for solving problems by analogy, the Contradiction Technology aimed at helping children see and formulate contradictions that underlie problems, and the Algorithm of Inventive Problem Solving (ARIZ) Technology aimed at helping children acquire a sequence of steps for dealing with inventive problems. All technologies are implemented with children through specifically designed tasks and games supported by very detailed teacher guides.

The Thinking Approach to Language Teaching and Learning

The thinking approach to language teaching and learning (TA) (Sokol 2008) is aimed at an integrated development of language and thinking skills of learners. Initially developed for teaching English, the TA is now used for many other languages: German, Russian, Latvian, Chinese, etc. OTSM-TRIZ is the underlying theory of the TA. Any TA course is an infusion thinking course as learners are developing inventive thinking skills while mastering their language skills. TA offers a modular structure that is based on the five technologies that underlie the approach:

- The Self-Study Technology aimed at educating the learner who wishes and is ready to take full responsibility for his/her learning and knows how to make learning a success
- The Creative Grammar Technology aimed at learning to see language as a system
- The Text Technology aimed at learning to see language as a means used for solving problems
- The Yes-No Technology aimed learning to see how various problem-solving models work in a system
- The Research Technology aimed at providing learning with the possibility for transfer of knowledge and skills (Sokol et al. 2008)

The TA technologies offer systems of tasks to learners. Learners' work on tasks is organized through three steps: challenging their current knowledge and getting them to build algorithms for dealing with a task and organizing their reflection. These are referred to as the thinking task framework. The work through the framework allows to expand the TA to other disciplines as reflected in latest projects developed by the proponents (see www.ta-teachers.eu).

Some Other Important Concepts

Thinking Curriculum/Meta-curriculum

The thinking curriculum is often seen as a meta-curriculum that constitutes the foundation for various subject curricula. It offers learners most general skills and models that can be later employed for acquisition of specific disciplines. Thus, the thinking curriculum becomes the driving force for the integration of different subjects.

Importance of (Inventive) Thinking Dispositions

Although the word skills is widely used for teaching thinking approaches, most researchers agree that skills alone are not enough for any practical learning outcome. It is essential that learners also develop dispositions to support the skills. In the context of inventive thinking, it means that one is not only able to cope with nontypical (creative) problems but is disposed to do it. When inventive thinking dispositions are developed, one deliberately searches for the unknown and tries to reveal the contradictions underlying each problematic situation. The dispositional aspect is very important for any initiative aimed at the development of inventive thinking skills.

Infusion Versus Stand-Alone Courses

Thinking skills instruction can be brought to learners either as a stand-alone or as an infusion course. The former option is still used a lot in many approaches; however, researchers tend to agree (Perkins 2002; Swartz and Parks 1994) that the latter option is more effective. In addition to the actual thinking skills instruction, an infusion approach establishes a connection with a discipline, thus allowing for an integration of a thinking skills instruction in the subject matter. It should be noted, however, that infusion courses place significantly higher requirements on teachers and, therefore, are more difficult to administer.

Open-Ended Issues

Materials/Books for Teaching (Inventive) Thinking

Most educational contexts presuppose the existence of textbooks for any subject offered to learners. Apparently, this makes the administration of courses easier for both learners and teachers. However, from the learning point of view, an availability of a textbook is not necessarily an advantage. This is especially so in the case of teaching inventive thinking, where the focus should always be on nontypical issues, while a textbook by definition presents a collection of typical solutions to well-known problems.

Teacher Education for Teaching (Inventive) Thinking

Traditionally, teacher training provides teachers with effective ways of conceptualizing the subject matter and mechanisms of successfully bringing it to students. No matter how modern the approach to either of this could be, from the point of view of inventive thinking, it is still dealing with a typical solution rather than facing the unknown. It is arguable whether the teacher who avoids facing the uncertainty can help learners develop the kind of thinking required for coping with ambiguity. It means that teachers themselves need to have developed dispositions for inventive thinking in order to be able to help their learners in the process. This puts serious implications for the process of teacher education.

Assessment in Teaching (Inventive) Thinking

Assessment is an essential component of any learning. Teaching for inventive thinking is no exception, and any approach to developing it should offer specific criteria on the difference between powerful and poor thinking when dealing with the unknown. However, this very same issue brings to a trap: if learners are aware of what exactly they are expected to do, it has become a typical problem that does not require any inventive thinking approach. This means, in turn, that assessment has stopped being assessment for learning.

Conclusions and Future Directions

It is widely accepted that inventive thinking skills can and should be improved. It is done best through integrating a thinking skills instruction into various disciplines. For achieving better results, the process should start as early as possible. Although programs may seem easier to adopt, one needs to start from the theory and approaches if aiming at a long-term innovation. TRIZ and its further developments appear the most effective theories for educational approaches, dealing with the development of inventive thinking. All materials for teaching thinking should be dynamic and "finalized" by teachers and learners involved in the actual learning process. Assessment for thinking should be developed and integrated in the normative education documents. Systemic approach to teacher education is essential: teachers who teach for thinking should be required to think.

Cross-References

▶ Creative Thinking Training
▶ Divergent Thinking
▶ Entrepreneurship Education
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Inventive Problem Solving (TRIZ), Theory
▶ Preparing Students for Learning Through Invention Activities
▶ Scientific Inventive Thinking Skills in Children
▶ Teaching as Invention

References

Altshuller GS. Creativity as an exact science (in Russian). Moscow: Sovetskoe Radio; 1979.

Bailin S. Skills, generalizibility and critical thinking, twentieth world congress on philosophy. Boston: The Paideia Archive; 1998.

Baron J. An hypothesis about the training of intelligence. In: Perkins DN, Lochhead J, Bishop J, editors. Thinking: the second international conference. Hillsdale: Erlbaum; 1987.

Baumfield V, Butterworth M, Downey G, Higgins S, Lin M, Moseley D, Rockett M. Thinking skills approaches to effective teaching and learning: what is the evidence for impact on learners? London: EPPI-Centre; 2004.

Davydov VV. The theory of developing education (in Russian). Moscow: INTOR; 1996.

Ennis R. Incorporating critical thinking in the curriculum: an introduction to some basic issues. Inquiry. 1997;16(3):1–9.

Ennis RH. An outline of goals for a critical thinking curriculum and its assessment. 2002. Available online at: http://faculty.ed.uiuc.edu/rhennis. Accessed on 20 Dec 2011.

Feurstein R. Instrumental enrichment: an intervention program for cognitive modifiability. Baltimore: University Park Press; 1990.

Ilyenkov EV. Dialeticheskaya logika. Politizdat: Moscow; 1984.

Khomenko N, Sidorchuk T. Thoughtivity for kids. Salem: GOAL/QPC; 2006.

Khomenko N, Ashtiani M. Classical TRIZ and OTSM as scientific theoretical background for non-typical problem solving instruments. Frankfurt: ETRIA Future; 2007.

Leontyev AN. Activity, consciousness. Moscow: Personality; 1974.

Lipman M. Harry Stottlemeier's discovery. Montclaire State College: Institute for the Advancement of Philosophy for Children; 1985.

Lipman M. Thinking in education. Cambridge: Cambridge University Press; 2003.

Lipman M, Sharp AM, Oscanyan FS. Philosophical inquiry. An instructional manual to accompany Harry Stottlemeier's Discovery. 2nd ed. Lanham: University Press of America; 1984.

Margolis AA. A comparison between the philosophy for children approach and the cultural-historical and activity approaches: psychological and educational

foundations. In: Lipman M, editor. Natasha. Vygotskian dialogues. Teachers College: Columbia University; 1996.
McGuinness C, Nisbet J. Teaching thinking in Europe. Br J Educ Psychol. 1991;61(2):174–83.
Moseley D, Baumfield V, Higgins S, Lin M, Miller J, Newton D, Robson S, Elliott J, Gregson M. Thinking skills frameworks for post-16 learners: an evaluation. A research report for the Learning and Skills Research Centre. Trowbridge: Cromwell Press; 2004.
Nesterenko A, Belova G. Knowledge workshop: the tools of the problem-centred education based on OTSM-TRIZ (in Russian) [CD-ROM]. Moscow: Effektivniye Obrazovatelnie Technologii; 2010.
Perkins DN. Mindware and the metacurriculum. In: Dickenson D, editors. Creating the future: perspective on educational change. New Horizons for Learning; 2002.
Perkins DN, Jay E, Tishman S. Beyond abilities: a dispositional theory of thinking. The development of rationality and critical thinking. Merill-Palmer Quart 1993;39(1):1–21.
Sokol A. Development of inventive thinking in language education [unpublished PhD thesis]. University of Latvia and the University of Strasbourg; 2008.
Sokol A, Khomenko N, Oget D, Sonntag M. The development of inventive thinking skills in the upper secondary language classroom. Think Skills Creat. 2008;3:34–46.
Swartz R, Parks S. Infusing the teaching of critical and creative thinking into elementary instruction. Pacific Grove: Critical Thinking Press and Software; 1994.
Vygotsky LS. Mishleniye i rech. Collected works in six volumes, vol 2. Moscow: Pedagogika; 1982.
Wiske MS, editor. Teaching for understanding. Linking research with practice. San Francisco: Jossey-Bass; 1998.

Inventiveness

▶ Creativity: Cultural Capital in Mathematics
▶ Nature of Creativity

Inventor

▶ Innovator

Inventory on Creativity

▶ Measurement of Creativity

IP System

▶ Patent System

Irrational Versus Rational Thinking

▶ Divergent Versus Convergent Thinking

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Joseph A. Schumpeter and Innovation

Christopher Ziemnowicz
Department of Management, Marketing, and International Business, The University of North Carolina at Pembroke, Pembroke, NC, USA

Synonyms

Creative destruction; Growth and development; Modernization

A variety of factors will cause changes in an economy. Among the most important are growth and development. These involve the introduction of innovations into the economy – such as new products, productive techniques, or technology. These special factors were analyzed by economist Joseph A. Schumpeter who became known for his contributions to economic theory in the area of innovation and entrepreneurship. This entry introduces Schumpeter's philosophy as well as his theoretical construct of creative destruction. He is often credited for starting modern growth theory that is based on the inevitable by-product of the process of development and innovation. Schumpeter's description of the innovation process and its diffusion continues to be characteristic in the contemporary knowledge- and technologically driven global economy (Carayannis and Ziemnowicz 2007).

Entrepreneurial Innovation and Economic Change and Development

Schumpeter's Early Theory

Schumpeter pioneered the idea that entrepreneurial innovation was central to economic change and development. Schumpeter's first theory about the role of the entrepreneur was presented in 1911 when he authored the book about the evolution of economies while he was a professor of economics and government at the University of Czernowitz. The book was translated from German as "The Theory of Economic Development" in 1934. Schumpeter's primary focus on the role of the entrepreneur or businessperson was in contrast to that held by most Keynesian or pre-Keynesian theorists.

Schumpeter reflected on the business-cycle volatility of the 1890s and concluded that capitalist economics grow in the long run. His view of Walrasian-style equilibrium analysis was empirically inadequate and too static to explain economic growth. The passive, price-taking approach with continual economic equilibrium did not reflect real-world behavior. Schumpeter noted the continual process of change in real economies and markets. He postulated that in a dynamic economy, there must be an assumption that a force exists within such an economy that can account for change and development. Schumpeter argued that this force is embodied in the entrepreneur. He defined entrepreneurship as "the carrying out of new combinations"

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(Schumpeter [1911] 1934, p. 66). Schumpeter's entrepreneur was "the agent of innovation," and he described them as "the pivot on which everything turns." He wrote that an entrepreneur does not invent but rather innovates. He explained that the quality of the entrepreneurial activities determines the speed of capital growth and whether this growth would involve innovation and change.

This was in contrast to David Ricardo's approach that described the productive functions in an economy as one of the three English socio-economic classes at the turn of the nineteenth century: labor from the working class, land from the aristocracy, and capital from the merchant class. The entrepreneurial function was identified with the capitalist or with the manager. The entrepreneurial function was simply identified with the roles performed by the capitalist, or the manager (McCraw 2007). Expanding this approach, Robert Solow's mid-twentieth-century growth theory called for the use of three options: more labor, more capital, or more capital per worker, to achieve economic growth. However, this concept still did not include and explain the role of innovation within the economy. On the other hand, Schumpeter introduced the hypothesis of entrepreneurial innovation as the primary factor that propels capitalist economies upward. He explained that it is the entrepreneur who creates innovation and further pointed out that innovation is not only invention. Schumpeter's entrepreneurs were driven by numerous factors such as competition to improve their organization, incorporate technology, and even take advantage of financial opportunities; they created change and did not behave according to traditional economic equilibrium theories. Schumpeter described: "in capitalist reality as distinguished from its textbook picture, it is not [textbook]... competition which counts but the competition from the new commodity, the new technology, the new source of supply, the new type of organization (the largest-scale unit of control for instance)–competition which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firms but at their foundations and their very lives" (Schumpeter, Capitalism, Socialism and Democracy, 1942, p. 82).

Schumpeter thus identified innovation as the critical dimension of economic change. He elaborated his theory to describe the process of innovation and also distinguished five types of innovation: (1) new production processes, (2) new products, (3) new materials or resources, (4) new markets, as well as (5) new forms of organizations (Schumpeter [1911] 1934, p. 66). As such, he also broke new ground in the field of innovation management. Schumpeter went further to describe diffusion of innovation or the process over time of acceptance or absorption of it within an economic system. Without innovation, no diffusion can take place; correspondingly, without diffusion, an innovation remains a singular isolated event. Diffusion is thus complementary in Schumpeter's theory. He suggested that innovation without diffusion would not lead to economic development (Brouwer 1991, p. 58).

Schumpeter described that the entrepreneurs who initiate, create, and adopt innovations generally gain profits. The entrepreneur's original innovation produces increasing profits for them. Others attempt to replicate the success of the innovator by coping the innovation. Depending on the resources available and entrepreneurial capability, diffusion can be rapid or slow. Schumpeter thus postulated that this process and transforming innovations, as well as their diffusion, will lead to waves of economic change that affect the entire economic system.

However, Schumpeter pointed out that the entrepreneur is not primarily motivated by the prospect of gain but also something else: "the dream and the will to found a private kingdom," "the will to conquer," as well as "the joy of creating" (Schumpeter [1911] 1934, p. 93). This is another way of describing the pleasures gained from being an agent of change as a result of the entrepreneur's innovative capabilities. Schumpeter explained that change in an economy is a function of innovation and entrepreneurial activities.

Schumpeter's Later Theory

Schumpeter presented a further elaboration of his ideas after studying how the capitalist system is affected by market innovations. This contribution came in 1942, during the Second World War, in the book "Capitalism, Socialism and Democracy."

Schumpeter's analysis came on the heels of the Great Depression when the defense of democracy and the structure of future economic systems – capitalism or socialism – were in question. He described the process where "the opening up of new markets, foreign or domestic, and the organizational development... illustrate the same process of industrial mutation, that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." This was a process that Schumpeter described as "creative destruction." He continued to argue that innovation by the entrepreneur leads to waves of "creative destruction" as numerous innovations cause existing stock of ideas, skills, technologies, and equipment to become obsolete. Schumpeter's core concept was not "how capitalism administers existing structures, . . . [but] how it creates and destroys them."

Schumpeter's seminal term of "creative destruction" came into existence late in his career, but it succinctly summarizes the theory of economic evolution that he held throughout his life. He had experienced a continuum of economic change during his career: from first-hand knowledge of entrepreneurial firms in turn-of-the-century Vienna to the large bureaucratic corporations during the 1930s and 1940s in the United States. He observed the innovations introduced by enterprises in the economy as "industrial mutation" that "incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter 1942, p. 83). Schumpeter's creative destruction theory is based on the process of modernization, the continuous progress implemented by individual entrepreneurs and corporate business managers working in a dynamic economy that bring about an improved standard of living for everyone. He stated that change is the only constant in the evolution of capitalist economies but that the rate of change is not constant. Schumpeter forewarned that capitalist economies do not evolve smoothly but discontinuously. He described the disruptive innovation process occurring at "irregularly regular" intervals.

After analyzing the capitalist model of the economy, Schumpeter tried to identify which companies would be in a better position to innovate. He developed the theory that a company's ability to innovate was mainly connected to its size. Initially he defended that small companies should be in a better position due to their flexibility, while large companies might get trapped in bureaucratic structures. Schumpeter now described that economic growth and technical progress is achieved by the enlargement of firms and the destruction of competition, not through the "invisible hand" of free competition. His theory was that large companies compete not strictly in price but in achieving successful innovations. In contrast to entrepreneurs and smaller firms, large corporations have better resources and more market power. Schumpeter explained that this type of competition proved to be more effective for achieving economic progress than the traditional approach through price competition.

Schumpeter's theory assumed that innovation-originated market power could provide more effective results than pure price competition. He described that technological innovation often creates temporary monopolies that produce excessive profits. This was driven by competition of the type that Schumpeter called product innovations. Schumpeter argued that this profit disequilibrium would be eliminated by the introduction of rivals and imitators. He explained that just as competition drives innovation, it also brings about "swarms" of imitators that want to capture the excessive profits and simply copy their rival's innovation. This process attracts investment and provides a boom in the marketplace. However, with more alternatives and supplies in the marketplace, the original innovator's profit advantage is eliminated as prices drop. Schumpeter explained that the market sector becomes less attractive, and investors leave until the next disruptive innovation is introduced, meaning the cycle restarts.

The "Creative Destruction" Process of Innovation

According to Schumpeter, the innovational process revolutionizes the economic structure from within, relentlessly destroying the old one while continually creating a new one. The process of creative destruction is the essential attribute of capitalism (Schumpeter 1942, p. 83), and Schumpeter described, “the history of capitalism is studded with violent bursts and catastrophes” (Schumpeter 1939) where “a perennial gale of creative destruction” is blowing (Swedberg 1991, p. 157). It is significant that Schumpeter’s hero is not the competitive market but the creative daring entrepreneur (Schumpeter 1934). Creative destruction triggers entrepreneurship, and entrepreneurs produce benefits that permeate the free-enterprise system. Schumpeter describes this economic growth as the consequence of entrepreneurs bringing knowledge that is qualitatively new to the existing economic system (Langlois 1991, p. 5). Entrepreneurs are therefore the dominant force for change, and their primary weapon is their energy in action (Bauer 1997). They induce change by putting together existing elements in new combinations.

The strategic stimulus to economic development, in Schumpeter’s (1934) analysis, is innovation: it may be a commercial or industrial application of something new, such as a new product, process, or method of production, but it may also manifest itself as new markets or sources of supply, as well as new forms of commercial business or financial organization. Entrepreneurs are change agents who challenge the status quo and create the new by destroying the old (Foster and Kaplan 2001). Schumpeter also extended and reoriented economic principles from the prevailing assumptions established during the 1920s and 1930s. His ideas concerning structural economic change evolved from classical economic theories, but he extended the fixed-structure theory of economic development.

Nevertheless, Schumpeter argued that the temporary monopolies provided the incentive necessary for corporations to develop new products and processes. Schumpeter now enhanced his theory that change in an economy is not only a function of innovation and entrepreneurial activities motivated by profit but also because of market power. Schumpeter explained that the results of these changes form what are known as “business cycles.” Even though economic activity may recede, one of Schumpeter’s arguments supporting the enduring strength of capitalism relates to the notion of creative destruction (Schumpeter 1934). He states that the competitive market is the key to the success of capitalism. In the real world of economic theory, the economy is always changing: new firms start up, old ones die out, new technologies are introduced, and old ones fade away.

Schumpeter’s change in his view of innovation came late in his career, and his discussion of innovation theory was a marginal part of his work. Innovation theory is thus derived only from his analysis of the different economic and social systems and because Schumpeter provided no empirical foundation for this perspective. Moreover, there is no strong evidence to support Schumpeter’s relationship between the size of a company and its ability to innovate. Nevertheless, Schumpeter’s ideas provide an important insight that when innovation is viewed as “creative destruction” that creates waves in dynamic economies and markets, then those who grasp discontinuities faster will reap benefits. This is because of the diffusion process whereby new methods of production are generalized throughout the economy reaching equilibrium prices, thus eroding the extra profits that were captured by the innovators and even the first followers, while late adopters run the risk of being driven out of the market. Schumpeter stated, “the problem that is usually visualized is how capitalism administers existing structures, whereas the relevant problem is how it creates and destroy them” (Schumpeter (1942), p. 86). Managers on the forefront of the restructuring of markets and early followers will be rewarded, while late adopters may be driven out of business.

Competition compels the various agents in an economy to innovate as well as to imitate. More contemporary “endogenous growth” theories build on Schumpeter’s idea as they describe technical change deriving from the profit-motivated research and development (R&D) corporate expenditures. Even more recently, it has been a fashion to focus on the “supply side” of innovation by being democratic in encouraging innovation and have everyone in an organization work on developing the next “big” idea. This approach has been institutionalized at numerous companies such as 3M and Google (The Economist 2010). This provides many ideas that require an evaluation system evaluated to identify the best innovations. Another way of promoting Schumpeter's ideas is to focus on closing the gap between the ideas and their implementation. This assists in making incremental improvements to existing products and processes but is less likely to produce breakthrough innovations as called by Schumpeter. Nevertheless, the entrepreneurial function will never become obsolete because as ever higher standards of living are achieved; wants automatically expand. Schumpeter was ahead of his time by identifying leisure goods as emerging economic wants (Schumpeter 1942).

Schumpeter took on the classical "static" mainstream economic doctrines and developed an innovative "dynamic" perspective, thus establishing the distinction between static and dynamic economic analysis. Schumpeter built upon the works of Smith, Ricardo, and Marx, but he introduced a dynamic theory that focused on understanding why economic systems change. However, he rejected Marx's violent revolutionary predictions about capitalism by examining factors outside normal quantitative analysis. He viewed different theoretical perspectives from other disciplines as complementary rather than competitive, able to coexist and enrich understanding of social phenomena (Schumpeter 1934). He thus took real-world examples and incorporated them into his economic theory. Schumpeter believed there were both internal and external factors that could make a cycle of change occur in an economy. This recognition is the key to his theory of entrepreneurship, which is at the core of "creative destruction" (Dahms 1995, p. 4).

Conclusion and Future Directions

Schumpeter's creative destruction philosophy is the rule, rather than the exception: organizations survive by focusing on what will allow them to be, and stay, one step ahead of the competition. Schumpeter observed how businesses conduct their operations and influence the quality of human lives and wrote that innovation was the preeminent mechanism by which individuals could rise and survive in competitive capitalism (Brouwer 1991, p. 18). Without innovation, business survival and success are unattainable. The contemporary environment abounds in disruptive (as opposed to sustaining) technologies, as well as discontinuous (as opposed to continuous) innovation. The latter type of innovation is significant because of the many attempts to determine the extent to which discontinuous innovations can be "managed" and how organizations can try to predict and leverage the emergence of disruptive technologies. Schumpeter's ideas are important because central to today's highly competitive global business environment is individual and organizational capacity for higher-order learning, as well as the ability to manage the stock and flow of specialized knowledge.

Schumpeter recognized that transformations within the economy were the key agents for innovation and economic development. He also identified change as the core factor for organizational survival. Obstacles to this creative process constrain growth, yet, managers often strive for business stability, making adaptation to changing situations difficult. Schumpeter also described economic evolution as altering the normal circular flow of demand, production, and consumption, demonstrating that moving away from the economic equilibrium can cause changes that generate new waves of opportunity. He regarded the introduction of innovation into economic activity as the destruction of existing arrangements. Advances in the contemporary knowledge-based global economy have resulted primarily from entrepreneurship and innovation – exactly as Schumpeter envisioned – and his ideas help explain how a climate of continuous change and potential improvement can create economic opportunity. Economic growth often brings rewards, but innovation can also create hardship for some because of the resulting upheaval. Innovation is frequently thus both the hero and the villain, because it impinges on every economic level in society. His ideas about innovation and its diffusion continue to be the foundation supporting the contemporary knowledge- and technologically driven global economy.

Cross-References

- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Innovation and Entrepreneurship
- ▶ Knowledge Capital and Small Businesses
- ▶ Knowledge Creation and Entrepreneurship
- ▶ Product Innovation, Process Innovation
- ▶ Schumpeterian Entrepreneur

References

Bauer JM. Market power, innovation and efficiency in telecommunications: Schumpeter reconsidered. J Econ Issues. 1997;31(2):557–65.
Brouwer M. Schumpeterian puzzles – technological competition and economic evolution. Ann Arbor: University of Michigan Press; 1991.
Carayannis EG, Ziemnowicz C, editors. Re-discovering Schumpeter four score years later: Creative destruction evolving into "Mode 3". Basingstoke, UK: MacMillan Palgrave Press; 2007.
Dahms HF. From creative action to the social rationalization of the economy: Joseph A. Schumpeter's social theory. Sociol Theory. 1995;13(1):1–13.
Foster R, Kaplan S. Creative destruction: why companies that are built to last underperform the market – and how to successfully transform them. New York: Currency Publishers; 2001.
Langlois RN. Schumpeter and the obsolescence of the entrepreneur, Working paper 91–1503, Department of Economics, University of Connecticut, November 1991.
McCraw TK. Prophet of innovation: Joseph Schumpeter and creative destruction. Cambridge: Belknap Press of Harvard University Press; 2007.
Schumpeter JA. The theory of economic development. An inquiry into profits, capital, credit, interest, and the business cycle. Cambridge: Harvard University Press; 1934. (Reprint 1983: Transaction Publishers (first published in 1911 in German)).
Schumpeter JA. Business cycles. A theoretical, historical and statistical analysis of the capitalist process, vol. 2. New York: McGraw-Hill; 1939.
Schumpeter JA. Capitalism, socialism and democracy. New York: Harper and Brothers; 1942.
Swedberg R, editor. Joseph A. Schumpeter: the economics and sociology of capitalism. PrincetonJ: Princeton University Press; 1991.
The Economist. Schumpeter: the innovation machine: two gurus look at the perspiration side of innovation. 2010. http://www.economist.com/node/16888745. Accessed 26 Aug.

Jugaad

▶ Innovation System of India

Knowledge

► Knowledge Society, Knowledge-Based Economy, and Innovation

Knowledge Application

► Academic Firm

Knowledge Capital and Small Businesses

Blandine Laperche
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

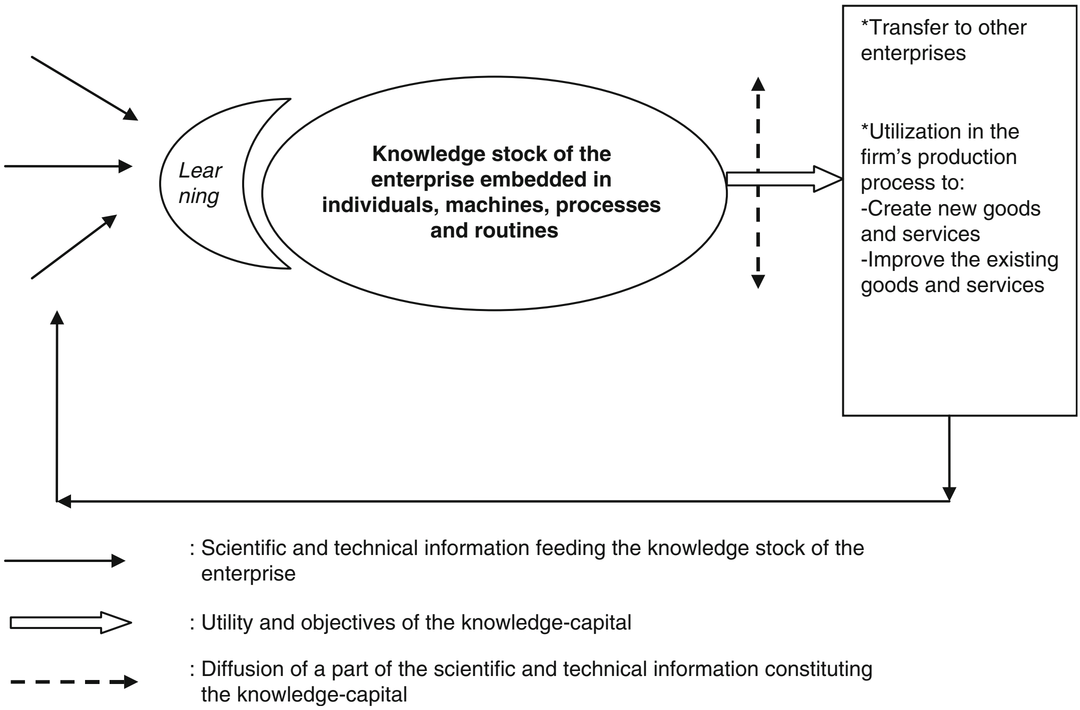
Entrepreneurship in open innovation systems; Innovative businesses; Innovator, competencies

To innovate, firms constitute an innovation potential, which we call "knowledge capital." It is made of knowledge produced by the firm itself or through cooperation. Innovation networks are thus built, where enterprises of various sizes and institutions – whether public or private (universities, research laboratories) – work together. But, what is the place of small businesses in these networks developed by larger companies? This entry begins with a definition of the concept of knowledge capital. It then presents the evolution of its formation and focuses on the place, assets, and limits for small businesses to participating to such innovation networks.

Knowledge Capital: Definition

We can define the "knowledge capital" as the set of scientific and technical knowledge and information produced, acquired, combined, and systematized by one or several firms for productive purposes. "Knowledge capital" (see Fig. 1) refers to the accumulated knowledge of one or several linked firms (embedded in the individuals – know-how – machines, technologies, and routines of the enterprise), which is continuously enriched by information flows and which is used in the production process or more globally in the value creation process. Thus, it is a dynamic concept – a process – that defines the knowledge accumulated by one or several firms and continuously enriched and combined in different ways, and eventually used or commercialized. This productive aim – the creation of value – is the main characteristic, which turns knowledge into "capital."

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
DOI 10.1007/978-1-4614-3858-8,



Knowledge Capital and Small Businesses, Fig. 1 The "knowledge capital"

A firm may use its "knowledge capital" in a value creation process by:

– Simply selling this knowledge base to another enterprise (e.g., the selling of a computer program). Thus, the "knowledge capital" (embodied in the software) is transferred to another enterprise, which can use it in its production process.
– Using this "knowledge capital" in its own production process. In this case, the "knowledge capital" can be considered as a means to produce or to improve goods and services and as a tool for reducing the production process completion time.

Evolution in the Formation of the Knowledge Capital: Toward Open Innovation

The management of innovation activities by the firm has been changing over time. The first R&D laboratories were developed within big companies at the end of the nineteenth century and at the beginning of the twentieth century (Liebig in Germany, General Electric in the United States) and then became a major component of their organization. During the twentieth century, the innovation activities of firms were supported by the States which in OECD countries accounted for more than 70 % of GERD (gross domestic expenditures on R&D) up to the end of the 1970s (30 % on average today). The innovation model was qualified as "linear": the R&D steps were achieved successively and at different places (basic research was achieved in universities and in research centers, applied research and technological development within enterprises).

In the early 1980s, when the mass production and consumption model reached its limits, innovation has become the engine of competition between firms implementing global strategies. First, the globalization of firms' strategies did not imply research laboratories, in order to reduce the risks of information and know-how outflows. The variety of intellectual property rights regimes also

Knowledge Capital and Small Businesses, Table 1 Partners of industrial firms, forms, and objectives of the collaborations

Type de partners	Forms of collaboration	Objectives of the firm
Academic research	Research programs	Access to an anticipated vision of the technological evolution and to new knowledge
	International and European tenders	Reduction of the risk and the cost of upstream research
	Researchers mobility and PhD funding	
	Licenses	
Clients/suppliers	Alliances (with or without capital participation)	Applied research and codevelopment of products
	Licenses	Reduction of the risk and the cost of product development
Competitors	Joint ventures	Conception of future technologies
	International and European research programs	Precompetitive research
		Reduction of the risk and the cost of precompetitive research
Small innovative firms	Financing, spin-off, and acquisition of start-up	Access to very specialized competences
	Cooperation agreements within clusters	Technological watch
	European and national research programs	Reduction of the risk and the cost of development

Source: Author

reinforced the risks of appropriation by competitors of their knowledge capital. In the current knowledge-based economy, information and communication technology facilitates the global exchanges of information and the codification of information widens to large parts of the knowledge. Intellectual property rights were harmonized and reinforced at the global scale, thus creating trust for investors. These are important reasons explaining that firms do not only locate abroad production and sale units but also research laboratories which have various aims, from the adaptation of goods produced by the home company to the complete local conception of goods which will be delivered globally. This period is also characterized by the development of the "open innovation paradigm" which means that "valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well" (Chesbrough 2003, p. 47). According to the author, the development of this model is linked to several changes: a growing mobility of high skilled workers, the growing presence of venture companies, new possibilities offered to market internal ideas, and the increasing capabilities of external suppliers. In this model of "open innovation," the creation of knowledge and the whole innovation process proceeds through feedbacks between R&D, design, production, and commercialization. In this chain-linked model, the genesis of innovation results from systemic links between knowledge and the market. The open innovation strategies put forward the growing importance of networks, within which the knowledge capital is built.

The tendency toward the collective constitution of knowledge capital is gaining ground in the context of the economic crisis (Laperche et al. 2011). As a matter fact, collaborative research gives the possibility for firms to reduce the cost and risk of innovation development. At the same time, it opens new opportunities for them to renew their supply, finding new technological paths and thus opening new markets. Companies collaborate at all stages of the innovation process (from design to the development of new goods and services) and with multiple partners. The objectives are diverse; we list them in Table 1.

Place of Small Businesses and Forms of Cooperation

Small businesses are traditionally less active than the big companies in innovative activity, in the production of internal resources, and in the access to external ones. In Europe, 9.5 % of innovative SMEs cooperate with other partners. Cooperation is higher in the leading innovative countries (Denmark, Finland, Germany, Sweden, Switzerland, United Kingdom) than in other countries (European Commission 2010). Open innovation is also more implemented within high-tech SMEs, such as biotechnology companies. For them, commercializing their technologies is one of their core competencies and provides a means of rapid growth. When SMEs cooperate with other firms or institutions, they privilege flexible forms, and their main aims are to access markets and to improve their products marketing, even if access to new knowledge is also a stated objective. Cooperation, especially in small companies, necessitates a similarity of skills (or low cognitive distance) and absorption capabilities.

If we focus more specifically on the relationship between small and large companies, we should put forward the contribution of small businesses in the constitution of their knowledge capital. Innovative small firms play a key role in the networks. Indeed, by making use of specialized high-performance small businesses in their areas, groups have access to technology outside their usual fields of research and can integrate within their knowledge capital particularly innovative technologies and complementary skills. Cooperation with small businesses also allows them to produce at a lower cost by increasing the speed of development.

One of the main forms of relations between small and large firms in innovative activity is that of investment in start-ups through venture capital. Corporate venture has soared in the United States during the 1990s and has spread in Europe before being held back by the bursting of the bubble of the net economy in 2001: many of these investments were oriented toward the achievement financial gain. They still exist today and investors' objectives are various: big corporations when investing in small businesses look for financial gain but also aim to develop at a lower cost and with fewer risks new technologies or seek to consolidate the group's activities (through, for example, the dissemination of a standard). This can be done through the acquisition on the start-up at the end of the financing period. In that case, the development cost of the acquired firm (and of its technology) has been shared between several investors. Or it may also be achieved through the signature of partnership agreements (including licensing). In other words, for groups, investment in venture capital fits into their financial and technological strategy.

Relations between groups and small innovative companies can also take pure partnership forms. Currently, some of these partnership programs are initiated by companies themselves. Big companies have been induced to concentrate on their core business, which by the way increased outsourcing strategies. Many small companies are thus the outcome of these outsourcing strategies. Spin-offs are an example of such strategy. But the relationship between the parent company and the small business often continues, through partnership agreements.

Partnership agreements may also be signed in the framework of national or international research program, or within clusters. As a matter of fact, in industrial countries, industrial policy has shifted from reducing costs of production to the increase of managerial know-how and the intensification of links between firms. Such cooperation may concern SMEs notably through local production systems but also the relations between SMEs, large companies, and public research. Then, it is through research programs at national and European levels or through clusters that SMEs are encouraged to work with large groups.

Assets and Limits of the Integration of SMEs in Corporations' Knowledge Capital

For an SME, taking part to the innovation strategy of a larger company may be an essential support for their technological product of process development, as a small business may benefit from the financial, technological, and marketing support of the big company. Taking part to an innovation network is thus a powerful mean to be profitable and even sometimes to survive.

But this type of collaboration may be difficult because of the unequal and asymmetrical power relation between the two partners. In case of conflicts, for example, dealing with intellectual property rights of products developed in common, the smaller business may be disadvantaged, due to its weak resources. The cognitive distance between small and big companies may also hinder the learning processes and be counterproductive.

Finally, cooperation sometimes leads to the acquisition of the small business by the corporation. In that case of course, that means the disappearance of the small unit. The integration of the small business within the bigger one may also lead to a lower creativity due to the different habits and routines of the two organizations. Even if the small company is not taken over by the bigger one, this kind of problem may appear if the small business loses the freedom of its managerial choices.

Conclusion and Future Directions

Strengthening the knowledge capital of large companies is more and more achieved by the multiplication of scientific and technical collaborations with all the actors of innovation. The strategy of open innovation is most often initiated by large companies because of the limited resources of small businesses and as a result of their low absorption capacity. Relations between small and large companies can be a "win-win" strategy when the small business provides specific expertise to the large company which in turn facilitates the development and dissemination of the technology. These relationships may also be hampered by an imbalance of power between the two organizations.

Governments seek to facilitate relationships between small businesses and large companies, especially through the cluster policy, implemented all over the world. Support should also take into account the need to strengthen the negotiating capacity of small businesses. It may be enhanced by an easier access to scientific, technical, and financial resources, by building of specific managerial capabilities but also by an easier access to intellectual property rights.

Cross-References

▶ Informal Venture Capital
▶ Network and Entrepreneurship
▶ Open Innovation and Entrepreneurship
▶ Spin-off
▶ Technological Entrepreneurship and Asymmetries

References

Chesbrough H. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003.
European Commission. European innovation scoreboard 2009. Luxembourg: Office for Official Publications of the European Communities; 2010.
Laperche B. Knowledge capital' and innovation in global corporations'. Int J Technol Global. 2007;3(1):24–41.
Laperche B, Lefebvre G, Langlet D. Innovation strategies of industrial groups in the global crisis: rationalisation and new paths. Technol Forecast Soc Change. 2011;78(8):1319–31.
Nooteboom B. Learning by interaction, absorptive capacity, cognitive distance and governance. J Manag Gov. 2000;4:69–92.

Knowledge Creation

▶ Model of Dialectical Learning

Knowledge Creation and Entrepreneurship

Susanne Durst[1] and Ingi Runar Edvardsson[2]
[1]University of Liechtenstein, Vaduz, Liechtenstein
[2]University of Iceland, Reykjavik, Iceland

Synonyms

Innovation; Knowledge development; Knowledge management; Learning

The business environment is rapidly becoming a global marketplace characterized by fierce competition, increasing consumer demands, and the need for value-added products and services. In order to survive in such an environment, firms need to have the capacity to differentiate themselves from others. Access to or the creation of new knowledge can help firms to master this challenge. New knowledge alone or in combination with established knowledge provides the fundamental basis for continuous improvements of the firms´ processes, products, and services. In addition, it might also represent the basis for radical innovation.

Given the IT advancements, firms regardless of size or industry, can make a niche for themselves in today's business environment. Yet, these firms are characterized by entrepreneurial individuals who are interested in changing existing structures and in delivering new products to the market. These products are the outcome of the entrepreneurial firms´ capacity to exploit new knowledge. As entrepreneurial firms are crucial contributors to economic growth and employment, it is important to understand the link between knowledge creation (as promoter of change) and entrepreneurship (as the notion of change).

The intention of the following sections is to link the concepts of knowledge creation and entrepreneurship. It starts with a discussion of each of the concepts separately. This is followed by a section intended to merge the two concepts and an overview of the current understanding of the association between the concepts. The entry concludes with a brief summary and a list of possible research questions that may inform more research activities in this area.

Knowledge Creation

The concept of knowledge creation refers to ways which focus on the construction of new knowledge. Knowledge creation in companies can be supported by, for instance, giving organizational members' time to experiment. Knowledge is not only internally produced, but external knowledge sources need to be considered as well. Given the natural limitations, smaller firms are often forced to make use of the latter (Egbu et al. 2005).

The knowledge management process can be divided into capturing or documenting knowledge, packing (cleaning, formatting, and indexing) knowledge for reuse, distributing knowledge, and reusing knowledge. In all of these steps, new knowledge and opportunities may emerge when individuals and groups sense problems in the process.

Knowledge creations have been measured as a process, output, and outcome (Mitchell and Boyle 2010). The process perspective assesses the steps or activities undertaken to create new knowledge, such as the uses of metaphors to externalize knowledge. As an output, knowledge creation is measured in terms of an immediate product of the knowledge creation process, usually reflecting a significant enrichment of existing knowledge, such as a representation of a spoken idea. Knowledge creation as an outcome is measured in terms of a value-adding object, for instance, new service, changed routine or product prototype. Here, the link with innovation and learning is quite prevalent.

Former research has shown that new knowledge can emerge by accident (e.g., the discovery of penicillin) or by deliberate discovery by following a gap in the literature. New knowledge can, further, generally emerge from new ideas or by emergent internal or external needs. Often, new ideas are transferred to the organizations via suppliers, professional bodies, consultants, or research literature (external influences) or they stem from internal creativity and inventions. New knowledge also originates from needs and pressures from customers, competition, legislation, and so on (external forces), or they originate from perceived problems and opportunities perceived by the staff and managers of organizations (Sparrow 2005).

Knowledge creation is closely linked to learning. Learning in organizations, for example, could happen through error detection. This would comprise a proper diagnosis of the error´s cause, and its correction so that organizations can learn from experience and implement suitable actions that are intended to avoid a repetition of these errors. "Often this leads to identifying a need that requires new knowledge to be created to answer the need" (Allard 2003, p. 375). A shared place is considered important for knowledge creation as well. According to Nonaka et al. (2002), Ba provides a platform for advancing individual and/or collective knowledge. Knowledge resides in Ba and is intangible. The interaction between tacit and explicit knowledge via socialization, externalization, combination, and internalization leads to the creation of new knowledge. Finally, organizational culture can facilitate or strain knowledge creation. Hence, culture characterized by a high degree of change and flexibility will have more positive effects on knowledge creation than cultures characterized by stability and formalization.

Entrepreneurship

According to Bridge et al. (2003), there is no generally accepted definition of the term "entrepreneurship." These authors discuss a narrow definition and a broader definition of entrepreneurship. According to the former, entrepreneurship is equal to starting a business, being in a business and growing and developing a business. The broader definition has a stronger orientation to the aspect of change, underlining the involvement of innovative attributes and behavior. Adopting the latter, for Bruyat and Julien (2000) entrepreneurship encompasses "a process of change, emergence and creation" (p. 173). This includes the creation of new value (i.e., an innovation and/or a new venture) and, at the same time, the change and development of individuals. Bruyat and Julien (2000) further argue that entrepreneurship by definition is primarily given in the founding stage. In the period of growth and establishment, innovative behavior is often replaced by managing the firm.

Knowledge Creation and Entrepreneurship

Regardless of whether a narrow or a broad definition of entrepreneurship is applied, both definitions indicate the relevance of entrepreneurial firms to have the capacity to create (new) knowledge. Assuming that entrepreneurship in its purest form is mainly given in the founding stage, many of those young firms may face resource constraints which hamper them from expanding the firm's knowledge base. In addition, in many of those young firms, the owner-managers take on a central position. In such an environment it is not uncommon that the processes of business planning and decision making are limited to only those individuals. This centrality also signifies that these people are particularly responsible for the recognition of the benefits related to knowledge management and knowledge creation, respectively, to support the firm's operations. As in the founding stage day-to-day business operations specifically require close attention, this may often result in situations where insufficient time is available for strategic issues, of which planning the future knowledge need is one aspect.

As resources are scarce in young entrepreneurial firms, new knowledge is likely to result from secondary data (e.g., trade journals, sector research, conferences, and professional magazines) or from personal contacts. In addition, as systematic knowledge search and creation is more expensive compared to informal meetings with suppliers, customers, or other stakeholders, it is likely that the latter will be favored by those firms as a source to new knowledge.

Yet, knowledge creation is not limited to young entrepreneurial firms, the more established entrepreneurial firms also need to find ways to continuously enlarge their knowledge stock.

Current Understanding of Knowledge Creation and Entrepreneurship

A literature review conducted by the authors of this piece of work suggested that so far rather few empirical observations are available (Edvardsson and Durst 2012). The main findings of the investigated studies centered around three topics:

Learning, networks, and tools as facilitator of knowledge creation, as well as description the process of knowledge creation.

Beginning with learning Cegarra-Navarro and Dewhurst (2006), for instance, looked into the aspects of learning and unlearning and their effects on the creation of Intellectual capital in the Spanish optometry industry in their study. Their findings demonstrated the importance of a firm's approach to facilitate unlearning prior the creation of relational capital. In a similar manner, a study on the high-tech SMEs industry in France came to the conclusions that knowledge management dynamic capabilities – internal and external learning competence – acted as a mediating and enhancing effect on innovation performance of the studied firms (Alegre et al. 2011). A research on Malaysian SMEs also shows that learning culture and people management skills (T-shaped skills) had a positive relation with the knowledge creation process. The knowledge creation process had, in turn, a positive relationship with organizational creativity (the creation of valuable, new product, service, idea, procedure, or process) that enhanced organizational performance (Soon and Zainol 2011).

Regarding the role of networks, a UK study (Hughes et al. 2009) showed how smaller firms engage in networks in order to obtain access to new knowledge. Much valued input, according to the studied firms, came from accountants, then the Internet, third by asking employees, suppliers, and eventually customers. Other sources, such as professional and academic institutions, were regarded as less beneficial. On the other hand, information overload and time constraints represent obstacles to knowledge creation (Egbu et al. 2005). The study also emphasized that knowledge creation should be accompanied by knowledge retention; particularly the latter seems to be a real challenge for firms. Another UK study (Chen et al. 2006) showed that the majority of SMEs considered both social and electronic networks as important sources of obtaining critical knowledge. Social networks seemed to be slightly preferred to electronic networks. Critical external knowledge is mainly seen in the areas of customers, competitors, suppliers, emerging market trends, and best practices/effective processes.

Concerning KM tools, the study by Ambrosine and Bowman (2008) illustrated the usefulness of applying causal mapping to help a firm (in the given case a consulting firm) uncover its tacit knowledge and to make explicit what it should try to replicate within the organization to sustain its success. By continuously asking the consultants on what they were doing the individuals themselves were able to identify aspects of their job they had not been recognized before. Hari et al. (2005) developed a knowledge capture awareness tool that is intended to help firms to implement and pursue a systematic knowledge capture strategy.

It was further found that most of the reviewed studies looked at knowledge creation as a process; the outcome and output of the knowledge creation and its impact on innovation represent under-researched fields.

Conclusion and Future Directions

Even though there is an apparent clear link between knowledge creation and entrepreneurship, current research provides only little understanding of how knowledge is actually created in entrepreneurial firms. Given the meaning of knowledge to firms, it is important to expand the current body of knowledge in this area as it may contribute to firms' competitiveness and survivability. Questions of interest might be: How do entrepreneurial firms identify the need for new knowledge? What are the factors initiating the need for new knowledge? How do entrepreneurial firms identify the type of new knowledge needed? What fosters or prevents knowledge creation? How can the process of knowledge creation be measured? How can entrepreneurial firms measure the impact/output of knowledge creation? How can they institutionalize the process of knowledge creation? This brief list of questions, which is by no means exhaustive, signals the huge potential this research area is offering; thus researchers are highly encouraged to make their contributions.

Cross-References

- ▶ Creative Collaboration
- ▶ Creative Destruction
- ▶ Entrepreneur
- ▶ Entrepreneurial Capability and Leadership
- ▶ Entrepreneurship and Business Growth
- ▶ Innovation Opportunities and Business Start-Up
- ▶ Innovations of and in Organizations
- ▶ Knowledge Capital and Small Businesses
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Network and Entrepreneurship

References

Alegre J, Sengupta K, Lapiedra R. Knowledge management and innovation performance in a high-tech SMEs industry. Intl Small Business J. 2011. doi:10.1177/0266242611417472 .

Allard S. Knowledge creation. In: Holsappe CW, editor. Handbook of knowledge management, vol. 1. Berlin: Springer; 2003. p. 367–379.

Ambrosini V, Bowman C. Surfacing Tacit Sources of Success. Intl Small Business J. 2008;26(4):403–431.

Bridge S, O'Neill K, Cromie S. Understanding enterprise, entrepreneurship and small business. 2nd ed. Basingstoke, New York: Palgrave Macmillan; 2003.

Bruyat C, Julien P-A. Defining the field of research in entrepreneurship. J Business Venturing. 2000;16: 165–180.

Cegarra-Navarro JG, Dewhurst FW. Linking shared organisational context and relational capital through unlearning: an initial empirical investigation in SMEs. Learn Org. 2006;13(1):49–62.

Chen S, Duan Y, Edwards JS, Lehaney B. Toward understanding inter-organizational knowledge transfer needs in SMEs: insight from a UK investigation. J Knowl Manag. 2006;10(3):6–23.

Edvardsson IR, Durst S. Knowledge creation as a source for innovation in SMEs: a literature review. Paper presented at the 7th international forum on knowledge asset dynamics (IFKAD) and knowledge cities world summit (KCWS), Matera (Italy), June 13–15, 2012.

Egbu CO, Hari S, Renukappa SH. Knowledge management for sustainable competitiveness in small and medium surveying practices. Struct Surv. 2005;23(1):7–21.

Hari S, Egbu C, Kumar B. A knowledge capture awareness tool. Eng Construct Architect Manag. 2005;12(6):533–567.

Hughes T, O'Regan N, Sims MA. The effectiveness of knowledge networks: an investigation of manufacturing SMEs. Educ Training. 2009;51(8/9):665–681.

Mitchell R, Boyle B. Knowledge creation measurement methods. J Know Manag. 2010;14(1):67–82.

Nonaka I, Toyama R, Konno N. SECI, Ba and leadership: a unified model of dynamic knowledge creation. In: Little S, Quintas P, Ray T, editors. Managing knowledge: an essential reader. London: The Open University in association with Sage Publications; 2002. p. 41–67.

Soon TT, Zainol FA. Knowledge management enablers, process and organizational performance: evidence from Malaysian enterprises. Asian Soc Sci. 2011;7(8):186–202.

Sparrow J. Classification of different knowledge management development approaches of SMEs. Knowl Manag Res Pract. 2005;3(3):136–145.

Knowledge Democracy

▶ Quality of Democracy and Innovation

Knowledge Development

▶ Knowledge Creation and Entrepreneurship

Knowledge Economy

▶ Innovation System of India

▶ Knowledge Society, Knowledge-Based Economy, and Innovation

Knowledge for Growth

▶ Epidemiology of Innovation: Concepts and Constructs

Knowledge in Innovation

▶ Semantic Technologies in Knowledge Management and Innovation

Knowledge Management

► Knowledge Creation and Entrepreneurship

Knowledge Paradigms

► Epistemic Governance and Epistemic Innovation Policy

Knowledge Production

► Academic Firm
► Epidemiology of Innovation: Concepts and Constructs

Knowledge Society, Knowledge-Based Economy, and Innovation

Nico Stehr, Marian Adolf and Jason L. Mast
Karl Mannheim Chair for Cultural Studies, Zeppelin University, Friedrichshafen, Lake Constance, Germany

Synonyms

Cognitive competencies; Displacement of metaphors; Innovation; Knowledge; Knowledgeability; Knowledge economy

> A man educated at the expense of much labor and time to any of those employments which require extraordinary dexterity and skill, may be compared to one of those expensive machines.
> Adam Smith (1776/2009, p. 62–3)

In spite of the insistence of Adam Smith, modern society and its economic systems were, until recently, understood primarily in terms of tangible assets (or property: land, equipment, structures that house the equipment, and inventories) and (manual) labor. Labor and property (capital) have had a long association in social, economic, and political theory. Work is seen as property and as a source of emerging property. Adam Smith (1776/2009, p. 586) explains, "Land and capital stock are the two original sources of all revenue both private and public. Capital stock pays the wages of productive labour, whether employed in agriculture, manufacturing, or commerce. The management of those two original sources of revenue belongs to two different sets of people; the proprietors of land, and the owners or employers of capital stock."

In the Marxist tradition, capital is objectified and encapsulated labor. On the basis of these attributes, individuals and groups were able to, or were constrained to, define their membership in society. In modern societies while the traditional features of labor and property certainly have not disappeared entirely, the new principle of "knowledge" has been added. To some extent, this challenges and transforms property and labor as the constitutive mechanisms of society and economic activity. This entry, therefore, focuses primarily on the new role of labor and property in the *knowledge-based economy* generating added economic value within the broader context of modern society as a *knowledge society*. This entry is less concerned with exclusivity as the distinguishing attribute of property or with the extent to which only labor may be viewed as a source of value. More so, it is concerned with the ways in which *novel* knowledge, defined as a capacity to act and as a capacity that primarily accounts for growth accomplishment in modern societies, is generated in knowledge-based economies through innovation.

Knowledge Societies

Different theoretical typologies of society are based on what are seen as their core principles. The core principles symbolize the constitutive mechanisms of societies, and their displacement by new core principles represents social change. Thus, *bourgeois society* was originally a society of owners. Later, it became a "laboring society" (*Arbeitsgesellschaft*), and it is now transforming into a *knowledge society*. It is doubtful that it is possible to precisely date the emergence or decline of a particular type of society. Daniel Bell (1973a, p. 346) argues, for example, even though he points out that it really is foolhardy to give precise dates to social processes, that the "symbolic" onset of the *postindustrial society* can be traced to the period since the end of World War II. It was during this era that a new consciousness of time and social change began to emerge. In contrast, Fred Block and Larry Hirschhorn (1979, p. 368) state that the 1920s mark the emergence of the new productive forces typical for postindustrial society (namely, information, knowledge, science, and technology), and in particular, the period when they began to make a decisive difference in production. In the 1920s, at least in the United States, the input of labor, time, and capital was constant or had begun to decrease, while output had begun to rise. Be that as it may, in modern society, as these observers concur, "knowledge" has become – in economic terms – the crucial source of (added) value.

The reason for analyzing the knowledge structure in modern society stems from the heightened social significance of knowledge in society more broadly and not only within the economic system, and this heightened significance is the result of the tremendous increase in the overall fund of knowledge and the historically unique-enhanced knowledgeability of its members. Of course, shared knowledge has always had a function in social life. In fact, one could speak justifiably of an anthropological constant: human action is knowledge based. This applies of course to economic life as well, as many political economists have recognized. Social *groups* and social roles of all types depend on and are mediated by knowledge. Similarly, power, productivity, competitive advantages, and economic success have frequently been based on advantages in knowledge, not only on physical strength. And, last but not least, societal reproduction is not merely physical reproduction but, in the case of humans, always cultural, that is, reproduction of knowledge.

In retrospect, one is therefore able to describe a variety of ancient societies as knowledge societies. For example, ancient Israel was a society structured by its religious-legalistic knowledge of the Torah. Ancient Egypt was a society in which religious, astronomical, and agrarian knowledge served as the organizing principle and the basis of authority. Similarly, historians such as Margaret Jacob and Larry Stewart (2004) have argued that the key explanatory variable accounting for the material and technological dominance of the West during the age of the early and the mature industrial society is the development of "useful and reliable" knowledge.

Contemporary society may be described as a knowledge society based on the extensive penetration of all its spheres of life and institutions by all forms of knowledge, especially scientific and technical knowledge. Knowledge societies arise not as the result of simple, one-dimensional processes of social change. Though modern developments in communication and transportation technology have brought people closer together, regions, cities, and villages are still by and large isolated from each other. The world may be opening up, and the circulation of fashions, goods, and people becoming more intense, but differing convictions as to what is "sacred" still create insurmountable barriers to communication. The meanings of such concepts as "time" and "place" are undergoing transformation, but borders separating people continue to be objects of intense respect and even celebration. Though fascinated by globalization, we also live in an age obsessed by identity and ethnicity. The trend toward the global "simultaneity" of events is accompanied by a territorialization of sensibilities and a regionalization of conflicts.

The Knowledge-Based Economy

The foundation for the transformation of modern societies into knowledge societies is to a significant extent based on systemic changes in the structure of their economies. The source of value-adding activities increasingly relies on knowledge. For the production of goods and services, with the exception of the most standardized forms, factors other than "the amount of labor time or the amount of physical capital become increasingly central" (Block 1985, p. 95) to the economy of advanced societies. Knowledge constitutes both input and output. The output of knowledge-based economies involves to a significant extent the increase in the knowledge intensity of its products and in efforts to achieve higher knowledge intensity of goods through intense support of innovation. Inputs in the knowledge-based economy consist to a significant extent of knowledge. The forces of production in the knowledge-based economy are less concentrated, and production is more likely nonmarket based, and public goods take on a greater role.

The dynamism of the global economy is no longer only driven by trade in conventional, durable commodities such as wheat, oil, cars, and steel but rather by traffic in *monetary* products such as currencies, stocks, bonds, and increasingly derivatives of the former. In addition, in knowledge-based economies, the flow of symbolic commodities of a *nonmonetary* nature or meaning are, for example, data ("sets of numbers"), technological trajectories, statistics, fashion regimes, programs, product marketing, as well as the growing flow of information within and across national boundaries, which attain a growing importance. The transformation of the structures of the modern economy by knowledge as a productive force constitutes the "material" basis and one of the justifications for designating advanced modern society as a knowledge society.

Although knowledge has only been defined explicitly as problematic in a minority of social and economic theories, it was always considered to be a determinant of social and economic order within the context of some of the core social theories. Marxist theories of society, for example, have always assigned decisive importance to the forces or means of production for societal development based on the assumption that man's mastery over nature is the foundation of production and wealth. As a result, general knowledge and science become a direct though not independent force of production. More recent Marxist theories, especially through the notion of the scientific-technological revolution developed by Radovan Richta and others, have analyzed scientific and technical knowledge as the principal motor of change. Max Weber's seminal inquiry into the unique features of Western civilization stresses the pervasive use of reason to secure the methodical efficiency of social action. The source of rational action and therefore of rationalization is found in particular intellectual devices.

Raymond Aron's theory of *industrial society*, which encompasses both socialist and capitalist forms of economic organization, stresses the extent to which science and technology shape the social organization of productive activities and, consequently, other forms of life in society. More recent theories of *postindustrial society* and similar efforts to forecast the course of social evolution in industrial society, in particular the efforts of Daniel Bell, have elevated theoretical knowledge to the axial principle of society. That is, codified theoretical knowledge becomes, as Bell (1979, p. 164) describes it, "the director of social change." In the economy, instrumental knowledge replaces labor as the source of added value. The strata of the producers of scientific and technological knowledge therefore become the key agency and actors of future social and economic development. Bell recognizes, of course, that every society has been dependent on knowledge. But very rarely, he stresses with emphasis, has this been theoretical knowledge. It is the "codification of theoretical knowledge that now becomes the source of advances and change in society" (Bell 1973b, p. 25), and only in the last half century have we seen "a fusion of science and engineering" (Bell 1979, p. 164) that has transformed the nature of technology itself. The accent in postindustrial society is evidently on the *instrumental mode of rational action*.

In the context of Bell's theory of postindustrial society and of theoretical concepts that resonate with his theory of modern society, knowledge – and the groups of individuals which acquire influence and control with knowledge – tend to be conceptualized rather narrowly as exemplifying the status of objective scientific knowledge and what Bell calls "intellectual technology" (see Bell 1979, p. 167). That is, the producers of knowledge claims in the natural and the social sciences generate more and more axiomatically structured assertions that employ formal languages as their medium of communication and are thereby increasingly distanced from empiricism (cp. Bell 1973b, p. 25), becoming embedded in "automatic machines" or computers. Paradoxically, perhaps, there is a general tendency in these theories of society to overestimate the "rationality" and the practical efficacy of "objective" or "reality-congruent" technical-scientific or formal knowledge.

Theories of modern society often display too much deference toward orthodox theories of science and therefore lack sufficient detail and scope in their conceptualizations of: the "knowledge" supplied; the embeddedness of the fabrication of knowledge; the reasons for the societal demand for more and more knowledge; the ways in which knowledge travels; the rapidly expanding groups of individuals in society who, in one of many ways, live off knowledge; the many forms of knowledge which are considered as pragmatically useful; and the various effects which knowledge may have on social relations.

In *Great Transformation*, Karl Polanyi (1944/1978) drew on Jeremy Bentham's notion of "social engineering" to argue that the science of organizations more than technological developments contributed to industrialization and economic growth. In his terms, "the main intellectual impetus of the Industrial Revolution were discoveries in the sociological field, not the technical inventions" (Polanyi 1944/1978, p. 167). Of course, both components, technology as an applied science of engineering on the one hand and the science of meaningful interactions between machines, humans, and organizations on the other, could be described as two sides of the same knowledge-based economical coin. Among those who also contributed to the idea of a knowledge-based economy, one needs to count Gunnar Myrdal (1957), who emphasized that the *growth rates* of industries whose cores are based on knowledge and knowledge work tend to be higher than those based on muscle and machinery. The same conclusion appears to apply to the sur*vival rate* of firms who innovate in contrast to businesses that fail to engage in innovation.

The theory of the knowledge-based economy and its political importance has been tightly interwoven with the policy activities and goals of the *Organization of Economic Cooperation and Development* (OECD) since the early 1960s and later the *European Union*. The OECD was formed in 1961 with the explicit mandate to base economic policies closer on the sciences. The OECD followed Raymond Ewell's lead, who in 1955 carried out one of the first quantitative studies that demonstrated a correlation between investment in research and developments and productivity. Among its core programmatic points were to coordinate member countries' policies of technological and scientific development, to transcend national boundaries, and to move member countries toward knowledge-based economies through coordinated research and development programs. The OECD activity resulted in the *Frascati Manual*, which features indicators for the observation and the comparison of scientific and technological achievement of countries. These indicators remain relevant to contemporary debates.

Innovation

In the knowledge-based economy, knowledge is not only a vital economic asset but also the main source for innovation, and innovation is the primary foundation for economic growth and survival. However, by definition innovation in the knowledge-based economy cannot mean the mere *reproduction* of knowledge. The plain reproduction of existing capacities for action that have been commodified is the routine business of economic conduct. Nonroutine conduct or innovation, as conceived here, is embedded in *novel capacities of action*. Novel capacities to act as ways of conceiving problems differently tend to destabilize the economic and social order, as Schumpeter's notion of creative destruction suggests. What are the foundations for the possibility of novel capacities of action and therefore for interpreting problems in a different light?

First of all, the creation/innovation of novel knowledge claims can only mean a *displacement* of knowledge on hand. Second, innovation therefore incorporates and refers to available knowledge (and relies on resources such as the available means of communication), such as, for example, knowledge on the intellectual commons, but it also transcends knowledge on hand. Third, specific social and cognitive conditions are conducive for the displacement of knowledge in place. Fourth, the entry costs to innovative activity have been lowered in the knowledge-based economy though they remain high in many fields of economic activity. The remainder of this entry focuses on the conditions that provide for the foundations for innovation in the sense of a displacement of meaning, a displacement of metaphors, rather than on different forms of knowledge and modes of innovation or the impact of innovative economic activities on regions and urban areas.

On principal, knowledge per se is not productive in and of itself. Building on Francis Bacon's famous dictum (*scientia est potentia*), knowledge may best be defined as a capacity for action. Knowledge can remain unused or even used for irrational purposes. The erroneous idea that scientific knowledge and technology bestows its own practical realization, regardless of side effects, remains a widespread conviction. Knowledge can only be realized through work in specific social contexts, a material underpinning, and a certain infrastructure just like the production of surplus is only achieved through work.

Conclusion and Future Directions

Certain cognitive competencies, which constitute the concept of knowledgeability, are crucial for precipitating creativity, invention, and innovation, and for sustaining entrepreneurship under the conditions of the knowledge economy. Representing an element of the cultural dimension identified in Carayannis and Campbell's (2011, p. 338) quintuple helix of innovation, knowledgeability refers to a bundle of competencies that have enabling capacities. The first two competencies, (a) the ability to generate novel and persuasive ideas through metaphorical displacement and (b) the faculty to engage in multiple viewpoints, speak to the requisite cognitive orientations for producing and realizing creative and inventive ideas. The second set of competencies, (c) the authority to speak and (d) the ability to mobilize defiance, refers to cognitive capacities associated with the ability to exercise agency and self-determination in a social context. The final three competencies, (e) the capacity to exploit discretion, (f) the facility to organize protection, and (g) the capacity of avoidance, represent a bridge between the processes of creative and inventive thinking to the ability to enact, protect, and cultivate these ideas in an entrepreneurial context.

These cognitive competences not only tend to be more common in knowledge-based economies but operate as a mental prerequisite for creativity, innovation, innovative processes; for conceiving of problems in a different sense; for fueling entrepreneurship; and for sustaining the comparative advantage of nations. Future research should investigate what specific orientations, cognitive competencies, and characteristics individuals must command in order to be innovative or to take innovative ideas from her environment on board, taking for granted of course that institutions provide important conditions for the possibility of innovations.

The stress on cognitive competencies or knowledgeability is not merely reiterating the much more common observation about the growing importance of a highly educated or skilled labor force in modern economies and in innovation regimes. In fact, this entry offers a rival hypothesis, namely, that the cognitive capacities enhancing innovativeness – although associated with formal education and years of education – are not only among the core foundations for innovation but also among the foundations for educational achievement, human capital, and entrepreneurship. As such, this entry represents a contribution to the sociology of innovation in distinction to the now dominant economic theory of innovation.

Cross-References

▶ Analogies and Analogical Reasoning in Invention
▶ Cognition of Creativity

▶ Creative Personality
▶ Creativity, Intelligence, and Culture
▶ Divergent Thinking
▶ In Search of Cognitive Foundations of Creativity
▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education
▶ Social Innovation

References

Bell D. The coming post-industrial society: a venture in social forecasting. New York: Basic Books; 1973a.

Bell D. The post-industrial society. In: Lazarsfeld PF et al., editors. Views from the socially sensitive seventies: seminars presented to the supplemental training program at AT&T. New York: AT&T; 1973b. p. 11–29.

Bell D. The social framework of the information society. In: Dertouzos ML, Moses J, editors. The computer age: a twenty-year view. Cambridge, MA: MIT Press; 1979. p. 163–211.

Block F, Hirschhorn L. New productive forces and the contradictions of contemporary capitalism. Theory Soc. 1979;17:363–95.

Block F. Postindustrial development and the obsolescence of economic categories. Politics Soc. 1985;14:71–104.

Carayannis EG, Campbell DFJ. Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the quadruple and quintuple helix innovation concepts and the 'mode 3' knowledge production system. J Knowl Econ. 2011;2:327–72.

Jacob MC, Stewart L. Practical matter: Newton's science in the service industry, 1687–1851. Cambridge, MA: Harvard University Press; 2004.

Myrdal G. Economic theory and underdeveloped regions. London: Gerald Duckworth; 1957.

Polanyi M. The great transformation: the political and economic origins of our time. Boston: Beacon; 1944/1978.

Smith A. An inquiry into the nature and the causes of the wealth of nations. Digireads.com. The Wealth of Nations. New York: Bantam Classics; 1776/2009.

Knowledgeability

▶ Knowledge Society, Knowledge-Based Economy, and Innovation

Knowledge-Capital and Innovation

Blandine Laperche
Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

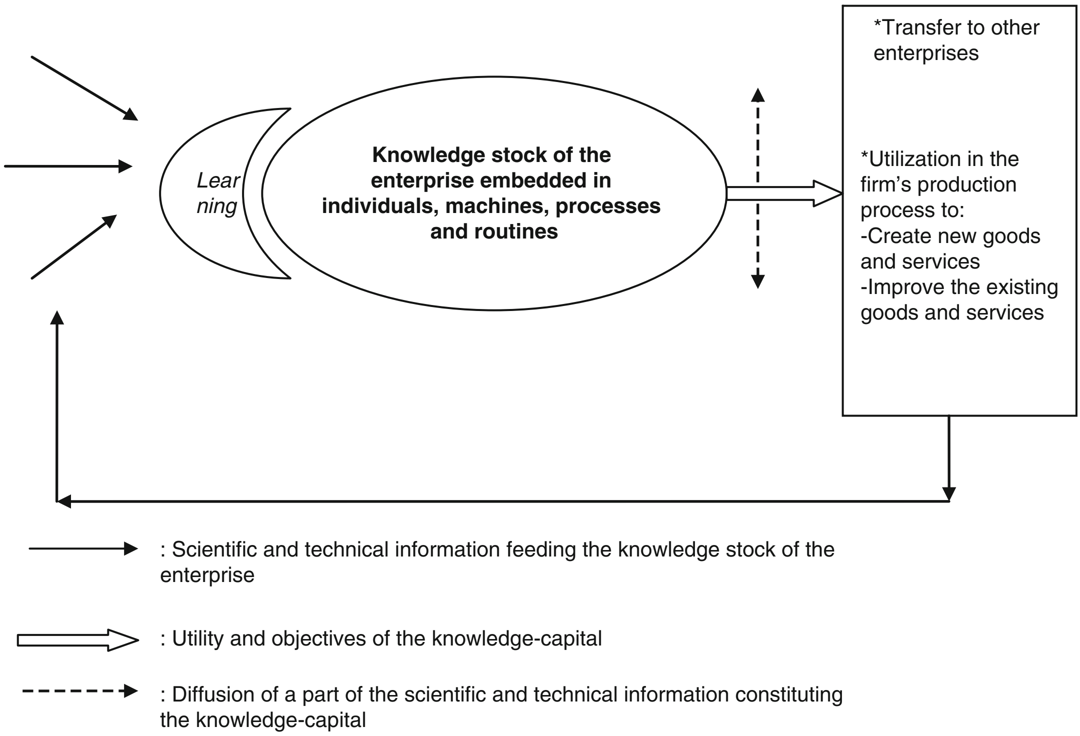
Information and knowledge stock; Innovation potential; Innovation strategy

Innovation means the development and dissemination of new combinations of production factors and takes the form of technological development (products, processes, and services), new markets, and new organizations. It has become the main engine of competition between enterprises at the global level. Innovation is also considered as the source of growth and competitiveness of regions and countries.

Innovation does not just happen. It is the result of costly and risky investments made by different kinds of organizations and institutions and of complex strategies of formation and protection of resources aimed to taking part to this process. In this entry, we focus on the firms' strategy to innovate and put forward a central element – the knowledge-capital – onto which firms focus to maintain and reinforce their capability to innovate.

The knowledge-capital is a set of information and knowledge produced and gathered by the enterprise in order to innovate. It is the backbone of their permanent innovation strategy.

The concept of knowledge-capital is very useful to study the innovation strategies of firms. How does the firm collect information on markets? With which kind of institutions does the firm cooperate (big and small firms, research centers, universities)? How does the firm learn and transform information into knowledge and routines? For what purposes? How does the firm



Knowledge-Capital and Innovation, Fig. 1 The "knowledge-capital". (Source: Laperche 2007; Laperche et al. 2008, 2011)

protect its knowledge-capital (role of intellectual property rights, of secrets, and lead time)? Knowledge-capital appears as a useful concept to study in depth all these current issues.

Definition of the Knowledge-Capital

We can define the knowledge-capital as the set of scientific and technical knowledge and information produced, acquired, combined, and systematized by one or several firms for productive purposes. Knowledge-capital (see Fig. 1) refers to the accumulated knowledge of one or several linked firms (embedded in the individuals – know-how – machines, technologies, and routines of the enterprise), which is continuously enriched by information flows and which is used in the production process or more globally in the value creation process. Thus, it is a dynamic concept – a process – that defines the knowledge accumulated by one or several firms and continuously enriched and combined in different ways and eventually used or commercialized. This productive aim – the creation of value – is the main characteristic, which turns knowledge into "capital."

The information collected on markets (through intelligence strategy, through the access to patent information, through the purchase of technology and the signature of license contracts...) is integrated into the knowledge stock through learning processes which are basic in the transformation of information (flow) into knowledge (stock). The use of the knowledge stock depends on market and production opportunities and on the degree of maturity of the developed technologies.

A firm may use its knowledge-capital in a value creation process by:

- Simply selling this knowledge base to another enterprise (e.g., the selling of a computer program). Thus, the knowledge-capital (embodied in the software) is transferred to another enterprise, which can use it in its production process.

- Using this knowledge-capital in its own production process. In this case, the knowledge-capital can be considered as a means to produce or to improve goods and services and as a tool for reducing the production process completion time.

Theoretical Roots of the Knowledge-Capital

Theoretically, the notion of knowledge-capital is based on the definitions and/or on the economic developments of three key concepts/notions: knowledge, firm, and capital. The economic analysis of knowledge has changed over the time. Neoclassical economists first considered technical progress as exogenous and knowledge as a public good, notably characterized by its nonappropriability. As for technical progress, the firm has also long been considered as a "black box" and did not very much catch the contemporary economists' eyes.

After the Second World War, the firm has become a *complete* object of study, place of production of new knowledge (Penrose 1959), and symbol of modern capitalism (Galbraith 1967). The interest that arose from the work of Schumpeter (1950, 1983) on the role of innovation in the economic dynamism but also from Solow's work (1957) on the residual technical progress and economic growth gave birth to new analysis aiming at explaining the origin of innovation and of knowledge. The evolutionist theory and the resource-based approaches stress the learning processes that are at the origin of the firm's own technological trajectories and put forward the double nature of knowledge, codified and tacit, which makes its appropriability possible (almost in part) (Nelson and Winter 1982; Dosi et al. 2000). The new growth theories have taken account of those new developments and associate to public intervention, the market as a place of allocation and appropriation (intellectual property rights, routines) of fundamental resources to growth.

The most recent developments insist on the role of external knowledge and notably on the way firms capture external information in its environment (which explain the key role of proximity and interactions) and to transform it in the enterprise's own knowledge. Knowledge production and innovation are thus considered as collective processes and are built within complex networks of cooperation (Laperche et al. 2008, 2010).

The notion of knowledge-capital is built on these main evolutions in the analysis of knowledge and firm. But it does not forget the crucial contributions of early authors.

The developments of the classical economists already stressed the collective nature of production and of innovation. Smith (1976) considered the technical and social division of labor as means to increase the productive and innovative power of labor. Say (1996) analyzed the links between the scientist, the entrepreneur, and the worker. Marx (1977) showed how production is based on the combined workforce – appropriated by capital – of the collective of workers. The notion of knowledge-capital also borrows from the classical economists their dynamic conception of capital. In this approach, capital is not only a stock of resources available for production; it is a process that indicates the constant renewal and the productive use of this stock. To sum up, knowledge-capital is fed by modern or more ancient approaches of knowledge creation, coordination, and diffusion.

Knowledge-capital also aims to integrate the value creation process (which can take, for instance, the form of the production and diffusion of a new machine). This determines the integration of information in the knowledge stock, the combination of information and knowledge, the codification of tacit knowledge, and the diffusion of knowledge. With this particular focus on the aim – the value creation process – we also reintegrate in the analysis the tensions linked to the relations of power existing between firms of different size and strength and that particularly occur, as studied below, in the current context of constitution and protection of the knowledge-capital.

The Formation of the Knowledge-Capital

The process of knowledge creation is today the result of a node of partnerships between the (more or less independent) units of a networked firm, other networked firms, and other institutions (universities, research labs, and start-ups). This collective process is usually referred to as the "open innovation paradigm," which means that "valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well" (Chesbrough 2003, p. 43). According to this author, the open innovation paradigm has tended to replace the earlier paradigm of closed innovation since the end of the twentieth century. The logic of the closed innovation paradigm was an internally focused logic where companies financed, generated, developed, built, and marketed their inventions. It corresponded to the linear model of innovation that was prevailing all along the twentieth century and where innovation resulted from a succession of separated steps (in time but also institutionally) from scientific development to the diffusion of new products and services. This model began to be undermined at the end of the twentieth century due to a conjunction of factors such as the growing mobility of high-skilled workers, the growing presence of private ventures companies, the new possibilities offered to market internal ideas, and the increasing capabilities of external suppliers. The economic context where innovation performance is the engine of competition and where profitability imperatives constrain the investment policy of firms is also an important factor explaining the growing importance of collaboration in the formation of the knowledge-capital. In this new model, knowledge creation and the whole innovation process proceed by feedback between R&D, design, manufacturing, and marketing services. In this chain-linked model of innovation, the genesis of innovation results from the systemic linkages between knowledge and the market. Open innovation strategies put forward the growing importance of networks, considered as knowledge factories and boosters. This is within these networks that firms now build their knowledge-capital.

The formation of this knowledge-capital is today achieved on a global scale. This can be assessed by the growing importance of international R&D partnerships between firms, patents and technology flows, and globalization of R&D. Moreover, firms are increasingly developing their knowledge bases thanks to the innovation networks into which they are involved.

Knowledge-Capital and Innovation, Table 1 Means of formation of the knowledge-capital

In-house means	External means
Investment in human resources	*Equity relations*
Investment in and management of R&D and means of production (tangible and intangible)	Joint venture
	Purchase of innovative enterprise
	Nonequity relations
	Contracts (including licensing) with other (industrial and service) firms
	Contracts (including licensing and hiring of short-term researchers) with institutions: e.g., university research labs
	More informal contacts

As a matter of fact, the formation of the enterprise's knowledge-capital implies the gathering of different types of inputs, that is, human resources (researchers and engineers), tangible resources (machines and tools), and intangible ones (patents, software, information, methodologies, and protocols). The enterprise has to produce and appropriate scientific and technical knowledge in order to expand the knowledge base it has already accumulated. Different means – that is, usually complementary in knowledge-based and innovative firms – are used: in-house (or internal) means (investment and management of human resources, R&D, and tangible and intangible resources) and external means. External means can be divided in two categories: equity relations (e.g., joint venture) and nonequity relations (contracts with firms and other institutions and more informal contacts) (see Table 1).

The purpose of all these strategies is to reduce the cost, risk, and length of technical progress and hence increase the short-term return on investment in the scientific and technical fields. This purpose is all the more important since the complexity of technological development increases. This implies a collective process of innovation that gives the possibility to innovate quicker and with less risk. Due to the profitability imperative, the big enterprise develops external means of formation of the knowledge base, which are both less risky and less costly. This does not mean, however, that the firm does not make in-house investments any more, as this kind of investment is crucial to understanding and absorbing the scientific and technical development achieved by other institutions on their own base and to define an architecture to organize the many parts of the new system.

As the knowledge-capital is the central tool of firms' competitiveness, the issue of its protection, as a whole and in its parts, is also crucial.

The Protection of the Knowledge-Capital and the Roles of Intellectual Property Rights (IPRs)

IPRs include industrial property rights: patents, trademarks, industrial models, and the protection of trade secrets. They also include copyright protection. The patent is a temporary monopoly (which lasts 20 years) given to an inventor, as an acknowledgement of the invention, whether a product or a process in all fields of technology, provided that it is new, involves an inventive step and is capable of industrial application. A trademark protects words, names, symbols, sounds, or colors that distinguish goods and services from those manufactured or sold by others and indicate the source of goods. Trademarks, unlike patents, can be renewed forever as long as they are being used in commerce. A design patent may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture. Trade secret laws protect individuals and businesses against the misappropriation of trade secrets by improper means. Copyrights protect works of authorship, such as writings, music, and works of art that have been tangibly expressed.

The many works dealing with the functions of intellectual property rights in enterprises give us the possibility to draw up a list of the main aims that encourage firms to use them (Table 2).

Knowledge-Capital and Innovation, Table 2 The reasons of the resort to intellectual property rights (in particular to patents)

Protection against imitation (copy dissuasion and/or lawsuits in case of counterfeiting)
Incentive to invest in R&D by making investments profitable (production and commercialization of protected products and/or signature of license agreements)
Negotiation means (in partnerships and/or with financing institutions)
Image/reputation of the enterprise
Assessment of internal performance/valuation of the enterprise
Blocking competitors/reinforcement of entry barriers

Well studied in the literature, they may main be summed up in three main roles: a defensive/incentive role, an offensive role, and a coordination role. The defensive/incentive role refers to the possibility given to firms owning IPRs to recoup the investments incurred to develop new goods and services thanks to these temporary monopolies and to defend their ownership in courts in case of infringement. The offensive role mainly refers to the fact that IPRs may be by themselves a source of value (through licenses) and may block competitors and reinforce entry barriers. Another role is gaining ground, which we call a “coordination role” (including the impact of IPRs in negotiation and in the reputation of the enterprise) (Laperche 2011). IPRs play an important role in the coordination of activities as they may clarify the relationship and thus reduce the transaction costs between all the partners that take part to the formation of a firm's knowledge-capital. The ownership of trademarks, for example, (and this also goes for patented inventions or designs) acts as a signal of the quality of the central firm or potential suppliers' products and services. In other words, trademarks may increase the reputation of the central firm and of potential suppliers that would be chosen thanks to the IPRs they own. In the case of subcontracting and in franchising contracts, licenses allow the different units to use the patented invention or the protected trademark or design usually owned by the central firm. Licenses are usually considered to be responsible for productive efficiency: they facilitate the efficient diffusion of proprietary products, they let others use the intellectual property rights as inputs to innovation (research tools), and they resolve blocking situation and enable the development of complementary inventions. IPRs allow the diffusion of technology within the enterprise and gives incentives for the production of specific assets. In the case of R&D partnerships, where specific assets are jointly built (co-contracting or contracts between the central firm and a research lab for example), shared patents reduce the possibility of opportunist behavior ("holdup" situations) between the co-contractors.

The coordination function of IPRs (reduction of transactions costs) and their role of incentives (for the creation of new knowledge) appear to be linked. The incentives offered by IPRs are usually explained by the temporary monopoly associated to their possession, which increases the profitability (or its assessment) of investments. However, in the networked enterprise, the incentives associated to IPRs are also linked to their impact on the coordination of activities. As a matter of fact, IPRs clarify the relationships between the co-contractors (coordination) and thus, by reducing transaction costs, give incentives to the collective building of knowledge-capital, by protecting the tangible and intangible elements that constitute it. In the networked enterprise, the coordination role of IPRs is linked to their more traditional defensive/incentive roles. The temporary monopoly conferred by industrial property rights gives the possibility to go to courts in case of infringement. IPRs thus secure merchant relations and give an incentive to joint investment efforts and to the internal transfer of technology. Within the networked enterprise, IPRs are a tool used by firms to replace the control based on the ownership of tangible assets by a control based on the ownership of intangible assets. The coordination function is also visible through the relationships with investors. IPRs give a value to R&D investments, in a context where profitability has become an imperative. Filing and holding patents transform potential inventions in valuable assets, which can give confidence to investors and shareholders concerning the profitability of the firm's investments.

However, if we come back to the first role assigned to IPRs (defensive/incentive), some limits have been put forward. For instance, patents spread too much information and are costly (direct and indirect costs). Strong patents increase the cost of innovation (notably in network activities) due the cost of cross-licensing agreements. Copyright protection implies the capacity to provide proof of being the first creator. To reduce the limits of IPRs, enterprises use joint tools of protection; in other words, they built a portfolio of protection tools, notably associating secrecy and lead time. This leads us to the offensive role of IPRs within innovation networks.

The innovation strategies of networked firms lead to a blurred distinction between the networked enterprise and the innovation network to which it belongs. As a matter of fact, the formation of the knowledge-capital implies contractual relations between the central firm and units and partners. The partners may be small and medium enterprises specialized in technological fields, but they may also be big enterprises and competitors of the networked firm as a whole. These kinds of alliances are meant to share the cost of development of new products and processes and to reduce the time needed for their conception. These alliances often lead to an important number of patents that can be owned separately by the different partners or be shared.

Whatever the chosen solution, the development of a new technique leads to an important number of patents, which can block the use or even the final production by a subcontractor that would have to sign too many and costly licenses. The number of infringements and litigations also increases. Some legal solutions are proposed to conciliate the incentives to innovate and the dissemination of knowledge, such as compulsory licensing, nonexclusive licenses, and modifying the duration and the breadth of patents. But another type of solution to these restrictions has been found in the way firms manage their industrial property rights. This is the case of patent pool that can be defined as the aggregation of intellectual property rights which are the subject of cross-licensing, whether they are transferred directly by patentee to licensee or through some medium, such as a joint venture, set up specifically to administer the patent pool. Patent pooling is not new and was often regarded as a threat to competition (notably in the USA under antitrust laws). However, since the beginning of the 1980s, patent pools have been considered as having significant procompetitive effects when they integrate complementary technologies, reduce transaction costs, clear blocking positions, avoid costly infringement litigation, and promote the dissemination of knowledge. The procompetitive effects of IPRs are thus clearly related to their coordination function.

Patent pooling is often studied in relation to its procompetitive effects, but it also plays an important role in the definition of the position of the firm within its network. As a matter of fact, patent pooling, even in the case when complementary technologies are involved, supports the idea of a growing private and oligopolistic appropriation of the knowledge-capital. Even if the formation of knowledge-capital depends on interdependent relations between increasing numbers of institutions (big firms, small businesses, research labs, etc.), only a few firms appropriate the return of their investment, thanks to the patents they own separately and/or collectively and that they license to each other. The other members of the innovation network (the users, clients, suppliers, subcontractors, etc.) who are not the owners of the technology have to pay a license fee to use the technology and/or to produce the products and services that derive from this technology. This is true, even if they have participated, in more or less easily observable ways (competencies, consulting, informal exchanges of information, etc.) in the formation of the knowledge-capital from which the licensed technology or set of technologies emerges. What is important here is that the practice of patent pooling, notably resulting from ex ante cooperation processes, contributes toward defining the position of firms (their hierarchy) within the networks. The members of the patent pool – the ones that own the separate or shared patents – are the leaders of the networks.

Thanks to the power conferred by the ownership of intellectual property rights, they build entry barriers protecting the highest level of networks (the leaders). These protected leaders can also keep their advance over competitors, by reinvesting the rents they receive from the commercialization of licenses in R&D processes meant to develop the next generations of technology. This strategy clearly shows the offensive role of IPRs within innovation networks, that is, to say their role in the definition of the position of firms within the network(s) to which they belong.

Conclusion and Future Directions

To understand the genesis of innovation, it is important to focus on the firms' strategy of formation and protection of their knowledge-capital. Collaboration is central: the networked firm develops collaborative strategies with other firms and institutions to be able to maintain its ability to innovate continuously. IPRs have important roles to play in the processes of formation and protection of the knowledge-capital. IPRs appear as the coordination device of the networked enterprise. This coordination role is associated with the more traditional incentive/defensive and offensive roles of IPRs. In the networked enterprise leading open innovation strategies, we consider that the coordination function (reduction of transaction costs, reputation, and resolution of blocking situation) contributes to increase the incentives to develop innovation and give confidence to partners for sharing the costs incurred in the formation of the firm's knowledge-capital. We also showed that the specific use of IPRs as a coordination mechanism is integrated in the leadership strategies of big networked firms. They contribute to the definition of each firm's position within its innovation network and to an oligopolistic appropriation of the knowledge-capital, basis of future innovations.

Cross-References

▶ Corporate Creativity
▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies
▶ Knowledge Capital and Small Businesses
▶ Open Innovation and Entrepreneurship

References

Chesbrough H. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003.

Dosi G, Nelson RR, Winter N. The nature and dynamics of organizational capabilities. Oxford: Oxford University Press; 2000.

Galbraith JK. The new industrial state. Boston: Houghton Mifflin Company; 1967.

Laperche B. 'Knowledge capital' and innovation in global corporations'. Int J Technol Glob. 2007;3(1):24–41.

Laperche B. How to coordinate the networked enterprise in a context of open innovation? A new function for intellectual property rights. J Knowl Econ. 2011. doi:10.1007/s13132-011-0052-9.

Laperche B, Lefebvre G, Langlet D. Innovation strategies of industrial groups in the global crisis: Rationalisation and new paths. Technol Forecast Soc Change. 2011;78(8):1319–1331.

Laperche B, Sommers P, Uzunidis D, editors. Innovation networks and clusters. The knowledge backbone. Brussels: Peter Lang; 2010.

Laperche B, Uzunidis D, Von Tunzelmann N, editors. The genesis of innovation, systemic linkages between knowledge and the market. Cheltenham: E. Elgar; 2008.

Marx K. Grundrisse, T.II. Paris: Anthropos; 1977 [1857].

Nelson RR, Winter SG. An evolutionary theory of economic change. Cambridge: Harvard University Press; 1982.

Penrose ET. The theory of the growth of the firm. Oxford: Blackwell; 1959.

Say JB. Catéchisme D'économie Politique, dans Cours D'économie Politique Et Autres Essais. Paris: GF Flammarion; 1996[1815].

Schumpeter JA. Capitalism, socialism and democracy. New York: Harper and Row; 1950[1942].

Schumpeter JA. The theory of economic development. New Brunswick/London: Transaction Publishers; 1983[1934].

Smith A. Recherches sur la Nature et les Causes de la Richesse Des Nations, Coll. Folio essais. Paris: Gallimard; 1976[1776].

Solow R. Technical change and the aggregate production function. Rev Econ Stat. 1957;39(August):313–320.

L

Lack of Disclosure

► Principal–Agent Model in Universities, Problems and Solutions

Language

► Speaking Pictures: Innovation in Fine Arts

Laws

► Patterns of Technological Evolution

Learning

► Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
► Knowledge Creation and Entrepreneurship

Learning from Experience

► Experiential Learning and Creativity in Entrepreneurship

Lesson Design

► Teaching as Invention

Levels of Creativity

► Levels of Invention

Levels of Invention

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Synonyms

Levels of creativity; Levels of problems

Original Concept

Through the analysis of numerous inventions during the development of the *Theory of Inventive Problem Solving (TRIZ)*, *Genrich Altshuller* discovered that different inventions involved

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different levels of creativity. It therefore seemed likely that different tools and techniques would be required to create a variety of inventions. (Clearly, the invention of a pencil with built-in eraser differed greatly from the invention of the steam engine.) In the late 1960s, Altshuller defined various levels for inventive problems related to (Altshuller 1999):

- The number of trial and error attempts required to guarantee a solution of a certain level
- The scale of change imposed on the original system

According to Altshuller, inventive problems can be divided into five levels, as shown below (Table 1):

It can be seen that the number of mental trials that must be entertained to guarantee a satisfactory solution grows dramatically as the level increases. In fact, for high-level inventions, the number of trials is so high (in the thousands) that there is no guarantee that a solution can be found at all; thus there is no control over the innovation process.

Example: Edison, who was known for his persistence (it took tens of thousands of trials to find a material suitable for use as a light bulb filament) was unable to build a nuclear motor using trial and error; inventions of this level are based on scientific discovery, and the necessary discovery (nuclear theory and neutron multiplication when a nucleus is divided) had not yet occurred.

In the course of his research, Altshuller conducted statistical analysis of inventions granted between 1965 and 1969 over 14 patent classes (former Russian patent classification). The results showed the following distribution among the five levels:

Level 1 – 32 %
Level 2 – 45 %
Level 3 – 18 %
Level 4 < 4 %
Level 5 < 1 %

Apparently, the inventions of high levels are rare given the amount of trials typically necessary to obtain them.

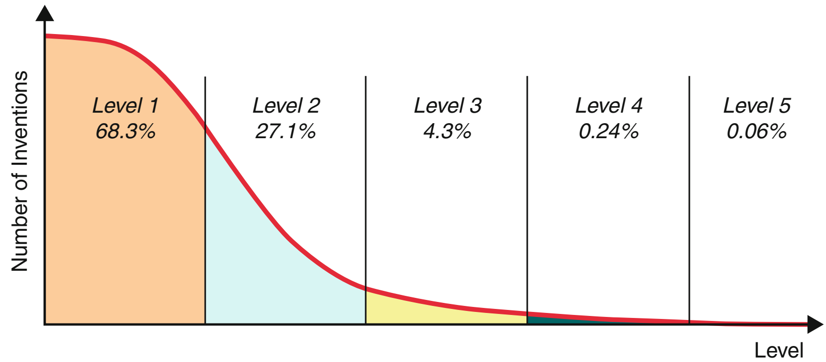
For each stage in the typical problem-solving process, Altshuller identified specific criteria to help identify the level of a particular invention. According to Altshuller, the typical invention stages included:

- Choosing the task
- Choosing the search concept
- Gathering data
- Searching for an idea

Levels of Invention, Table 1 Levels of Inventions: Description

Level	Description	Typical number of trials	Example
1	Smallest inventions produced by methods well known within the specialty. No contradictions have been resolved	Up to 10	Using modular design to facilitate easy repair of a complex device
2	Minor improvements to an existing system. Contradictions are resolved using methods known within the industry	Up to 100	Bifocal glasses
3	Fundamental improvements to an existing system within the same paradigm. Contradictions are resolved using methods known outside the industry but within the same domain of knowledge (mechanics, chemistry, etc.)	Up to 1,000	Automated transmission
4	A new generation of a system that entails a new operating principle for performing the system's primary functions (paradigm shift). Contradictions are resolved using methods known outside the relevant domain of knowledge	Up to 100,000	Jet aircraft
5	Pioneering invention typically based on a new scientific discovery	Over 100,000	Laser, radio

Prepared for this article



Levels of Invention, Fig. 1 Suggested new distribution of inventions among the levels (Zlotin and Zusman 2004)

- Finding the idea
- Practical implementation

Altshuller regarded the discovery of levels of invention as a very important step in the development of TRIZ as a pure engineering science (i.e., a science based on the statistical research of patents and other sources of technical information). He also used his findings to emphasize the fact that high-level inventions were always the main focus of TRIZ, and that TRIZ was the only way to control the process of high-level innovation, as it reduced (and possibly eliminated) the number of blind trials required. At the same time, however, the concept of levels of invention has not provided any specific instruments facilitating practical invention and/or problem-solving processes.

Further Development of the Original Concept

Distribution of Inventions Among the Levels

Work with inventions of various levels conducted by the authors and their associates between 1982 and 1985 suggested that the distribution of inventions among the levels as defined above should be close to the Gaussian (normal) distribution curve, as shown below (Fig. 1).

The difference between the Gaussian distribution and Altshuller's numbers (in Altshuller's research there were fewer inventions at level 1 than level 2, which does not comply with the normal distribution) can be explained as follows:

- Level 1 inventions often go unpatented, for various reasons, for example:
  - Local importance and limited value of the invention
  - Unwillingness to disclose the invention to competitors
  - Preference for treating low-level inventions as useful suggestions
- Inventions of level 1 are likely to be rejected by patent examiners for insufficient novelty.

Solving a Problem at Different Levels

The level is assigned to an invention rather than to a problem as many problems can be solved at different levels, depending on the available *resources* of the system and the imposed limitations to system change. Table 2 below shows the results of a project aimed at reducing the vibration of an electrical generator for a specific transport scenario, and describes typical solutions found at different levels.

Given the above, it is clear that levels should be attributed to the inventions (solutions) rather than the problems. For practical purposes, however, it is convenient to rank inventive problems as well. To resolve this issue, it was suggested that the level of a problem be determined according to the *acceptable* solution level. In the above case, a level 1 solution was satisfactory and the problem was ranked accordingly.

The discovery that a problem can have solutions at different levels was an important argument in the discussion of what the primary focus of TRIZ should be – providing a single,

Levels of Invention, Table 2 Solving a problem at different levels of invention

Level of invention	Technical solution	Drawback
0	Install generator on rubber pads to absorb vibration	Vibration at certain frequencies not effectively addressed
1	Use multilayer pads of different materials, with the thickness of each layer calculated to better reduce vibration in the given range	Does not address haphazard impacts
2	Introduce pneumatic cylinders with feedback-based control mechanisms to adjust cylinder pressure according to the magnitude and direction of haphazard impacts	Space around generator is limited; solution is expensive
3	Position the generator on strong permanent magnets with electromagnetic windings. Winding current can be changed to dampen vibration	System has high inertia; strong electromagnetic field dissipation
4	Replace generator with a device that can generate electrical energy without rotating parts, which cause vibration (e.g., by using isotopic elements – a brand new direction at the time of the project)	System is too new; costly research and testing required
5	Not considered for this project	

Level 0 denotes conventional noninventive solutions (Zlotin and Zusman 2004)

ideal (or closest to ideal) solution, or providing an array of solutions at different levels of ideality (and inventiveness) from which the ones that best fit the particular situations and requirements can be selected. Apparently, low-level inventions are better suited to short-term goals (such as reducing the cost of an existing product) while high-level inventions are better suited to long-term strategies (e.g., ideas for next-generation products).

"Relativity Principle" for Levels of Invention

Estimating the level of an invention can be considerably influenced by the area, current state, and overall level of technology. For example, Archimedes' screw for the water supply in Ancient Greece can be classified as a level 5 invention for the time; about a 1,000 years ago, a screw attaching a visor to a knight's helmet would rank between levels 4 and 5; today, using a screw to fix two parts together is not considered an invention at all.

The opposite effect – where the level of invention increases over time – can have much more important consequences. This can be illustrated with the history of the following invention:

In 1840, a lamp that burned whale oil in a specially shaped glass was invented. This remained a "small" invention until 1855, when kerosene was invented. Kerosene had the following benefits:

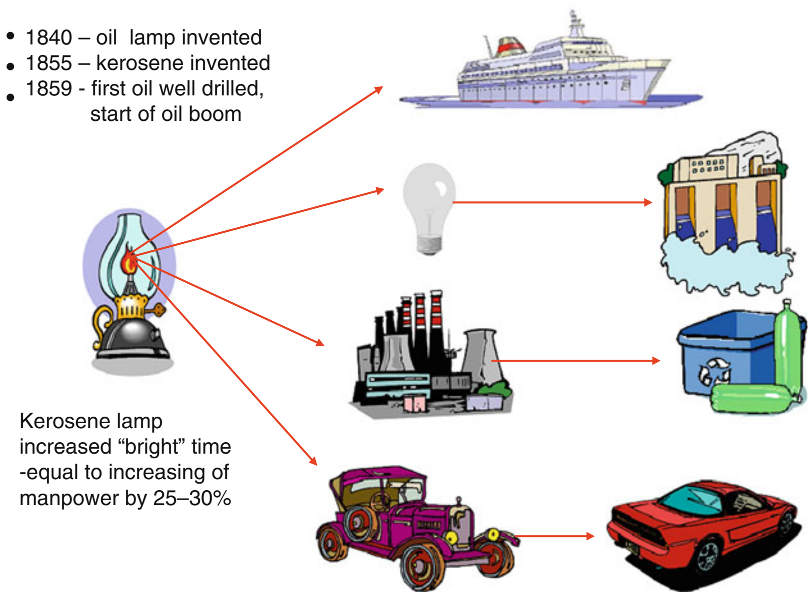
- It produced a pleasant, bright white light
- It burned without creating smoke
- It was safe (kerosene lamps were not explosive like other gas lamps).

The invention of the kerosene lamp abruptly increased the demand for oil which, at the time, was available only from oil pits. To satisfy the growing demand, exploration and new oil production methods were necessary; in 1859 the first successful oil drill launched the oil boom.

The introduction of a bright, inexpensive, and safe source of light allowed for a longer work day, night shifts, and more time for reading, education, entertainment, etc. The need for good illumination activated by the invention of the kerosene lamp stimulated the development of electrical power and of the electrical industry in general.

The mass production of kerosene created a problem, however: What could be done with the by-products, such as gasoline, that were unusable for illumination purposes because they were explosive, or heavy oil components with complex hydrocarbons? Ultimately, these by-products offered inexpensive fuel for the growing automotive

Levels of Invention, Fig. 2 “Marketing Tornado” originated by the kerosene lamp invention (Zlotin and Zusman 2004)



industry, as well as a rich source of raw material for the emerging chemical industry.

At the same time, the utilization of oil fuel instead of coal eliminated the most serious drawbacks to the expanding military and civil fleets (steam boat engines that burned coal required a lot of stoking).

The kerosene lamp (Fig. 2 above) serves as a good illustration for how a modest invention activated an avalanche (“invention tornado”) of industrial evolution. Other illustrations are the invention of typography, gun powder, hay production, the cotton gin, etc.

Levels of Invention, Implementation Strategy, and Return on Investment (ROI)

The main concepts and approaches in TRIZ were developed on the basis of statistical research of patent literature, and thus always lacked details about how the inventions were implemented. Common sense suggests that the implementation time for high-level inventions is typically long, mainly due to the lack of necessary knowledge and the research required for gaining that knowledge. Another reason is the high psychological barrier associated with a paradigm shift. At the same time, the analysis of information other than patents (including anecdotal knowledge about how particular inventions were implemented), shows that another important reason for delays in implementation is the number of problems that must be solved to ensure success.

Typically, the implementation of a level 4 invention cannot occur unless a number of level 3 inventions have been made (i.e., to solve secondary or so-called consequent problems). In turn, each level 3 invention might require a number of level 2 inventions, etc., ultimately entailing the solution of many conventional engineering problems.

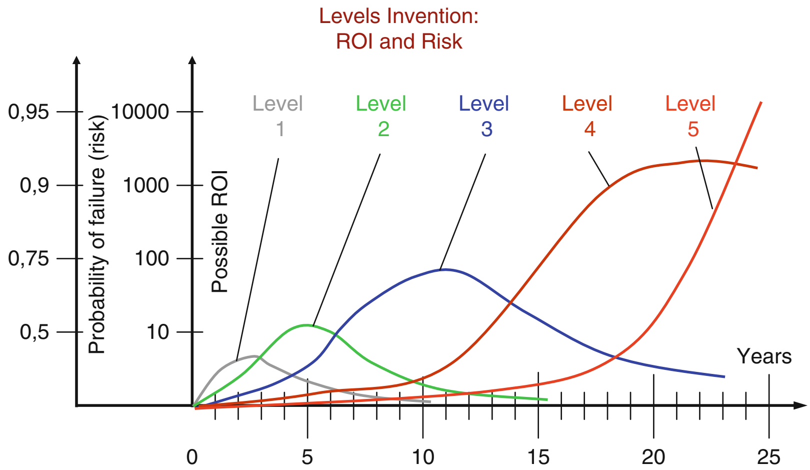
Given the above, an effective implementation strategy should include the timely identification and resolution of consequent problems at all levels. Failure to do so can result in long delays in implementation.

It is important to note, however, that consequent problems should not be more difficult to solve than the original problem.

The consideration that every higher level invention contributes multifold in the number of lower lever inventions with each level down can provide another (additional) explanation of huge difference between the number of inventions of high and low levels.

Implementation time and actual return on investment (ROI) are significantly dependent on the level of the invention. The first idea for an invention often

Levels of Invention, Fig. 3 Levels of inventions, ROI and Risks (Zlotin and Zusman 2004)



emerges when there is no practical means to realize it. For example, the first theoretically possible laser was described by Einstein in 1913. In 1948, the Russian scientist V. Fabricant patented the idea of a coherent light source (the term "laser" came later), but could not get enough financing to build a working device. In the early 1950s, Towns in the USA and Basov and Prochorov in Russia almost simultaneously built the first maser – a gas device operating in the radio frequency range (later all three shared the Nobel Prize for their achievement). At that time, however, there was no practical application for the new invention. Not until 1959, when R. Gould (a disciple of Towns) successfully built the first solid laser based on a ruby crystal, did the practical application of lasers actually begin. Still, it took another 20 years until lasers were widely applied in consumer electronics and significant profit was generated.

In recent times, the acceleration of scientific and technological progress has significantly reduced the implementation time required for large inventions – but not enough. The typical correlation between implementation time, ROI, and risk for inventions of different levels is shown in the Fig. 3 below.

Apparently, none of the levels is optimal; each has its advantages and disadvantages:

- Low-level inventions are typically fast and easy to implement and the risk is low; however, they do not provide a competitive edge or significant ROI.
- High-level inventions can provide a competitive edge and high ROI but require substantial and long-term effort before beginning to pay off, making them very risky.

Below one can see a number of strategies that can help "harmonize" the invention output.

Strategies for Low-Level Inventions

As mentioned earlier, low-level inventions have never been the primary focus of TRIZ, yet their importance and value can grow enormously. The rich resources that arose with the invention of the kerosene lamp (that eventually resulted in a "tornado") went unnoticed for a long time, delaying the recognition of the invention's value. The studies of US and European patents show that underestimating an invention's value often results in patents that cover no more than 10–15 % of the newly created opportunities. Such patents provide limited protection and can disclose more than they protect, serving as invitations for potential competitors to capitalize on strong, original ideas. To avoid this situation, it is crucial to unveil, in a timely fashion, newly emerged resources, for example, by conducting Directed Evolution® (Directed Evolution is a registered Trademark of Ideation International Inc.) paying special attention to new areas of application (Zlotin and Zusman 2001).

Example: The evaluation of an optical film intended for use in gift wrapping resulted in the identification of a new area of application – home interior (following the last boom in housing).

Given the above, new possibilities discovered for a low-level invention can increase its overall value (and ROI) while maintaining advantages such as short implementation time (at least for the first area of application), low initial investment, and relatively low risk.

Strategies for High-Level Inventions

The main problems associated with implementing high-level inventions are long implementation time, expensive R&D, and high risk. In these cases, it is critical to review the entire technology and its evolutionary resources (Zlotin et al. 2005), paying special attention to:

- Identifying partial low-level inventions and applications associated with the given high-level technology, especially those that can be quickly and inexpensively implemented.
- Identifying secondary (consequent) problems at lower levels, which must be solved to ensure successful implementation.
- Timely unveiling and resolving potential problems that could delay or complicate the implementation, for example, by conducting *Anticipatory Failure Determination* (AFD).

Some of the recommendations suggested for increasing the value of low-level inventions, such as searching for new applications or linking to "tornados," are applicable for high-level inventions as well.

Conclusion and Further Directions

1. Aside from its theoretical importance, the concept of levels of invention is valuable in terms of practical application. For different levels, different problem-solving and intellectual property strategies can be recommended.
2. The level of an invention can be identified using a set of criteria, detailed descriptions and illustrations of which are embedded in software.
3. Further research could be done in the directions of increasing precision and possibly quantifying the levels of innovation.

Cross-References

▶ Creativity and Innovation: What Is the Difference?
▶ Intellectual Property Rights
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Invention Versus Discovery
▶ Inventive Problem Solving (TRIZ), Theory
▶ Measurement of Creativity

References

Altshuller G. The innovation algorithm. 2nd ed. Moscow Worker Publishing House, 1973 (in Russian). Translated into English by Lev Shulyak (Worcester: Technical Innovation Center; 1999).

Zlotin B, Zusman A. Directed evolution: philosophy, theory and practice. Southfield: Ideation International; 2001.

Zlotin B, Zusman A. Levels of invention. Presented at TRIZCON 2004.

Zlotin B, Zusman A. The concept of resources in TRIZ: past, present and future. Presented at TRIZCON 2005 (Brighton, MI, April 2005).

Levels of Problems

▶ Levels of Invention

Leveraged Buyouts

▶ Spin-off

Likeness

▶ Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education

Linear and Nonlinear Innovation

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Linear Innovation

► Academic Firm
► Epistemic Governance and Epistemic Innovation Policy

Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Magdalena Bielenia-Grajewska[1,2], Elias G. Carayannis[3] and David F. J. Campbell[4,5]
[1]University of Gdansk, Gdansk, Poland
[2]Scuola Internazionale Superiore di Studi Avanzati (SISSA), Trieste, Italy
[3]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA
[4]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[5]University of Applied Arts, Vienna, Austria

Synonyms

Business discourse; Creativity, invention, innovation and entrepreneurship, discourse; English, a global language; Entrepreneurs' discourse; Global language; Innovation through language; Linguistic identity; Linguistic managing through innovation; Linguistic side of business performance; Organizational linguistic identity

Introduction

The spheres of creativity, invention, innovation, and entrepreneurship are strictly related with the life and performance of organizations. Companies have to be creative, inventive, innovative, and entrepreneurial if they want to be competitive and prosperous on the modern market (Carayannis and Chanaron 2007). Due to the variety of products and services offered by the business entities in most industry sectors, it is mainly knowledge of gloCal (global and local) character (Carayannis and von Zedtwitz 2005) that makes the company outstanding among similar organizations and enhances its market attractiveness. Although companies have to search continuously for innovations and the spirit of entrepreneurship (Drucker 2006), determining the competitiveness of modern economies (Welfens et al. 1999), because they operate in the multilevel systems of knowledge (Carayannis and Campbell 2006), in several of them, immediate results and profits are valued more than both the long-term learning and the time-consuming dissemination of novel thoughts and ideas (Moore 2010). Additionally, although knowledge is an indispensable part of company performance, being created and represented in routines, practices, cultures, and relationships (Badaracco 1991; Lemon and Sahota 2004), its importance is not taken into account in many organizations. The other considerable issue is the alternating nature of knowledge since the characteristics of cognition and instruction have changed with the flow of time. In the past, geographical distance was one main factor shaping human relations, also the ones responsible for creation and invention, whereas nowadays, common interests determine the individuals' choices of joining groups (McPherson et al. 2001). Thus, modern innovation networks are created by people who may represent different cultures and it is the diversity of innovative environments that determine their success (Baker 2009; Thatcher and Brown 2010), since heterogeneous information flows increase the probability that the incoming data is related to the already known information (Cohen and Levinthal 1990) or they provide novel solutions to existing problems. Additionally,

> *the competitiveness and superiority of a knowledge system is highly determined by its adaptive capacity to combine and integrate different knowledge and innovation modes* via *co-evolution, co-specialisation and competition knowledge stock and flow dynamics* (Carayannis and Campbell 2009: 223).

Thus, knowledge isolation influences the economy in a negative way, whereas the openness for new cultures and domains increases the innovative potential and stimulates the absorption of new innovation-oriented stakeholders. The mentioned diversity demands, among others, advanced linguistic skills to create and disseminate knowledge in a culturally and linguistically diversified setting.

It should also be remembered that knowledge is not what is only visible in words and numbers, but it may be also tacit, not written down, not easy to observe, unrecognizable, and hard to categorize and describe (Nonaka and Takeuchi 1995). Thus, it is language that enhances or hinders the creation and usage of knowledge since the proper selection of linguistic tools may help understand novel ideas and thoughts, especially the ones that are difficult to be perceived, named, and disseminated. The diversity of ideas and thoughts should also concern the hierarchical dimension of organizations. Taking into account the type of communication to be used, the leaders should follow the rules of "social poetics" (Shotter and Cunliffe 2002), stressing the dialogue between supervisors and subordinates. In the case of CI2E (*creativity, invention, innovation, and entrepreneurship*) networks in organizations, social poetics deals with the mutual input in and for idea creation and maintenance, in discussing some innovative issues within the organization, with all the workers, customers, and other people related to the performance of organizations. The notion of diversified stakeholders, which is related to the concept of "heterophily" that can be understood as the dissimilarity between interlocutors in terms of (for example) education, gender, beliefs, and social status, and "homophily" that is perceived as homogeneity among participants in discourse as far as their individual features are concerned (Rogers 1995), shapes organizational communication that focuses on structuring and maintaining an organization that is creative, innovative, inventive, and entrepreneurial. Linguistic heterogeneity emphasizes the communicative aspect of CI2E. The linguistic heterogeneity of the studied domains is related to input heterogeneity, process heterogeneity, and output heterogeneity. Input heterogeneity refers to the diversity of factors shaping economic activity, such as land, labor, capital, entrepreneurship. On the other hand, process heterogeneity relates to the differences in using the inputs. The third aspect, namely, the output heterogeneity, concerns (among others) such issues as number and size of firms, company performance, and market concentration (Carayannis 2008). Taking into account the mentioned aspects, that is, the heterogeneous input, process, and output, the languages of CI2E will be to some degree homogeneous, but possess also important heterogeneous features. Each of them has different heterogeneous inputs, processes, and outputs and, consequently, expresses a different linguistic heterogeneity. Thus, the language of CI2E should be homophilous and heterophilous at the same time; it should possess homophilous characters since only common communication tools allow for efficient and quick communication, using linguistic tools that are understood and used by both encoders and decoders of messages. At the same time, they should have heterophilous elements since only diversity allows for the variety of perspectives and the magnitude of available solutions (Bielenia-Grajewska 2012b).

Moreover, nowadays, society experiences an era of hyperconsumption, with people consuming many goods, in different places and at different times (Lipovetsky 2011), being bombarded by changing media images, techno-images, finance-images, and idea-images (Appadurai 2005) that they cannot "digest" themselves. Taking into account the mentioned situation, the direct dialogue would be more and more impossible. Thus, the future is in the hands of various types of connectors, translators, net-creators, whose tasks are to build relations and transfer information (Szlendak 2010). Taking into account the mentioned feature, it can be stated that such a role can be played by modern organizations. For example, employees can be the mediators, communicators, and translators of innovations. The last feature can be understood as translating the language of innovation for potential stakeholders, by presenting innovations in such a way as to make them clear and easily applicable (Bielenia-Grajewska 2011). Referring to the mentioned characteristics of language, in the coming sections it will be discussed, how language determines the sphere of CI2E.

CI2E and Linguistic Issues

The relation between CI2E and language is mutual. First of all, language allows for information flows between various domains (specialized disciplines) of knowledge. Thus, it offers to those, who are looking and searching for data, several diversified sources of information that can be selected according to one's needs and preferences (Bielenia-Grajewska 2012a). Secondly, it is the language understood in the broad sense, with its written and spoken mode, with its formal and informal style that allows for effective CI2E knowledge creation and knowledge communication. Thirdly, since creativity, invention, innovation, and entrepreneurship aim at creating something new or innovative, the role of language, among others, is to name new ideas and their products. Moreover, the activities of creating, inventing, innovating, or entrepreneurship rely on some sources during the act of constructing some novelty, with linguistic resources being one of them. Simultaneously, language mirrors the state of art in each of the studied domains.

Thus, observing the communicative sphere of creativity, invention, innovation, or entrepreneurship informs readers or listeners about the level of technological or economic advancement of the studied domain. To add, language is an important part of branding since the chosen name for the merchandise determines the success or failure of service or products related to CI2E. At the same time, all the components shape the language as such since they determine the need for communication and the creation of new terms and concepts. Moreover, the popularity and usage of the newly coined words and phrases mirror the successes and failures of each CI2E domain. Thus, the advancement of CI2E determines the development of lexicons and, at the same time, language influences the level and characteristics of CI2E. Since communication not only allows for the exchange of services and goods, but also for ideas and thoughts (Bennett 1998), those not in possession of advanced linguistic skills have lower chances of participating thoroughly in innovation networks since they may have problems with articulating their ideas. Thus, the process of creation, invention, innovation as well as commercializing novel products or services is determined by linguistic factors. The mentioned barriers may result from the linguistic characteristics of the organizational lingo such as linguistic policies as well as the low communicative skills of broadly understood stakeholders, related to their psychological features and social skills.

Moreover, language is an indispensable element of corporate allostasis. Allostasis, being originally a biological term, denotes the organisms' ability to adopt to new conditions by means of hormones and mediators (Karatsoreos and McEwen 2010). Consequently, corporate allostasis is related to all the actions necessary for the company to react to the changes in its environment. Communication, especially the language itself, constitutes a very powerful element of corporate allostasis since it allows the organizations to react to any alternation and impose necessary actions. Proper dialogue proves to be especially important in the times of risk and crisis when the organizations have to communicate with diversified stakeholders (Bielenia-Grajewska 2012c).

Furthermore, all the issues related to the linguistic side of company performance can be treated as an important element of company capital. Thus, the term *company linguistic identity capital* can be used to show how much can be achieved by creating and exercising effective company linguistic identity (Bielenia-Grajewska 2012d). In the case of the studied concept CI2E, company linguistic capital is shaped by various systems, such as political, social, cultural, and economic ones, and the creative, inventive, innovative, and entrepreneurial nature of the organization itself.

Relations Between CI2E and Language from a Systemic Perspective

As far as the methodology is concerned, the postmodernistic studies are taken into account by concentrating on the systemic approach (the open system perspective), which allows to study each of the mentioned domains as a separate system to some degree, but at the same time to concentrate on the relation between various domains. Moreover, these systems are dynamic, responding both to the inner and outer factors (e.g., Balestri 2005; Becker 1997; Johnson et al. 1964; Teubner 1984). For example, innovations do not exist in a vacuum and they do not concern exclusively one product, service, or idea, but they are determined by the relations between political, economic, and social systems (Küppers and Pyka 2002). Looking at the issue from the perspective of the Quadruple Helix, four helices determine the innovation system: academia/universities, industry/business, state/government, and media and culture-based public relations as well as civil society (Carayannis and Campbell 2009). The mentioned discussion can be also conducted with the use of the Quintuple Helix approach, by taking into account the role of social ecology (Carayannis and Campbell 2012). In addition, it should be stressed that the systemic nature can be observed at both the microsphere and macrosphere. Taking a larger perspective, every innovation network can be understood as a subcomponent of a larger innovation network (Carayannis and Campbell 2012). Applying the micro-point-of-view and the internal-systemic-environment, it is reasonable to take the notion of creativity into account that is directly connected with the interaction of three elements: a culture of symbolic rules, a person who introduces the novelty in the symbolic sphere, and a group of experts who understand and accept the innovation (Csíkszentmihályi 1996). The same can be observed with other notions of CI2E since they all require the presence of three indispensable elements: the initiator, the receivers, and the environment they function within.

Additionally, the application of systems theory is also useful, because the cooperation of subsystems may lead to synergic results (Kerzner 2009). Thus, the existence of various systems within the domain of CI2E is also the source for the uniqueness of the concept as such as well as its constituting domains. Moreover, as Luhman states: In every system, there is a main element that undergoes constant reproduction to maintain the fundamental functions of the system. In the case of social systems, it is communication that is the main determinant (Ramage and Shipp 2009), with language shaping and maintaining the organizational ecosystem. Thus, in the next section, the attention focuses on selected linguistic characteristics and features of CI2E to show the general patterns of the language that shape creativity, invention, innovation, and entrepreneurship.

CI2E Domains from a Systemic Linguistic Perspective

The characteristics discussed here are representative not only for the studied domain itself, but due to the interrelation of the spheres belonging to CI2E, they determine the shape of the other disciplines constituting a CI2E system. The main feature related to the growing importance of CI2E in the modern economy is related to the growing popularity of these concepts, also for everyday life. For example, in the twentieth century, creativity is not only referred to as being the characteristics of art or literature, but it is also employed to denote the novelty of everyday human activities (Mueller 2010). Thus, creativity can also be discussed when one's everyday actions are observed. One of the examples related to creativity is its linguistic dimension. Creativity expresses a relationship to language, since people are capable of constructing their own sentences, the ones they have never heard before but created themselves (Kintsch 2010; Runco 2007). Since language can serve as an identity marker (Scollon and Wong Scollon 2001), the sentences coined by individuals mirror their characteristics, education, preferences, social background, etc. The same can be discussed in the case of organizations. Apart from the *compositional creativity* that is connected with creating new products or services in carefully planned processes, modern organizations also use *improvisational creativity* when they have to face emergent crisis or risk situations (Fisher and Amabile 2009). The mentioned improvisational creativity also concerns the linguistic dimension of organizational performance. Unexpected corporate events may require using not only the well-known strategies, but also trying to create novel communication solutions to address the appearing problems. Since creativity has to be accepted by the social environment (Mueller 2010), it has to be communicated in a way that is understood by every receiver. Thus, such linguistic tools have to be selected that allow for quick and efficient corporate dialogue. The power of language in relation to creativity is related to the fact that creativity gives the individual not only the fulfillment, but also leads to results that will influence future actions (Csíkszentmihályi 1996). Thus, looking at the issue from the process perspective, the way that language is used in the course of creation will determine the success or failure of products or services in the future. For example, the mistakes made during the creation process resulting from communication problems determine the later stages of product or service implementation and acceptance.

Language also influences the domains of invention and innovation. Invention and innovation are terms that are often confused in the literature.

> *Invention is the discovery of a new product or process, whereas innovation is the process through which inventions and new ideas become a business or operational reality* (Needle 2004: 355).

In invention, the idea of repetition is common; when something proves useful, adding a feature or an element might be a good solution (Weber 1996). The same can be applied in the case of communication. When a linguistic strategy is efficient, it is likely to be used further with some modifications. The act of invention is strongly connected with language since

> *one invents with language or with other symbol systems, which are socially created and shared by members of discourse communities* (LeFevre 1987: 34).

As far as innovation is concerned, the role of both, individual and group characteristics, determine the creation and maintenance of innovation. According to social constructivist approaches, group interactions determine how an individual perceives oneself and the world and one's approach to innovation. Moreover, groups may create anti-innovative identities that may hinder future innovations (King and Anderson 2002). To add, since language may be also the element of divide, the role of Innovation Diplomacy is to eliminate the linguistic distance and enhance the initiatives aiming at increasing the potential of markets and investors (Carayannis and Campbell 2012). It should also be stressed that linguistic issues depend on the type of innovation models. Consequently, the model of linear innovation modes is different from the model of nonlinear innovation modes, also from a communication perspective (Carayannis and Campbell 2009). One of the factors shaping both the individual as well as the social approach to innovation is language. Thus, one's linguistic identity may serve as pro- or anti-innovation factor and, consequently, hinder or enhance innovation acceptance and dissemination.

The sphere of entrepreneurship is also determined by linguistic factors, with language being the tool of creating and maintaining competitive advantage. Moreover, entrepreneurial discourse supports novel products and services since their conception and formation draw stakeholders' attention to the unique features of the offered merchandise.

Metaphors in CI2E Discourse

Among others, linguistic symbolism plays a crucial role in the CI2E communication. Thus, linguistic rituals, figurative language, metaphors, and storytelling are an important part of CI2E. Taking into account figurative creativity (Kövecses 2005), one of the most visible examples of human cognitive ability is the ability to create, use, and understand metaphors. Metaphor creativity is not exclusive for literature, but can be found in various contexts and uses (Semino and Steen 2010). For example, metaphors are used in professional communication since they make the dialogue quicker and more efficient (Bielenia-Grajewska 2009). One of the reasons for the popularity of metaphors in different types of communication is the fact that metaphors themselves have some elements of creativity, innovation, invention, and entrepreneurship embedded in themselves. First of all, metaphors, by using well-known and novel domains, allow to show similarities and differences between objects (Olds 1992) and offer an indefinite number of interpretations (Schon 1969). Metaphors enhance the understanding of novel concepts by using well-known domains (Brown 1994; Reeves 2005), since they are able to verbalize novel ideas (Kurth 1999), especially when the available linguistic resources are not sufficient (Lakoff and Turner 1989). Secondly, people create metaphors when they have difficulty in using literal language to express their feelings or send some information (Gibbs 1999). Thus, a metaphor is not a decorative element only, but it is related strictly to individuals' cognition (Deignan 2005; Vega Moreno 2007). Consequently, the way one creates metaphors depends on the way he or she perceives the reality. In the case of corporate discourse, the way one coins and uses metaphors depends on both the individual personae and group identity.

The other reason for the popularity of metaphorical names is the fact that they are remembered easier than standard expressions (Espunya and Zabalbeascoa 2003), and they allow the receivers to see and perceive something from a different perspective (Cacciari 1998). However, their characteristics may also lead to some problems with their understanding since

> *metaphors must be approached and understood as if they were true at the same time that we are aware they are fictious-created and artificial* (Spicer and Alvesson 2011: 35).

It should be also stated that the relation (relationship) between CI2E and metaphors is mutual. As has been presented above, the way metaphors are used shapes the way CI2E is perceived by various stakeholders. At the same time, the level of CI2E and its characteristics influence the usage of metaphors since people construct metaphors about concepts they know better (Edwards and Clevenger 1990). For example, it could be argued that the term and concept of the "Quadruple Helix" innovation system (Carayannis and Campbell 2012) has also some metaphorical qualities in the support of explaining the dynamics of knowledge production and innovation application in the knowledge society, knowledge economy, and knowledge democracy. Metaphors are also important at the individual level of CI2E since it allows persons with leadership quality to show their future vision as to persuade social actors into their ideas (Vincent 2012). However, metaphors may also entrap those who use them. Although a short-term rhetorical success can be achieved by using a metaphor, it can turn out that the action that was pictured by metaphors as strong and efficient is not that powerful in reality (Burkholder and Henry 2009).

Despite the circumstance that metaphors can be found in all languages belonging to the sphere of CI2E, it is the language of entrepreneurship that is abundant in figurative language. Since

> *entrepreneurship is a dynamic process of vision, change, and creation that requires an application of energy and passion toward the creation and implementation of new ideas and creative solutions* (Kuratko 2009: 21),

it also involves the linguistic creativity in creating and implementing novel thoughts and achievements. It should be stressed that metaphors also have been changing since leadership is evolving. For example, in the past, the metaphors of commander and controller were used that stressed the mechanistic and structural aspect of leadership, whereas nowadays metaphors such as designer, coach, covenant-maker, maestro, steward, and moral-exemplar are popular (Bogue 2010). Moreover, the used metaphor mirrors one's leadership style. For example, the leadership person who uses the metaphor of a family to describe his or her team exercises a different management style than the one who describes his or her subordinates as the "ant colony" (McLeod 2012). Another way of looking at entrepreneurship is through the prism of an orchestra metaphor, with the conductor being

> *responsible for bringing out the artistic talents and gifts of each symphony member, while the musicians work together to blend and harmonize the music* (Komives et al. 2007, p. 32).

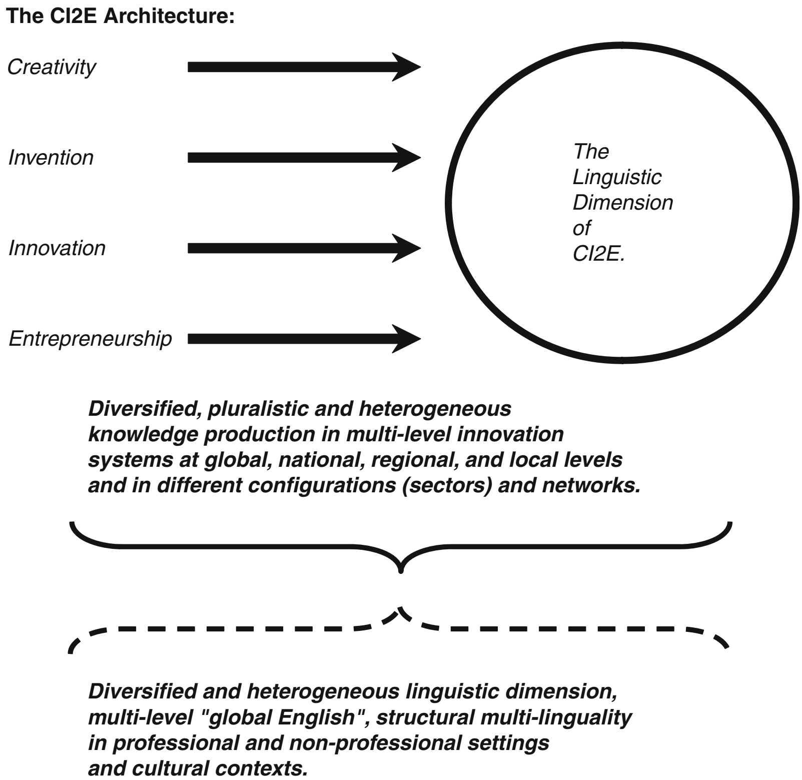
The difficulties and complexities of entrepreneurship are also being presented by metaphors.

For example, the metaphor of journey is utilized to exemplify such features such as complexity, having some obstacles and problems in the process of realization (Dodd 2002). The job of managing can be compared, for example, to navigating the ship, with a map and a compass in hands (D'Egidio 2003). Furthermore, complexity (and stages) may be exemplified in the metaphor of building as well as the metaphor of raising a child (Dodd 2002). Since entrepreneurship is also connected with fighting for a good position on the competitive market, it is occasionally pictured by using the metaphor of "war" (Dodd 2002; Lumby and English 2010). Another area of metaphorization in organization is cognition. Thus, the metaphors of learning, brain, and knowledge are used and are being employed (Henry 2001).

Conclusion and Future Directions

As has been discussed, the language of CI2E (*creativity, invention, innovation, and entrepreneurship*) has several distinct features that determine the communication with different stakeholders that should be understood broadly. However, one should remember that each domain within the CI2E sphere has its own distinctive features. One of the reasons is the function of the domain itself which determines the linguistic sphere of its performance. Thus, each system within CI2E relies on carefully selected linguistic devices to describe the domain. For example, the degree and type of linguistic symbolism vary, taking into account different communicators, audiences, and purposes. At the same time, the language used by each system is not the same since it is shaped by different relations between the subsystems, both within the CI2E sphere and with other outer systems.

Is there a language of creativity, invention, innovation, and entrepreneurship? The analysis presented here suggests that the CI2E architecture of knowledge production and innovation systems (innovation application) also finds an expression in a linguistic dimension of CI2E. The linguistic dimension of CI2E should make creativity, invention, innovation, and entrepreneurship visible. However, more importantly, it would also have to be asked: *What is the proper language of creativity, invention, innovation, and entrepreneurship*, to be creative and innovative, to support knowledge production and innovation application? The more diversified, pluralistic, and heterogeneous knowledge production evolves in advanced economies, societies, and democracies, and in multilevel arrangements of innovation systems (Carayannis and Campbell 2012: 21, 32–35), the more diversified and heterogeneous also the linguistic dimension of CI2E should develop. *Between CI2E knowledge production and the linguistic dimension of CI2E, there are several interlinkages and cross-references, even suggesting a coevolution.* There can be advances in CI2E knowledge production and in CI2E language. Furthermore, language shapes culture. Kuhlmann, for example, uses the term and expression of the "innovation culture" (Kuhlmann 2001: 958). Language of innovation may also cross-relate with a culture of innovation. *Is nonlinear innovation coupled to a nonlinear language of innovation?* In addition, multilevel innovation systems in gloCal (global and local) settings require also the formation and evolution of a global language so that there can be global communication in world-wide systems of knowledge production and innovation. There exists already the concept of "English as a global language" (Crystal 2012). In several contexts, this actually implies diversified forms of bi-linguality or multi-linguality, where English is the language for professional communication, being accompanied by other languages for regional, local, and personal communication. Multi-linguality may add to "creative knowledge environments" (on CKEs, see Hemlin et al. 2004). Multilevel innovation systems, operating at the same time at global, national, regional, and local levels and in different (also different sectoral) configurations, require a structure of a "multilevel expression of global English," where professional English as well as professional and nonprofessional other languages coexist. Global English is a social expression of and in knowledge production, and can be enhanced by IT (perhaps also by artificial intelligence) in the future. Global English



Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship, Fig. 1 The co-evolution of the linguistic dimension of CI2E and the CI2E of knowledge production and innovation systems

integrates knowledge production and innovation globally in context of multilevel innovation systems and systematically introduces and amplifies multi-linguality in culture. Advances in the linguistic dimension of CI2E should be related to advances in CI2E knowledge production and innovation systems (see Fig. 1).

Cross-References

- ▶ Business Creation
- ▶ Creative Knowledge Environments
- ▶ Entrepreneur's "Resource Potential," Innovation and Networks
- ▶ Entrepreneurial Opportunities
- ▶ Entrepreneurial Organizations
- ▶ Innovator
- ▶ Interactive Processes in the Form of Creative Cooperation
- ▶ Inventive Resources
- ▶ Nonlinear Innovations

References

Appadurai A. Nowoczesność bez Granic. Kulturowe Wymiary Globalizacji. Cracow: Universitas; 2005.

Badaracco J. The knowledge link: how firms compete through strategic alliances. Boston: Harvard Business School; 1991.

Baker AC. Catalytic conversations: organizational communication and innovation. Armonk: M.E. Sharpe; 2009.

Balestri G. Manuale di economia e gestione aziendale. Milan: Ulrico Hoepli Editore S.p. A; 2005.

Becker CB. The analysis of organizational culture as a thermodynamic process. In: Barnett GA, Thayer L, editors. Organization-communication: emerging perspectives. The renaissance in systems thinking. Greenwich: Ablex Publishing Corporation; 1997. p. 121–39.

Bennett MJ. Basic concepts of intercultural communication. Yarmouth: International Press; 1998.

Bielenia-Grajewska M. The role of metaphors in the language of investment banking. Ibérica. 2009;17: 139–56.

Bielenia-Grajewska, M. Informacyjny aspekt innowacyjności współczesnych organizacji. Rola komunikacji wewnętrznej i zewnętrznej w kreowaniu nowatorskich firm; 2011. http://innopomorze.pomorskie.eu/innowacyjnosc-w-organizacji/innowacyjnosc-w-organizacji.html. Accessed 20 June 2012.

Bielenia-Grajewska M. Linguistics. In: Bainbridge WS, editor. Leadership in science and technology. A reference handbook. Thousand Oaks: SAGE; 2012a. p. 41–8.

Bielenia-Grajewska M. Linguistic aspects of informal learning in corporate online social networks. In: Dennen VP, Myers JB, editors. Virtual professional development and informal learning via social networks. Hershen: IGI Publishing; 2012b. p. 93–112.

Bielenia-Grajewska M. Business performance management from the systemic communicative and linguistic side. In: Christiansen B, editor. Cultural variations and business performance: contemporary globalism. Hershen: IGI Publishing; 2012c. p. 230–44.

Bielenia-Grajewska M. Corporate linguistic rights through the prism of company linguistic identity capital. In: Akrivopolou C, Garipidis N, editors. Human rights and risks in the digital era: globalization and the effects of information technologies. Hershen: IGI Publishing; 2012d.

Bogue EG. The leadership choice. Designing climates of blame or responsibility. Bloomington: WestBow; 2010.

Brown V. The economy as text. In: Backhouse R, editor. New directions in economic methodology. London: Routledge; 1994. p. 368–82.

Burkholder TR, Henry D. Criticism of metaphor. In: Kuypers JA, editor. Rhetorical criticism: perspectives in action. Lanham: Lexington Books; 2009. p. 97–116.

Cacciari C. Why do we speak metaphorically? Reflections on the functions of metaphor in discourse and reasoning. In: Katz AN, Cacciari C, Gibbs RW, Turner M, editors. Figurative language and thought. New York: Oxford University Press; 1998. p. 119–57.

Carayannis EG. Conceptual framework for an analysis of diversity and heterogeneity in the knowledge economy and society. In: Carayannis EG, Kaloudis A, Mariussen A, editors. Diversity in the knowledge economy and society: heterogeneity, innovation. Cheltenham: Edward Elgar; 2008. p. 95–116.

Carayannis EG, Chanaron JJ. Leading and managing creators, inventors, and innovators: the art, science and craft of fostering creativity, triggering invention, and catalyzing innovation. Westport: Praeger; 2007.

Carayannis EG, Campbell DFJ. Mode 3': meaning and implications from a knowledge systems perspective. In: Elias GC, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2006. p. 1–25.

Carayannis EG, Campbell DFJ. Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. Int J Technol Manage. 2009;46(3/4):201–34.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems: twenty-first-century democracy, innovation, and entrepreneurship for development. New York: Springer; 2012.

Carayannis EG, von Zedtwitz M. Architecting gloCal (global–local), real-virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies: lessons learned and best practices from current development and business incubation practices. Technovation. 2005;25:95–110.

Cohen WM, Levinthal DA. Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q. 1990;35(1):128–52.

Crystal D. English as a global language. Cambridge: Cambridge University Press; 2012.

Csíkszentmihályi M. Creativity: flow and the psychology of discovery and invention. New York: Harper Collins; 1996.

D'Egidio F. La nuova bussola del manager. Il valore del capitale intellettuale e la completitivitá dell'impresa. Milan: ETAS; 2003.

Espunya A, Zabalbeascoa P. Metaphorical expressions in English and Spanish stock market journalistic texts. In: Jaszczolt K, Turner K, editors. Meaning through language contrast. Amsterdam: John Benjamins; 2003. p. 159–80.

Deignan A. Metaphor and corpus linguistics. Amsterdam: John Benjamins, B.V; 2005.

Dodd SD. Metaphors and meaning. A grounded cultural model of us entrepreneurship. J Business Venturing. 2002;17:519–35.

Drucker PF. Nadchodzi nowa organizacja. In: Zarządzanie wiedzą. Gliwice: Helion/Harvard Business School Press; 2006. p. 7–28.

Edwards R, Clevenger T. The effects of schematic and affective processes on metaphorical invention. J Psycholinguist Res. 1990;19(2):91–102.

Fisher CM, Amabile T. Creativity, improvisation and organizations. In: Rickards T, Runco MA, Moger S, editors. The Routledge companion to creativity. Abingdon: Routledge; 2009. p. 13–24.

Gibbs RW. Metaphors. In: Pritzker SR, Runco MA, editors. Encyclopedia of creativity. San Diego: Academic; 1999. p. 209–20.

Hemlin S, Allwood CM, Martin BR. Creative knowledge environments. The influences on creativity in research and innovation. Cheltenham: Edward Elgar; 2004.

Henry J. Creativity and perception in management. London: Sage; 2001.

Johnson RA, Kast FE, Rosenzweig JE. Systems theory and management. Manage Sci. 1964;10(2):367–84.

Karatsoreos IN, McEwen BS. Stress and allostasis. In: Steptoe A, editor. Handbook of behavioral medicine: methods and applications. New York: Springer; 2010. p. 649–58.

Kerzner H. Project management: a systems approach to planning, scheduling, and controlling. Hoboken: Willey; 2009.

King N, Anderson N. Managing innovation and change: a critical guide for organizations. London: Thomson; 2002.

Kintsch W. How the mind computes the meaning of metaphor: a simulation based on LSA. In: Gibbs RW, editor. The Cambridge handbook of metaphor and

thought. New York: Cambridge University Press; 2010. p. 129–42.
Kuhlmann S. Future governance of innovation policy in Europe – three scenarios. Research Policy. 2001;30:953–76.
Küppers G, Pyka A. The self-organization of innovation networks: introductory remarks. In: Pyka A, Küppers G, editors. Innovation networks - theory and practice. Cheltenham: Edward Elgar; 2002. p. 3–21.
Komives SR, Lucas N, McMahon TR. Exploring leadership: for college students who want to make a difference. San Francisco: Wiley; 2007.
Kövecses Z. Metaphor in culture: universality and variation. Cambridge: Cambridge University Press; 2005.
Kuratko DF. Entrepreneurship: theory, process, practice. Mason: South-Western Cengage Learning; 2009.
Kurth E. Altered images. Cognitive and pragmatic aspects of metaphor translation. In: Vandaele J, editor. Translation and the re(location) of meaning. Leuven: University of Leuven; 1999. p. 97–116.
Lakoff G, Turner M. More than cool reason. A field guide to poetic metaphor. Chicago: The University of Chicago Press; 1989.
LeFevre KB. Invention as a social act. Carbondale: Conference on College Composition and Communication, Southern Illinois University Press: Carbondale; 1987.
Lemon M, Sahota PS. Organizational culture as a knowledge repository for increased innovative capacity. Technovation. 2004;24(6):483–98.
Lipovetsky G. The hyperconsumption society. In: Ekström KM, Glans K, editors. Beyond the consumption bubble. New York: Routledge; 2011. p. 25–36.
Lumby J, English FW. Leadership as lunacy. And other metaphors for educational leadership. Thousand Oaks, CA: Sage; 2010.
McLeod PL. Leading teams. Choose the right metaphor. Leader Excel. 2012;29(3):8–9.
McPherson M, Lovin LS, Cook JM. Birds of a feather: homophily in social networks. Annu Rev Sociol. 2001;27:415–44.
Moore S. Strategic project portfolio management. Enabling a productive organization. Hoboken, NJ: Wiley; 2010.
Mueller R. Critical analysis of creative metaphors in political speeches. In: Low G, Todd Z, Deignan A, Cameron L, editors. Researching and applying metaphor in the real world. Amsterdam: John Benjamins, BV; 2010. p. 321–32.
Needle D. Business in context: an introduction to business and its environment. Andover: Cengage Learning EMEA; 2004.
Nonaka I, Takeuchi H. The knowledge-creating company: how Japanese companies create the dynamics of innovation. New York: Oxford University Press; 1995.
Olds LE. Metaphors of interrelatedness: toward a systems theory of psychology. Albany: State University of New York; 1992.
Ramage M, Shipp K. Systems thinkers. London: Springer; 2009.
Reeves C. The language of science. Abingdon: Routledge; 2005.
Rogers EM. Diffusion of innovations. New York: The Free Press; 1995.
Runco MA. Creativity: theories and themes: research, development, and practice. Burlington, MA: Elsevier; 2007.
Schon DA. Invention and the revolution of ideas. London: Tavistock; 1969.
Scollon R, Wong Scollon S. Intercultural communication-a discourse approach. Oxford: Blackwell; 2001.
Semino E, Steen G. Metaphor in literature. In: Gibbs RW, editor. The Cambridge handbook of metaphor and thought. New York: Cambridge University Press; 2010. p. 232–46.
Szlendak T. Siecio -smycze i wartości przyszłości. Pomorski Przegląd Gospodarczy. 2010;44:44–6.
Shotter J, Cunliffe AL. Managers as practical authors: everyday conversations for action. In: Holman D, Thorpe R, editors. Management and language: the manager as practical author. London: Sage; 2002. p. 15–37.
Spicer A, Alvesson M. Metaphors for leadership. In: Alvesson M, Spicer A, editors. Metaphors we lead by. Understanding leadership in the real world. Abingdon: Routledge; 2011. p. 31–50.
Teubner G. Autopoiesis in law and society: a rejoinder to Blankenburg. Law Society Rev. 1984;18(2): 291–301.
Thatcher SMB, Brown SA. Individual creativity in teams: the importance of communication media mix. Decision Support Syst. 2010;49:290–300.
Vega Moreno RE. Creativity and convention: the pragmatics of everyday figurative speech. Amsterdam: John Benjamins, B.V; 2007.
Vincent CP. Heuristique: création, intuition, créativité et stratégies d'Innovation. Paris: Editions BoD, France; 2012.
Weber RJ. Toward a language of invention and synthetic thinking. Creativ Res J. 1996;9(4):353–67.
Welfens PJJ, Addison JT, Audretsch DB, Gries T, Grupp H. Globalization, economic growth and innovation dynamics. Berlin/Heidelberg: Springer-Verlag; 1999.

Linguistic Identity

► Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Linguistic Managing Through Innovation

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Linguistic Side of Business Performance

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Listening Creativity

▶ Creativity in Music Teaching and Learning

Localized Industries

▶ Entrepreneurship in Creative Economy

Localized Knowledge

▶ Industrial Atmosphere

Love Money

Arvind Ashta[1], Anuja Cabraal[2] and Karl Dayson[3]
[1]Burgundy School of Business (ESC Dijon-Bourgogne), CEREN, CERMi, Dijon, France
[2]Graduate School of Business and Law, College of Business, RMIT University, Melbourne, VIC, Australia
[3]Department of Sociology and Criminolgy, University of Salford, Salford, UK

Synonyms

Family enterprise investment

Introduction

Entrepreneurial finance includes both equity and loans. The equity aspect includes personal savings, family and friends, business angels, venture capitalists, and the public equity market. The caption "love money" relates to the financing of a business by family and friends. Love money can be defined as money or capital given by family or friends for business start-up. The basis of giving money is based on the relationship that exists between the two parties. Family can include parents, siblings, as well as uncles and other members of the extended family.

The first recorded use of the term love money found was by the Canadian House of Commons Report of the Standing Committee on Industry (Ottawa: Parliamentary Publications Directorate, October 1994) on p. 44: "The term 'love money' refers to capital advanced by the entrepreneur of the SME (including personal loans secured by personal property of the entrepreneur such cars and houses), family, friends and neighbours" (cited by Lefton 1998 in footnote 2). Over time, the founder's own capital seems to have escaped the definition, and love money is now considered to include money invested in business by family and friends.

Other Related Concepts

Sweat Equity: It is the free services provided by cofounders, often before the enterprise starts, for which no remuneration is provided. The value of the entrepreneurial project is of course more than the value of the sweat equity, which is just one part of the total project value. However, sweat equity may continue at future stages of the enterprise. The use of family labor in microenterprises and family supervision or managers in small and medium companies is well documented (Thankur 1999). However, the love of family and friends required to build up an enterprise often goes beyond offering labor or supervision and includes offering money.

Transactional Sex: The term "love money" can conjure up ideas of transactional sex, perhaps because love may include sex. It may also include gifts to sexual partners not amounting to transactions, such as accepted social practices in some countries where it is the duty of boyfriends to offer money gifts for love to their girlfriends (Poulin 2007). It is clarified that even if such gifts could occasionally be used for entrepreneurship, this entry does not look into this area.

Angel Investors (Also Known as Business Angels): Angel investors are wealthy individuals who invest in risky projects of entrepreneurs in the early stages and often provide advice and social contacts. Their motives are largely economic although noneconomic motives may play a part (Riding 2008). It is clarified that the accepted notion of business angels excludes those belonging to family and friends (Ramadani 2009).

Reasons for Love Money

There are a number of reasons people would take money from family and friends to help finance their businesses. These include lower transaction costs, greater control over the business, desire to retain profits, too many strings attached to outside money, access to family resources, and failure to raise money from outside sources (Steier 2003).

The lower transaction costs are related to agency theory. The hiring of professional managers requires monitoring, and this imposes costs. If family members invest money, the trust which has already been built up allows for a reduction in monitoring costs.

The advantages of investing in family businesses include alignment of long-term interests of the family, lower monitoring costs, selfless rationalities inherent in family, and loyalty to the family. The disadvantages include conflict in private life affecting business, opportunities to engage in inefficient or slack behavior (free riding), limited talents of family members (compared to professional managers), and families have limits to growth if they rely only on supervision by family members (Steier 2003 cites Pollak 1985). This may lead to repaying family loans even if loans to all others are waived in bankruptcy.

Sociological and Anthropological Roots of Love Money

Consumption and Social Interaction

Love money has also been associated with the consumption of goods and services, most notably by Miller (2001). Consumption for Miller is a process where family members both seek to influence each other and create familial solidarity. This connection between social relations and economic transactions according to Zelizer (2005) is insufficiently understood partly due to the disciplinary tensions between economics and sociology. Drawing on the work of Biggart and Castanias (2001), Zelizer explores the "interplay" between economic exchange and social relations and highlights how social relations can predate economic exchange and therefore "can facilitate exchange", as well as acting as a means of managing risks (p. 337). This suggests that love money investment is a function of strong social bonds between family members owing to the concept that strong social relationships are important.

Social interactions do more than alter economic exchanges, they change the nature of the money itself. Zelizer (2005) details how household incomes are earmarked depending on both their source and use. For example, prostitutes will spend their earnings on drugs, drinks, and clothes, while simultaneously carefully guarding to ensure any family expenditure comes from income earned outside of prostitution. A similar process occurs in household production with members matching "meaningful relations with appropriate economic transactions and media" (2005, p. 242). Zelizer's concept of earmarking suggests a weakness in the existing literature on love money: we do not know enough about how money for investment is created, negotiated, and identified or the ongoing discussions after the decision has been made. Although Riding has helped provide an indication of the scale of the investment made and the respective failure rate, we still do not know, for example, whether the investing party simply lost their money due to business practices, or whether they wanted to withdraw it at an inopportune moment in the firm's development, or indeed whether intra-family disputes about the investment were the causal factor.

International Usage

Daphne Berdahl's (1999) study of an East German village demonstrated the bond between love money and personal relations. In a state where goods and services were difficult to access, both money and barter were used as a means to maintain relationships. It was the strength and breadth of these connections that enabled household members to access comparatively preferential treatment, but without gifts, barter and bribing relationships could not be used to access the informal economy.

Section 2: The Economics of Love Money Investments

The love money investors may be passive investors or active investors. The distinction is that active investors take part in the operations of the business in which they have invested. In a study in Canada, it was found that 29% are passive and 71% are active, and it was estimated that passive investors make losses 62% of the times while active investors make losses only 47% of the time (Riding 2008). Nevertheless, the size of the love money investor market is thrice the size of the business angel market which, in turn, is estimated to be twice the size of the formal venture capital market (Riding 2008). Earlier research indicates that for the 15 countries providing data, the informal market is 1.6 times the venture capital market, and almost half the market for informal investments is provided by family and over a third by neighbors and colleagues (Bygrave et al. 2003). Irrespective of the country differences and difficulties in estimation, this topic is clearly very important for entrepreneurs and researchers.

The motivations of family members investing in family businesses are twofold: one is the economic motive of earning money and the second is the nurturing motive of helping the family member grow (Steier 2003).

The governance and control mechanisms of family businesses therefore find a mix of market mechanisms (price), relational mechanisms (trust, altruism), and hierarchical elements (administration) (Steier 2003).

Drivers of Love Money Investment

Szerb et al. (2007) divide the informal investors in four components. They define classic love money as family with no ownership experience while they consider family with experience as kin money. Similarly, outsiders with no ownership experience are distinguished from business angels (who have ownership experience). They find that what drives informal investments of all four categories is personal context (knowing the entrepreneur, seeing the opportunity, skills, and fear of failure) rather than macroeconomic factors (economic development, start-up costs, taxation, education). Classic love money and nonowners help out in times of crisis, while kin money is more active in periods of growth. In developed countries, outside investment is more forthcoming. Foreign direct investment is negatively correlated with kin money.

Implications

There is little evidence about the extent of love money investment in SMEs, though work by Allan Riding (2005) for the Canadian government suggests that it stands at 11 billion Canadian dollars, which is three times the investment made by business angels. However, Riding found there was minimal evidence that love money investment was an effective means to capitalize new firms. When he produced further research in 2008, he found that not only do business angels secure better returns but that family and friends' investments perform dismally. Perhaps an explanation for the poor performance of love money, especially given that the financial cost of raising love money capital is likely to be cheaper than business angels, was contained in Schulze et al. (2001) who showed how owner-managers of small firms often create perverse agency problems, such as not hiring the best staff and being slow to react to market changes because of lack of independent investor demands. Equally, owner-investors allow nonpecuniary factors to shape their judgment, or they overinvest causing their children to free ride. Despite this, Kang (2000) points out that family investors can be more patient and wait longer for an economic return. According to Schulze et al. (2001), this is insufficient and suggests family firms should incorporate internal control mechanisms to minimize the possibility of the problems outlined above.

There are a number of difficulties that come into play in relation to love money.

Is It a Gift or an Investment?

If a parent provides love money to one child's enterprise, and the parent dies, is the money given a loan or investment, or is it a gift? Depending on the treatment, the succession rights of this child versus other inheritors would change (Steier 2003).

What Is a Fair Return on the Investment?

If the enterprise is successful and the entrepreneur repays the loan to his family, how should they decide on equity and in-kind help (sweat equity)? For example, some relatives may have provided a free place to stay; others may have spent time building morale. No matter how much the entrepreneur pays them for this, there may be unclear notions of expected returns (Steier 2003).

How to Get Informal Investors to Register

In many countries, investment can be sought from registered investors. Informal investors, such as love money investors and business angels, may not even be aware that they have to be registered (Riding 2008).

Involvement of Unsophisticated Investors

It is also possible that unsophisticated investors may provide less useful advice and unnecessary constraints that impede the business performance (Riding 2008).

Conclusions and Future Research Directions

Overall, we know that love money exists and that family and friends invest in business enterprises. We also know that the informal entrepreneurial investments are greater than other more formalized systems such as business angels or even venture capital. What remains uncertain is the breakdown between those who invest for altruistic reasons and those who invest for return on investment. Comparisons between love money and other form of business enterprise investment would provide useful insight into entrepreneurial finance.

Cross-References

▶ Angel Investors
▶ Microfinance and Entrepreneurship
▶ Venture Capital and Small Business

References

Berdahl D. Where the world ended: reunification and identity in the German borderland. Berkeley: University of California Press; 1999.

Bygrave W, Hay M, Ng E, Reynolds P. Executive forum: a study of informal investing in 29 nations composing the Global Entrepreneurship Monitor. Venture Capital. 2003;5(2):101.

Kang D. The impact of family ownership on performance in public organizations: a study of the U.S. Fortune 500, 1982–1994. 2000 Academy of management meetings, Toronto, 2000.

Lefton JA. Venture capital in Canada: focus on small and medium technology enterprises. 1998. From http://web.idrc.ca/en/ev-023027-201-1-DO_TOPIC.html. Accessed 2 Oct 2011.

Miller D. The dialectics of shopping. Chicago: Chicago University Press; 2001.

Pollak R. A transaction cost approach to families and households. Journal of Economic Literature. 1985;23(2):581–608.

Poulin M. Sex, money, and premarital partnerships in southern Malawi. Soc Sci Med. 2007;65(11):2383–93.

Ramadani V. Business angels: who they really are. Strat Change. 2009;18(7/8):249–58.

Riding A. Estimating informal investment in Canada. Ottawa: Small Business Policy Branch Industry Canada; 2005.

Riding AL. Business angels and love money investors: segments of the informal market for risk capital. Venture Cap. 2008;10(4):355–69.

Schulze W, Lubatkin MH, Dino RN, Buchholtz AK. Agency relationships in family firms: theory and evidence. Org Sci. 2001;12(2):99–116.

Steier L. Variants of agency contracts in family-financed ventures as a continuum of familial altruistic and market rationalities. J Bus Venture. 2003;18(5):597–618.
Szerb L, Terjesen S, Rappai G. Seeding new ventures – green thumbs and fertile fields: Individual and environmental drivers of informal investment. Venture Cap. 2007;9(4): 257–84.
Thankur SP. Size of investment, opportunity choice and human resources in new venture growth: Some typologies. J Bus Venture. 1999;14(3):283–309.
Zelizer VA. The purchase of intimacy. Princeton: Princeton University Press; 2005.

Low- to Mid-Tech SMEs

▶ Low-Tech Entrepreneurship

Low-R&D-Intensity Entrepreneurship

▶ Low-Tech Entrepreneurship

Low-Tech Entrepreneurship

Sophie Reboud[1,2] and Mazzarol Tim[3]
[1]UWA Western Australia
[2]Groupe ESC Dijon Bourgogne, Burgundy School of Business, Dijon, France
[3]UWA Business School, Crawley, WA, Australia

Synonyms

Low- to mid-tech SMEs; Low-R&D-intensity entrepreneurship; Low-tech small firms; Non-research-intensive entrepreneurship

Definition and Issues at Stake

The Organisation for Economic Co-operation and Development (OECD) classifies a high-technology industry as one in which the level of research and development (R&D) intensity (a measure of the proportion of annual turnover invested in R&D) is greater than 5 %. By contrast, low-tech firms have an R&D intensity of less than 3 %, while mid-tech firms have an R&D intensity of between 3 and 5 % (Bender et al. 2005; Hirsch-Kreinsen et al. 2008). A large proportion of industries are low to mid tech, including motor vehicle manufacturing, pharmaceuticals, aerospace and electronics industries, food processing, printing, furniture manufacturing, household appliances, and plastics (Hirsch-Kreinsen et al. 2006). The vast majority of small firms all around the world are active in low- to mid-tech industries.

From the Literature

Previous findings suggest that significant differences exist between the low-R&D firms and their high-R&D counterparts in relation to the number and type of innovations generated and how such firms manage the process of commercialization (Mazzarol et al. 2011).

As small firms are different from large firms in the way they operate and are managed (Welsh and White 1981; Gibb and Scott 1985; D'Amboise and Muldowney 1988; Julien 1993; Torrès 1997), it is not surprising to find that they have different approaches to their innovation processes. Limited scale and resources encourage small firms to adopt more informal processes for organizing their activities, utilizing personal ties and social networks, and taking advice from nontraditional sources such as friends who are also in business (see ▶ Network and Entrepreneurship and ▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)). This seems particularly true in low-to mid-tech sectors.

Studies of small to medium enterprise (SME) manufacturing firms suggest that innovation is a necessary but not sufficient prerequisite for competitive performance (Liao and Rice 2010). Such SMEs appear to gain from having clear innovation strategies and formal structures for commercialization (see ▶ Innovation Opportunities and Business Start-up; Terziovski 2010). Yet differences appear to exist between low-tech firms and those with higher levels of investment in R&D. The mid- to high-tech manufacturers seem to get more benefit from R&D investment that is directed toward product development, while the low-tech firms get benefits from investment in product development process innovations (see ▶ Product Innovation, Process Innovation). These are innovations relating not to the creation of new products but of processes (e.g., computer-aided design (CAD) systems) that can assist them to produce their existing products more flexibly and faster (Raymond and St-Pierre 2010).

Importance and Issues at Stake

Despite the relative importance of low- to mid-tech firms, much of the focus of government policy within what is often called the national innovation system (NIS) (see ▶ National Innovation Systems (NIS); Lundvall 2007) is upon high-tech industries or what has been referred to as "the Silicon Valley business model" (see ▶ Business Model; Cohen 2010; OECD 2010). While much of the traditional work on innovation has focused on technological R&D-driven inventions, and this type of work continues to be prioritized by government R&D investment policies, there has been increasing recognition that innovation needs to be considered with a much wider lens (see, e.g., Godet et al. 2010). More and more studies show that the traditional high-tech "Silicon Valley" venture capital-funded business model is not the only approach adopted by small firms seeking to innovate and many small innovative firms are growing without major external funding (see ▶ Venture Capital and Small Business; Maskell 1998; Von Tunzelmann and Acha 2006). Results on this matter are an important finding as they signal the importance of other models of innovation for small firms. Indeed, there is a strong case for "ordinary SMEs" to innovate with more modest, self-funded innovations and still make a sound contribution to the national economy.

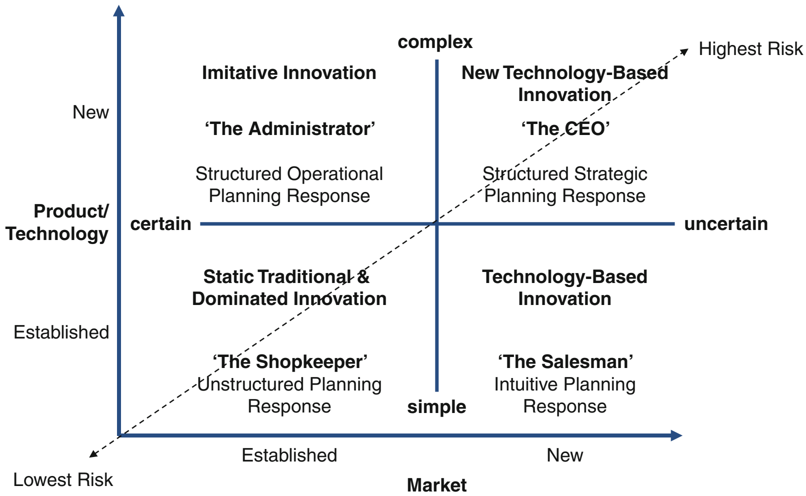
What is important from both research and policy perspectives is that significant innovations can occur throughout the value chain and may involve collaboration with other parties. This is particularly relevant for innovation processes in small firms. The ability of many small firms to successfully engage in innovation and commercialization is often restricted by their lack of resources, weak or unsystematic marketing and management competencies, and inadequate use of appropriate third-party advisors (Adams 1982; Vermeulen 2005). Yet findings demonstrate that small firms can be active innovators (see ▶ Innovator) in spite of their limited scale and resources.

High- and Low-R&D-Intensity SMEs: Organizational Configuration for Innovation

Tidd (2001) observed that despite several decades of research into the management of innovation, there remained no clear or consistent findings or even a coherent set of advice for managers. He proposed a matrix model comprising four quadrants that were defined by the two primary dimensions of uncertainty and complexity. The four organizational structures (see ▶ Entrepreneurial Organizations) that emerged from this framework were:

- *Differentiated* (low uncertainty and low complexity): The key competitive advantage comes from product and service differentiation, marketing competence, and the formation of a structure that is focused on product or market divisions.
- *Innovative* (high uncertainty and low complexity): Here the key competencies required are scientific or technological in nature, and organizational structure is likely to be functional.
- *Networked* (low uncertainty and high complexity): This requires competence in project management and organizational structure focusing on professional skills and knowledge.
- *Complex* (high uncertainty and high complexity): This requires a range of competencies as well as adaptive learning.

Mazzarol and Reboud (2009) developed this complexity–uncertainty trade-off into a model of strategic innovation management which is illustrated in Fig. 1. As shown in the figure, there are four strategic planning responses depending on



Low-Tech Entrepreneurship, Fig. 1 A model of strategic innovation management (Source: Mazzarol and Reboud 2009)

the uncertainty found within the market and the level of complexity found within the product technology. Simple innovations with low levels of complexity that are being commercialized within markets that are stable and certain are what have been referred to as static traditional or dominated (Rizzoni 1991). This type of planning response is what Mazzarol and Reboud (2009) refer to as "the shopkeeper" and is one that involves a relatively unstructured planning response with low levels of formality.

By contrast, the high-risk, disruptive innovation that is associated with new technologies requires a structured strategic planning response, or what is described as "the chief executive officer (CEO)." In situations in which the technology is already well established but the market environment is uncertain require the planning response of "the salesman," which is typically that of a less formal, more intuitive approach, while the new technological innovation that requires high levels of complexity in its development, but is to be commercialized into a market that is certain, requires the planning response described as that of "the administrator." This is formal and structured, but of an operational not a strategic nature (Mazzarol and Reboud 2009).

This model proposes that there is an interrelationship between the type of innovation that is being commercialized, the nature of its target market environment, and the type of planning response that is optimal for these conditions. It is consistent with the framework proposed by Tidd (2001), and, as discussed below, it provides a conceptual basis for understanding the notion of low-tech entrepreneurship.

The Issue of Innovation Measure

Noting that although innovation is supposed to take several forms (including organization innovation, e.g., see the Oslo Manuel (OECD 2005)), it is almost always measured based on product innovation only; other authors (e.g., Raymond and St-Pierre 2010) propose to encompass other forms of innovation like process innovation. As they state: "*While having been the object of numerous studies, the link between R&D activities and innovation in SMEs still requires clarification and further understanding*." They argue that taking into account process innovation, even not giving a perfect picture of all innovative activities in a firm, improves the view of the amount of innovation produced by SMEs (see ▶ Measuring Organizational Climate for Creativity and Innovation).

Studying creative industries, where lots of SMEs are highly innovative, Lindman, Scozzi, and Otero-Neira (2008) give also elements indicating a high level of non-technological innovation in small firms especially based on innovations in design.

Another proposition aiming at capturing other forms of innovation carried out by small firms is proposed by Teixeira, Santos, and Oliveira Brochado (2008). They analyze collaboration based on R&D between small firms and show that lots of SMEs in low-tech sectors develop relationships based on R&D and innovation. It gives also a view that proximity (both geographic and cultural) has a strong influence on the level of formalization and sophistication of the R&D involved in such partnerships.

Size and R&D Intensity and Consequences on Management and Strategy

In a study of innovation practices within small firms from eleven OECD countries, a size effect was found in relation to R&D intensity (Mazzarol and Reboud 2011). Micro and small firms were identified as having higher R&D intensity ratios than their medium to large counterparts. This suggests that as the business matures, it is more likely to focus on consolidation of existing products within established markets than trying to launch new products into new markets. Funding for innovation was in this case largely derived from retained profits with little interest shown in equity financing. However, equity financing and venture capital were more likely to be of interest to firms with high R&D intensity. Compared with their low-R&D-intensive counterparts, the high-R&D-intensive businesses were more likely to feel that the generation of new products and innovations were a major focus for their firm. They were also more likely to involve customers in the development of the innovation and to have a formal new product development (NPD) process in place. Such firms were likely to be focused in their NPD process on technological product innovations as a primary area of attention, followed by market development innovations as a secondary priority. By contrast, the low-R&D-intensive firms were more likely to be engaged in the development of technological process innovations. This finding is consistent with the research of Raymond and St-Pierre (2010) who examined manufacturing firms.

While these high-R&D-intensive firms were found across all industry sectors and throughout all the countries from which the study was drawn, it was more likely to find them in nontraditional industries such as Information and Communication Technologies (ICT) or biotech rather than manufacturing, services, or retailing. However, it is not suggested that R&D intensity, and with it innovation management formality, is restricted only to these more “high-tech” sectors. These findings are consistent with those of Covin and Prescott (1990) who found that low-tech product innovators differed from their high-tech counterparts in terms of their structure, market orientation, and need for external financing. High-tech firms were more focused on building their market share and had a greater need for external financing. As found by Terziovski (2010), formalization in the innovation management process and the organizational structure associated with it is likely to be rewarded with superior performance.

Managerial Competence

In high-tech fields such as biotech, there is a need for senior management teams to comprise a balance between scientific, technical areas and financial and marketing skills (Sardana and Scott-Kemmis 2010). However, while such a balance of competencies is clearly valuable in all industries, it may be less common in micro firms in low-tech sectors (Maskell 1998).

Nonetheless the success of new ventures in low-tech sectors can rely heavily on the capacity of adaption and anticipation of their managers (Evers 2011; see ► Entrepreneurial Capability and Leadership).

Effectuation Style Decision Making

Several studies provide evidence to support the decision-making principles used by entrepreneurs in situations of uncertainty called effectuation Sarasvathy (2001); Read and Sarasvathy (2005). Small low-tech firms are engaged in a view of the future where they were seeking support and precommitments from customers. The basis for taking action toward the commercialization of these innovations is often intuitive.

This is also true when seeking to internationalize their activity (Andersson 2011).

This suggests managers of small innovative firms demonstrate a willingness to take on new innovation and its unexpected outcomes. Furthermore, as discussed by Gibb and Scott (1985), the strategic awareness and personal commitment of the managers are vital for small firms to achieve their objectives for product and market development.

Conclusion and Future Directions

A Lower Public Support

Due to a number of reasons, from the difficulties of measuring innovation to the lower visibility of more incremental innovation, low-tech entrepreneurship and the innovative activity of low-tech SMEs are often underestimated. Even if a huge part of the economic activity is carried out by small low-tech firms all over the world, high-tech ventures are more visible and more supported by governments. Studying the situation in Austria, Radauer and Streicher (2007) note, for example, "*that Low-Tech SMEs are actually more innovative than commonly thought and that supporting these industries might yield positive effects. The Austrian innovation system is diversified, yet programmes that aim at low to mid tech (LMT) innovations are scarce*" (p. 247).

The Importance of the SME Ordinaire

Few taxonomy have focused on innovation within small firms. Rizzoni (1991) offered six types, and, as discussed above, Tidd (2001) and Mazzarol and Reboud (2009) have offered four types. Jones-Evans (1995) sought to classify entrepreneurs from technology-based firms into four types known as "researcher," "producer," "user," and "producer" with some subcategories. Autio and Lumme (1998) also proposed a four-part typology for new technology-based firms that included (a) "application," (b) "market," (c) "technology," and (d) "paradigm" innovators.

However, this does not address innovation directly. Although there is the classification of low-, mid-, and high-tech firms based on the proportion of annual turnover invested in R&D, it remains linked to technology-based ventures.

More and more studies suggest that there is a high level of innovation activity taking place among small firms that may not be gazelles or associated with traditional high-technology sectors. As a benchmark of innovation activity, the level of "R&D intensity" is a potentially better measure for differentiating firms, although to classify high- and low-R&D-intensity firms into high or low technology was not strictly correct. It seems therefore that more work needs to be done to develop a robust and universally applicable taxonomy for small firms engaged in innovation. A first attempt in that direction would be to use a two-part taxonomy in which firms are classified into what could be described as "*SME Ordinaire*" and "*SME Entrepreneuriale*." The first group comprises the vast majority of small firms that are capable of innovation but not necessarily strongly focused on growth or engaged in high technology. They do not conform to the "Silicon Valley business model" that has captured so much attention in recent decades. The second group is more the "growth-focused, venture capital-seeking business" that is likely to be, although not necessarily, technology-based.

These two types of firm should not be viewed as two ultimate choices. They are not mutually exclusive constructs. It is more appropriate to view them as the end points of a continuum and perhaps to be strategic choices that an entrepreneur or small business owner–manager can select from at given points in time. For example, as Mazzarol and Reboud (2009) suggest that the choice of a "shopkeeper," "salesman," "administrator," or "CEO" strategic planning response is contingent on the level of uncertainty and complexity facing the firm's management team and the type of innovation they are seeking to commercialize. In the early years after establishment, it is to be expected that a firm might be quite entrepreneurial as it seeks to find its market niche. However, once it matures and enjoys stability, the focus may return toward the *SME Ordinaire* behavior. More work is needed to fully develop this understanding, but it is clear that there must be greater recognition of the *SME Ordinaire* within academic and policy circles.

References

Adams A. Barriers to product innovation in small firms: policy implications. Int Small Bus J. 1982; 1(1):67–86.

Andersson S. International entrepreneurship, born globals and the theory of effectuation. J Small Bus Enterp Dev. 2011;18(3):627–43.

Autio E, Lumme A. Does the innovator role affect the perceived potential for growth? Analysis of four types of new, technology-based firms. Technol Anal Strateg Manage. 1998;10(1):41–54.

Bender G, Jacobson D, Robertson P, editors. Non-research-intensive industries in the knowledge economy, special issue of perspectives on economic, political and social integration. Lublin: Catholic University; 2005.

Cohen S. The role of small and medium-size firms in innovation. Paper prepared for the OECD LEED Program. Paris: OECD; 2010

Covin JG, Prescott JE. Strategies, styles, and structures of small product innovative firms in high and low technology industries. J High Technol Manage Res. 1990;1(1):39–56.

D'Amboise G, Muldowney M. Management theory for small business: Attempts and requirements. Acad Manage Rev. 1988;13(2):226–40.

Evers N. International new ventures in "low tech" sectors: a dynamic capabilities perspective. J Small Bus Enterp Dev. 2011;18(3):502–28.

Gibb A, Scott M. Strategic awareness, personal commitment and the process of planning in the small business. J Manage Stud. 1985;22(6):597–631.

Godet M, Durance P, Mousli M. In: CAE, editors. Créativité et innovation dans les territoires. Paris: Conseil d'Analyse Economique – DATAR – Académie des Technologies; 2010

Hirsch-Kreinsen H, Hahn K, Jacobson D. The low-tech issue. In: Hirsch-Kreinsen H, Jacobson D, editors. Innovation in low-tech firms and industries. Cheltenham\Northampton: Edward Elgar; 2008. p. 3–22.

Hirsch-Kreinsen H, Jacobson D, Robertson PL. 'Low-tech' industries: innovativeness and development perspectives—a summary of a european research project. Prometheus. 2006;24(1):3–21.

Jones-Evans D. A typology of technology-based entrepreneurs – a model based on previous occupational background. Int J Entrep Behav Res. 1995;1(1):26–47.

Julien PA. Small businesses as a research subject: some reflections on knowledge of small businesses and its effects on economic theory. Small Bus Econ. 1993;5:157–66.

Liao T-S, Rice J. Innovation investments, market engagement and financial performance: a study among Australian manufacturing SMEs. Res Policy. 2010;39(1):117–25.

Lindman M, Scozzi B, Otero-Neira C. Low-tech, small- and medium-sized enterprises and the practice of new product development: an international comparison. Eur Bus Rev. 2008;20(1):51–72.

Lundvall B-Å. National innovation systems—analytical concept and development tool. Ind Innov. 2007; 14(1):95–119.

Maskell P. Low-tech competitive advantages and the role of proximity. Eur Urban Reg Stud. 1998; 5(2):99–118.

Mazzarol T, Clark D, Reboud S. Chapter 14. Conclusions and lessons learnt. In: Mazzarol T, Reboud S, editors. Strategic innovation in small firms. Cheltenham: Edward Elgar; 2011. p. 395–435.

Mazzarol T, Reboud S. The strategy of small firms, strategic management and innovation in the small firm. Cheltenham, UK: Edward Elgar Publishing; 2009.

Mazzarol T, Reboud S, editors. Strategic innovation in small firms, an international analysis of innovation and strategic decision making in small to medium enterprises. Cheltenham, UK: Edward Elgar; 2011.

OECD. Oslo manual: guidelines for collecting and interpreting technological innovation data. 3rd ed. Oslo: Organisation of Economic Co-operation and Development, European Union, Eurostat; 2005.

OECD. SMEs, entrepreneurship and innovation. Paris: OECD (Organisation for Economic Co-Operation Development); 2010.

Radauer A, Streicher J. Low-tech, innovation and state aid: the Austrian case. Int Entrep Manage J. 2007;3(3):247–61.

Raymond L, St-Pierre J. R&D as a determinant of innovation in manufacturing SMEs: an attempt at empirical clarification. Technovation. 2010;30(1): 48–56.

Read S, Sarasvathy SD. Knowing what to do and doing what you know – effectuation as a form of entrepreneurial expertise. J Priv Equity. 2005; 9(1):45–62.

Rizzoni A. Technological innovation and small firms: a taxonomy. Int Small Bus J. 1991;9(3):31–42.

Sarasvathy SD. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. Acad Manage Rev. 2001;26(2):243–63.

Sardana D, Scott-Kemmis D. Who learns what?—a study based on entrepreneurs from biotechnology new ventures. J Small Bus Manage. 2010;48(3): 441–68.

Teixeira AAC, Santos P, Oliveira Brochado A. International R&D cooperation between low-tech SMEs: the role of cultural and geographical proximity. Eur Plann Stud. 2008;16(6):785–810.

Terziovski M. Innovation practice and its performance implications in small and medium enterprises (SMEs) in the manufacturing sector: a resource-based view. Strateg Manage J. 2010;31(8):892–902.
Tidd J. Innovation management in context: environment, organization and performance. Int J Manage Rev. 2001;3(3):169–83.
Torrès O. Pour une approche contingente de la spécificité de la PME. Revue Int PME. 1997; 10(2):9–43.
Vermeulen PAM. Uncovering barriers to complex incremental product innovation in small and medium-sized financial services firms. J Small Bus Manage. 2005;43(4):432–52.
Von Tunzelmann N, Acha V. Innovation in “low-tech” industries. In: Fagerberg J, Mowery DC, Nelson RR, editors. The Oxford handbook of innovation. Oxford: Owford University Press; 2006. p. 407–32.
Welsh JA, White JF. A small business is not a little big business. Harv Bus Rev. 1981;59(4):18–32.

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Mathematical Creativity

► Mathematical Discovery

Mathematical Discovery

Peter Liljedahl and Darien Allan
Faculty of Education, Simon Fraser University, Burnaby, BC, Canada

Synonyms

Mathematical creativity

Introduction

What is the genesis of mathematics? What mechanisms govern the acts of mathematical discovery, invention, and creativity?

> The genesis of mathematical creation is a problem which should intensely interest the psychologist. It is the activity in which the human mind seems to take the least from the outside world, in which it acts or seems to act only of itself and on itself, so that in studying the procedure of geometric thought we may hope to reach what is most essential in man's mind. (Poincaré 1952)

There are two theories regarding the origins of mathematics (Hersh 1997). The first theory, attributed to Plato, states that mathematics exists independent of man's involvement in the field. As such, mathematical knowledge is "discovered," much in the same way knowledge about the natural world is discovered. The second theory, referred to as the "formalist theory," poses that mathematics is a construct of mankind, a product of human thinking. In this case, new knowledge in mathematics is "invented," much like new technology is invented. Although some mathematicians cling to one or the other of these theories as being the truth concerning the nature of mathematics and its origins, many find a middle ground that combines attributes of both. To see how these two extremes, along with the middle ground play out in practical terms, consider the example of the infinitude of prime numbers. A platonist would argue that the prime numbers existed independent and prior to us and that they existed in infinitude. Humans merely discovered them. A formalist would argue that prime numbers exist because they were defined as such. One possible middle ground between these two views is that the numbers themselves were invented (or defined) but the property that some numbers are prime was discovered, as was the fact that there is an infinite number of prime numbers. That is, mathematics is created by humans but does not bend to the will of humans (Stewart 2006).

This example highlights how it might be possible to draw a distinction between the usage of *invented* and *discovered*. In an attempt to draw further distinction, it can be suggested that mathematics is *invented* when someone deliberately and willfully creates something new, even if it is only new to that one individual. On the other hand, mathematics is *discovered* if by some mechanism a mathematical property emerges out of some already existing mathematical object (numeric, algebraic, geometric, or otherwise). So, for example, Napier invented logarithms, while Fermat discovered the theorem that bears his name. However, when definitions (which are invented) and properties (which are discovered) become conflated, this distinction becomes convoluted. Hadamard (1945) offers an anecdote that nicely explains this conflation.

> Such distinction has proved less evident than appears at first glance. Toricelli has observed that when one inverts a closed tube on the mercury trough, the mercury ascends to a certain determined height: this is a discovery; but, in doing this, he has invented the barometer; and there are plenty of examples of scientific results which are just as much discoveries as inventions. Franklin's invention of the lightning rod is hardly different from his discovery of the electric nature of thunder. (p. xvii)

Hadamard goes on to state that because of this inability to make a clear distinction between discovery and invention, he will not concern himself with it and will, instead, treat them equally. Furthermore, he states that the "psychological conditions are quite the same for both cases" (p. xvii). For these very same reasons, the phenomena of discovery and invention will be treated here without distinction.

A further conflation that the above example (and, indeed, the first paragraphs) exemplifies is the role of *creativity* within the phenomena of discovery and invention. As will be seen in the pages to come, creativity is an aspect of discovery and invention that is often indistinguishable and inseparable from either discovery or invention. As such, these terms will be used interchangeably throughout this entry but at some points will be treated in isolation.

History

In 1902, the first half of what eventually came to be a 30-question survey was published in the pages of *L'Enseignement Mathématique*, the journal of the French Mathematical Society. Édouard Claparède and Théodore Flournoy, two French psychologists, who were deeply interested in the topics of mathematical discovery, creativity, and invention, authored the survey. Their hope was that a widespread appeal to mathematicians at large would incite enough responses for them to begin to formulate some theories about this topic. The first half of the survey centered on the reasons for becoming a mathematician (family history, educational influences, social environment, etc.), attitudes about everyday life, and hobbies. This was eventually followed up, in 1904, by the publication of the second half of the survey pertaining, in particular, to mental images during periods of creative work. The responses were sorted according to nationality and published in 1908.

During this same period, Henri Poincaré (1854–1912), one of the most noteworthy mathematicians of the time, had already laid much of the groundwork for his own pursuit of this same topic and in 1908 gave a presentation to the French Psychological Society in Paris entitled *L'Invention mathématique* – often mistranslated to Mathematical Creativity (c.f. Poincaré 1952). At the time of the presentation, Poincaré stated that he was aware of Claparède and Flournoy's work, as well as their results, but expressed that they would only confirm his own findings. This presentation, as well as the essay it spawned, stands to this day as one of the most insightful and thorough treatments of the topic of mathematical discovery, creativity, and invention.

> Just at this time, I left Caen, where I was living, to go on a geological excursion under the auspices of the School of Mines. The incident of the travel made me forget my mathematical work. Having reached Coutances, we entered an omnibus to go some place or other. At the moment when I put my foot on the step, the idea came to me, without anything in my former thoughts seeming to have paved the way for it, that the transformations I had used to define the Fuschian functions were identical with those of non-Euclidean geometry. I did not verify the idea; I should not have had the time, as, upon taking my seat in the omnibus, I went on with the conversation already commenced, but I felt a perfect certainty. On my return to Caen, for conscience' sake, I verified the results at my leisure. (Poincaré 1952)

So powerful was his presentation, and so deep were his insights into his acts of invention and discovery that it could be said that he not so much described the characteristics of mathematical creativity, as defined them. From that point forth, mathematical creativity, or even creativity in general, has not been discussed seriously without mention of Poincaré's name.

Inspired by this presentation, Jacques Hadamard (1865–1963), a contemporary and a friend of Poincaré's, began his own empirical investigation into this fascinating phenomenon. Hadamard had been critical of Claparède and Flournoy's work in that they had not adequately treated the topic on two fronts. As exhaustive as the survey appeared to be, Hadamard felt that it failed to ask some key questions – the most important of which was with regard to the reason for failures in the creation of mathematics. This seemingly innocuous oversight, however, led directly to his second and "most important criticism" (Hadamard 1945). He felt that only "first-rate men would dare to speak of" (p. 10) such failures. So, inspired by his good friend Poincaré's treatment of the subject, Hadamard retooled the survey and gave it to friends of his for consideration – mathematicians such as Henri

Poincaré and Albert Einstein, whose prominence were beyond reproach. Ironically, the new survey did not contain any questions that explicitly dealt with failure. In 1943, Hadamard gave a series of lectures on mathematical invention at the École Libre des Hautes Études in New York City. These talks were subsequently published as *The Psychology of Mathematical Invention in the Mathematical Field* [51].

Hadamard's classic work treats the subject of invention at the crossroads of mathematics and psychology. It provides not only an entertaining look at the eccentric nature of mathematicians and their rituals but also outlines the beliefs of mid-twentieth-century mathematicians about the means by which they arrive at new mathematics. It is an extensive exploration and extended argument for the existence of unconscious mental processes. In essence, Hadamard took the ideas that Poincaré had posed and, borrowing a conceptual framework for the characterization of the creative process from the Gestaltists of the time (Wallas 1926), turned them into a stage theory. This theory still stands as the most viable and reasonable description of the process of mathematical invention.

Defining Discovery and Invention

The phenomena of mathematical discovery and invention, although marked by sudden illumination, actually consist of four separate stages stretched out over time, of which illumination is but one stage. These stages are initiation, incubation, illumination, and verification (Hadamard 1945). The first of these stages, the *initiation* phase, consists of deliberate and conscious work. This would constitute a person's voluntary, and seemingly fruitless, engagement with a problem and be characterized by an attempt to solve the problem by trolling through a repertoire of past experiences. This is an important part of the inventive process because it creates the tension of unresolved effort that sets up the conditions necessary for the ensuing emotional release at the moment of illumination (Hadamard 1945; Poincaré 1952).

Following the initiation stage, the solver, unable to come up with a solution, stops working on the problem at a conscious level and begins to work on it at an unconscious level (Hadamard 1945; Poincaré 1952). This is referred to as the *incubation* stage of the inventive process and can last anywhere from several minutes to several years. After the period of incubation, a rapid coming to mind of a solution, referred to as *illumination*, may occur. This is accompanied by a feeling of certainty and positive emotions (Poincaré 1952). Although the processes of incubation and illumination are shrouded behind the veil of the unconscious, there are a number of things that can be deduced about them. First and foremost is the fact that unconscious work does, indeed, occur. Poincaré (1952), as well as Hadamard (1945), used the very real experience of illumination, a phenomenon that cannot be denied, as evidence of unconscious work, the fruits of which appear in the flash of illumination. No other theory seems viable in explaining the sudden appearance of solution during a walk, a shower, a conversation, upon waking, or at the instance of turning the conscious mind back to the problem after a period of rest (Poincaré 1952). Also deducible is that unconscious work is inextricably linked to the conscious and intentional effort that precedes it.

> There is another remark to be made about the conditions of this unconscious work: it is possible, and of a certainty it is only fruitful, if it is on the one hand preceded and on the other hand followed by a period of conscious work. These sudden inspirations never happen except after some days of voluntary effort which has appeared absolutely fruitless and whence nothing good seems to have come . . .. (Poincaré 1952)

Hence, the fruitless efforts of the initiation phase are only seemingly so. They not only set up the aforementioned tension responsible for the emotional release at the time of illumination but also create the conditions necessary for the process to enter into the incubation phase.

Illumination is the manifestation of a bridging that occurs between the unconscious mind and the conscious mind (Poincaré 1952), a coming to (conscious) mind of an idea or solution. What brings the idea forward to consciousness is unclear, however. There are theories of the aesthetic qualities of the idea, effective surprise/shock of recognition, fluency of processing, or breaking functional fixedness. For reasons of brevity, this entry will only expand on the first of these.

Poincaré proposed that ideas that were stimulated during initiation remained stimulated during incubation. However, freed from the constraints of conscious thought and deliberate calculation, these ideas would begin to come together in rapid and random unions so that "their mutual impacts may produce new combinations" (Poincaré 1952). These new combinations, or ideas, would then be evaluated for viability using an aesthetic sieve, which allows through to the conscious mind only the "right combinations" (Poincaré 1952). It is important to note, however, that good or aesthetic does not necessarily mean correct. Correctness is evaluated during the *verification* stage.

The purpose of verification is not only to check for correctness. It is also a method by which the solver reengages with the problem at the level of details. That is, during the unconscious work, the problem is engaged with at the level of ideas and concepts. During verification, the solver can examine these ideas in closer details. Poincaré succinctly describes both of these purposes.

> As for the calculations, themselves, they must be made in the second period of conscious work, that which follows the inspiration, that in which one verifies the results of this inspiration and deduces their consequences. (Poincaré 1952)

Aside from presenting this aforementioned theory on invention, Hadamard also engaged in a far-reaching discussion on a number of interesting, and sometimes quirky, aspects of invention and discovery that he had culled from the results of his empirical study as well as from pertinent literature. This discussion was nicely summarized by James Newman (2000) in his commentary on the elusiveness of invention.

> The celebrated phrenologist Gall said mathematical ability showed itself in a bump on the head, the location of which he specified. The psychologist Souriau, we are told, maintained that invention occurs by "pure chance", a valuable theory. It is often suggested that creative ideas are conjured up in "mathematical dreams", but this attractive hypothesis has not been verified. Hadamard reports that mathematicians were asked whether "noises" or "meteorological circumstances" helped or hindered research [. . .] Claude Bernard, the great physiologist, said that in order to invent "one must think aside". Hadamard says this is a profound insight he also considers whether scientific invention may perhaps be improved by standing or sitting or by taking two baths in a row. Helmholtz and Poincaré worked sitting at a table; Hadamard's practice is to pace the room ("Legs are the wheels of thought", said Emile Angier); the chemist J. Teeple was the two-bath man. (p. 2039)

Given the formalist nature of mathematics discussed earlier, it should be mentioned that invention and discovery are not "part of the theories of logical forms" (Dewey 1938). They are extralogical. That is, discovery and invention are not representative of the lockstep logic and deductive reasoning that mathematics is often presumed to embody. Invention and discovery are part of a cohort of extralogical processes that includes creativity, intuition, and imagination.

Approaches to Creativity

The four stages of mathematical discovery and invention described above and characterized in Hadamard's seminal work were not original to Hadamard. A psychologist by the name of Wallas (1926) used the same characterization to describe the general creative process about 20 years prior to Hadamard's work. Because of this close relationship between the three phenomena (invention, discovery, and creativity), the body of literature on creativity is one that cannot be ignored. Aside from offering a variety of examples of invention and discovery, this literature also contributes to the construction of a better understanding of the phenomena through three distinct academic discourses: the focus on product, process, and person. This is not to say that there exist only three discourses but rather that this entry focuses on only three discourses. A brief synopsis of each of these discourses follows.

"Creativity" is a term that can be used both loosely and precisely. That is, while there exists a common usage of the term, there also exists a tradition of academic discourse on the subject. A common usage of "creative" refers to a process or a person whose products are original, novel, unusual, or even abnormal (Csikszentmihalyi 1996). In such a usage, creativity is assessed on the basis of the external and observable products of the process, the process by which the product comes to be or on the character traits of the person doing the "creating." Each of these usages is the roots of the discourses that we present here, the first of which concerns products.

Consider a mother who states that her daughter is creative because she drew an original picture. The basis of such a statement can lie either in the fact that the picture is unlike any the mother has ever seen or unlike any her daughter has ever drawn before. This mother is assessing creativity on the basis of what her daughter has produced. However, the standards that form the basis of her assessment are neither consistent nor stringent. There does not exist a universal agreement as to what she is comparing the picture to (pictures by other children or other pictures by the same child). Likewise, there is no standard by which the actual quality of the picture is measured. The academic discourse that concerns assessment of products, on the other hand, is both consistent and stringent (Csikszentmihalyi 1996). This discourse concerns itself more with a fifth, and as yet unmentioned, stage of the creative process: *elaboration*. Elaboration is where inspiration becomes perspiration (Csikszentmihalyi 1996). It is the act of turning a good idea into a finished product, and the finished product is ultimately what determines the "creativity" of the process that spawned it; that is, it cannot be a creative process if nothing is created. In particular, this discourse demands that the product be assessed against other products within its field, by the members of that field, to determine if it is original and useful. If it is, then the product is deemed to be creative. Note that such a use of assessment of end product pays very little attention to the actual process that brings this product forth.

The second discourse to be discussed concerns the creative process. The literature pertaining to this can be separated into two categories, a prescriptive discussion of the creativity process and a descriptive discussion of the creativity process. Although both of these discussions have their roots in the four stages that Wallas (1926) proposed makes up the creative process, they make use of these stages in very different ways. The prescriptive discussion of the creative process is primarily focused on the first of the four stages, *initiation*, and is best summarized as a *cause-and-effect* discussion of creativity, where the thinking processes during the initiation stage are the *cause* and the creative outcome is the *effect* (Ghiselin 1952). Some of the literature claims that the seeds of creativity lie in being able to think about a problem or situation analogically. Other literature claims that utilizing specific thinking tools such as imagination, empathy, and embodiment will lead to creative products. In all of these cases, the underlying theory is that the eventual presentation of a creative idea will be precipitated by the conscious and deliberate efforts during the initiation stage. On the other hand, the literature pertaining to a descriptive discussion of the creative process is inclusive of all four stages (Kneller 1965; Koestler 1964). For example, Csikszentmihalyi (1996), in his work on "flow," attends to each of the stages, with much attention paid to the fluid area between conscious and unconscious work, or initiation and incubation. His claim is that the creative process is intimately connected to the enjoyment that exists during times of sincere and consuming engagement with a situation, the conditions of which he describes in great detail.

The third, and final, discourse on creativity pertains to the person. This discourse is dominated by two distinct characteristics: habit and genius. Habit has to do with the personal habits as well as the habits of mind of people that have been deemed to be creative. However, creative people are most easily identified through their reputation for genius. Consequently, this discourse is often dominated by the analyses of the habits of geniuses as is seen in the work of Ghiselin (1952), Koestler (1964), and Kneller (1965) who draw on historical personalities such as Albert Einstein, Henri Poincaré, Vincent Van Gogh, D. H. Lawrence, Samuel Taylor Coleridge, Igor Stravinsky, and Wolfgang Amadeus Mozart, to name a few. The result of this sort of treatment is that creative acts are viewed as rare mental feats, which are produced by extraordinary individuals who use extraordinary thought processes.

These different discourses on creativity can be summed up in a tension between absolutist and relativist perspectives on creativity. An absolutist perspective assumes that creative processes are the domain of genius and are present only as precursors to the creation of remarkably useful and universally novel products. The relativist perspective, on the other hand, allows for every individual to have moments of creativity that may, or may not, result in the creation of a product that may, or may not, be either useful or novel.

> Between the work of a student who tries to solve a problem in geometry or algebra and a work of invention, one can say there is only a difference of degree. (Hadamard 1945)

Conclusion and Future Directions

Mathematical discovery, invention, and creativity are remarkably complex concepts which are intricately woven together. Having said this, they are also self-defining. That is, one knows when one has been creative, made a discovery, or invented something even if it is difficult to explain these phenomena to the uninitiated.

Cross-References

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▶ Creative Personality
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity Definitions, Approaches
▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
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▶ Invention Versus Discovery
▶ Measurement of Creativity
▶ Mental Models and Creative Invention
▶ Nature of Creativity
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References

Csikszentmihalyi C. Creativity: flow and the psychology of discovery and invention. New York: HarperCollins; 1996.
Dewey J. Logic: the theory of inquiry. New York: Henry Holt; 1938.
Ghiselin B. The creative process: reflections on invention in the arts and sciences. Berkeley: University of California Press; 1952.
Hadamard J. The psychology of invention in the mathematical field. New York: Dover; 1945.
Hersh D. What is mathematics, really? New York: Oxford University Press; 1997.
Kneller G. The art and science of creativity. New York: Holt, Reinhart, and Winstone; 1965.
Koestler A. The act of creation. New York: Macmillan; 1964.
Newman J. The world of mathematics, vol. 4. New York: Dover; 2000.
Poincaré H. Science and method. New York: Dover; 1952.
Stewart I. Letters to a young mathematician. New York: Basic Books; 2006.
Wallas G. The art of thought. New York: Harcourt Brace; 1926.

Mathematical Model

▶ In Search of Cognitive Foundations of Creativity

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Measurement of Creativity

Daniela Villani and Alessandro Antonietti
Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Synonyms

Creativity assessment; Creativity testing; Inventory on creativity; Test of creativity

Different Ways of Measuring Creativity

About a decade ago, the National Center on the Gifted and Talented identified more than 100 techniques to assess creativity (Treffinger et al. 2002), and Cropley (2000) reminded that a list of at least 255 creativity tests can be filled. Indeed, a variety of instruments and procedures have been devised to evaluate creativity. This stresses the need to organize conceptually the different ways in which creativity can be measured.

Creativity is assessed either as an *actual* behavior or disposition or as a *potential* skill or attitude. In the former case, evaluators analyze and judge an artifact that was produced or a behavior that was held, which are allegedly creative in their own nature; alternatively, evaluators require evaluated individuals to do so by themselves. In the latter case, evaluators ask the evaluated people to do something which is not creative in itself but which can be conceived as an indirect index of the level of creativity, that is, assumed those people can actually express in other relevant situations.

Furthermore, creativity can be measured with respect either to the *cognitive* processes, which are involved, or to the *personality* traits, which are associated to it. In the first case, the ability to perform mental operations, which are meant as activated during the generation of a creative outcome, is assessed. In the second case, the goal is to evaluate to what extent a person shares the features, which are conceived as characteristics of prototypical creative individuals.

Measuring Potential Creativity: Cognitive Processes

The creative potential is usually assessed through tests requiring people to perform relatively simple tasks, which have been invented to activate the basic mental operations involved in more complex situations where creativity is needed. Hence, such tests can be categorized according to the specific operations they imply, which in turn depend on the underlying theoretical framework.

The conception that creativity concerns primarily the production of abundant and diverse ideas was stressed by the factorialistic perspective, which prompted the construction of different tasks in which individuals are asked to give many responses starting from a given stimulus. Performance is evaluated according to the richness of the thinking flow and the ability to follow new directions in order to achieve uncommon outcomes. The divergent generation of original ideas can be measured by the *Creativity Tests for Children*, the test consisting in the completion of schematic pictures included in *Creativity Assessment Packet* and the *Torrance Tests of Creative Thinking* (TTCT), which is currently the most frequently employed psychometric tool to assess creativity. Also, a set of tasks devised specifically by Wallach and Kogan for young children in the 1960s is grounded on the assumption that creativity depends on the ability to produce many differentiated and original ideas.

According to associationism, creative ideas are achieved through the unusual combination of known ideas. Already Vygotsky in the 1930s claimed that creative activity consists of the recombination of information already known or previously acquired. In the 1960s, Mednick argued that creativity can be identified by the ability to connect ideas which are semantically distant from each other. The *Remote Association Test* (RAT) was constructed to measure such ability: it requires to complete a series of three words with a fourth word which can be associated to each of the three given terms. To do so, the respondents must find words, which have a weak, uncommon association with the given terms.

Finally, what is commonly meant by "creativity" refers to what Gestalt psychologists called "productive thinking," which allows individuals to identify new properties of the given elements and to conceive and use them in new roles or perspectives. Such skills can be measured by means of instruments as the *Purdue Elementary Problem-Solving Inventory*, which requires finding problems, asking questions, analyzing situations, formulating hypotheses, and drawing conclusions by changing the mental perspective. Also the *Test of Creative Thinking* (TCT) is based on Gestalt psychology grounds, such as the tenet that creativity needs to break mental boundaries in order to consider situation from a different point of view and to restructure it. Similarly, the *Creative Reasoning Test* (CRT) is based on riddles whose solution requires overcoming fixation on the usual meaning of the given elements.

Recently, the attempts to construct new tests were inspired by the need to integrate the different mental operations involved in creativity. This was the case of the tests elaborated by Antonietti and coworkers (see Antonietti et al. 2011), which tried to assess jointly the three main mental operations mentioned above. For instance, the *Widening-Connecting-Reorganizing* (WCR) test, consisting of two versions (multiple-choice questions and open questions), includes visual – such as images of objects, geometrical figures, or scenes – and verbal stimuli, ranging from the presentation of single words to hypothetical questions. In the *Widening* subtest of the multiple-choice version, the respondent is asked to choose one answer among alternatives, which varies according to the degree of originality. In the *Connecting* subtest, the respondents are asked to choose, given a list of words or images ranging from common to rare associates, the elements that they would relate to the given situation and to justify the choice. In the *Reorganizing* subtest, the respondents, faced with a hypothetical situation, are asked to choose one answer among alternatives, which vary gradually from obvious to unusual consequences.

As a second case of the tendency mentioned above, we can make reference to the *Evaluation of Potential for Creativity* (EPoC) (Lubart et al. 2011). EPoC measures different processes involved in creativity in different domains. More precisely, EPoC allows evaluators to assess both divergent-exploratory and convergent-integrated modes of thinking. The divergent-exploratory mode consists in expanding the range of ideas. The convergent-integrative mode consists in combining elements in new ways. EPoC includes two alternative forms. Each form is composed of eight subtests covering two domains (verbal and graphic). In the divergent-exploratory subtests, respondents are asked to generate many ideas with reference to a given stimulus. The convergent-integrative subtests require an integrated and finalized composition of elements.

Measuring Potential Creativity: Personality Traits

If some researchers view creativity entirely as a cognitive process, others see it as a set of personality traits. Within this approach, personality inventories, self-report adjective checklists, biographical surveys, interest and attitude measures, and interviews are all methods used to assess the creative person.

Among personality inventories, the *Gough's Adjective Check List* is strictly focused on creative personality. Specifically, it identifies 30 adjectives that reliably differentiate more from less creative people; 18 of those adjectives are positively related to creativity (capable, clever, confident, egotistical, humorous, individualistic, informal, insightful, intelligent, interests wide, inventive, original, reflective, resourceful, self-confident, sexy, snobbish, and unconventional). Other instruments are worth mentioning: the *Barron-Welsh Art Scale* and the *Creative Perception Inventory* require individuals to endorse personality traits associated to creative personality.

Other two self-report tools measure creativity as a factor included in the wide personality assessment. This is the case of the *Myers-Briggs Type*

Indicator and the *NEO Five-Factor Personality Inventory*. The first one is a self-report measure to assess individuals' preferences for different types of information processing. It rates individuals on four dimensions by presenting 300 forced-choice items: introversion-extraversion, intuitive-sensing, thinking-feeling, and perceiving-judging. The creativity index, which can be computed through the Myers-Briggs Type Indicator, is a pattern among the four dimensions closely associated with creativity. An introverted, intuitive, thoughtful, and perceiving person may be more likely to be a creative individual. The *NEO Five-Factor Personality Inventory* broadens the three factor models of personality (based on neuroticism, extraversion, and openness to experience) to other two factors (conscientiousness and agreeableness). This self-report personality inventory includes bipolar adjective pairs asking respondents to rate themselves on a nine-step scale. The factor structure underlying this inventory has impressive validity across cultures, life span, and gender.

Within personality assessments, projective tests are also used to measure creative personality within a psychodynamic approach by assessing unconscious motivations and needs that may energize creative behavior. The basic assumption of projective tests is that participants' responses to vague stimuli will tend to portray personality style. The most used projective tests used in creativity assessment are the *Rorschach Inkblot Test* and the *Thematic Apperception Test* (TAT). The first consists of ten cards, each containing an inkblot. Five cards are black or gray and five are colored. Respondents have to report what they see or what might be represented by the inkblot, one at a time. Although all scoring systems require considerable training and practice, generally more original responses are interpreted as reflecting more creativity and productivity, and people can feel more comfortable in expressing their personal view. The TAT has been developed to measure creativity, and it has been showed that it can be successfully employed to evoke the motive to create.

Among creative personality measures, personality inventories are more structured than projective tests, which rely on qualitative interpretation for meaning and, even with the most rigorous scoring systems, can reach only modest reliability and validity.

Measuring Actual Creativity

Explicit definitions and theories of creativity do not ever access the wealth of information inherent in accomplishments in creative fields. For this reason, Plucker and Runco (1998) suggested that, when people engage in creative activity, "their thoughts and actions are guided by personal definitions of creativity and beliefs about how to foster and evaluate creativity that may be very different from the theories developed by creativity experts" (p. 37).

The *Creative Activities Checklist*, suitable for use with children in Grades 5–8, is based on this ground. The test simply asks participants to indicate how frequently they have participated in recent times in real-life activities in six areas: literature, music, drama, arts, crafts, and science. A similar but more recent assessment is represented by the *Creative Achievement Questionnaire* (CAQ), which measures creative accomplishments in ten domains: visual arts, music, dance, architectural design, creative writing, humor, inventions, scientific discovery, theater and film, and culinary art. Only people with significant achievements in at least one domain receive high scores on the CAQ. Two further instruments are worth mentioning. The *Creative Experiences Questionnaire* (CEQ) allows evaluators to assess how frequently an individual is prone to fantasy. The *Emotional Creativity Inventory* (ECI) measures the actual capacity to experience and expresses original and relevant combinations of emotions, meant as an expression of the richness of a person's emotional life. Individuals scoring high in this inventory know and apply a variety of regulation strategies as well as experience more complex emotions.

Another method of measuring creative achievement is the use of expert ratings as a criterion for eminence. Five professors of architecture, for example, were asked by McKinnon to nominate the living architects who had had the most influence on the field. Using this method, information on creativity was collected during open-ended interviews with nominees. Other authors used biographical inventories to measure creativity, also if they do not focus exclusively on creativity. The two best known instruments of this kind are the *Biographical Inventory* and Taylor's *Alpha Biographical Inventory* (ABI). They include 165 and 300 items, respectively, some of them in multiple-choice format, some requiring the selection of alternatives, and some open-ended. Specifically, the scale of the Schaefer and Anastasi's *Biographical Inventory* focuses on factual information and concerns five areas: family background, intellectual and cultural orientation, motivation – pervasive and continuing enthusiasm, breadth of interest, and drive toward novelty and diversity.

A recent developed inventory is the *Biographical Inventory of Creative Behaviors* (BICB), a 34-item scale assessing everyday creativity across a broad range of domains, such as arts, crafts, and creative writing but also covering social creativity, such as leadership, coaching, and mentorship.

Interesting is the focus on creative self-concepts proposed by the *Creativity Domain Questionnaire* (CDQ) (Kaufman 2006), which measures people's beliefs about their level of creativity in different domains. Self-beliefs about creativity play a critical role in many high stakes decisions, because people use their beliefs about their traits, preferences, and abilities when choosing hobbies, careers, friends, and relationship partners. The *Revised Creativity Domain Questionnaire* (CDQ-R) (Kaufman et al. 2009) includes 21 items, which form four factors: drama, mathematics/science, arts, and interaction. Each item is completed on a six-point scale, and the four domain scores can be averaged to obtain a global creativity score.

Another interesting interpretation of creativity in act is that proposed by Csikszentmihalyi. The author, looking at different individuals who had produced works that were publicly acknowledged as creative and who had all affected their culture in some important ways, concluded that the major distinguishing characteristic of creative people is the capacity to experience "flow." Flow is conceptualized as the balance between opportunities of action (challenges) and personal abilities (skills) and the experience of timelessness and oneness with activity in which one is engaged. Several methods have been developed to measure the flow state, including semi-structured interviews, questionnaires, and the *Experience Sampling Method* (ESM). According to Nakamura and Csikszentmihalyi (2002), the semi-structured interview is the approach of choice in studies directed toward rich, integrated description, whereas paper-and-pencil measures, such as the *Flow Questionnaire*, are more appropriate when the goal is not to identify but instead to measure dimension of the flow experience and/or differences in its occurrence across contexts or individuals. ESM is the most widely used approach for measuring flow, and it is not limited by reliance on retrospective evaluation. In ESM, subjects are paged periodically and asked to fill out questionnaires describing the moment at which they are paged. Within this approach, flow represents a good indicator of creative people.

Conclusions and Future Directions

Given the many methods of assessing creativity, what is the most useful approach? First, one must consider the reason for the assessment (Lopez and Snyder 2003), according to the domain, such as education, counseling, job placement, or others and the age of the evaluated individuals. Secondly, a solution to overcome limits related to the complex concept of creativity could be that of considering the multiplicity of measures as indicative of viable, dynamic, creative field. Houtz and Krug (1995) suggested that "multiple instruments and methods permit flexibility and adaptability to new problems and situations, maximum theory development, and application to real-world problems" (p. 273).

The psychology of creativity ought to be open to innovative approaches to assessment and one less obvious reason is that it will accelerate the growth of evidence in creativity assessment (Silvia et al. 2011) as is already achieved in other fields (Plucker and Makel 2010).

Cross-References

- ▶ Creative Personality
- ▶ Creative Styles
- ▶ Creativity Tests
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Measurement of Creativity
- ▶ Psychology of Creativity

References

Antonietti A, Colombo B, Pizzingrilli P. The WCR model of creativity. From concept to application. Open Educ J. 2011;4:80–9.

Cropley AJ. Defining and measuring creativity: are creativity test worth using? Roeper Rev. 2000;23:72–9.

Houtz JC, Krug D. Assessment of creativity: resolving a mid-life crisis. Educ Psychol Rev. 1995;7:269–99.

Kaufman JC. Self-reported differences in creativity by ethnicity and gender. Appl Cognit Psychol. 2006;20:1065–82.

Kaufman JC, Cole JC, Baer J. The construct of creativity: a structural model for self-reported creativity ratings. J Creative Behav. 2009;43:119–34.

Lopez SJ, Snyder CR. Positive psychological assessment: a handbook of models and measures. Washington, DC: American Psychological Association (APA); 2003. p. xvii 495.

Lubart TI, Besançon M, Barbot B. Evaluation du potentiel créatif (EPoC). Paris: Editions Hogrefe; 2011.

Nakamura J, Csikszentmihalyi M. The concept of flow. In: Snyder C, Lopez S, editors. Handbook of positive psychology. Oxford: Oxford University Press; 2002. p. 89–105.

Plucker JA, Makel MC. Assessment of creativity. In: Kaufman JC, Sternberg RJ, editors. Cambridge handbook of creativity. New York: Cambridge University Press; 2010. p. 48–73.

Plucker J, Runco M. The death of creativity measurement has been greatly exaggerated: current issues, recent advances, and future directions in creativity assessment. Roeper Rev. 1998;21:36–9.

Silvia PJ, Wigert B, Reiter-Palmon R, Kaufman JC. Assessing creativity with self-report scales: a review and empirical evaluation. Psychol Aesthetic Creativity Arts. 2011;30.

Treffinger DJ, Young GC, Selby EC, Shepardson CA. Assessing creativity: a guide for educators. Washington, DC: National Research Center on the Gifted and Talented; 2002.

Measuring Organizational Climate for Creativity and Innovation

Igor N. Dubina
Economic Information Systems, Altai State University, Barnaul, Russia

Synonyms

Creative climate; Innovative climate; Innovativeness; Innovativity; Work environment

Definition

Organizational climate is a relatively stable set of physical, social-psychological, administrative, and economic factors characterizing the conditions for work and influencing on employees' professional activities within an organization domain.

Introduction

The alteration of a company's work environment for creativity represents the most important way to develop employees' creativity and to manage this process. For maintenance of the "continuous creativity" strategy, it is necessary to create a favorable organizational and psychological climate for creativity, not only for "creative employees" (such as inventors, managers, and engineers), but also for all workers. For example, Japanese firms support and accumulate not only inventions but any "fine" ideas ("secondary innovations") as well. These secondary innovations are the main source of competitiveness since they promote constant production update, cost reduction, and quality improvement. The aggregated effect of secondary innovations often is greater than that of a few giant ideas because modern business depends on a continuous flow of ideas.

Improving the organizational climate for creativity and innovation can promote effective problem-solving in a company, and often increases a company's productivity and competitiveness. Therefore, optimizing the work environment for creativity to achieve maximum effectiveness with limited investment can be considered as one of the key elements of creativity management. The creative environment depends on many different factors such as management structure, leadership style, workplace conditions, and available resources. In the literature, there are many recommendations for improving the work environment for creativity and innovation, such as how to motivate employees to be more creative and how to eliminate different blocks against creativity. But improving an organizational climate also requires some assessment methods and measurement instrument to evaluate improvement efforts. The conception of ► Creativity Management Optimization supposes that interventions for improving the environment for creativity are directed to the most appropriate areas and in the most appropriate amounts.

Main Terms and Definitions

The literature refers to the metaphorical term "creative climate" to describe socio-psychological conditions for creativity (the fourth P – Press – in the ► 4P Creativity Model), paralleling meteorological conditions ("warm," "cold," "storm," "calm") and attributes of the work environment. Researchers, applying this term, pay attention mostly to psychological and sociological aspects of creativity development. Usually, they do not take into account some organizational, economic, and management mechanisms for creativity management. For a firm, it is very important not only to have a creative climate but also to use the creativity of their employees effectively.

The term "creative climate" refers to the "inner" environment in which new ideas are being generated and supported. This, however, does not necessarily consider any *practical* results of creativity development. On the other hand, the special term "innovativeness" frequently has been used for characterizing how innovative a company is. In contrast to the "creative climate," innovativeness emphasizes the intensity and results of a firm's innovative activity more than conditions for creativity.

This terminology reflects the fact that an organizational climate for creativity and the climate for innovation are not the same, although both characteristics correlate closely and even overlap. For example, using CCQ, Isaksen and Kaufmann (1990) demonstrate that more innovative and commercially successful companies express a more creative organizational climate. King (1995) provides another example: a study of four subunits of a large chemical company revealed that the subunit, whose climate was most favorable toward creativity, was not most successful in terms of innovation. "The most innovative division showed characteristics generally found to inhibit individual creativity; conflict, disharmony, and lack of trust" (King 1995, p. 85). Ekval (1996) suggests that some characteristics of creative climate may be favorable to incremental innovation, small step improvements of the existing products and processes, but they may be hampering for radical innovation, and vice versa.

Dubina (2005) proposed to combine the above terms and introduced the term of "innovativity" as an organizational capability for actualizing employees' creativity and shaping it into practical tangible results. *Innovativity* integrates creative and innovative aspects of the work environment in an organization. This suggests a complex index, underscoring a firm's dependence on innovations, its sensitivity to changes, the conditions for the promotion of new ideas, and the support, encouragement, and realization of creative initiatives of the employees.

Factors, Methods, and Instruments

Several approaches to assess the work environment for creativity and innovation have been developed recently, including the following methods and instruments:

- Assessing the Climate for Creativity (KEYS), originally called the Work Environment Survey (Amabile 1996; Amabile et al. 1999)

- Creative Climate Questionnaire (CCQ), originally called the Climate for Innovation Questionnaire (Ekvall 1996, 1999)
- Situational Outlook Questionnaire (SOQ), an English version of the CCQ (Isaksen et al. 1999)
- Team Climate Inventory (TCI) (Anderson and West 1996)
- Siegel Scale of Support for Innovation (SSSI) (Siegel and Kaemmerer 1978)
- The Art of Innovation (AI) (Michaelides 2007)

These instruments often are used to measure how conductive work environments are for employees' creativity. The critical analysis, carried out in Mathisen and Einarsen (2004), revealed a number of ways for improving these instruments, including the selection of evaluated factors, scale development, and a more emphasis on impeding factors. Despite various organizational characteristics measured by the instruments, it seems possible to specify several major characteristics or climate categories.

Challenge refers to the emotional involvement of the members of the organization in its operations and goals, when the members find satisfaction in their jobs (CCQ, SOQ). Similarly, the KEYS instrument measures *Challenging Work* as a source of motivation.

Freedom involves the independence or autonomy that organizational members can exert, when completing tasks or developing ideas. This dimension was identified in the CCQ, SOQ, AI, and KEYS. Similarly, the SSSI identifies *Ownership* as the feeling of control that organizational members obtain, when creating, developing, and executing ideas.

Idea support is the extent to which ideas are treated in a constructive and positive way (CCQ, SOQ). Similarly, the KEYS includes a *Supervisory Encouragement* dimension that refers to a supervisor, who serves as a good work model, values and supports ideas of employees. The SSSI links *Leadership* to support and other organizational aspects such as distribution of power, development of ideas, and personal development. The TCI defines *Support for Innovation* as the expectation, approval, and practical support given to teams.

Trust/openness refers to emotional safety in relationships (CCQ, SOQ). Similarly, *Participative Safety* is being described in the TCI as the extent to which the environment is nonthreatening for organizational members to present and develop ideas. The KEYS mentions trust and openness under the *Work Group Supports* dimension.

Dynamism/liveliness is described in the CCQ and SOQ as the eventfulness of life in the organization, the frequency of organizational changes. The SSSI addresses a dimension called *Continuous Development*, which involves continuous organizational changes in which deep-seated assumptions, goals, and problem-solving approaches are questioned.

Playfulness/humor is defined as a spontaneous and relaxed atmosphere in the organization (CCQ, SOQ, AI).

The category *Debates* refers to the occurrence of encounters between view points, ideas, opinions, and experiences (CCQ, SOQ). The KEYS mentions constructive challenge under the *Work Group Supports* dimension. The TCI identifies a *Norms for Diversity* dimension, where few behaviors are considered as deviant, as an openness for diversity.

Conflict refers to the presence of emotional and personal tensions (in contrast to conflicts between ideas) in the organization. This is the only negative factor in CCQ. Similarly, the KEYS mentions internal strife and destructive competitions as organizational impediments. The TCI cites nonthreatening environment as means to create participative safety.

Risk taking is defined as a tolerance for uncertainty and ambiguity (CCQ, SOQ, AI). Risk taking is also mentioned as an aspect of *Organizational Encouragement* in KEYS.

Idea time is being described in the CCQ and SOQ as the amount of time people can use for developing and elaborating new ideas. The KEYS identifies extreme time pressure, under the *Workload Pressure* dimension, as an obstacle for creativity and the development of ideas.

Organizational encouragement involves the company-wide system that promotes creativity by a fair evaluation of ideas, risk taking, reward and recognition of creativity, and an active flow of ideas. The antithesis of organizational encouragement includes formal management structures and bureaucracy (KEYS).

Sufficient resources includes the availability of money, tools, materials, information, and the assistance of organizational members in developing and executing their ideas facilities (KEYS).

Task orientation involves the extent to which team members commonly agree and commit themselves to task quality and excellence, when interconnected with the group's vision and methods to evaluate results (TCI). Similarly, the KEYS includes shared commitments to projects as a part of the *Work Group Supports* definition.

Vision is the degree to which the group's vision and goals are clearly defined and reachable (TCI). Shared vision is listed under the *Organizational Encouragement* dimension in the KEYS. Similarly, *Consistency* is being described in the SSSI as a steadiness of processes and desired products to preclude organizational member deviation from project objectives.

These instruments are well described and analyzed in the literature and widely used in practice. Despite some imperfections (Mathisen and Einarsen 2004), they may be very helpful for managers and consultants in assessing the effect of creative climate improvement efforts and identifying relative strengths and weaknesses within and between work groups.

The mentioned approaches to assess a creative climate do not directly include factors of organizing and controlling creativity. As an attempt to improve existing instruments, Dubina (2006) suggested an approach to quantitative assessment of the work environment for creativity. In his model, the work environment for creativity is represented by the organizational creative capacity (OCC) that is measured by three groups of parameters such as:

- Supporting, facilitating, and developing employee creativity
- Encouraging and fostering employee creativity
- Organizing, directing, focusing, and monitoring employee creativity

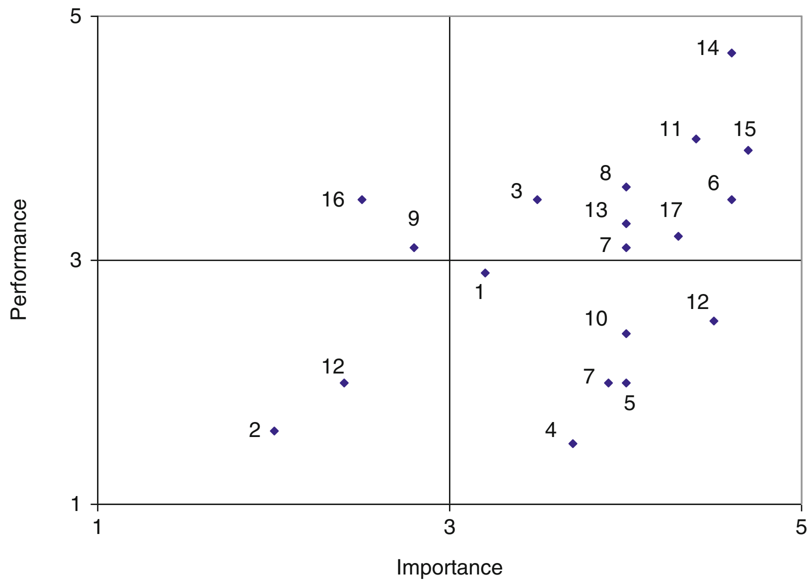
These parameters are characterized with indicators such as:

- A company's sensitivity to new ideas, tolerance for uncertainty and mistakes, risk taking, workplace conditions, granting time and resources for creativity, cooperation stimulation, freedom and flexible conditions for work, information exchange, available resources, and creativity trainings
- Cultivating intrinsic motivation and financial and nonfinancial stimulation
- Creativity and/or innovation strategy development, employee participation in decision-making, creativity hazard control, coordination of employee interests and the company goals, and creative leadership

To collect attitude data for assessing climate indicators, a Likert scale is usually applied, so appropriate mathematical and statistical methods should be used for processing the results obtained with such a scale for undertaking correct quantitative analysis. There are also other problems and inconveniences with using such instruments. All of them are based on a set of questions (usually, 50–150 items) and the categories (or factors) of an organizational climate are evaluated on the basis of replies to these questions. The questionnaires often take considerable time to complete. Usually, it also takes much time to analyze data, while sometimes a manager needs just a quick evaluation of a climate. Finally, it is not so easy to modify an existing instrument to use in another cultural context. The development of the SOQ is an example. It is an English version of the CCQ, and it is based on the same climate model and consists of as many items as the CCQ. But actually, they are different instruments since a "direct" and literal translation is impossible because of linguistic and cultural realities. The translation of questionnaire items results in a new instrument. According to the theory of measurement, changing any item of a questionnaire may change the indexes of measurement reliability and validity. Therefore, multifold testing is required for a "translated" measurement instrument.

All of these factors were a rationale to develop a simpler instrument which can be based on direct

Measuring Organizational Climate for Creativity and Innovation, Fig. 1 Estimates for climate factors in Improvement Priority Matrix (Source: The author's own work)



evaluation of climate categories (Dubina and Umpleby 2011). Seventeen key factors that contribute to the generation of new ideas and their successful implementation as projects in organizations are evaluated:

1. Safety for suggesting new ideas
2. Supervisory tolerance for risk and uncertainty
3. Employees' freedom/autonomy in decision-making
4. Sufficient resources provided for elaborating new projects
5. Sufficient time provided for employees' work on new projects
6. Challenging work
7. Supervisory encouragement to work cooperatively on new projects
8. Organizational openness to new ideas
9. Effectiveness of team work
10. Trust in the workgroup
11. An effective system for recognizing new ideas in an organization
12. Producing new ideas for trying new opportunities for business, not only for current product development
13. Supervisory positive acceptance of employees' creative suggestions
14. Supervisory encouragement of employees' creative approach to doing work
15. Fair rewards for creative suggestions
16. Dynamism of an organization and its openness to changes
17. Effectiveness of creativity and innovation activities

Employees evaluate these factors with two 5 point scales: importance scale (from 1 that is unimportant to 5 that is extremely important) and performance scale (from 1 that is very poor to 5 that is excellent). The averaged estimates for each factor are used as coordinates in a diagram with the importance – performance axes and four quadrants (Improvement Priority Matrix) (Fig. 1).

The factors of greatest interest for improvement are those that fall in the southeast quadrant defined by high importance and low performance. Those climate factors are considered the highest priority elements for an organization and need to be improved most of all. A ratio of importance to performance (IPR) was also calculated to increase the accuracy of climate assessment: $IPR = I/P$. The higher the IPR, the higher the priority a factor has.

An advantage of this approach to climate assessment is making allowance for the importance (or "weight") of each climate factor for an organization. Traditional approaches usually do not take item or factor "weights" into account.

The method is rather easy for respondents to understand. Applying this approach, it is possible to very quickly (up to 7–10 min) assess an organizational climate and get a clear "snapshot" of it. This method may be used independently or in a complementary way for assessing climate with the existing approaches in order to gain additional information about the work environment for creativity and innovation.

Conclusion and Future Directions

Measuring an organizational climate can help to identify necessary directions and amounts for interventions for improving the climate. The measurement of the climate characteristics can help to answer the following questions: How well does the climate fit the tasks or purposes of the organization? What structures may help promoting employees' creativity and better match the needs of the organization? The assessment of the work environment may direct interventions to the most appropriate areas, and in the appropriate amounts, to improve organizational performance.

Some organizational characteristics and climate dimensions are differently perceived by people with different creative styles. In other words, some types of people view their work environment as favorable to creativity, while other types of people perceive the same environment as less favorable. In particular, *Adaptors* and *Innovators* (see ▶ Creative Styles) prefer and need different climates for their creativity to flourish. Contemplating these differences may also be useful for managers, who need to learn applying different approaches for different members of the same group. Such an understanding can help organizations to better leverage their human recourses in order to get the maximum effect from employee creativity.

More studies are required to investigate the relative influence of different environment factors on work performance. Therefore, the correlation of environment factors with indicators of work performance represents one prospective possibility for future research. For this purpose, the development of usable and reliable quantitative methods and tools for auditing and diagnosing the work environment for creativity is necessary to make an organization's creative and innovative activities more effective.

The methods and measurement instruments for measuring an organizational climate can help to design an optimal organizational structure to facilitate, develop, encourage, and induce the appropriate aspects of creative performance needed for effectiveness. Repeated use of these methods, about every 6 months or a year, can provide an optimal strategy for managing employees' creativity more systematically, methodically, and relevantly to the specificity of an organization, its goals, and resources.

Cross-References

▶ Business Creativity
▶ Creative Management
▶ Creative Styles
▶ Creativity Management Optimization
▶ Four Ps in Organizational Creativity
▶ Four Ps of Creativity

References

Amabile TM. Creativity in context: update to the social psychology of creativity. Oxford, MA: Westview Press; 1996.

Amabile TM, Burnside RM, Gryskiewicz SS. User's manual for assessing the climate for creativity. Greensboro: Center for Creative Leadership; 1999.

Anderson NR, West MA. The team climate inventory: development of the TCI and its applications in teambuilding for innovativeness. Eur J Work Org Psychol. 1996;5:53–66.

Dubina IN. Managing creativity: theoretical approaches to employees' creativity regulation. Int J Manage Concept Phil. 2005;1(4):334–49.

Dubina IN. Optimising creativity management: problems and principles. Int J Manage Decis Making. 2006; 7(6):677–91.

Dubina IN, Umpleby SA. A quality improvement approach to assessing an organization's climate for creativity and innovation. In: The proceedings of the 17th annual international deming research seminar, New York, 2011, pp. 107–12.

Ekvall G. Organizational climate for creativity and innovation. Eur J Work Org Psychol. 1996;5:105–23.

Ekvall G. Creative climate. In: Runco MA, Pritzker SR, editors. Encyclopedia of creativity. San Diego: Academic; 1999. p. 403–12.
Isaksen SG, Kaufman G. Adaptors and innovators: Different perceptions of the psychological climate for creativity. Stud Psychol. 1990;32(3):129–41.
Isaksen SG, Lauer KJ, Ekvall G. Situational outlook questionnaire: a measure of the climate for creativity and change. Psychol Rep. 1999;85:665–74.
King N. Individual creativity and organizational innovation: an uncertain link. In: Ford CM, Gioia DA, editors. Creative action in organizations: ivory tower visions and real word voices. Thousands Oaks: Sage Publications; 1995. p. 82–7.
Mathisen GR, Einarsen S. A review of instruments assessing creative and innovative environments within organizations. Creativity Res J. 2004;16(1):119–40.
Michaelides D. The art of innovation: integrating creativity in organizations. Nicosia: Gassoulides and Son; 2007.
Siegel SM, Kaemmerer WF. Measuring the perceived support for innovation in organizations. J Appl Psychol. 1978;63:553–62.

Medical Innovation

▶ Healthcare and Innovation

Medium-Size Business

▶ Small Business

Men

▶ Gender and Innovation

Mental Image

▶ Imagery and Creativity

Mental Imagery

▶ Imagination

Mental Model

▶ Models for Creative Inventions

Mental Modeling

▶ Imagination

Mental Models and Creative Invention

Norbert M. Seel
Department of Education, University of Freiburg, Freiburg, Germany

Synonyms

Internal models; Working models of invention

Key Concepts and Definition of Terms

Invention, as defined by Webster's Dictionary, is a device, contrivance, or process originated after a period of extensive study and experimentation. Generally, it is argued that invention is something that is novel and useful.

A mental model is a construct of cognitive science that refers to beliefs and ideas that intelligent systems consciously construct from their experiences. Mental models control thoughts and actions; they create the expectation of certain results of thought experiments and give meaning to objects and events of the world. Although mental models provide some internal stability in a continuously changing world, they also blind their users to facts and ideas that challenge or defy deeply held beliefs. By nature, mental models are fuzzy and incomplete. Moreover, they are highly idiosyncratic, i.e., everyone develops mental models that differ completely or in detail from everyone else's with regard to the same object to be understood.

Theoretical Background and Open-Ended Issues

This entry is based on the presumption that creative invention necessarily and sufficiently presupposes the construction and use of mental models. It is assumed that it is common practice for inventors to use mental models as sets of heuristics to develop their projects. Accordingly, a mental model can also be defined as the ideas and concepts an inventor has about an invention. Mental models are often dynamic prototypes an inventor can run in the mind's eye. Their decisive advantage is that they allow an inventor to radically reconstruct previous knowledge about various domains to help to solve a complex problem. In other words, mental models for invention are often based on analogies between different domains. This can be illustrated through the example of the telephone. Its inventor Alexander Bell had expertise in human anatomy that he used in developing a mental model of the telephone (Gorman and Carlson 1990). Another example is provided by Thomas Edison, who made a career out of taking parts from one invention and fitting them together with a different invention to produce a third one. Edison's use of mental models also demonstrates one of the problems of using such techniques. When Edison was trying to develop the kinetoscope, he was hampered by having the same mental model for motion pictures as he did for the phonograph. He saw the kinetoscope as a single-use device, and in the end, he was compelled to discard his mental model of a "phonograph with pictures" (Carlson and Gorman 1990). This is an example of the observation that a mental model can also make one blind to facts and ideas that challenge or defy deeply held beliefs.

How Mental Models Work in General

The idea of mental models is based on the assumption that an individual who intends to provide a rational explanation for something or to invent something new must develop practicable methods in order to generate adequate explanations from his knowledge of the world and his limited information processing capacity: Thus, the individual constructs a *model* that both integrates the relevant knowledge and meets the requirements of the situation to be mastered cognitively. The idea that mental models play a significant role in complex problem solving and discovery has a long tradition in the twentieth century psychology and epistemology in which various roots can be distinguished. However, it was Craik (1943) who introduced the idea of *internal models* to epistemology with the notion of a working model. This model "works" when it is within the realm of the subject's knowledge as well as the explanatory need with regard to the concrete situation to be mastered cognitively. A similar conception of internal models has been adapted by numerous psychologists who were concerned with the investigation of people's operation of complex technical or physical systems (see, e.g., Hacker 1977; Veldhuyzen and Stassen 1977).

According to mental model theory, individuals create internal representations in order to understand and explain individual experiences and events (Johnson-Laird 1989). Individuals also make sense of a new, unusual, or complex phenomenon by creating and using mental models (Seel 1991, 2001). Thus, a mental model is an internal, subjectively plausible, ad hoc construction for explaining a phenomenon of the world or inventing something that did not exist before.

According to Rumelhart, Smolensky, McClelland, and Hinton (1986), people have three essential abilities for processing information and acting successfully in various environments. First of all, people are very good at *pattern matching*. They are obviously able to quickly "settle" on an interpretation of any input pattern. This ability is central to perceiving, remembering, and comprehending. It is probably ***the*** essential component of most cognitive behavior – and it is based on the activation and instantiation of schemas. Second, people are very good at *modeling* their worlds due to their ability to anticipate new states of affairs resulting from actions in the world or from an event they might observe. Both pattern matching and modeling are grounded on building up expectations by "internalizing" experiences and are crucial for making inferences (Seel 1991). Third, people are good at *manipulating* their environments. This can be considered as a version of man-the-tool-user, which is perhaps the crucial skill for building a culture. Especially important here is the ability to manipulate the environment and to create artifacts as external representations which can be manipulated in simple ways to obtain answers to very difficult and abstract problems. As people gain experience with the world created by their actions, they internalize their experiences with external representations to develop mental models.

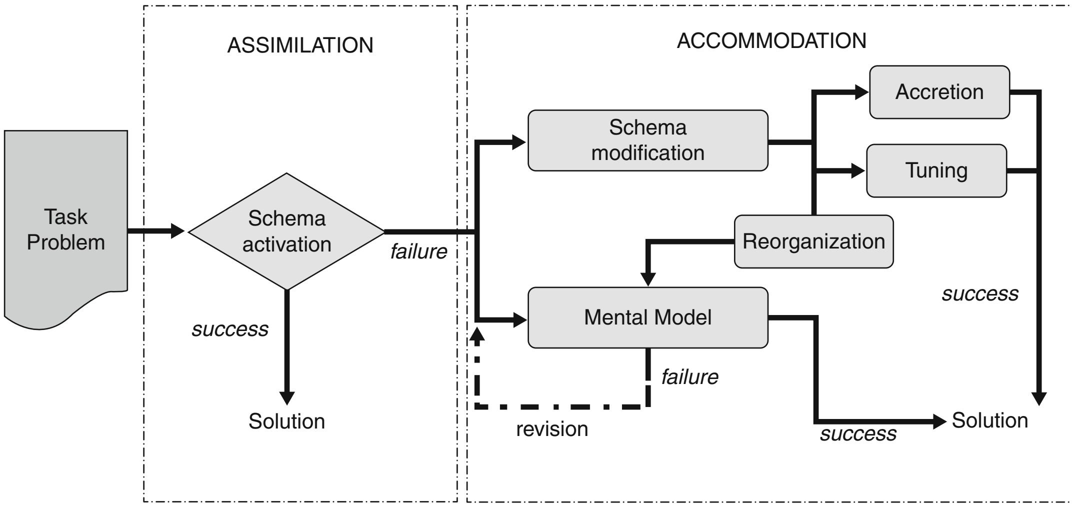
In order to explain these basic capabilities of intelligent systems, Rumelhart et al. (1986) divide the cognitive system into two modules or sets of units. One module – called an *interpretation network* – is concerned with producing appropriate responses to any input from the external world, while the other module is concerned with constructing a *model of the world* and producing an interpretation of "*what would happen if we did that*" with a particular external representation. The modeling part of the cognitive architecture is concerned with generating expectations about changes to the world that may result from imagining an external representation and operating on it. The interpretation network receives input from the world and reaches a relaxed mental state by producing relevant cognitive responses, whereas the "model of the world" predicts how the input would change in accordance with these responses.

Mental models constitute the fundamental basis for developing "models of the world," discussed here in accordance with Rumelhart et al. (1986), and they may serve as *models for reasoning* as well as *models for understanding and invention* (Seel 1991). In both cases, mental models are constructed to meet the specific requirements of situations and tasks the subject is faced with for which the activation and/or modification of a schema fails. While a schema is a slot-filler structure, a mental model contains a set of assumptions that must be justified by observations. This justification of assumptions is closely connected to a *reduction to absurdity* (Seel 1991), which is a process of testing continuously whether a model can be replaced with a better model. As long as this is not possible, the model is considered suitable.

Models for understanding and invention have their starting point in the tentative integration of relevant simple structures or even single bits of domain-specific knowledge step by step into the coherent design of a working model in order to meet the requirements of the task to be accomplished. Johnson-Laird (1983) considers this process of a stepwise enrichment of models as a "fleshing out" that also refers to the learning-dependent progression of mental models. Mental models for understanding represent the structure of world knowledge because they are generated to structure it and not to reproduce or copy a given external structure. Models for understanding and invention correspond to pragmatic conceptions of modeling. They can be externalized by means of particular symbol systems and generate subjective plausibility with regard to complex phenomena to be understood and explained. However, in contrast to the pragmatic approach of modeling, proponents of the mental model theory agree on the point that mental models are cognitive artifacts which correspond only more or less to the external world since people can also construct pure *thought models* which bear no direct correspondence to the external world but rather only to world knowledge. This corresponds to the idea of coherence epistemology (Seel 1991). In general, models for understanding and invention have the following characteristics: (a) They are incomplete and constantly evolving, (b) they are usually not an accurate representation of a phenomenon but typically may contain errors and contradictions, (c) they are parsimonious and provide simplified explanations of complex phenomena, and (d) they often contain measures of uncertainty about their validity that allow them to be used even if incorrect.

When People Must Construct Mental Models . . .

In the cognitive architecture provided by Rumelhart et al. (1986), schemas and mental models are considered as two basic mechanisms



Mental Models and Creative Invention, Fig. 1 Cognitive functions of assimilation and accommodation (Seel et al. 2009)

of cognition. The observation that creativity was considered to be closely related to the formation of new schemas of thinking in the literature of the 1960s (e.g., Guilford 1967) raises the question as to whether the construct mental model is necessary to explain human creativity.

Clearly, the construction of mental models presupposes semantic knowledge that is – according to cognitive psychology – organized by schemas. Schemas are considered as building blocks of cognition (Rumelhart 1980) and, in consequence, also as building blocks of mental models. In recent decades, schemas have emerged as a central theoretical construct of cognitive psychology, and schema theory has enriched the psychological knowledge about information processing, logical reasoning, and problem solving (Rumelhart 1980; Rumelhart et al. 1986). In cognitive psychology, a schema is conceptualized as a unit of mental representation in which the conceptual structures, relations, and processes of a particular semantic phenomenon of the world are organized as slot-filler structures that run automatically when triggered by input information that fits with the default values of a schema.

The cognitive architecture proposed by Rumelhart et al. corresponds to a great extent to Piaget's genetic epistemology and its basic mechanisms of assimilation and accommodation. Actually, assimilation is dependent on the availability and activation of cognitive schemas, which regulate the incorporation of new information into cognitive structures that can be addressed and activated through the default values of a schema. However, if a schema does not fit immediately with the requirements of a new task it can be adjusted to meet the new requirements by means of *accretion, tuning, or reorganization* (Seel 1991). This modification of a schema is a central part of accommodation. If and only if accretion, tuning, or reorganization of preexisting schemata is not successful, accommodation advances to the construction of a mental model (see Fig. 1).

In the rare case that no schema is available or can be activated, an immediate construction of a mental model may occur. In this case, an individual constructs a mental model which collects and integrates the relevant *bits of semantic knowledge* into a coherent structure step by step in order to meet the requirements of a phenomenon to be explained. Both "fleshing out" and "reduction to absurdity" are necessary for the completion of a mental model, which runs as a preliminary working model for invention. Mental models, like heuristics in general, often become apparent when the problem solver encounters a kind of resistance to the explanation of something. For example, an expert who solves a particular class of problems automatically by triggering schemas may have to struggle to find a solution to a novel problem and may be forced to develop a mental model. Indeed, creative invention necessitates the construction and improvement of a mental model.

Mental Models for Inventions

Creativity is often placed on a level with spontaneity, but creative invention is usually not the result of spontaneous ideas but rather the end-point of a long-term cognitive confrontation with a complex problem. First of all, invention is "hard work," and second, *necessity is the mother of invention*. Third, mental models provide the "frame" for an invention by constraining proto-inventions to an applicable product, which is generally considered as both sufficiently new and useful. The use of the prefix "proto" indicates a precondition or an early stage of development of a solution to a problem. According to mental model theory, inventors develop tentative mental models of the problem in order to generate proto-inventions through design heuristics. In mental model theory, this is called "reduction to absurdity," which refers to a continuous process of testing and revising a mental model and the resulting proto-invention. A small number of design heuristics can generate an abundance of proto-inventions, but a really successful invention will be rare.

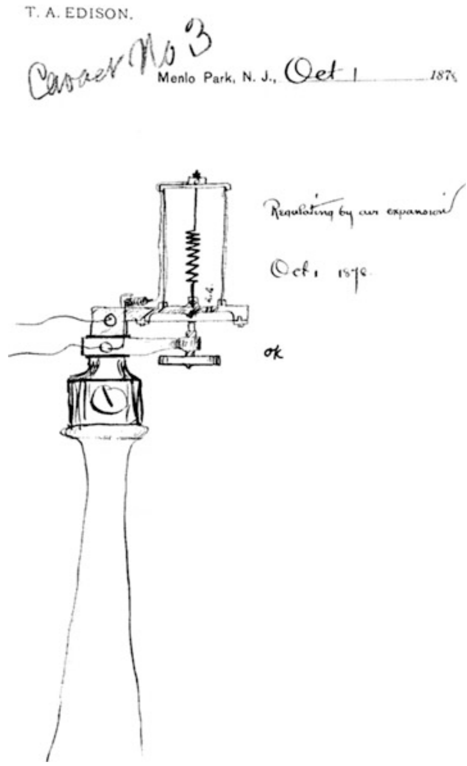
One can increase the probability of constructing an effective mental model for creative invention by developing analogy models that are built on what is known and can be transferred successfully to a new problem. The person creating a model for a proto-invention constructs an initial solution model by selecting only a few attributes from a known base domain and then mapping them to the target domain. This can be illustrated by an example provided by Holyoak and Thagard (1995, p. 33): "Our knowledge of water provides us with a kind of internal model of how it moves. Similarly, our knowledge of sound provides us with a kind of model of how sound is transmitted through the air. Each of these mental models links an internal representation to external reality. But when we consider the analogy between water waves and sound propagation, we are trying to build an isomorphism between two internal models. Implicitly, we are acting as if our model of water waves can be used to modify and improve our model of sound."

If this process of building an isomorphism between two mental models leads immediately to an acceptable *conclusion by analogy*, the procedure will be finished. But in the case of creative inventions, this situation should arise relatively infrequently since usually it is not easy to construct a mental model to explain an unknown phenomenon on the basis of previous experiences with similar phenomena within another domain. However, if the construction of a mental model is successful, it may serve four major functions: (1) Models aid in the *simplification* of an investigation to particular and relevant phenomena in a closed domain. (2) Models aid in the *envisioning* (or visualization) of a complex structure or system. (3) Models aid in the *construction of an analogy,* which helps to identify the structure of an unknown domain with the help of the structure of a known domain. In this way, a well-known explanation (e.g., Rutherford's atomic model) can be mapped onto a phenomenon to be explained (e.g., quantum mechanisms). Such models are called *analogy models*. (4) Finally, models may aid in the *simulation* of the processes of a system. This occurs when an individual interacts with the objects involved in a situation in order to manipulate them mentally in such a way that the cognitive operations simulate specific transformations of these objects that may occur in real-life situations. These *simulation models* operate as thought experiments that produce qualitative inferences with respect to the situation to be mastered.

Naturally, there is a substantial lack of empirical research on the role of mental models for great inventions that cannot be forced by experimental treatments. However, one can find some good case descriptions of great inventions in the literature (e.g., Brockman 2000) that demonstrate how inventors construct mental models by engaging in analogical reasoning and performing "thought simulations" and then rule out unpromising designs and follow up on promising ones. A nice example of this "thought simulation" by means of a mental model that can be found in the literature is Oatley's (2011) essay about Shakespeare's invention of the theatre. Other good accounts of the role of mental models for inventions refer to Thomas Edison (1847–1931), with a particular emphasis on the cognitive processes involved in Edison's creative inventions (Carlson and Gorman 1990; Gorman and Carlson 1990). With regard to the invention of the light bulb, one can state that Edison began his efforts to solve the problem by creating a regulating system that kept a platinum filament between the incandescent and melting temperatures. This phase of operating exclusively in the design space of regulated platinum filament bulbs lasted some months (Fig. 2).

In the following phase (January 1879 to October 1879), Edison adopted a strategy of functional decomposition of the complex problem when he discovered that gasses boil out of a platinum filament raised to incandescence and damaged the wire. He now explored how different filaments changed due to high temperatures generated by a blowtorch. During the next months (up to December 1879) Edison developed the first practical high-resistance carbon bulbs. It took Edison nearly 1 year to invent the light bulb, and the invention process was associated with cognitive processes that are characteristic of the construction and revision of a mental model. First, he referred to his broad knowledge of mechanisms to develop self-regulating bulbs, but these efforts at finding an analogy model were not successful, not until he broke down the functional relationship of the complex problem into its constituent parts and employed a kind of "beam search" at various phases.

Beam search is a heuristic search which optimizes a best-first search in order to reduce memory requirements as well as to organize partial solutions to a problem in accordance with a heuristic which aims at predicting how close a particular solution is to a successful overall solution. In terms of mental model theory, beam search corresponds largely to a reduction to



Mental Models and Creative Invention, Fig. 2 Edison's first design of a light bulb (1878)

absurdity of model candidates. Beam search uses a breadth-first search strategy to generate all possible consequences of a current model and sort them in increasing order of heuristic cost.

The effectiveness of mental models and related heuristics (such as beam search) can also be demonstrated by referring to other great inventors, such as Nikola Tesla (1856–1943) who "electrified the world." In his autography (Johnston 1983), Tesla reports that he relied heavily on his capability of visualization and mental simulation for inventions. More specifically, he informs us about his creative inventions by using a kind of mental model:

> My method is different. I do not rush into actual work. When I get an idea I start at once building it up in my imagination. I change the construction, make improvements and operate the device in my mind. It is absolutely immaterial to me whether I run my turbine in thought or test it in my shop. I even note if it is out of balance. There is no difference whatever, the results are the same.

> In this way I am able to rapidly develop and perfect a conception without touching anything. When I have gone so far as to embody in the invention every possible improvement I can think of and see no fault anywhere, I put into concrete form this final product of my brain. Invariably my device works as I conceived that it should, and the experiment comes out exactly as I planned it. In twenty years there has not been a single exception. .... The incessant mental exertion developed my powers of observation and enabled me to discover a truth of great importance. (Tesla 1919; retrieved from http://www.tfcbooks.com/tesla/my_inventions.htm#I.%20My%20Early%20Life)

Conclusion and Future Directions

Since its introduction into the literature in the 1980s, the concept of mental model has played an increasing role in science education literature. Franco et al. (1999), for instance, discuss the relationships between external representations, mental models, and ideational realizations by referring to scientists' and inventors' mental models as working devices for creative inventions. Innovation and creative inventions are inherently very complex phenomena and subject to manifold cognitive and social requirements. As the evidence grows that there is a close link between invention and mental models (and their basic functions), there is no doubt that there is a need for theoretical and practical advances in the understanding of how mental models work in making inventions. This chapter discussed key aspects of creative invention and mental models, including definition issues of some basic constructs which underscore the need for a cognitive perspective. The review and discussion of mental models and creative invention reveals not only numerous advances but also substantial research questions that require more complex and comprehensive approaches than the previous case studies to be found in the literature (Calabrese-Barton 1998).

The chapter concludes with a reference to a promising project – the "invention curriculum" proposed by Sharif and San (2001) – which is designed to enable students to be creative in their thinking, innovative, and inventive. Students are enabled to create artifacts by applying a design process, starting with problem identification and idea formulation and continuing with prototype building and evaluation. The results of this UNESCO project show great promise for the training of discovery learning in the classroom.

Cross-References

- ► Analogies and Analogical Reasoning in Invention
- ► Cognition of Creativity
- ► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
- ► Fostering Creativity Through Science Education
- ► Imagery and Creativity
- ► Radical invention
- ► Science of Creativity
- ► Strategic Thinking and Creative Invention
- ► Thinking Skills, Development

References

Brockman J, editor. The greatest inventions of the past 2,000 years. London: Weidenfeld & Nicolson; 2000.

Calabrese-Barton A. Examining the social and scientific roles of invention in science education. Res Sci Educ. 1998;28(1):133–51.

Carlson WB, Gorman ME. Understanding invention as a cognitive process: the case of Thomas Edison and early motion pictures, 1888–91. Soc Stud Sci. 1990;20(3):387–430.

Craik KJW. The nature of explanation. Cambridge: Cambridge University Press; 1943.

Franco C, et al. From scientists' and inventors' minds to some scientific and technological products: relationships between theories, models, mental models and conceptions. Int J Sci Educ. 1999;21(3):277–91.

Gorman ME, Carlson WB. Understanding invention as a cognitive process: the case of Alexander Graham Bell, Thomas Edison, and the telephone. Sci Technol Hum Val. 1990;15(2):131–64.

Guilford JP. The nature of human intelligence. New York: McGraw-Hill; 1967.

Hacker W. Bedeutung und Analyse des Gedächtnisses für die Arbeits- und Ingenieurpsychologie – zu Gedächtnisanforderumngen in der psychischen regulation von Handlungen. In: Klix F, Sydow H, editors. Zur psychologie des gedächtnisses. Bern: Huber; 1977. p. S.150–S. 74.

Holyoak KJ, Thagard P. Mental leaps. Analogy in creative thought. Cambridge, MA: MIT Press; 1995.
Johnson-Laird PN. Mental models. Towards a cognitive science of language, inference, and consciousness. Cambridge: Cambridge University Press; 1983.
Johnson-Laird PN. Mental models. In: Posner MI, editor. Foundations of cognitive science. Cambridge, MA: MIT Press; 1989. p. 469–99.
Johnston B, editor. My inventions. The autobiography of Nikola Tesla. Williston: Hart Brothers; 1983.
Oatley K. Shakespeare's invention of theatre as simulation that runs on minds. Int J Sci Educ. 2011;22:1117–32.
Rumelhart DE. Schemata: the building blocks of cognition. In: Spiro R, Bruce B, Brewer W, editors. Theoretical issues in reading comprehension. Hillsdale: Lawrence Erlbaum; 1980. p. 33–58.
Rumelhart DE, McClelland JL, Hinton GE. Schemata and sequential thought processes in PDP models. In: McClelland JL, Rumelhart DE, The PDP research group, editors. Parallel distributed processing. Explorations in the microstructure of cognition, Psychological and biological models, vol. 2. Cambridge, MA: MIT Press; 1986. p. 7–57.
Seel NM. Weltwissen und mentale modelle. Göttingen: Hogrefe; 1991.
Seel NM. Epistemology, situated cognition, and mental models: "Like a bridge over troubled water". Instruct Sci. 2001;29(4–5):403–28.
Seel NM, Blumschein P. Systems modeling in learning and instruction: a theoretical perspective. In: Blumschein P, Hung W, Jonassen D, Strobel J, editors. Model-based approaches to learning: using systems models and simulations to improve understanding and problem solving in complex domains. Rotterdam: Sense; 2009. p. 3–15.
Seel NM, Ifenthaler D, Pirnay-Dummer PN. Mental models and problem solving: Technological solutions for measurement and assessment of the development of expertise. In: Blumschein P, Hung W, Jonassen D, Strobel J, editors. Model-based approaches to learning: using systems models and simulations to improve understanding and problem solving in complex domains. Rotterdam, The Netherlands: Sense Publ; 2009. p. 17–40.
Sharif AM, San KM. The invention curriculum: A Malaysian experience. Geneva: UNESCO International Bureau of Education; 2001.
Tesla N. My inventions. Electrical Experimenter. 7 (1, Whole No. 73); 1919.
Veldhuyzen W, Stassen HG. The internal model concept: an application to modelling human control of large ships. Hum Factors. 1977;19:367–80.

Mental Simulation

▶ Imagination

Merits of Aesthetics in Realm of Science

Vuk Uskoković
Therapeutic Micro and Nanotechnology Laboratory, Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, CA, USA

Introduction

Some may say that an image is worth thousands of words. This short discourse begins with two of them posed side by side, a scientific and an artistic one (Fig. 1). On the left, one could see a scanning electron micrograph of parallel monolayers of electrospun collagen fibers which resemble the pattern of the sky on the legendary Van Gogh's painting, Starry Night shown on the right. The similarity in the pattern between a scientific and an artistic image may prompt us to look deeper into their more fundamental commonalities. Finding those within their methodological roots rather than explicating the surface ones will be the subject of the following discourse. For when found at the roots, homologies on the surface could be recognized and fostered with ease. Therefore, the first steps in the discourse that follows will correspond to opening the views on physical phenomena in general. This would also turn out to be equal to plunging deep into the foundations of the eye that sees the world.

Teaching: The Pragmatic Principles of the Philosophy of Co-creation

Perceivable outlines of the physical reality are neither solipsistic nor objective but could be rather seen as falling into the category of intersubjective phenomenalism. From Heisenberg's uncertainty principle and the measurement problem to the findings of the constructivist school of cognitive science, empirical signs are everywhere that the subject co-defines the properties of the perceived reality as much as the latter is determined by its

Merits of Aesthetics in Realm of Science, Fig. 1 A scanning electron micrograph of self-assembled collagen fibers on glass (*left*) and Vincent Van Gogh's Starry Night (*right*). Reproduced with the permission from the Museum of Modern Arts, New York, NY

objective propensities. The author's fastidious blending of subjective creative effects in the perception of reality and those that are undeniably common and thus partially objective has yielded the philosophy of co-creation articulated on previous occasions (Uskoković 2009b, c, 2012).

The co-creational thesis dictates that every experience is the product of the impressions of the world as it is as well as of the subject's own, inner creativity defined by his biological nature in the current stage of evolution and by intentions, aspirations, emotions, and other psychological attributes of the mind. Every detail of the perceived reality is thus partially drawn by the cognitive subject himself, and, as such, it hides the essence of the subject's own being as much as it outlines the features of the "real" world, the beauty of which is independent and only "in touch" with the subject. Or, as Arthur Eddington summed this up, "All through the physical world runs that unknown content which must surely be the stuff of our consciousness; here is a hint of aspects deep within the world of physics and yet unattainable by the methods of physics" (Schuller 1980). At the very end of one, the so-called measuring apparatus pole in this co-creational dialogue in which the experiential reality is being drawn the deepest values of the human mind could be recognized, whereas at the other, the so-called measured system end, the creative intelligence hidden behind the veil of the physical reality, nameable as Nature, Creator, or God, could be foreshadowed.

Philosophically meticulous exploration of experiential details can thus naturally lead the explorer to recognize in them the reflections of both the hidden ontological aspects of the origins of the physical reality and of one's own intrinsic nature, including all the prejudgments, anticipations, and values nourished from within. "Nature always wears the colors of the spirit" (Emerson 1836), Emerson proclaimed, and his viewpoint becomes readily understandable upon knowing that any perception always reflects both how the subject is and how the world, independently of the subject, is. Either of the two alone, without being intermingled with the other, cannot be made knowable. Both of these creative poles are imperceptible per se, comparable to the sound of one hand clapping from the popular Zen koan. Only in pair can they produce something perceptible; the very question of whether the sensual information comes from one or the other pole then becomes meaningless.

Since they arise in the co-creational dialogue between the human mind and Nature, all scientific models and relationships are partly human inventions aside from constituting literal discoveries. All products of scientific measurements arise from the interaction between the measured systems and the measurement devices, whereby the latter include the observer's mind and all the presuppositions with which one approaches the measurements. All of these assumptions about the object of one's study become inconspicuously reflected in the final measurement outcomes. All the properties and qualities that scientists and experimenters ascribe to the worldly objects should thus be considered as attributes since they are partly objective but partly defined by their subjective nature as observers. The world perceived by the observer is thus the world of one's experience first and foremost, albeit the fact that the latter still possesses solid objective traits which enable humans to share experiences, including objects and insights. Therefore, one could consider scientific imagery not as truthful, realistic, and universal reflections of an objective world identical for all observers, but as partly subjective and metaphorical in nature, a product of individual and social imagination as much as an objective reflection of the world per se. In view of this, products of scientific creativity partly serve the pragmatic purpose of enlightening human experiences instead of discovering the one and only truthful nature of the physical reality.

As the co-creational thesis suggests, the element of discovering and the one of inventing are, in fact, inextricably entwined, as much as the roles of the subject and the object are equally involved in defining the features of the object in the subject's eyes. Beauty lies in the object itself, but it is also partly in the eyes of beholder, as some might say. An immediate consequence of this phenomenal insight is that all the efforts in the scientific arena have the ultimate purpose of enlightening the world of other people's experiences, and the greater the shine of love in one, the more open the road to extraordinary scientific discoveries will lie ahead. The more one loves and respects humanity and fellow earthlings, the greater the drive will be in one to diligently explore the mysterious seas of scientific knowledge and eventually come up with lustrous pearls of wonderful insights. Besides, the feeling is that common sense wisdom too blossoms most efficiently from the stems of selfless care for weak and fragile creatures of the world, which all humans ultimately are and which could be therefore seen as an incessant fuel for the flights of human imagination and creativity toward stars. Hence, as in the Tai-Chi-Tu symbol, knowledge can be found in the center of the spinning of the vortex of love, whereas love can be seen standing at the foundation of the incessantly rising towers of human knowledge.

To sum up, scientific imagery is not truthful and universal; it is rather a result of imagination and inventiveness of the human mind. As such, it is only one of countless potential ways of describing the reality. Genuinely metaphorical in nature, it can be seen as arising from the same, pragmatic roots of the human tree of knowledge from which arts originated, only later, on the surface, branching out to its special avenues and approaches. Consequently, it comes as no surprise that the nature of human thinking, both scientific and nonscientific, is analogical, metaphoric as much it is logical and analytical in its nature. As such, it is unequivocally inspired by the artistic eye for natural phenomena.

When asked about the sources of inspiration for developing his theory of relativity, Albert Einstein said, "The theory of relativity occurred to me by intuition, and music is the driving force behind this intuition. My parents had me study violin from the time I was six. My new discovery is the result of musical perception" (Schuller 1980). On another occasion, Einstein alludes to the complementariness of science and arts by claiming that "both music and scientific research are nourished by the same source of longing, and they complement one another in the release they offer" (Wilczek and Devine 1988). Many extraordinary scientists would agree that aesthetic sensibility presents a core of exceptionally inventive exhibitions of the powers of the brain and that love and compassion could thus be considered as the essence of rationality and intellect. Numerous scientists were in love with poetry and music and intensively played an instrument or two, from Pythagoras to Werner Heisenberg to Richard Feynman to Enrico Fermi. At the end of his Critique of Pure Reason, Immanuel Kant noticed how "two things still fill my mind with ever increasing wonder and awe... the starry heavens above me and the moral law within me" (Kant 1781). Not only may his division of the ultimate mystery of being to two elementary poles be correlated with the aforementioned metaphysical poles – the essences of mind and Nature – that in their co-creational interaction give rise to the spiritual and physical evolution of life and matter, but it is apparent that the two resulting aspects of human creativity – the productivity evident in the world outside and an artistic, aesthetically sublime and profoundly compassionate heart cultivated within – always go hand in hand and can be thus considered as one and the same (Wilkinson 1979).

Application: Science and Art Are One and the Same

The most important, although often not readily recognizable, discovery of the empiric approach to scientific method was the "discovery" of the very method of arrival at scientific discoveries (Whitehead 1925). Adopting the programmatic method of reaching novel discoveries, however, resulted in gradual distancing of human aspirations, passions, the sense of sacred intimacy with Nature, and, more than anything, love of science and Nature away from the subjects of science and lab benches. Slowly, over time, the romantic charm of doing science has been put asleep and at this point in time, witnessed is a rise in the way of doing science that has not existed before. Namely, it seems as if scientific research is about to fully transform itself into an entrepreneurial activity that can follow practically any prototypical self-profiting business model. Management and administrative skills have thus become equally or even more important for conducting the scientific "business" successfully than embracing the physical phenomena studied with a whole lot of devotion and passion. Scientists are wrongly taught that the larger the amount of funding for a given research, the more significant outcomes will result. Despite the fact that the blue-sky research (Braben 2004), disconnected from immediate gains and applications and focused on basic scientific aspects solely, was shown to be the most fruitful one from the perspective of the advancement of human knowledge and technologies throughout the history, funds are nowadays primarily given to scientific projects focused on short-term goals. Yet, every gardener knows that what grows fast in his field is most probably nothing but weed, whereas all the fruitful trees require time to yield their first fruits and even more to grow to their full size and capacity. Arts are no exception to this either. Conducted with the desire to comply with commercial demands, they similarly transform to mainstream movements, with a little of artistic value, and as such, luckily, do not stand impressed for a very long time in the collective mind of humanity.

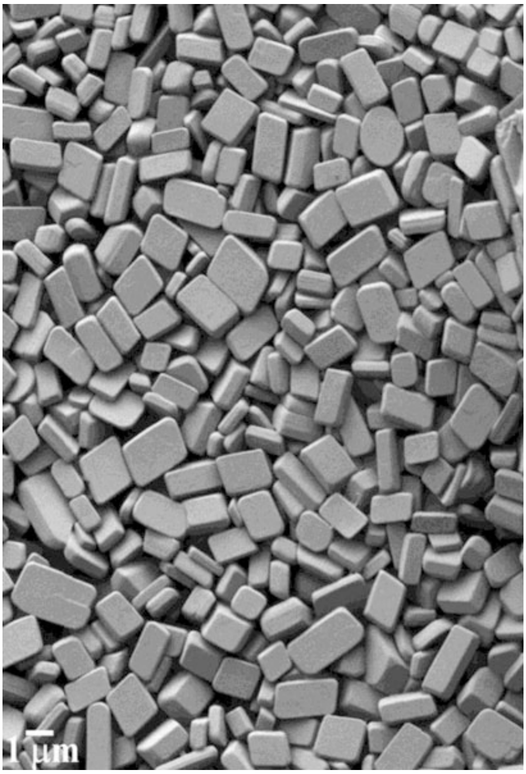
This age has consequently produced scientific minds that contrast Galileo, Leonardo, and other romantic figures that were risking their lives in fighting for truth and norms of timeless beauty against the intellectual repression of the establishment. Ours is the time pervaded with scientists that present their results by wishing to satisfy merely their funders and other reward holders, disregarding the precious connections with the wells of inspiration residing within their own minds, ending up suffocating the romantic charms of doing science, inherently tied to paradigm-shifting originality that borders nonconformist dissent, and becoming inert and uninspiring slaves of academic authorities. The mainstream scientist has thus become more obsessed with securing one's own academic recognition, tenure, and, increasingly, exorbitant salaries and social benefits more than with altruistically subduing the spell of Nature to the spirit of science. Instead of passionately searching for "truth" through the genuine dialogue between the human mind and Nature that all sciences represent, scientific activities have thereby begun to resemble any other business in which the creative force behind the production of goods is made passively subservient to demands of other people.

While depriving the modern scientific practice of the renaissance charm and profound, alchemical enthusiasm that used to endow scientific endeavors in the past, the majority of scientists have lost faith in the importance of nourishing gorgeous beliefs and aspirations as something that should underline each research effort. Yet, we could argue that truly significant scientific discoveries would hardly ever be made by one unless one's whole being starts living for their sake. The hypothesis that could be put forward at this point is that unless scientific conceptualizations and experimentations are pervaded with silent prayers radiating from the scientist's heart, the overall successfulness of the implemented methodologies will be, more or less, predestined for failure. Luckily, however, even when one cannot readily recognize the sources of love and care for the beings of the world behind the appearances of one's knowledge, they exist, deeply hidden like the roots of a tree, which is why even when it seems as if one carries out one's daily tasks absentmindedly, without any lovingness underneath one's breath, beneficial results may still miraculously appear in front of one.

The solution to this problem seems to lie not in rebuilding the artistic bases of scientific practice, but in illuminating them since they already exist in place, though most of the time unrecognized and ignored, the task much simpler than their recreation. By reinstating awareness of the artistic nature of scientific endeavors and bringing back the wholehearted passion for doing science, scientists may restore some of the personality traits and preferences that typified scientists and philosophers of the romantic era. For example, the love of science underlying scientific inquiry and practice has gone hand in hand with the interdisciplinary orientations of scientists. Leonardo, Galileo, Paracelsus, Goethe, or, more recently, Gregory Bateson, who were all combining, crisscrossing, and mutually fertilizing many areas of human inquiry and creativity, may be historical examples of scientists with exceptional interdisciplinary inclinations (Capra 2007). For when one loves something and cares about it, one naturally tends to look at it from a wide array of perspectives so as to enrich one's knowledge thereof and ensure its sustainability. The blind spot effect can also demonstrate how staring for too long at any particular system from a fixed stance makes one blind to many of its qualities. Interdisciplinary inquiry thus tends to pay off as constant changes of perspectives do not suffocate, but rather foster one's abilities to penetrate and comprehensively examine the investigated systems.

Another thing entailed by this romantic charm is a belief that one could do incredible things with a fistful of resources. Without these beliefs that stood behind many groundbreaking discoveries in science, including quantum theory and theory of relativity, no brave and "crazy" paradigms that turn the actual scientific outlooks upside-down could be arrived at. Just as exorbitant expenditures on health care have failed to increase life expectancy beyond certain levels (Garber and Skinner 2008), so has fosterage of ever more experimentation had little effect on boosting scientific excellence (Hollingsworth et al. 2008). The psychosomatic roots of human health and imaginative roots of scientific discovery are rather immune to attempts to enhance them guided by the simple norm "the more, the better," and looking back at the history of science can make one realize that most of the groundbreaking discoveries came out of little or no investment at all (Hollingsworth 2007). No wonder therefore that some of the most exciting scientific findings (Ball 2006), from penicillin to solar cells to Big Bang, were derived partly serendipitously (Roberts 1989). If the blueprints used for planning scientific or any other quests for meaning in life were drawn with a perfect precision, without leaving any space for an inflow of accidental, random effects, the prospect of paths projected toward discovery and innovation would seem vain. But a mind that holds on to logical concepts and guidelines and is yet open to absorb sudden and unpredictable signs arising on the research paths is the one suited for making remarkable discoveries. For the balance between analytical orderliness and dreamy voyaging to stars sets conditions for all types of progress in life. In other words, scientific conduct is inherently imaginative, spontaneous, and artistic and as such resists any attempts to confine it within a set of fixed instructions.

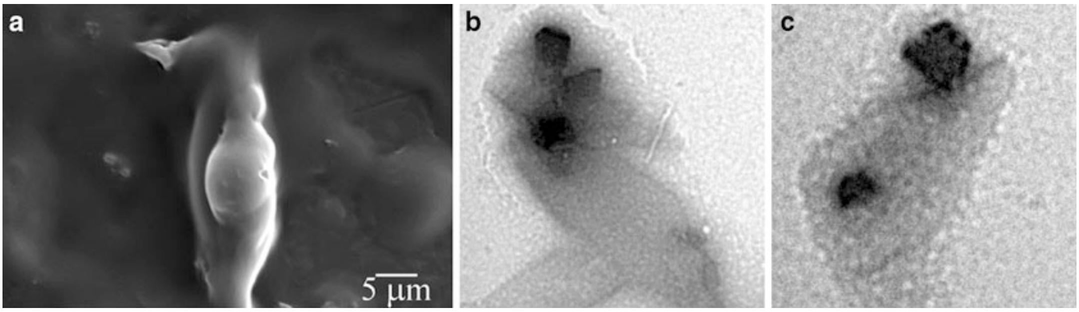
Serendipity, voted the most popular English word toward the turn of the century, derives its name after a Persian princess who had a natural gift for making extraordinary discoveries quite by accident (Uskoković 2010b), and if one's wish is to bring this elusive princess onto one's side, so to say, one better lets beautiful, lifesaving visions and emotions emanate from the depths of one's mind. For when tapping in the dark along innumerable possible sets of boundary conditions that could yield a desired product is required in the research realm, listening to the voice of intuition tapping on one's shoulder, often pointing at metaphorical signs in the everyday life that may be relevant for the given research, is of immense benefit. Indeed, then, embarked on a research voyage aimed at producing stable dispersions of cholesterol particles (Fig. 2; Uskoković and Matijević 2007), enormous amounts of time were spent outside, walking next to Raquette



Merits of Aesthetics in Realm of Science, Fig. 2 Monodisperse particles of cholesterol obtained by creatively traveling along parallel rails, one of which was emotive serendipity and the other one of which was epistemic clarity

River, caressing trees, climbing their branches, and rolling back against their bark in an eruption of pastorally amiable emotions. At the same time, a wish was constantly nourished to attain the aim and that never for the sake of advancing in career, but selflessly, for the sake of bringing forth discoveries that would benefit humanity. For unless steps in science or anything one engages one's creativity in are not made with a silent prayer radiating from the depths of one's heart, singing melodies that engrain a wish to bring beauty and salvation to the creatures of the world, whatever one does will not live up to the immense potentials that all human beings hold within. Poetically and prayerfully, therefore, even though one spends time diving for pearls in the sea of science, the kingdom where knowledge and reason occupy much higher place on the hierarchy of values compared to emotions and intuitions, one's actions are to be conceived and conducted in accordance with the simple guideline given by Blaise Pascal in his Pensées, "Heart. Instinct. Principles" (Pascal 1669), in no other order than this. It is with sadness in eyes that one could then observe the lifeless and passionless processions of modern professionals inertly following the streams of beliefs that any form of emotional involvement is a distraction rather than a motivation and drive essential for their endeavors in life to succeed. For since pragmatic purposefulness stands at the root of all sciences, neglecting to cultivate altruistic, warmhearted feelings during even the most routine lab bench work means going against the grain of genuine scientific creativeness, predisposing the resulting scientific edifices to be erected on inherently unstable, shaky foundations.

In that sense, an aesthetic eye can be said to be as important in navigating voyages toward discovery in the scientific realm as obedience to analytical principles that dominate the given field. To further illustrate this, three aesthetically pleasing images that possess scientific meanings too are displayed. In Fig. 3a, one could see a penguin-shaped deposit of amelogenin on the surface of fluorapatite/silica glass-ceramic, showing mineral formation associated with the penguin's "heart." Aside from an aesthetic appeal of the image, it possesses an intricate scientific message too by demonstrating that the nucleation and crystal growth of apatite in the presence of amelogenin, the main protein of the developing enamel matrix, starts from the amelogenin layers deposited on top of apatite surface, thus yielding vital insights into the mechanism by which amelogenesis in vivo proceeds (Uskoković et al. 2011b). The same parallel scientific and artistic meaningfulness could be ascribed to the transmission electron micrographs in Fig. 3b-c, where one could recognize an amelogenin cloud surrounding a few apatite particles akin to a supermodel doing a catwalk (Fig. 3b) and a cheerful hailer (Fig. 3c). Aside from their aesthetic appeal, these images demonstrate thorough binding of amelogenin to apatite particles (Uskoković et al. 2011a). Finally, getting back to the similarity in the wavy navy blue pattern in



Merits of Aesthetics in Realm of Science, Fig. 3 Scanning electron micrographs of calcium phosphate nucleating from within an amelogenin layer deposited on top of a fluorapatite/glass substrate (**a**) and 100 × 100 nm transmission electron micrographs of hydroxyapatite particles suspended inside of an amelogenin matrix (**b**, **c**)

Fig. 1a and b suggests not only that aesthetic appeal can assist scientists in their research but that there are hopes that scientific tools and imagery will be increasingly utilized in future in attempts to enrich and improve the fineness of artistic expression in numerous artistic genres and schools. To illustrate the immense potentiality of the envisioned encounter of sciences and arts, a starting point could be the Arts and Technology program conceived by the Los Angeles County Museum of Art in the late 1960s, whereby pairing scientists and artists around common projects resulted in numerous productive mutual fertilizations of ideas. Half a century later, an experimental project called Great Arts for Great Science is being developed at CERN with the aim to bring scientists and artists together under its umbrella and set up a platform for enhancing mutual understanding and communication between the two, starting from the assumption that "science has an emotional impact," whereas "art micro-influences people's perceptions and ways of approaching things" (Feder 2011). The effects of one such communication were probably most striking in the case of collaboration between the Californian painter, Robert Irwin, and the NASA physicist, Ed Wortz, of which Irwin said the following: "The biggest product of the Art and Technology thing is the effect we had on each other. I radically changed Ed's life, and he radically changed mine" (Weschler 2009). Experimentation in sensory deprivation in which they engaged through this common project propelled Irwin in the direction of more profound understanding and explication of the philosophy of perception, aside from mere artistic expression, while Wortz, who until that time had virtually no interest in art, eventually left his research in physics to become a gestalt psychotherapist at Los Angeles Buddhist Meditation Center.

Conclusions and Future Directions

The metaphoric nature of all human knowledge brings together scientific and artistic expressions under the same pragmatic umbrella. To realize that reaching for love and care stands at the root of all communications, scientific and artistic alike, is to reveal aesthetic foundations of all the diverse types of human inquiry about the place our being occupies in the cosmic scheme of things. Individual branches of the tree of human knowledge are to be naturally ramified in the course of its evolution, but cultivating a sense of unity supported by that fact that all these branches sap the underground waters from a common stem presents an equally important challenge. And this common stem stands for nothing other than aspirations of love and care for the fellow earthlings and life as a whole, animate and inanimate alike. It is them that could be hypothesized to act as the fundamental wheels of scientific creativity.

Scientists should be more widely inspired to write about and recognize the metaphoric meanings of relationships and imagery present in their sciences rather than ashamedly pushing them aside and indulging in unnaturally dull presentations of their paths to discovery (Uskoković 2009a). This would help interrelate their scientific thinking with real-life observations all until a feedback between the two is established. The real-life insights could then inspire one's scientific quests and vice versa. By explicating the importance of creative qualities forged through appreciation of human arts for productive and innovative scientific conduct, as well as by enhancing the impressiveness of artistic expressions by utilizing the scientific eye to the world, many benefits for both sciences and arts could be reached. In such a way, lights on the importance of bridges that extend between more aesthetic fields of human inquiry about the nature of reality, including theology (Uskoković 2010c) and arts (Uskoković 2010a), and empirical sciences, traditionally dominated by the merits of analytical reasoning, would be shed.

The artist dormant in every human spirit tells that without great passions and wholeheartedness, strivings to grasp the physical reality and bring it on to the side of humanity, so to say, will be futile. The rational thinker, on the other hand, tells that without analytical clarity and disciplined consistency, the artistic endeavors would appear chaotic and ungraspable. What may be called for then is bringing scientists and artists of the modern day face to face and appealing on them to imitate each other, all until a balance is reached. The former, constrained by the rigid norms of logic and ratio, unable to let go and follow the voice of their heart, and the latter, carelessly, without solid bases of analytical thinking, uncontrollably flying around in their flights of fancy, would be transformed for better. By mirroring each other, scientists may end up opening their hearts and filling them up with vivid imaginations which would then be included in guiding their day-to-day professional activities and decisions in the lab. For to be a truly inspiring scientist, one needs to feed the thirst of one's philosophical and artistic senses and to constantly question the meaning of it all, alongside devoting his studying efforts to aims that surmount the narrow confines of his ego. As for the artists, this would instill analytical order and discipline into the nihilistic chaos and frequent fruitlessness of their mindsets. Needless to say, both would prosper. For art is meant to serve the purpose of glorifying both the human spirit and the world, of awakening love and wonder in human eyes, and pointing at immaculate traces of beauty that reality abounds with. In return, such feeding of creative potentials of human beings through arts and deifying the world by artistic means goes back to produce ever more wonderful scientific and technological creations which are then to ignite the artistic sense of wonder in humans in this endless feedback cycle during which human spirit enriches the world that enriches human spirit. With each spin of this wheel whereon science and arts are intimately conjoined, human spirits become ever more elated and the world ever more inspiring and fulfilling.

To sum up, the message for the stereotypical scientist of the modern times is that the qualities of bright intellect alone, without the support of the shining grace of human heart underneath, would never be able reach enduring solutions to the problems of life lying ahead. This is why, prior to engaging in any scientifically creative endeavor, it is necessary to look back first through the eyes caring to build the foundations of the embraced research approaches in the light of love and passion, and only then look forward, in the direction of the new coasts of knowledge and epistemic treasures that crave to be discovered, peeking at us gleefully from beyond the horizon. "I like the view but I enjoy sitting with my back turned to it," Gertrude Stein said once, offering a thought that neatly reflects what tedious conformists that inhabit the academic hallways of the modern day may merely see as a sympathetic quirkiness in the way of doing science of one who has held on to the hereby advocated balance between analyticity and artfulness. For with one such fanciful descent into the foundations of the eye that sees the world did this discourse begin, and the streaming of humanity toward horizons of enlightening futuristic insights and discoveries will be inevitably conditioned by the human willingness and ability to descend to the deepest foundations of experience every now and then and lightly sweep the dust of human ignorance collected over time on the antique pillars found thereon, on which the world is sustained.

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Cross-References

▶ Cognition of Creativity
▶ Creative Brain
▶ Creativity and Emotion
▶ Creativity and Systems Thinking
▶ Creativity, Experiential Theories
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
▶ Freedom and Constraints in Creativity
▶ Ideas and Ideation
▶ Imagery and Creativity
▶ Imagination
▶ Interdisciplinary Research (Interdisciplinarity)
▶ Invention Versus Discovery
▶ Nature of Creativity
▶ Psychology of Creativity
▶ Science of Creativity
▶ Thinking Skills, Development
▶ Transdisciplinary Research (Transdisciplinarity)

References

Ball P. Chancing upon chemical wonders. Chemistry World. 2006;32:6 (June 2006).

Braben DW. Pioneering research: a risk worth taking. New York: Wiley; 2004.

Capra F. The science of Leonardo: inside the mind of the great genius of the renaissance. New York: Doubleday; 2007.

Emerson RW. Nature. New York: Penguin; 1836.

Feder T. High-energy physics lab seeks discovery-oriented artists for close interactions. Phys Today. 2011;64(4):23–5.

Garber AM, Skinner J. Is American health care uniquely inefficient. J Econ Perspect. 2008;22(4):27–50 (Fall 2008).

Hollingsworth RJ. High cognitive complexity and the making of major scientific discoveries. In: Sales A, Fournier M, editors. Knowledge, communication and creativity. London: Sage Publications; 2007. p. 129–55.

Hollingsworth RJ, Müller KH, Hollingsworth EJ. The end of the science superpowers. Nature. 2008;454: 412–3.

Kant I. Critique of pure reason. Belgrade, Serbia: BIGZ; 1781.

Pascal B. Pensées; Pensée No. 155 (trans: Krailsheimer AJ). Harmondsworth: Penguin; 1669.

Roberts RM. Serendipity: accidental discoveries on science. New York: Wiley; 1989.

Schuller G. Form and aesthetics in twentieth century music. In: Curtin DW, editor. The aesthetic dimension of science. New York: Philosophical Library; 1980.

Usković V. On science of metaphors and the nature of systemic reasoning. World Futures J Gen Evol. 2009a;65:241–69.

Uskoković V. On the light doves and learning on mistakes. Axiomathes Int J Ontol Cogn Syst. 2009b;19:17–50.

Uskoković V. On the relational character of mind and nature. Res Cogitans J Philos. 2009c;6(1):286–400.

Uskoković V. A collection of micrographs: where science and art meet. Technoetic Arts J Specul Res. 2010a;7(3):231–48.

Uskoković V. Serendipity in the realm of science. Synapse. 2010b;54(16):3–4.

Uskoković V. The metaphorical model: the bridge between science and religion. J Interdiscip Res Relig Sci. 2010c;6:11–34.

Uskoković V. Collected books in English. 2012. Available online at http://uskokovic.yolasite.com/books-in-english.php. Accessed 1 July 2012.

Uskoković V, Matijević E. Uniform particles of pure and silica coated cholesterol. J Colloid Interface Sci. 2007;315(2):500–11.

Uskoković V, Odsinada R, Djordjevic S, Habelitz S. Dynamic light scattering and zeta potential of colloidal mixtures of amelogenin and hydroxyapatite in calcium and phosphate rich ionic milieus. Arch Oral Biol. 2011a;56:521–32.

Uskoković V, Li Wu, Habelitz S. Amelogenin as a promoter of nucleation and crystal growth of apatite. J Crystal Growth. 2011b;316:106–17.

Weschler L. Seeing is forgetting the name of the thing one sees: expanded edition, over thirty years of conversations with Robert Irwin. Berkeley: University of California Press; 2009. p. 135.

Whitehead AN. Science and the modern world. Belgrade, Serbia: Nolit; 1925.

Wilczek F, Devine B. Longing for the harmonies: themes and variations from modern physics. New York: W. W. Norton & Company; 1988. p. xi.

Wilkinson DH. The Universe as artefact. In: Harris H, editor. Scientific models and man, The Herbert Spencer Lectures delivered in the University of Oxford, 1976. Oxford, UK: Clarendon; 1979.

Metacognition

▶ Strategic Thinking and Creative Invention

Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education

Hernan Casakin
School of Architecture, Ariel University
Center of Samaria, Ariel, Israel

Synonyms

Cognitive mechanism; Figure of speech; Likeness

Introduction

Contemporary theories define "metaphors" as devices that aid in structuring our thoughts. Metaphors influence how we perceive the world, classify experiences, and guide our reasoning. These tools can help *reflect*, *understand*, and *solve a problem* from new and unconventional perspectives. For these reasons, metaphors play a critical role in the "design" domain, where they not only contribute to *organize design thinking*, but also have the potential to enhance "creativity." Another characteristic is that they allow designers to think unconventionally and encourage the application of original ideas to design problems. The use of metaphors is well documented in the design literature despite not many empirical studies were carried out in order to analyze the contribution of metaphors to design and to design creativity in particular. In this entry, the relations of metaphors and design creativity, and their implications to practice and education are discussed.

The Notion of "Metaphor" in "Problem Solving" and the Generation of "New Concepts"

Metaphors

Numerous definitions have been given for *metaphor*. This notion is defined as a figure of speech where a word or phrase literally signifying one type of object or idea is used in place of another to imply a likeness between them. Metaphors allow reflecting on a *concept* by considering other concepts that are either weakly related or not related at all. Metaphors can also help comprehend an *experience* in regard to another experience. For example, the metaphor "falling into a sea of love" suggests the existence of infinite love. In language, metaphors can be recognized by the preposition "as" or the verb "is" (e.g., "each person *is* a whole world" or "a city *as* a jungle").

Metaphors are generally used as linguistic devices in daily communication (e.g., Lakoff and Johnson 1980), but can be also found in a diversity of domains such as science, engineering, art, literature, design, and education.

One of the most well-known contemporary theories of metaphor was proposed by Lakoff and Johnson (1980) and by Lakoff (1993). This theory considers metaphors as cognitive tools that enable to categorize human experiences according to a *conceptual system*. Accordingly, metaphors influence how people understand, think, perceive, and organize concepts and experiences in their minds. When a metaphor is incorporated into our conceptual system, it may change our perception of a particular situation and provide a new understanding.

Metaphors can be classified into verbal and figural:

- *Verbal metaphors* – are concerned with abstract ideas and concepts generally represented by text or speech.
- *Visual metaphors* – concepts are represented by visual displays, such as drawings and photographs, and are of particular importance for the design domain.

Metaphorical Reasoning

Metaphorical reasoning is defined as the *cognitive act* that enables a description of an object or event, real or imagined, using concepts that cannot be applied to the object or event in a conventional way. The vague nature of metaphors enables a unique type of reasoning that permits exploring unknown ideas and to establish novel relations with other unrelated ideas. Basically, metaphorical reasoning refers to the identification of previously overlooked or unnoticed *similarities* between two apparently unrelated *ideas*. In many cases, such ideas belong to different fields that are *distant* one from another, like, for example, architecture and literature. By means of metaphorical reasoning, it is possible to establish a comparison between two ideas that have some characteristics in common, but at the same time they differ in others.

Metaphors and Problem Solving

Metaphors are viewed by cognitive psychologists and linguistics as efficient *heuristics* aiding in *problem solving*. Problem solving is referred to the area of cognitive psychology that studies the thought processes involved in solving problems. As *cognitive strategies*, metaphors enable problem solvers to enlarge the universe of possible solutions, affecting the way they perceive and structure knowledge in their minds when dealing with a problem. Therefore, the power of metaphors is essential to reflect, understand, and solve a problem from new and unconventional perspectives.

The use of metaphors in problem solving is characterized by the following steps, proposed by Gentner et al. (2001):

- *Retrieval and interpretation of metaphorical concepts* – one or more unfamiliar concepts are identified and retrieved from remote metaphorical sources and are interpreted and represented through a number of principles. In this first step, potential relationships with the problem at hand are generally not obvious to the problem solver.
- *Mapping of relationships* – it consists in establishing a system of correspondences or relations between the metaphorical source and the problem at hand, enabling a novel understanding of the situation.
- *Transference of relationships* – the system of relationships obtained from a metaphorical source is transferred to the problem at hand, and a novel concept is applied and developed as a problem solution.

Metaphors are especially useful in problem-solving tasks such as design, where the production of creative solutions is a most important and critical aspect.

Metaphors and the Generation of New Concepts

Another virtue of metaphors is the generation of *innovative concepts*. The creation of novel and innovative concepts is related to how individuals *interpret* and *structure* their *experiences*. Perceiving and structuring an experience from an unfamiliar point of view can contribute to the transformation of conventional and familiar concepts and to the reinterpretation of a situation in terms of *transformed* and unfamiliar concepts. Transformed concepts are defined as extensions of old and known concepts that have been modified, and therefore they embrace new views of a known situation.

The metaphor "a city is a kind of living organism" illustrates the transformation of the traditional concept of "city." The meaning of "a kind of living organism" and its projection on the idea of "city" will very much depend on how the metaphor is interpreted and applied to the novel situation. However, the notion of living organism is not associated to any organism in particular, but instead to a group of concepts that can be subjectively related to it. Thus, the relationships established in a metaphor can be seen as the result of the transformation of concepts influenced by personal experience as well as by individual expectations.

"Design" by "Metaphor"

Design

The notion of *design* is generally referred to as a drawing or a plan created to illustrate the appearance and function of an artifact, big as a building or small as a microchip, before it is made. The *act of design* not only allows elaborating the form of an object, but also to *plan* and *direct actions* to foresee how the object will look and behave. Primarily, to design is about the manipulation of form, function, aesthetics, and materials of an artifact, and in domains such as architecture, it is also concerned with the treatment of light, space, and environment. The design of an artifact needs to satisfy goal specifications, a number of constraints, and a set of requirements. The design activity extends to a variety of areas such as industrial, engineering, architectural, graphic, and textile design.

Design Problems

A characteristic of *design problems* is that they are *ill-defined* (also called *wicked problems*), and as such they are difficult to formulate (Goel 1995). These singular problems are complex, unstructured, and undetermined. A basic difference with *well-defined* problems is that these type of problems lack:

- *Completely specified initial conditions* – when problem solving begins, the starting state of the design process is ambiguous and controversial.
- *Means for transforming initial conditions* – problems cannot be totally solved through the use of automatic operators, or by the application of algorithms since they are nonroutine, meaning that they differ from one to the other. Therefore, solving an ill-defined problem involves searching a large number of potential unique solutions.
- *Completely defined goals* – the end state, or the target be reached, is unclear and ill-specified.

Due to the nonroutine, unclear, and ambiguous nature of the design problems, it is difficult to know beforehand what type of information will lead to a successful solution. It is also difficult to know how the design outcome will look like. For all these reasons, design problems embrace the generation of *creative* and *unpredictable solutions*.

Design Process

From the late 1970s, design problem solving started to be viewed as a nonroutine and unique activity strongly based on individual experience and innovative thinking (Dorst and Cross 2001). Since then, many studies have been conducted to gain insight into the nature of the design process. A main focus was set on the individual thoughts, intentions, and goals of the designer, which are fundamental to not only structure and represent design problems, but also to guide the design process.

According to Schon (1985), the design process can be characterized by a *cyclical interaction* between the *reflective designer* and a permanently evolving design situation. In his view, the design process can be described as *reflection-in-action*, which is the result of an iterative search cycle where the designer is involved in a *reflective conversation* with the design situation. The main phases of the reflection-in-action approach are:

- Identification of relevant aspects of a design situation
- Definition and representation of the design problem according to personal interpretations and experiences of the designer
- Performing design actions to find a viable solution
- Reflecting on the design outcomes

Understanding the design process as reflection-in-action is very helpful in the early stages of the design process, where design alternatives can be manipulated and transformed as the interpretation and representation of the design problem evolves.

Using Metaphors in Design Problem Solving

Designers use different types of aids to deal with design problem solving, such as references, typologies, design principles, analogies, and metaphors. Instead of attempting to solve problems through known design solutions, the use of metaphors enables to *reflect* on the ill-defined nature of design problems from the beginning of the design process. In this way, metaphors assist in converting ill-structured design situations into *manageable problems*.

Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education, Fig. 1 The Lloyds Bank building, London, 1985 by architect Richard Rogers, depicting the use of the verbal metaphor "form follows function." (**a**) Frontal view of main façade. (**b**) Lateral view of main façade

Despite designers are not always conscious of the role played by metaphors, they often use them as primary aids to:

- Clarify design ideas and organize design thinking
- Structure undetermined design situations
- Characterize, represent, and redefine designs anew
- Limit the large number of potential design solutions

However, establishing metaphorical relations with design problems is a most difficult step of the process. This is achieved through an iterative process, which develops progressively as designers become more acquainted with the design situation (Casakin 2011).

The strength of metaphor in design problem solving also resides in its vagueness and *ambiguity*, since without being anything in particular, it can be many things simultaneously. From a design perspective, ambiguity is what differentiates between:

- *Literal use of a metaphor* – an identical copy of an object that served as a metaphorical source
- *Using a metaphor through personal interpretation* – as a tool for restructuring a design situation by reflecting and elucidating on the object used as a metaphorical source

The ambiguous nature of metaphors allows to move beyond constraints imposed by conventional design, explore unfamiliar alternatives, and gain broader understanding of previously unforeseen design aspects.

The Use of Verbal and Visual Metaphors in Design

There is a vast collection of examples reporting the use of *verbal* and *visual metaphors* in the design literature. In the architectural domain, metaphors influenced entire generations of designers. For example, in his book "Complexity and Contradiction," the architect Robert Venturi refers to the verbal metaphor "less is a bore" to "promote richness and ambiguity over unity and clarity" and "contradiction and redundancy over harmony and simplicity." The Lloyds Bank building by the celebrated architect Richard Rogers illustrates the use of the verbal metaphor "form follows function." Accordingly, the external appearance of the building is the outcome of the exposition of the building's internal uses such as staircases, lifts, and pipes (see Fig. 1a, b).

Antoni Gaudi's formal explorations on fantastic organically inspired designs illustrate an example of the use of visual metaphors evoking the presence of natural patterns. His architecture transcends mere functionality to create extremely innovative motives, forms, structures, and spaces that are sensitive to a poetic view of reality. The Catalan architect incorporates into his designs principles adopted from nature, such as

Metaphorical Reasoning and Design Creativity: Consequences for Practice and Education, Fig. 2 Casa La Pedrera, Barcelona, 1905 by architect Antoni Gaudi, depicting the use of visual metaphors taken from nature such as organic forms and growing patterns. (**a**) Facade. (**b**) View from the terrace

organic curves and growth patterns, using a method technically known as organic construction. Typical examples of breathtaking creations bringing to light underlying principles behind Gaudı's designs are Park Guel and Casa La Pedrera (see Fig. 2a, b). Another example is the Heinz Galinski School by Zvi Hecker, who also became interested in organic and complex forms. Hecker uses the visual metaphor of "an open book" to design a singular learning environment represented by a series of twisted spaces organized by a radial system. The idea of an open book allowed the design of a singular school in which private irregular places surrounding a central patio open to panoramic views to the city. As a result, an unusual experience of endless and surprising smashed spaces is generated.

"Creativity" and "Design"

Creativity

Creativity refers to a fascinating and stimulating human ability that goes beyond daily and routine thinking and doing. Numerous definitions have been given for the notion of creativity, for example, the ability to restructure known concepts to make uncommon inventions. According to Csikszentmihalyi (1997), creativity is related to the ability to perceive reality from unconventional viewpoints, communicate original thoughts, explore unusual alternatives, and make valuable discoveries. Creativity is associated with unusual or statistically infrequent things that are also remarkable and valuable. This notion is also concerned with the application of cognitive processes related to *innovative problem solving* that can lead to the generation of remarkable and helpful solutions.

Assessment of Creativity

A key subject in the creativity literature deals with the problem of how creativity can be assessed. When creativity is put into practice to assess individual performance, it is typically defined by four main factors proposed by Guilford (1981):

- *Fluency*: total number of relevant responses
- *Flexibility*: different categories of relevant responses
- *Elaboration*: amount of detail in the responses
- *Originality*: statistical rarity of the responses

Self-assessment of Creativity

Self-assessment of creativity is defined as the manner that people *evaluate* their *own creativity*. In the early 1970s, a diversity of tests of creativity were conceived to assess an individual's self-perception of creativity. Studies conducted in different domains such as writing, statistics, and psychology showed that the way people assess their own creativity affect their thinking. For example, high self-assessment of creativity was shown to improve the enthusiasm and devotion to work.

Creativity in Design

Creativity is a most important characteristic of the design activity. *Design creativity* refers to the design acts necessary to produce useful but also novel and valuable outcomes. A characteristic of creative design problems is that they are nonroutine and innovative, and thus cannot be solved by retrieving prior knowledge. Design creativity refers to the exploration of unfamiliar information and the development of new ideas that conduct innovative solutions. This requires restructuring and a shift in the perception of the design problem anew.

Most research on design creativity focused on the grounding of creativity, the personality of the designer, the design process, and on the promotion of creativity, such as the development and application of models, methods and strategies for enhancing, or supporting creative design outcomes. Other studies centered on the personal motivations leading to the generation of creative acts, but only few of them centered on the assessment of design creativity (e.g., Casakin and Kreitler 2008).

Assessment of Design Creativity

In the design domain, the *assessment of design creativity* is an important but poorly acknowledged subject. In most cases, design creativity is evaluated as an all-inclusive assessment sustained by the agreement or common understanding shared by experts of the field. It is quite frequent that the evaluation of creativity in design is not based on objective parameters, or on well-defined criteria, and thus it remains biased and fuzzy. When design creativity is assessed by expert knowledge based on objective criteria, originality is seen as the most dominant factor, followed by fluency and flexibility. Elaboration, however, is considered a weak factor (Kreitler and Casakin 2009).

Self-assessment of Design Creativity

Self-assessment of design creativity refers to the way that designers *evaluate* their *own creativity*. The capability of designers to explore and find out new knowledge is assumed to depend to a large extent on the manner they perceive and assess their own designs. However, the validity of self-perceived creativity as a measure of design creativity depends on how their understanding of the design process is affected by their:

- Knowledge
- Skills
- Experiences
- Emotions
- Attitudes
- Goals
- Motivations

Despite some have questioned the validity of self-assessment of creativity, learning from self-assessment has important implications for design practice and design education. Understanding the manner that designers, and design students in particular, assess their own designs plays a crucial role in knowing how to support and assist them through the process.

"Metaphors" and "Design Creativity": The "Design Studio"

Metaphors and Creative Design

Metaphors are ideal to support and enhance *design creativity*. One of the reasons is that creative design is characterized by the exploration of a vast number of alternatives, most of which extend besides known and familiar solutions. Another reason is that metaphors help enhance creativity by encouraging reflection on design problems anew (Schon 1985).

Metaphorical reasoning also enables stressing some aspects of the design problem while momentarily ignoring specific constraints that can be detrimental to develop design creativity. The use of metaphors allows designers to think *unconventionally* as they support the application of new ideas to familiar design problems. Changing from one metaphor to another strongly affects how designers understand and represent a design situation. Therefore, different metaphors can potentially lead to a large number of diverse and creative problem redefinitions. Interpreting and representing a problem through the use of metaphors contributes to a more prolific exploration of innovative and creative candidate design solutions.

Creative Design and the Design Studio

The acquisition and development of theoretical and practical professional knowledge is a major aim of *educational programs* in departments of design. A large part of the educational process takes place in the *design studio*. The design studio is defined as the most important educational environment where students acquire skills, integrate theoretical with practical knowledge, while they enhance their expertise and competence, and develop their judgment progressively. The design studio is also the place where students imagine, plan, and develop innovative artifacts. It is in this educational environment where the use of metaphors can contribute to enhance the creativity of the students.

The Design Studio Pedagogy and Creativity

The traditional *design studio pedagogy* is based on two main *educational approaches* dealing with:

- *Learning-by-doing* – refers to the transference of experience from teachers to students, mainly in a *listening* and *doing* way. During "one-to-one" training sessions, students develop their designs in a *trial-and-error* manner, while teachers criticize the projects and make recommendations to improve their achievements. A main shortage of this educational approach resides on the dependency established by the students with their teachers, in particular at the beginning of the career, which can be detrimental to the development of individual design creativity.
- *Precedent-based reasoning* – in this educational method, students are exposed to a collection of selected *projects*, such as artifacts and buildings designed by master designers that are in some ways similar to the design problem at hand. Through this pedagogical approach, students learn a series of design issues that are supposed to help them deal with the problem. However, a disadvantage of this approach is the frequent lack of capacity and skills to identify and retrieve critical knowledge from the design examples and transfer it to the design situation. Thus, most cases, students blindly copy existing projects, resulting in uncreative design outcomes.

Despite the shortages and disadvantages of the above educational approaches, they are fully adopted in most design studios around the world.

Metaphors in the Design Studio and Their Contribution to Creativity

The use of metaphors in the design studio constitutes an *alternative pedagogical approach* to the traditional design studio methodologies (Casakin 2011). Metaphors are proposed as an unconventional educational method that helps students develop their project according to their own views and beliefs. An advantage of this approach is that it sensibly reduces dependence ties established with studio teachers and the inability to deal with imposed design precedents.

The use of metaphors in the studio showed to have a positive effect on promoting creativity with regard to three main components:

- *The design student* – endows with meaningful personal experiences to improve their learning and creative skills
- *The design process* – contributes to identification of design goals, clarification and definition of design situations, exploration of remote domains not associated with the design problem, and restructuring design situations from scratch, a stage considered critical in creative design problem solving
- *The design outcome* – enhances originality, innovation, and elaboration of the design product

Conclusions and Future Directions

Metaphors were showed to be powerful cognitive strategies that assist in problem-solving tasks demanding creative skills such as design. Metaphors affect how designers reflect, understand, and solve a problem from novel viewpoints. Perceiving a design situation from unfamiliar perspectives can contribute to the restructuring of design thinking, which is particularly helpful in the early stages of the process.

The use of metaphors has important implications for both design practice and design education. The application of these tools in real practice can contribute to think unconventionally and avoid or reduce reutilizing familiar design schemas and existing solutions. The variety of concepts retrieved from different metaphors can guide the designer to a large number of problem interpretations and eventually to generate more innovative design products. Besides this, metaphors showed to play an important role in the design studio and to enhance the creativity of students. Future intervention programs should consider the adoption of metaphor use in the design studio as a genuine alternative to existing pedagogical approaches.

Cross-References

- ▶ Cognition of Creativity
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity from Design and Innovation Perspectives
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Nature of Creativity

References

Casakin H. An empirical assessment of metaphor use in the design studio: analysis, reflection and restructuring of architectural design problems. Int J Technol Des Educ. 2011. doi:10.1007/s10798-010-9149-x.

Casakin H, Kreitler S. Correspondences and divergences in creativity evaluations between architects and students. Envir Plan B Plan Des. 2008;35:666–78.

Csikszentmihalyi M. Creativity: flow and the psychology of discovery and invention. New York: Harper Perennial; 1997.

Dorst K, Cross N. Creativity in the design process: co-evolution of problem–solution. Des Stud. 2001;22: 425–37.

Gentner D, Bowdle B, Wolff P, Boronat C. Metaphor is like analogy. In: Gentner D, Holyoak KJ, Kokinov BN, editors. The analogical mind: perspectives from cognitive science. Cambridge: MIT Press; 2001. p. 199–253.

Goel V. Sketches of thought. Cambridge: MIT Press; 1995.

Guilford JP. Potentiality for creativity. In: Gowan JC, Khatena J, Torance EP, editors. Creativity: its educational implications. 2nd ed. Dubuque: Kendall Hunt; 1981. p. 1–5.

Kreitler S, Casakin H. Motivation for creativity in design students. Creat Res J. 2009;21(2):282–93.

Lakoff G. The contemporary theory of metaphor. In: Ortony A, editor. Metaphor and thought. New York: Cambridge University Press; 1993. p. 202–51.

Lakoff G, Johnson M. Metaphors we live by. Chicago: University of Chicago Press; 1980.

Schon DA. The design studio: an exploration of its traditions and potentials. London: Royal Institute of British Architects; 1985.

Method for Creating Wisdom from Knowledge

Michihiko Esaki
Wisdom Management Research, DTCN International Incorporation, Gifu City, Japan

Synonyms

Abductive, deductive, and inductive thinking; Bridging knowledge management to wisdom management; Creative thinking; Decision making and judgment; Optimization; Problem solving by wisdom; Project management; Research and development; Wisdom management methodology

Background of Methodology

To think, take action, and get results in a complex problem and task realization, it is necessary to know where to start and what is the end result.

The "Method for Creating Wisdom from Knowledge" published in 2009 is the most comprehensive and universal method in the world at present (2013).

The development of this methodology started with the writing of the Japanese paper "A Method of Decision Making for Management" using information of difference in 1976 and the English version in 1977 for the 4th International Conference on Production Research (Tokyo, Japan). Since then, there have been many applications leading up to its full development.

For example, in 1979 and 1985, it was successful in the creation of the Design to Cost procedure http://dtcn-wisdom.jp/1979-Design-to-cost-procedure-WashDC.pdf which led to the further development of the Method for Changing Knowledge to Wisdom (1999–2010). As a result, the English version of the Method for Creating Wisdom from Knowledge was presented in 2010. The entire contents of this methodology has been put on the public domain from September 2011 (http://dtcn-wisdom.jp/00001-E-wisdom%20book.pdf) and can be utilized by anyone around the world in order to "Save the Earth, create and satisfy customers."

The entire contents include Problem solving by wisdom, Method for creating wisdom for task realization, and Wisdom Management Methodology.

Each method can be downloaded from: http://dtcn-wisdom.jp/00001-E-problem-solving.pdf http://dtcn-wisdom.jp/00001-E-wisdom%20book.pdf http://dtcn-wisdom.jp/00001-E-wisdom-managent.pdf

The "Method for Creating Wisdom from Knowledge" consists of the componential method stage, way of thinking, and the elements of methods, as shown in Fig. 1.

Explanation 1: Relationship of the Purpose and Measure

The starting stage is ⓪, which is the stage in chaos (Fig. 1). This is the Measure.

The upper most purpose is to realize "Save the earth, create customers, and satisfy customers" as shown in ①. The upper first level purpose is "to get results of the upper level purpose, i.e., customers' satisfaction and safety"②.

The upper second level purpose is "to secure the minimum profit required for the above-mentioned purpose including risk cost" ③.

In order to do the above, it is necessary to have the mindset of ④ and ⑤ and the component method of ⑥ to ⑭ in Fig. 1. Figure 1 must be read from top to down while repeating, "in order to do XX, it is necessary to do YY."

Explanation 2: Explanation of Each Mindset of the Components and Methods

④ Decision mechanism by information of difference.

⑤ Exact usage of the questions: "In order to do what, how to go about doing it" and "Why,"

i.e., "In order to do . . ., how to do . . .?" This question is directed to the future and creates wisdom (for the future). However, the question "Why?" arrives at a dead end (refer to above URLs).

⑥ Switch "Problems" to "Tasks," but when it is a task to begin with, do not make the switch.

In the case of problem solving, the first step is to think about the cause of the problem. However, in the case of the task, the first step is to think about the purpose or upper purpose of the task.

To combine this thinking style, it is necessary to switch "Problems" to "Tasks," but when it is a task to begin with, do not make the switch.

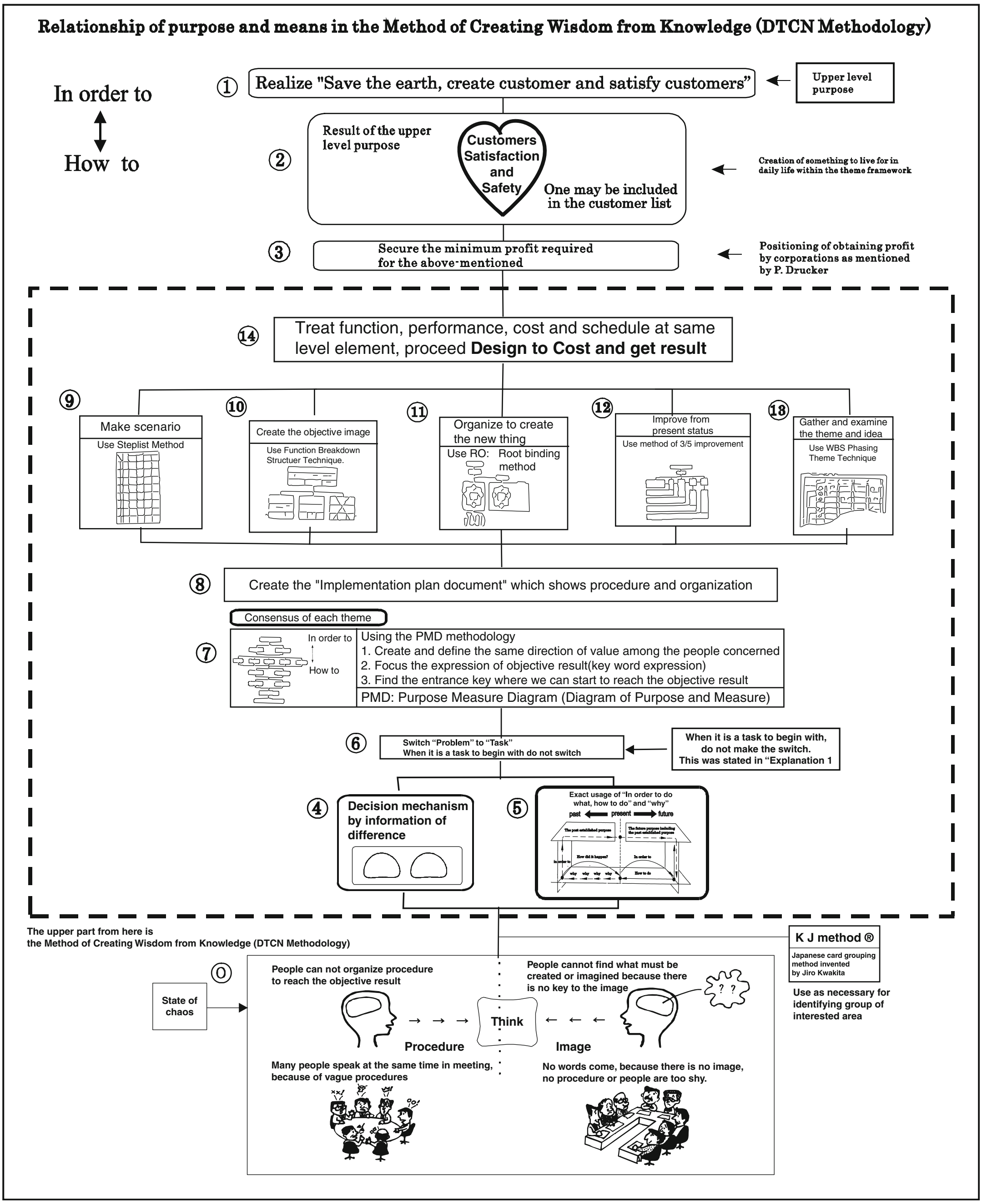
⑦ Use the PMD (Purpose Measure Diagram) method to grasp the Direction of Will and the "Main Keyword," for decision making and judgment under the mechanism of theory of decision and judgment mechanism using information of difference (presented in Japanese in 1976 and in English in 1977).

This method can effectively be used for abduction (hypothesis) and deduction thinking simultaneously by having the direction of Will and its "Main Keyword" for success.

⑧ Create the implementation plan document to effectively use the component methods of ⑨, ⑩, ⑪, ⑫, ⑬, ⑭.

⑨ Use the Steplist method to create a faultless inductive/deductive approach thinking and actions for each phased procedure of thinking, actions, decision, and judgment.

This model comes from the Japanese rice cooking process for tasty eating catered to the customers' requirements. This model also includes well-controlled quality assurance and quality



Method for Creating Wisdom from Knowledge, Fig. 1 The relationship of the Purpose Measure component in the Method for Creating Wisdom from Knowledge which can lead to the Wisdom Management Methodology

management mechanisms. This is referred to as exact and faultless phased project management procedures.

⑩ Use FBS (function Breakdown Structure) technique for creating structure of things or systems and their operations. This method integrates and creates effective and efficient structured Things and System WBS (Work Breakdown Structure) and their operation.

Method for Creating Wisdom from Knowledge, Table 1 Relationship of Knowledge, Will, Wisdom, and "New Knowledge by result of wisdom" Michihiko Esaki 2000/9/17、Rev4 2011-3-17. (Note) An introductory chapter to the Method for Creating Knowledge from Wisdom can be found at http://dtcn-wisdom.jp/00001-R3E1.pdf

Have Knowledge of "Knowledge to Wisdom"	Feed back	1	Have Knowledge: If one has the knowledge of the Method for Creating Wisdom from Knowledge, whether consciously or unconsciously, people can proceed to action rows 2 to 4 faultlessly.		Have Knowledge indicates having the following 2 information: 1. Have information on cause-effect relationship. To have knowledge means that if something is done, a certain result can be expected (For example, having knowledge that if the light switch is turned on, the light bulb will shine.) 2. Have information on the existence. Information on the existence of 'things' or 'information'. (ex.1) Information that a building exists somewhere. (ex.2) Information that the following "Information on wisdom" exists	Method of acquiring knowledge	Have knowledge through experience	Experience gained through experience, have sensory knowledge. (ex.) To know how to ride a bicycle. (characteristics) To unconsciously know the cause-effect relationship.
							Have knowledge through studying.	To have knowledge in the narrow sense obtained through reading and hearing.
							To Analyze http://dtcn-wisdom.jp/00001-E-analysis.pdf	For things that have already occurred, clarify ① what are the Will (of people, nature's laws or Will), ② what is the input and output relationship and ③ whether the results have come out.
		2	Have Will	A	Have wants, needs and seeds	Wants means to have the desire or wish to do something. Needs means to have the demand to want something that is realizable. Seeds indicates having the seed or means that a thing can be used for something. Having one or more of these things is acceptable.		
				B	Organizing the Will (Organize in the Direction of Will and the Main Keyword).	In order to realize any one or the combination of the above wants, needs and seeds one will have to grasp the Main Keyword and the Entrance Keyword, which will realize the Main Keyword and show where to start, by asking oneself "In brief, how to do it?", "In brief, to do what?" (The PMD (Purpose Measure Diagram) is very effective in organizing this. In addition, by grasping the Main and Entrance Keywords, the mechanism of decision making and judgment through Information of Difference will be able to be used to realize it.)		
		3	Have Wisdom	A	Have procedure in order to realize the following	1. Based on 1., information relating to a "Faultless Phased procedure", which shows how to realize the desired results, will be created. (example) Information relating to a Faultless-Phased procedure such as "In order to brighten a dark room, a lighter will be used to find the light switch on the wall so that it may be turned on." (The Steplist method is very effective in creating this procedure.)		
				B	Have the structural component of things or systems of the desired results	2. Information concerning the mechanism and components of 'things or systems' are created so that one may understand what 'things or systems' are needed in order to realize it. (ex.) Information relating to the mechanism of things need to be on hand or must be created so that one may know what kind of reinforcements are necessary to design a house capable of withstanding an earthquake with a magnitude of 7. (The FBS (Function Breakdown Structure) method is very effective in creating an optimized structural component.)		
		4	Have new knowledge as a result of using wisdom			By being able to explain to others the above wisdom, this wisdom then changes into 'new knowledge'. Then, it can be passed on to others as knowledge.		

By returning the result which has the new information of 4. back to "Have knowledge" of 1., it can be used to create new wisdom by the newly created "Wisdom Engine"

⑪ Use the RO (Root Organizing) method to organize new things and systems in conventional organizations.

⑫ Use the 3–5 improvement method for defining the temporary, middle, and final stages.

⑬ Use the WBS phasing theme technique to "pick up" the theme/idea for all lifecycle stages to prevent undesirable results in operation.

⑭ If you want to proceed with the Design To Cost procedure, you can proceed by using the above-mentioned methodology which has the cost and schedule elements in it.

Explanation 2: How to Proceed with Wisdom Management

1. Add the knowledge of Method for Creating Wisdom from Knowledge to conventional knowledge or management knowledge. Then, it will be in the wisdom management domain.
2. In order to have wisdom, it is only necessary to have the direction of Will and the Main Keyword to accomplish it.
3. In order to have the direction of Will and the Main Keyword in it, it is necessary to use the PMD (Purpose Measure Diagram) method which shows the direction of Will and Main Keyword (Fig. 1, ⑦).
4. The PMD is created with cards using Verb and Noun expressions with minimum adverbs and/or adjectives. These expressions will answer what is going to be done and what is necessary to be done under the Task or theme/subject in the order of "In order to do . . ., how to do . . ." This sequence will be repeated from top to down on paper in visible form. Thus, these expressions can be adjusted on paper in visible form among the people concerned for task realization.
5. For example, Knowledge consists of the following:
   (a) Information of the existence of things.
   (b) The process, i.e., if we drop a glass as a process, we shall have broken glass with sharp edges as the result. This is knowledge.
6. If we want to have broken glass with sharp edges, this is Will.

In order to realize the Will, it is necessary to drop the glass from a sufficient height for the process. We will get broken glass with sharp edges as the result. This is wisdom.

Explanation 3: How to Attain the Complete Wisdom Management Cycle

Have Knowledge as shown in Table 1 and use it effectively for the purpose of wisdom management.

Conclusion and Future Directions

As problem solving becomes a part of task realization, finding the solution can be simplified. This methodology also clarifies one's upper purpose (ulterior motives included) and constrains one to implement plans honestly or in light of others' monitoring. The uppermost purpose of this methodology should always be to give all people stability and safety and/or to save the Earth. I hope that in the future, the knowledge of this methodology will be taught to students before entering society in order to contribute to world peace.

(Note) This wisdom from knowledge methodology basically comes from my oldest article and book found in Reference Esaki, (1977a), (1977b), Esaki (1979) New Thinking and Procedure of Design-to-Cost by Steplist Management Thinking, 1979 Washington, D.C., and Esaki (2002) Advanced project management methodology with the method for changing knowledge to wisdom in wisdom management era.

Cross-References

▶ Convergent Versus Divergent Thinking
▶ Creativity
▶ Decision Making and Judgment
▶ Invention
▶ Problem Solving
▶ Project Management
▶ Research and Development
▶ Strategic Thinking and Creative Invention

References

Esaki M. Method for creating wisdom from knowledge. Tokyo: Japan Materials Association; 2009. More details can be downloaded at http://dtcn-wisdom.jp/00001-E-wisdom%20book.pdf.

Esaki M. Advanced project management methodology, Conference proceedings at International Conference of Society for American Value Engineers at Washington, D.C.; 1998.

Esaki M. Advanced project management methodology with the method for changing knowledge to wisdom in wisdom management era, American Supplier Institute; 2002. More details can be downloaded at http://dtcn-wisdom.jp/E-pdf%20entrance.html

Esaki M. A method of decision making for management, Conference proceedings of Industrial Conference Production Research, at Tokyo, Japan; 1977.

Esaki M. The method of steplist management. Conference proceedings of International Conference of Society for American Value Engineers, at Detroit, Michigan, May 1977; 1977.

Esaki M., New thinking and procedure of design-to-cost by steplist management thinking, Conference proceedings of Society of American Value Engineers Conference, at Washington, D. C; 1979.

Microcredit

► Microfinance and Entrepreneurship

Microenterprise

► Small Business

Microfinance and Entrepreneurship

Arvind Ashta[1], Mawuli Couchoro[2] and Abu Saleh Mohammad Musa[3]
[1]Burgundy School of Business (ESC Dijon-Bourgogne), CEREN, CERMi, Dijon, France
[2]CERFEG, FASEG, Université de Lomé, Lome, Togo
[3]Credit and Development Forum (CDF), Dhaka, Bangladesh

Synonyms

Microcredit

Introduction

Microfinance is the provision of financial services to the poor and the financially excluded. These financial services include credit, savings, insurance, remittances, and guarantees, among others. As a result, an associated vocabulary includes microcredit, microsavings, microinsurance, microremittances, and microguarantees.

The major common problem of providing all these services to the poor is that the transaction size is very small. As a result, any processing cost, or transaction cost, becomes a high percentage of the transaction amount. This makes the product very expensive for commercial banks and formal financial institutions to provide these services to the poor, who, therefore, remain excluded. A second common problem is that the poor lack not only financial capital but are often socially excluded and lack bridges to rich people. A third common problem is that they are often uneducated, even illiterate, and excluded from technological innovations.

To solve these problems, microfinance institutions (MFIs) have created social innovations which permit them to offer financial products which were not viable commercially (Armendàriz and Morduch 2010; Couchoro 2011). Seeing the success of MFIs, commercial financial institutions are also downscaling to profit from the vast market at the bottom of the pyramid. All of these are trying to use advanced technologies such as management information systems, mobile banking, and online financing to increase their outreach (Ashta 2011).

One possible solution for the poor to rise from poverty is to become microentrepreneurs and take charge of their own fate.

Although microfinance can include personal finance as well as entrepreneurial finance, in this entry we will restrict ourselves to features of microfinance impacting entrepreneurship. We will focus largely on microcredit because it is the most developed form of microfinance, but today, it is being increasingly realized that other financial products are more necessary for the poor than microcredit.

Microcredit and Entrepreneurship

What Is Microcredit?

In underdeveloped countries, the vast majority of the population has no access to the banking system, whether in rural or in urban areas. The absence of appropriate formal financial services had long led the people to the informal financial sector. At best, they use Rotating Savings and Credit Associations (ROSCAs), a traditional practice of mobilizing savings, brilliant but sometimes very risky (and reserved for the middle class, the one having the capacity to save), and at worst, they are entrenched with the usurious moneylender, with very prohibitive interest rates. In the 1990s, it was estimated that 90% of adult African population was excluded from financial services compared to 85% for Brazil (Gentil and Servet 2002).

Microcredit is an innovative strategy which aims to fight effectively against credit exclusion. It aims towards a minimal equality in the access to credit by allowing people excluded from the traditional financial system to take loans for creating their own jobs. It can be defined as any loan initiative intended to create income-generating activities, focused on microentrepreneurs with no access to traditional bank lending. It aims to fight against poverty.

The Microfinance Information eXchange (MIX) 2010 statistics show that gross loans portfolio and the average loan are different from one region to another (Table 1).

Owing to low transaction sizes, and because of the relatively high processing costs, the microfinance institutions (MFI) apply an interest rate generally higher than that of the banking sector. Regulators do try, in some countries, to control this, but the ceiling varies over time. For example, in the particular case of countries of the West African Monetary Zone (Couchoro 2010) with centralised laws on usury for all financial institutions operating in the area, "a usury ceiling" not exceeding twice the discount rate of the central bank (i.e., 17% per year) was initially decreed. The MFIs have since obtained a waiver; the central bank has revised the law on usury. Today, there are two ceilings: one for commercial banks (18%) and the other for MFIs (27%).

Microfinance and Entrepreneurship, Table 1 Microcredit institutions loans statistics

Regions	Gross loan portfolio (billions of $)	Average loan ($)
Africa	4.6	371.9
Latin America and the Caribbean	22.9	1,024.4
South Asia	8.4	144.0
East Asia and the Pacific	21.2	305.6
Eastern Europe and Central Asia	8.3	1,687.8

Source: The microfinance information eXchange (MIX) 2010

Evolution of Microcredit

Microcredit is staged today as a global movement, part of a globalization process, and is considered as an excellent indicator of economic, social, and cultural opportunities, "an important lever for change, contributing to local development . . ." (Gentil and Servet 2002).

The number of customers has more than doubled from 2003 to 2011 (Table 2). Table 3 provides the geographical distribution of microfinance.

Microcredit Model

Microcredit consists generally of short-term loans with repayments that occur as soon as the loan is disbursed. Repayment is either weekly or monthly.

In order to reduce default risk and to avoid excluding candidates to credit, microcredit program sets up an innovative mechanism in the financial world: group lending based on joint guarantee. Apart from group lending, there are other mechanisms such as progressive lending, local management, compulsory savings, and training in the management of income-generating activities. Group lending consists of granting credit to a group whose members are chosen freely and are responsible for the repayment of all the loans to the group. If one member fails, the

Microfinance and Entrepreneurship, Table 2 Number of people served by microcredit

	Minimum Number of MFIs reporting	Customers served (in millions)	Number of poorest in first loan (in millions)	Numbers of women among poorest (in millions)	Percentage of women among poorest (%)
Dec 31, 2003	2,931	81	55	45	82.5
Dec 31, 2009	3,589	190	128	105	81.7
Dec 31, 2010	3,652	205	138	113	81.9

Source: State of the microcredit summit campaign report 2004, 2011, and 2012 (Daley-Harris 2004; Daley-Harris 2011; Maes and Reed 2012)

Microfinance and Entrepreneurship, Table 3 Number of active borrowers of microcredit

Regions	Number of microcredit institutions	Actives borrowers in millions
Sub-Saharan Africa	1,009	12.7
Asia and the Pacific	1,746	169.1
Latin America and the Caribbean	647	13.8
Middle East and North Africa	91	4.3
Eastern Europe and Central Asia	73	5.2
North America and Western Europe	86	0.2
Total	3,652	205.3

Source: State of the microcredit summit campaign report 2012 (Maes and Reed 2012)

others are forced her to honor the commitment; otherwise, they are the ones who pay back in her place. Progressive lending is to provide credit in tranches whose amount increases as the previous loan tranches are repaid. Future loans are provided only if the previous loan has been repaid.

Microcredit and Entrepreneurial Opportunities

Development actors want to show the potential of poor people to take entrepreneurial initiatives. Through microcredit, they want to highlight the ability of the poor to create their own business, doing their own jobs, if they are freed from the constraint of self-financing their projects. Microcredit is for the masses excluded from the conventional financial system, sometimes subject to the whims of suppliers and the dependence on moneylenders, with a hope to enable them to develop a wide range of productive activities, thus generating income, and in turn, improve their living conditions and social status.

Microcredit is characterized by a strategy based primarily on a participatory process. This process requires the active involvement of all actors in society, especially the borrowers, towards the objectives of fighting against poverty. Through this approach, the poor will find the opportunity to influence policies that affect their lives. The philosophy of microcredit is that the beneficiaries should not be passive actors in the fight against poverty (which makes them assisted) but rather active actors, responsible for improving their living conditions. Undoubtedly, it has the characteristics of participation and empowerment that are radically different from assistantship.

However, the scope of microcredit is limited to the ability of beneficiaries to enhance the resources that are available to them. Microcredit should not give the impression that everyone is able to create, manage, and develop her own business.

Other Microfinance Products and Entrepreneurship

Microsavings and Entrepreneurship

"Saving is where financial services begin and end" (Rutherford 2001). Microsavings are the small amounts of money saved by poor people with financial institutions, mostly microfinance institutions (MFIs). They serve two main purposes. Firstly, they provide a source of lump-sum cash in case of future events, that is, emergencies, start-up business capital, and major life cycle events, and secondly, they support daily consumption needs of the poor people (Mersland and Eggen 2007).

MFIs have the development objective of employment creation to facilitate growth of enterprises along with poverty reduction. As financial service providers, MFIs on one hand provide loans to accelerate growth of existing enterprises and facilitate creation of new enterprises while, on the other hand, give the entrepreneurs access to secure places for savings. Among the poorest of the poor, the most important element of microfinance is not lending but providing savings opportunities (Collins et al. 2010). Such savings can be quite useful in the lives of the poor people, as once a large amount is accumulated together, this can finance acquisition of assets, construction of houses, and more importantly starting up community-based enterprises.

Stuart Rutherford (1999) describes three basic ways people can covert a flow of savings into a lump sum: “saving up,” “saving down,” and “saving through.” Saving up is mentioned as small accumulation of money till it reaches a lump sum; saving down refers to loans, where people save in the form of making the repayments of the loans; and savings through is either through insurance or some other group based system where the poor people may get access to a lump sum at the time it is needed through a series of small savings. All three systems are important to promote entrepreneurial activities as financing the entrepreneurship needs of the poor clients is on the top of the list of financial services provided by MFIs, as this smoothens the client’s income, thus help building a sustainable livelihood (Tavanti 2010).

Empirical evidence also suggests that poor people use saving products more than they use credit. Opportunity International Bank of Malawi has 45,000 borrowers and 250,000 savers, Equity Bank in Kenya has 715,000 borrowers and 4 million depositors, and Grameen Bank has over $1.4 billion in deposits, which is 145% of its outstanding loan portfolio of $965 million (Maes and Reed 2012). In a study on Bangladesh, it is found that there are 27.8 million depositors and about 20.6 million borrowers in a sample of 28 MFIs and that 26 of these 28 Bangladeshi MFIs have more depositors than borrowers (Khan and Ashta 2012). The excessive use of microcredit may have led to overleveraged microenterprises and perhaps suicides by microentrepreneurs owing to the creation of stress in the relationship between the credit agent who needs to show a 100% recovery and the borrower who cannot always ensure this (Ashta et al. 2011). It was suggested that microsavings may be one way to balance the relationship between the MFI and the borrower so that the agent is not only giving loans to the client but also receiving deposits from him and cannot therefore alienate him.

Microequity

Another way to balance the stress of over-leveraged entrepreneurs would be to use microequity which lowers downside risk (Ashta et al. 2012).

Although individual microequity is difficult to document, because it often hides in the informal love money market, there are isolated movements which indicate that microangels exist and that they often band together in clubs to provide both equity and advice to small enterprises. In France, for example, since 1983, these microangels have been getting together and forming clubs called CIGALES in which each contributes between 7.50 Euros per month to 450 Euros per month depending on how micro he or she is. Once the combined savings of the club is large enough, they finance projects which require equity of as little as 1,000 Euros to projects where many clubs may get together to invest 25,000 Euros.

They believe in proximity and provide advice and mentoring to the entrepreneur. However, if the mentor is unable to answer the question, he uses the combined human capital of the entire club to get an answer. And if they cannot, the members use their network to find people who can help the entrepreneurs. Finally, once a CIGALES club is associated with a project, a strong signal is given to other financiers, including banks, that the project is good, and therefore loans also come in where otherwise bankers feared to tread.

Microequity takes away the downside risk of putting their money in the risky enterprise since the microangels will not ask for money back if the enterprise is a failure, and it thus removes downside risk and the effect of loss aversion (Quattlebaum 1988; Tversky and Kahneman 1991; Ashta and Otto 2011).

Microinsurance and Entrepreneurship

The first noted search for microinsurance is a paper by Dror and Jacquier (1999). However, insurance for the poor as mutual protection was the foundation of many insurance countries in the nineteenth century (Churchill 2007). A notable publication is an edited publication by Churchill (2006).

Microinsurance is insurance for the poor which is characterized by low premiums and low caps. Microinsurance may be either directly related to entrepreneurship or indirectly related.

Examples of direct relationship with entrepreneurship include property risks such as crop insurance, cattle/livestock insurance, theft/fire insurance, and insurance for natural disasters. The reasoning is that when a farmer has insurance against downside risk, he is inclined to be more risk seeking which can pull him out of poverty. For example, if he is insured against crop failure, he can use innovative cropping strategies which may have higher yields.

Examples of indirect relationship with entrepreneurship include health and accident insurance (illness, injury, disabilities). Often, if a poor entrepreneur falls ill, he is unable to work and repay loans. As a result, his business collapses. If health insurance kicks in, he is able to survive during this critical period and continue repaying his loans. Research suggests that households that are insured against hospitalization and accidental death have less diversified income portfolios (Kwon 2010). This focus on a core business may improve profits.

No centralized agency maintains public access documents for microinsurance. A survey in Africa (Matul et al. 2009) estimated that there were 14.7 million poor people insured in Africa, 56% of who are in South Africa. The most used insurance product was credit life insurance, that is, an insurance which repays the debt if the insured dies.

Microinsurance may be delivered directly by insurance companies, but is often packaged in ways by which it can be delivered by microfinance institutions, which are directly in contact with microborrowers. Some microinsurance programs are community-based mutualization of risk but suffer from low coverage.

Two preconditions for commercial microinsurance firms to successfully sell directly to the poor are to understand how the poor are different and have different needs and to educate the poor on the use of insurance (Churchill 2007).

A study of 600 MFIs indicated that MFIs' willingness to offer microinsurance is positively correlated to a rise in the financial expense ratio, loan repayments in arrears, years of operation, number of borrowers, woman borrower ratio, life insurance penetration ratio, and family size. In contrast, it is negatively correlated with their loan asset ratio, bad loan write-off ratio or average loan size in comparison to GNI per capita (Kwon 2010).

Microremittances and Entrepreneurship

Human beings migrate since the beginning of civilization. People migrate for food and security, searching better employment opportunities, and income security. Today, migration does not take place only to change the destiny of the migrating people but also to improve the livelihood conditions of families staying back in the home countries. This is done through remittances, which channel the migrants' income. In 2005, the worldwide officially recorded remittances were US $ 232 billion. Of this, the developing countries received US$167 billion, which was more than twice the level of development aid from all sources (Global Economic Prospects 2006).

Remittance is the surplus portion of earnings sent back by the expatriate community from the country of employment to the home country. Over the years, remittance has emerged as an important source of external development finance (Hasan 2006). Remittance has significant impact at household level. This impact of remittances partially depends on the characteristics of the migrants and the recipients, that is, whether they constitute the rural poor, or the more educated sectors of the population generally residing in urban areas (Hasan 2006).

Remittances are cited as making up around 60–70% of recipient poor households' total income (De Bruyn and Kuddus 2005). Investment in health and education is valuable for long-term economic growth and poverty reduction. Studies have found that migrant families invested more in these areas (Murshid et al. 2002). While such investment works as indirect contributor towards developing entrepreneurial skill, remittance acts as an enabler to develop human capital as well as direct investment in enterprise. The money sent by migrants to their families facilitates investment in both productive and consumption goods, which otherwise would not have been possible due the nature of large cash involvement in such initiatives (Yang 2008).

Microguarantees and Entrepreneurship

In developed countries, mutual guarantee associations or government-backed public institutions guarantee part of banks' loans to entrepreneurs (De Gobbi 2003). This reassures the bank because often entrepreneurs are able to pay back a large part of the loan, even if they are not successful in total reimbursement. The European Association of Mutual Guarantee Societies has 34 members providing guarantees for 1.9 million small and medium enterprises (Source: aecm.org, 2009 statistics). However, although such guaranteeing institutions are cropping up in developing countries, they do not have the required outreach among the poor.

Guarantees are closely related to microcredit. Part of the reason microentrepreneurs, especially poor ones, are not able to get loans is that they do not have collateral. Microfinance has used social solidarity guarantees to overcome this problem: if one of the borrowers cannot pay, someone else from the group would not get a loan or someone else from the group must pay (De Gobbi 2003).

Of course, microentrepreneurs can also get guarantees from people who do have collateral. But very often, poor people lack the bridging social capital to meet richer people who would be willing to put their assets at risk for helping out the poor.

Today, thanks to technology, we see the development of websites such as UnitedProsperity.org which take cash from someone in a rich country which then serves as cash collateral for a bank loan to a MFI in a poor country and from the MFI to a poor entrepreneur, thus extending the ability of the MFI to give loans to poor people.

Conclusion/Future Directions

Microfinance is both evolving as a social institution as well as utilizing new technologies such as cloud computing information systems, mobile banking, and online financing of microfinance institutions for the development of its outreach (Ashta 2011). Many of the financial services being targeted to the poor, including microsavings, microinsurance, remittances, and transfer payments from the government to the poor payments, are based on innovative institutional creation. All of these represent areas for future research.

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Cross-References

- ▶ Entrepreneurship
- ▶ Entrepreneurship and Social Inclusion
- ▶ Entrepreneurship Financing
- ▶ Entrepreneurship in Developing Countries
- ▶ Female Entrepreneurship
- ▶ Financing Entrepreneurship
- ▶ Love Money
- ▶ Microfirms
- ▶ Social Entrepreneurship
- ▶ Social Innovation

References

Armendàriz B, Morduch J. The economics of microfinance. Cambridge, MA: MIT Press; 2010.

Ashta A, editor. Advanced technologies for microfinance: solutions and challenges. Hershey: IGI Global; 2011.

Ashta A, Khan S, Otto PE. Does microfinance cause or reduce suicides? Policy recommendations for reducing borrower stress. Available at SSRN: http://ssrn.com/abstract=1715442; 2011.

Ashta A, Estapé-Dubreuil G, Hédou J-P, Bourcieu S. Microangels and microequity: the missing ingredients of microfinance, microfinance focus; 2012.

Ashta A, Otto PE. Project valuation in the presence of loss aversion during economic crises. Strateg Change Brief Entrep Financ. 2011;20(5/6):171–86.

Churchill C, editor. Protecting the poor a microinsurance compendium Geneva. Switzerland: ILO and Munich Re Foundation; 2006.

M

Churchill C. Insuring the low-income market: challenges and solutions for commercial insurers. Geneva Papers Risk & Insur – Issues & Practice. 2007;32(3):401–12.
Collins D, Morduch J, Rutherford S, Ruthven O. Portfolios of the poor: how the world's poor live on $2 a day. Ranikhet: Permanent Black; 2010.
Couchoro M. Microcrédit et réduction de la pauvreté, une application au cas du Togo. Sarrebruck: Les Editions universitaires européennes; 2010.
Couchoro M. Transformation des relations banques/institutions de microcrédit (IMC) au Togo. Une lecture à partir des cadres théoriques de l'innovation. 2011; 41(1–2):71–87.
Daley-Harris S. State of the microcredit summit campaign report 2004. Washington, DC; 2004.
Daley-Harris S. State of the microcredit summit campaign report 2011. Washington, DC: Microcredit Summit Campaign; 2011.
De Bruyn T, Kuddus U. Dynamics of remittance utilization in Bangladesh, IOM migration series. Geneva: International Organisation for Migration; 2005. 18.
De Gobbi MS. Mutual guarantee associations for small and micro-entrepreneurs: lessons learned from Europe and Africa. African Dev Rev. 2003;15(1):23–34.
Dror DM, Jacquier C. Micro-insurance: extending health insurance to the excluded. Int Soc Security Rev. 1999;52(1):71.
Gentil D, Servet JM. Entre « localisme » et mondialisation: la microfinance comme révélateur et comme levier de changement socio-économique. Revue Tiers monde. 2002;172:738–60.
Global economic prospects 2006: Economic implications of remittances and migration. Washington, DC: The World Bank.
Hasan RA. Harnessing remittances for economic development of Bangladesh. Working paper series. Dhaka, Bangladesh, INAFI; 2006.
Khan S, Ashta A. Cost control in microfinance: lessons from the ASA case. Cost Manag. 2012;27(1):5–22.
Kwon WJ. An analysis of organisational, market and socio-cultural factors affecting the supply of insurance and other financial services by microfinance institutions in developing economies. Geneva Papers Risk & Insur – Issues & Practice. 2010;35(1):130–60.
Maes JP, Reed LR. State of the microcredit summit campaign report 2012. Washington, DC: Microcredit Summit Campaign; 2012.
Matul M, McCord M, Phily C, Harms J. The landscape of Microinsurance in Africa. Microinsurance working paper 4. Geneva: International Labour Office. 2009; 4: 54.
Mersland R, Eggen Ø. You cannot save alone – financial and social mobilization in savings and credit groups. SSRN eLibrary; 2007.
Murshid KAS, Iqbal K, Ahmed M. A study of remittance inflows & utilization. Dhaka: International Organization for Migration; 2002.
Quattlebaum OM. Loss aversion: the key to determining individual risk. J Financ Plan. 1988;1(2):66.
Rutherford S. The economics of poverty: how poor people manage their money. Ideas in Development Journal: Communities Without Borders. http://media.microfinancelessons.com/resources/Economics_poverty_rutherford.pdf; 2001.
Rutherford S. The poor and their money: an essay about financial services for poor people. Institute for Development Policy and Management, University of Manchester; 1999
Tavanti M. Before microfinance: the social value of microsavings. In Vincentian Poverty Reduction 17th Annual International Vincentian Business Ethics Conference. DePaul University, Chicago; 2010.
Tversky A, Kahneman D. Loss aversion in riskless choice: a reference dependent model. Q J Econ. 1991; 106(4):1039–61.
Yang D. International migration, remittances and household investment: evidence from Philippine migrants' exchange rate shocks. Econ J. 2008;118(528):591–630.

Microfirms

Michel Marchesnay
ERFI, Université de Montpellier, Montpelier, France

Synonyms

Angels investors; Craft trade; Craftsmanship; Cyber entrepreneurship; Developing countries; Entrepreneur; Female entrepreneur; Incubators; National culture; Networks; Proximity; Self entrepreneurship; Services; Small business; Small business firms; Smaller firms; Social entrepreneurship; Social responsibility; SOHO; Start-up

The word "microfirm" is both a recent neologism and a generic concept. It refers to the so-called smallest business firms, that is, those tiny size firms theoretically governed (managed and/or owned) by one person. However, the *world* of microfirms reveals itself to be highly heterogeneous. As well as the small shops or stalls in African markets, it comprises also highly skilled "SOHOs" (small organization, home office) working at a worldwide level!

In spite of the fact that microfirms are undoubtedly the most numerous of business entities in the world, they are mostly ignored by economic theories. The "entrepreneurship wave," since the last quarter of the twentieth century, is primarily based on the start-up of very small businesses (one or two people), mostly in craft or services activities, from low-tech to high-tech businesses. Moreover, the recent interest in "sustainable development" has underlined the socioeconomic and even political impact of "eco-entrepreneurial" microfirms.

Contrary to their organizational simplicity, researchers have found extreme complexity in both internal and external relationships of microfirms. Thus, more than with the general model, and following P-A Julien (1998), they suggest a list of criteria, leading to a pragmatic classification. The main criteria are the following ones:

- Registered or not
- Number and kind of employees (family, community, salaried)
- Activity sector
- Working at home or not
- Tangible and intangible assets or not
- Identity of the entrepreneur: age, gender, community membership, level of education and training, goals, and vision

Obviously, the turnover and the number of employees is the most frequently inaccurate. However, empirical studies suggest a "ceiling" of seven people, showing that beyond that size, organizational problems, specific to bigger firms (task differentiation and individual integration), arise (Pearson et al. 2006).

By combining the two famous definitions of the entrepreneur, respectively, by Richard Cantillon (mid-eighteenth century) and Frank Knight (mid-twentieth century), the entrepreneur, viewed as an ideal type, may be loosely defined as "everybody earning an uncertain income in a risky business" (Schumpeter 1952). Thus, it logically includes, according Mark Casson's opinion (1982), "immoral" activities, as seen below.

Nowadays, entrepreneurship research is faced with two contrasting figures of the "microentrepreneur." The first one will be specified as the microentrepreneur "by force," suffering from a low or mediocre social legitimacy and economic competitiveness. The second one will be entitled microentrepreneur "by choice," based on the search for both higher social status and economic performance.

The Microfirms "By Force"

"By force" means that those people are more or less constrained to adopt the status of entrepreneur, as defined supra. They would generally have preferred to be recruited, ever as salaried workers, possibly in a big concern, or as civil servants. However, it matters to make a sharp distinction between the "poor workers," proletarian, and the "supported entrepreneurs," pertaining to the lower class. The status of "craft entrepreneur" may be seen as a way to have access to the middle class.

1. *Survival microentrepreneurs* are poor, with unstable jobs. Their business is unregistered and too often located in the underground economy, precarious, unsafe, and risky businesses, including criminal activities (such as illegal drug dealers). They earn a low revenue, just enough to survive and help their family. Those proletarian microentrepreneurs proliferate in megalopolis (illegal immigration). In spite of their contribution to their own family, and even of some prestige among their native community, they suffer from a far lower social status. Moreover, as shown in the cast system, in many underdeveloped countries, the poorest are often debtors vis à vis usurers, actually working in a kind of slavery.

A Case of a "Survival Microentrepreneur"

Mohamed sells illegally smuggled cigarettes on the street, in a "tough neighborhood" (Barbès) located on the Paris East Side. Born in Algeria, unemployed, he decided to come illegally to France. He sells each packet for 3 euros, and earns around 400 euros per month. He says that "it is not a 'genius' for work, but I searched for a job on the markets, on the construction sites, but nothing!" To one passerby, he whispers, "Marlboro, Marlboro. . ." and concludes the deal. An accomplice comes to pick up the carton hidden in an iron column of the elevated railway. "Today, it's OK, but sometimes I sell nothing all the day."

2. *Supported microentrepreneurs* aim to get a higher rank in the social hierarchy and to benefit from a higher legitimacy. During the early 1960s, the Johnson administration undertook a program, called "The New Frontier," designed to help minorities and poor communities. Consequently, the SBA (Small Business Act) started, in charge of the promotion and learning of start-up microfirms. During the 1970s, the worldwide rise of unemployment, mainly due to the manufacturing crisis, entailed an enlargement of the entrepreneurship programs to the whole set of unemployed peoples, firstly in the Northern America, and secondly in Europe (e.g., the European Small Business Act, voted by the European Parliament). Today, a lot of public, associative, and private organizations offer a large span of free and paid supports.

The Case of "Self-Employed" Entrepreneurs

Governments, in developed countries, promote the so-called self-entrepreneurship by offering tax exemptions and easier registration. They intend to support part-time workers and retired people and to induce them to earn a (legally) complementary income by undertaking registered "small jobs." For instance, one retired person explains that "his pension being insufficient, he earns around 400 euros per month with home activities of repairing, assembling, masonry, tiling, and so on." Another one (an ex-cook) says he "earns 20 euros per hour doing plumbing and electrical work." A third one explains that he cannot decently live with a pension of 1,000 euros per month, and, consequently, put advertisements in the local newspapers ("Retired, well equipped, can do small jobs in your home or garden for 15 euros/hour"). However, a lot of registered "self-employed entrepreneurs" declare no annual revenue (two thirds or around five hundred thousand registered "auto-entrepreneurs" in France).

During the last decades of the twentieth century, such supporting programs for the "disabled" or communities expanded to underdeveloped countries or areas. These programs are mostly administered by nongovernmental organizations, mostly depending on the various programs of the Organization of the United Nations or the World Bank. Besides these official incentives, there are also private ones, supported by foundations and sponsorship, for example, Bill Gates and DANONE, who promote "supported microfirms."

The Case of Grameen Bank

The Grameen Bank experiment with microcredit for the poorest people in Bangladesh, undertaken by the Nobel Peace Prize winner, Muhammad Yunus, is the best known case of this kind of support. Pr. Yunus thought indeed that the multilateral institutions "are unable to understand that the poor may be entrepreneurs and create employment." The Grameen Bank lends money for inexpensive investments (a sew machine, a bike, tools, etc.) at a low interest rate (compared to the practiced loan sharks in underdeveloped countries). Furthermore, the Grameen Bank has enlarged its credit loans to all types of small businesses and to other countries (India, etc.). It must be noted that the rate of payback by entrepreneurs (primarily women) was very high, until the last years. However, the Grameen Bank and Yunus recently encountered troubles from their government and critics in the media, partly due to the ambiguity between the initial "social business" and the current more classical "banking business."

3. *Community microfirms* are supported by a group of people, linked by ethnic values, issued from, or living in the same territory (ISBJ 2011). For instance, the community, or the "enlarged family," will help a teenager to acquire some experience in a given activity, knowing that, most often, each community is specialized in a given activity (ethnic restaurant or café owner, mason, grocer, etc.). Similarly, the "tontine" system aims to allow and dispatch credits inside a community (e.g., inside an African village). Each saver, in turn, will benefit from a loan designed to acquire a business asset (tool, machine, commercial premises, etc.).

   A lot of ethnic communities, everywhere in the world, benefit from a high spirit of enterprise, an "innate" propensity to create their own businesses. Those communities most often originate from difficult regions (mountain, desert, island, etc.) or from lower social classes so that they emigrate toward more munificent places or countries. Being often religious and austere, they work hard, in order to get both economic comfort and social appreciation, and send money to their family or village, hoping to retire in their native place.
4. *Family microfirms* are owned and managed by the family members. Family governance in western societies is primarily limited to the

nuclear family, consisting of parents and children. The family members primarily intend to maintain the independence of their shared patrimony and avoid borrowing and "external" associates. Those family microfirms flourish in local, stable markets, for instance, in food and retail trades. Some of them, named "Enokians," may even survive over several generations so that the family chief acquires a social promotion, becoming an influential person in the village, town, region, etc., for instance, in the town council or the chamber of commerce. Most often, such "survivor" microfirms expand and become bigger concerns.

A Case of "Family Group of Microfirms"

For several generations, this family has been embedded in a residential suburb of an expanding town. They designed to buy out the nearby bakeries, closing either for failure or retirement. The family now possesses the majority of the bakeries in the neighborhood. In order to benefit from economies of scale, they centralized the bread making in a one baker's oven. Each bakery is managed by a family member, in charge of adapting the business model to the local customers. This strategy may be observed also in community firms.

5. *Craft microfirms* are defined as the business units where the entrepreneurial competence is primarily based on both technical and practical learning and secondarily on mastering the professional customs in the craft activity. The origins of the craft manufacturing system are linked to the birth of the cities, during the early stages of the urban civilizations. Each craft activity is structured by two hierarchical institutions:
   - Firstly, the socioeconomic status is linked to the estimated value of the craftwork. Since early times, lower status is attributed to the activities dealing with dirty, unsafe, insecure, and/or polluting and raw materials, such as carcass, hide, dye, earth, cast iron, etc. Those activities are rejected in suburbs, or desert places, and such craftsmen are affiliated to the lower classes (or casts in underdeveloped countries). The higher craft works (and consequently craftsmen) are luxury goods, needing high skill, long training, expansive matters, and so on. Concerning the intermediate level, the French classification, for instance, registers more than 150 official craft activities in manufacturing and service units below ten employees. As members of the middle class, the social status of craftsmen may evolve from the highest (one prestigious chef managing a famous restaurant) to the lower (one pizza maker working out of his van).
   - Secondly, inside the craft microfirm, the work is shared between the master, the journeyman, and the apprentice. The master – the entrepreneur – has acquired a high degree of experience and technical skill in his job, usually vouched for by a diploma. The journeyman has a narrower field of professional competence and know-how. The apprentice has to acquire a practical experience (learning by doing). This three-tiered organization may be observed everywhere, in all countries and communities and in all historical eras, for instance, during the Roman Empire or the Middle Age in Europe.

Consequently, the craftsmen are embedded, and even officially registered, in institutions named "corporations" or "guilds." Their activity is mostly limited to proximate markets and moreover implies a tight networking with suppliers, clients, and colleagues. They are increasingly highly specialized and skilled. Moreover, the most entrepreneurial or "eldest" (family) artisans are embedded in public, professional, or private institutions. They benefit from a social promotion and get the status of *notable*, that is, of influential and recognized person on his territory.

The Microfirms "By Choice"

The "new capitalism," following on the industrial and manufacturing one, is based on service activities and intangible (intellectual) assets. Consequently, it entails the explosion of new ventures and micro-sized units in various service sectors. This is true for several reasons:

- The big manufacturing corporations outsource a whole set of functions and activities not essential for their core competence or too specialized – a niche market, according to Tilton-Penrose (1957, Chapter 3).
- The higher education system has enhanced the learning level at the master and Ph.D. degrees. More generally, the student skills have accrued, including a better knowledge of the enterprise world during their studies.
- The emerging needs at a worldwide level are primarily centered on services activities, such as health care (especially for disabled and eldest peoples), ecology and sustainable development (for developing countries or areas), agronomic research, new energies, training and consulting, and so on.

However, it is advisable to make some distinctions between these "willingly" microfirms. The main criterion is based both on the required skill and the role of innovation. It entails a classification made of "expert," "adaptive," "innovative," and "creative" microfirms.

1. *Expert microfirms* include the whole set of knowledge-based activities. It mainly refers to the private professions in free markets. The key competence of entrepreneurs, associates, or assistants is primarily based on the mastering of a discipline – most often validated by a diploma. Examples include lawyer, chartered accountant, real estate expert, NTIC engineer, doctor, expert in logistics, and, more generally, the freelance entrepreneur. Empirical researchers underline several distinctions:
   - According to a distinction between proximate and outside strategy, the search for proximity implies a deep embeddedness in the local milieu, in order to promote loyalty (e.g., a general practitioner). The alternative strategy conversely implies to "open his/her mind" on the global market, in order to scan all the events in relation to the field of expertise (e.g., a specialist in international finance).
   - Those activities are based on the production of intangible services, implying an economic and legal distinction between the services "of doing," legally compelled to obtain a definite result (e.g., a bridge for an engineer), and the services "of advising" (e.g., a doctor), just implying advice and suggestions.
   - The management of those microfirms may be individual or collective. The governance is collective, when the core competence is made of a "basket of skills," for instance, in the case of complex projects, or in order to spread overhead costs (receptionist, offices, machines, etc.) between several members, as inside a group law or consulting firm.
2. *Adaptive innovation in microfirms* occurs when they implement "new" technologies (processes), products (goods and/or services), markets (needs, places, people), or organizations. However, empirical studies reveal that the microentrepreneur gives an extensive meaning to the word "innovation." He/she usually refers to any "change" or "improvement" happened or achieved inside his/her business. Thus, there must be made a distinction between three kinds of "change": flexibility, adaptability and creativity.
   - The simplest change implies some flexibility, when the entrepreneur decides to stop the processing or delivering of some product, to terminate a contract with a supplier or a retailer, to fire or recruit an employee, and so on. The change is declared highly flexible when its "withdrawal cost" is weak (no compensations or redundancy payments, for instance). It is usually assumed that very small firms are more flexible than bigger ones due to a lesser amount of irreversible, inflexible assets. However, they are submitted to the "magnifying effect" of such decisions: in a three-person firm, a lay off of one member entails a manpower cutback of one third!

A Case of Flexible Craft Strategy

This couple lived and worked in Paris, respectively, employed as a pastry cook in a prestigious palace and a bank employee. They decided to move to a town in southern France where they bought a bakery from a retired couple. The husband intended to promote the supply of high-quality (and expensive) pastries, his distinctive craft skill. But his wife observed that the clients were demanding a larger choice and higher-quality breads. So the couple gave up "luxury" pastries and enlarged the supply of breads, with the support of a nearby miller of ecological flour. The "flexibility cost" was indeed more psychological than monetary, the profit margin being higher in bread than in pastry. After a few years, they decided to sharply change their strategy: they sold their business, in order to start a less tiring business (a fast food shop).

- Adaptability is defined as the ability to modify one or several parts of one business; to create new processes, products, or markets; and to recruit people. Inquiries confirm that microentrepreneurs mostly equate "adaptation" with "innovation." This may be partly explained by the fact that the ideas for new ventures are primarily based on imitation of "fashionable" or "cheap" businesses. Consequently, with easy entrance (and exit) from the markets, there is cutthroat competition. But the main reason for adaptation is that microentrepreneurs usually practice an incremental decision-making process, a succession of daily "microdecisions," what Henry Mintzberg (1973) describes as "emergent strategies," as opposed to the "deliberate" ones. More recently, Richard Sennett (2008) envisages, namely, in microfirms, the emergent process as a pragmatic ("craft") one, where the practical learning of the way to implementing one decision steadily modifies the way of thinking and gives rise to new ideas. For sake of simplicity, handbooks on entrepreneurship assume any venturing project as starting from an "innovative idea."

A Case of Adaptive Craft Strategy

This couple started, with two part-time employees, a business of confectionery sweets, inspired by a local recipe. The start-up period strengthened these new entrepreneurs in their project due to the high level of satisfaction expressed by the former clients. In particular, the sweets were offered to conference participants, as a welcome gift, with pretty packaging including a hand-tied ribbon. During an informal talk with the employees, it appeared that to tie the ribbon took too much time, and that this packaging was too costly. The two entrepreneurs adapted the product concept; the new packaging is less attractive, but cheaper. Doing so, they enlarged their market vision, and seized new opportunities, by getting orders from big retailing.

3. The *innovative process* of microfirms induces entrepreneurs to find and implement new ideas inside their business. The increasing propensity in the "neo-management" of big concerns is to outsource to small highly specialized businesses. This contributes to the emergence of "singular" (unique, peculiar) microfirms. The so-called resources-competences based approach has pointed out the role of idiosyncratic (original, unique) resources, defined as inimitable, nontradeable, rare, protected, and valuable. The best known cases of such "singular" strategies are seen in nurseries, incubators, innovation centers, clusters, and so on. But, more generally, the prevailing entrepreneurial skill is the ability to seize opportunities to implement an innovating concern, even in mature markets.

A Case of "Singular" Microfirms

Eurosign is a young microfirm (three employees) working in a very small village located in the south of France. The firm is well known in the world as one of the leaders in the technology of magnetized badges. It exports in Europe and to the USA. After 3 years of research, they have implemented a device designed to easily raise manhole covers. Designed for sewer, water channels, telecommunications, etc., big public and private concerns have already ordered the device because it reduces work-related injuries. Faced with increasing orders, the entrepreneur decided to replace the Swedish subcontractor with a local workshop of 300 square meters, built with the financial support of the regional council. He plans to sell 1,000 covers during the first year, and to double each year, in order to get a turnover multiplied by five in 2 years.

4. The *creative work microfirms* adopt a deliberate process, knowing that their professional skill is the search for innovative "ideas," "concepts," "products," "processes," and the supply of their own "creative energy." The "bundle" of creative microentrepreneurs is located in leisure, arts, and performance activities, as, for instance, art painters, designers, couturiers, rockers, graphics or game boy designer, and so on.

- The span of art and crafts activities goes from decorative objects (more or less artistic) to musical instruments (as the string instruments makers). These microfirms may be supported by state or local institutions, for instance, to implement a craft cluster.
- Fine arts, architecture, and design activities are primarily based on microfirms and freelance entrepreneurs. Those microentrepreneurs, called SOHO (small organization, home office) frequently work at home, even in remote and quiet places, in order to preserve their peace of mind and enhance their creative skills. However, they remain strongly embedded in external and even worldwide networks, including all types of stakeholders (colleagues, clients, art galleries, and so on). These new entrepreneurs are called "lifestyle entrepreneurs." They may be both locally embedded (the will to "take children to school") and be connected to global networks (the need to "start a Visio – conference with anybody anywhere on the Planet"). As artists, or experts, they have to promote their own creativity and originality to acquire a personal, unique ("singular") style.
- Performance activities have hugely expanded with the postmodern "entertainment society." They include not only actors, musicians, scriptwriters, directors, conductors, etc., but also the whole set of technicians working with a precarious status of "freelance," of casual workers.
- The world of communication and publishing (*lato sensu*, including releases, translators, etc.) is made up of a host of microfirms employing one or a few members microfirms. Concerning the novelists and writers, those are mostly registered, ever as "auto-entrepreneurs," or occupy a full- or part-time job.

A Case of "Creative (and SOHO) Microentrepreneurs"

These two 30-year-old men live and work in their apartment, located in the heart of the "historical center" of a southern French town. The furniture is all covered with a lot of mangas and Japanese objects. Here is the office of the young publishing microfirm, owned and managed by both editors and cotenants. During one year, they matured their project (concept, market, business plan), based on the edition of mangas targeted for young and mature adults, on the theme of fight games. They prospect in Korea and Japan, in order to buy license rights, in spite of their ignorance of Korean and Japanese languages. Indeed, they base their opinions on the illustrations, techniques, and reputation of the authors. Doing so, they take risks, but their first "baby" was successful, and the three succeeding ones have "found their public." They intend later to publish mangas written by French, or targeted for women, at a rate of seven new publications per year. But one of those two microentrepreneurs says: "Yeah, but now we have to do the real planning."

Conclusion and Future Directions

As for insects, the word "microfirms" refers to a world made of myriads of yet undiscovered kinds. Researchers on entrepreneurship have to increasingly take into account the high diversity of the worldwide population of "people with uncertain earnings," as defined by Cantillon, including unsighted ones.

Cross-References

► Creation
► Ethnic Entrepreneurship
► Family Business
► Innovation

References

Auctores V. Special issue: socio-cultural factors and entrepreneurial activity. Int Small Bus J. 2011;29(2).
Casson M. The entrepreneur: an economic theory. Oxford: Martin Robertson; 1982.
Julien P-A, editor. The state of the art in small business and entrepreneurship. Aldershot: Ashgate; 1998.
Marchesnay M. Small business and sustainable development. In: Lesca N, editor. Environmental scanning and sustainable development. London: ISTE, Wiley; 2011.
Marchesnay M, Julien P-A. Small business as a transaction space. J Entrepreneurship Regional Dev. 1990;2(2):267–77.

Medeiros CL, Pena R. Micro-enterprises, Livros e Leituras, 2001.
Mintzberg H. Strategy-making in three modes. Calif Manage Rev. 1973;XVI(2):44–53.
Pearson TR, Stringer DY, Mills LVH, Summers DF. Micro vs small enterprises: a profile of human resource personnel, practices and support systems. J Manage Res. 2006;6(2):102–12.
Schumpeter J. History of economic analysis. London: Allen and Unwin; 1952.
Sennett R. The craftsman. London: Yale University Press; 2008.
Tilton Penrose E. The theory of the growth of the firm. Oxford: Basil and Blackwell; 1959.
Yunus M. Creating a world without poverty. Philadelphia: Perseus Books; 2007.

Milieu

▶ Clusters, Networks, and Entrepreneurship

Military Technology

▶ Innovation in Defense Technologies

Mindfulness

▶ Conflict and Creativity

Minority

▶ Diversity and Entrepreneurship

Mission

▶ Risk, Uncertainty, and Business Creation

Missions and Business

▶ Church and Entrepreneurship

Mode 1

▶ Academic Firm

Mode 1, Mode 2, and Innovation

Michael Gibbons
SPRU (Science Policy Research Unit), University of Sussex, Brighton, UK

Introduction

It is too easily forgotten that it is only since World War II, that science – in the form of basic research – was taken up by the universities, transforming them into the major players in the forward march of science that they are today. In the beginning, it was through the persuasive efforts of Vannevar Bush and others that government in America and elsewhere decided to back universities as the prime sites for the research that would underpin technological innovation (Bush 1945, Etzkowitz and Leyersdorff 2000). As a result, universities and their research and training functions gradually moved to the foreground as the key institutions to supply the knowledge and manpower to drive economic progress. However, the establishment of research in universities took science in a specific direction, that is, down a route that would lead to the development of the academic disciplines and the administrative and financial structures to support it. The disciplinary structure of science is now dominant in universities globally, and it guides the development of most research activity in mathematics and physics, chemistry and biology, economics and sociology, and even linguistics and literature.

In part, *The New Production of Knowledge* was a response to this development. In that volume, clarification by contrast was used to distinguish the characteristics of discipline-based research (Mode 1) from those of an emergent mode (Mode 2). A subsequent publication, *Re-thinking Science*, built on the notion of

Mode 2 but went more widely and deeply into the history and sociology of knowledge production, exploring some distinctive features of new social developments in what was termed an emerging Mode 2 society (Gibbons et al. 1994; Nowotny et al. 2001).

Mode 1 and Mode 2 Forms of Knowledge Production

As configurations for the production of knowledge, Mode 1 and Mode 2 are differentiated as follows. In Mode 1, problems are set and solved in a context governed by the interests of specific academic communities. By contrast, Mode 2 knowledge production is carried out in a context of application. The context of application should not be thought of as applied science because as yet there is no science to be applied in that context. Mode 1 is discipline-based while Mode 2 is transdisciplinary. The latter draws knowledge from a range of sources and integrates them in frameworks which help to identify and formulate the key research questions to be addressed. Strictly speaking, it is neither multidisciplinary nor interdisciplinary because the knowledge elements that enter Mode 2 draw on sources beyond those of any set of disciplines.

Each mode manifests different organizational characteristics. Mode 1 is hierarchical and tends to preserve its form while Mode 2 forms are heterarchical and transient. Even a superficial consideration of the operation of the disciplinary structure of science would reveal a hierarchy not only of disciplines with the mathematics and physics usually at the top but also of personnel with its professors, associate and assistant professors, postgraduate fellows, and doctoral students. Such distinctions tend to be blurred in Mode 2, in part because not all participants in knowledge production came from universities. Some might have come from government laboratories, some from industry, and others from social action groups and concerned citizens, perhaps with no particular scientific training at all. In Mode 2, all have something to contribute to the formation of a research agenda.

Equally, while the disciplines tend to develop by dividing into more and more specialisms and subspecialisms that reproduce similar organizational structures, Mode 2 configurations and their collaborations are many and varied and continue only so long as the problem in hand requires them. Afterward, Mode 2 forms might dissolve or perhaps be reconstituted around another problem with a different array of participants and organizational structure. Finally, each mode employs a different type of quality control. In contrast with Mode 2, Mode 1 scientists are accountable to one another and their discipline. In Mode 2, peer review continues to operate but accountability is more broadly based socially. Mode 2 is reflexive and absorbs knowledge inputs from many sources on a continuous basis, adjusting its organizational structure as appropriate. In summary, in contrast with Mode 1, Mode 2 involves a more temporary and heterogeneous set of practitioners, collaborating on problems identified in specific, localized contexts. Among its vehicles are research centers of various kinds.

Research centers that support the development of Mode 1 research have been in existence for many years. They can be found in universities, industry, and government laboratories. Now the genre is being extended to Mode 2 research, the characteristics of which have been outlined above. These centers are organized to adopt, adapt, and integrate knowledge from many different sources, including science, to attain a variety of scientific, technological, social, and economic objectives. They are free-standing, time-limited organizations with most staff employed on contracts. Many are funded by government in collaboration with industry, charitable institutions, and wealthy individuals. Because of the flexibility they offer, research centers are becoming a preferred mode for funding organizations. As institutions with sound reputations for pursuing independent inquiry, research centers are increasingly found in universities.

Research Centers and Socially Robust Knowledge

There is an important difference between Mode 1 research that is carried out in typical university laboratories and the Mode 2 knowledge being produced in research centers. In Mode 1, academic scientists are seeking breakthroughs in fundamental science. Much of this research is guided by the paradigms of normal science that were described some years ago by Thomas Kuhn (1996). Paradigms are relatively stable frameworks of inquiry which direct researchers down certain lines of inquiry while, for the time being, eschewing others. Day to day, they are, in effect, testing the limits and robustness of particular paradigms. In contrast, and keeping in mind this entry's focus on industrial innovation, researchers operating in Mode 2-type research centers could be said to be searching for *stable technological paradigms* that can guide technological development by individual companies (Dosi 1982). In typical Mode 2 style, research centers draw together a range of knowledge resources, including some that will forward some Mode 1 research agendas. That is one reason why many academic scientists are attracted research centers, not infrequently on a part-time basis.

In these centers, researchers from a range of backgrounds come together to seek stable technological paradigms. Here, too, in the early stages, search is characterized by a broad range of activities and the context is open to movement, in and out, of a range of participants. Indeed, a number of research centers may be established in a particular technological domain because at the outset it is unclear which of the many possible paths will yield the sought-for stability while also being pregnant with possibilities for further development. In this phase, a time-limited research center is an ideal organizational form for companies to work together with others, sharing resources until a stable paradigm emerges.

A stable paradigm is one not only capable of technological development but is also flexible enough to accommodate a wide range of economic, social, and political constraints. Thus, it was argued in *Re-thinking Science* that research centers can be in search of socially robust knowledge. In Mode 1, scientific authority operates through internal peer review. In Mode 2, peer review is more broadly based and authority becomes much more closely linked to concrete practices, their results, and impacts. Knowledge will be tested not only in the "idealized" experimental configurations of the laboratory but in a variety of local circumstances. In Mode 2, the methods that yield the reliable scientific knowledge of the disciplines continue to operate, but they are augmented to accommodate the particular context. Constant awareness of possible implications keeps inquiry open to broad range of inputs. In this way, context sensitivity changes the ways in which problems are conceived and prioritized and inquiry organized. In the process, reliable knowledge is transformed into socially robust knowledge (Nowotny et al., 2001 p. 116).

In sum, the difference between scientific and technological paradigms is not simply a relabeling of the, now traditional, distinction between pure and applied science. Rather, in Mode 2, research is molded by a broader context than Mode 1. The more strongly contextualized a scientific field or a research domain is, the more it is likely to produce socially robust knowledge.

Transaction Spaces and Contact Languages

In the more open, porous society described in *Re-Thinking Science*, new "spaces" house diverse forms of inquiry. Research centers, for example, provide organizational frameworks in which still tentative, and as yet inadequately institutionalized, interactions can take place. However, these interactions are far from being random encounters. They are the sources from which emerge the "trading zones" described by Galison in his analysis of the history of nuclear physics (Galison 1997).

From the perspective being developed here, trading can give rise to the emergence of *contact languages*, rather like "pidgin" English (e.g., Creole in the southern USA). As a means of communication, contact languages are inevitably undeveloped but, unless they "work," trading ceases. In this manner, the physicists, experimentalists, and engineers described in Galison's research were not engaged in translating from one language to another as they pieced together their microwave circuits, nor were they producing "neutral" observation sentences that some philosophers of science have suggested occur. Rather, they were working out a powerful, locally understood, language to coordinate their actions. Despite obvious limitations, some kind of understanding and exchange does occur in such situations. In *Re-thinking Science*, the metaphor of the trading zone was extended and generalized beyond interactions among scientific subcultures to wider exchanges that take place across knowledge boundaries, more generally. To accommodate this more broadly, in this entry, trading zones were relabeled as transaction spaces.

The notion of a trading zone sheds considerable light on the internal dynamics of knowledge generation in Mode 2. Perhaps here may be discerned an analytical framework to guide policy makers and others in understanding the internal dynamics of the innovation process, a process that moves from an initially inchoate situation involving many "languages" to the contact languages of stable technological paradigms. Within this view can be readily discerned the problem of trying to introduce other factors, such as cost or health and safety considerations, into a technological paradigm that is approaching stability. Policy makers should note that it is simply very difficult to add another language – say, environmental or cost implications – to a functioning contact language that has already been developed. This is why, in the generation of stable technological paradigms, inputs from a variety of sources are necessary from the beginning. Galison has shown that transaction spaces and contact languages can emerge quite naturally in the scientific subcultures of Mode 1. Why ever should they not also appear in the more complex environments of Mode 2 knowledge production? In fact, the emergence of contact languages could become an empirical litmus test for the success or otherwise of any collaboration.

Links to Other Forms of Analysis

The question naturally arises about the relationship of Mode 2 forms of knowledge production to other analyses. For example, the Triple Helix adds to the conventional interaction of the scientific and industrial estates an "overlay" of government policy making. It is incontestable that the economic development of a country depends upon a mutually supportive relationship between these three sets of actors. However, in articulating the notion of the Triple Helix, the authors argue that Mode 2 actually preceded Mode 1 in that networks of informal communications have, in fact, been the normal mode of the operation of science from its inception. Within this framework, Mode 1 is a later, and perhaps transitory, system of knowledge production, the transition being characterized by the movement from Mode 1 to a Triple Helix structure (Etzkowitz and Leydesdorff 2000).

As presented herein, Mode 2 possesses a number of characteristics, not just the reemergence in the twentieth century of nineteenth-century informal networks of scientists and industrialists. In *Re-thinking Science*, Mode 2 forms of knowledge production were seen to be the knowledge dimension of an emerging Mode 2 society. It is the open nature of this society and its correlate, the open systems of knowledge production, that are driving changes in the Mode 1 forms of knowledge production by drawing knowledge producers into the construction and execution of research agendas not only governments but users of many different stripes. It is doubtful if these forms of interaction in their current abundance and diversity were present in the eighteenth or nineteenth centuries. Societies were simply not yet in a form – open enough – to support diverse social and economic groups in the articulation of their demands or to accommodate them in the production of knowledge.

In contrast to the Triple Helix, Mode 3 offers a more comprehensive analysis of contemporary knowledge production. Mode 3 draws heavily on the concepts of systems theory (Carayannis and Campbell 2009). As is typical of this genre, the analysis is focused on the relations between high level political, economic, and social structures. The perennial challenge for system-based theories has been to explain a system's dynamics in concrete cases, not least to be able to draw out potential implications for policy. One attempt to do this has been adumbrated in terms of the notion of "articulation systems" – subsystems which mediate between different, higher order, systems. This approach goes some way to demonstrating how higher order systems interact with one another through the medium of articulation systems. With these, one begins to understand how large complex systems might interact with one another (Dalitz et al. 2012).

The dynamics of the interactions between Mode 2 knowledge production and its conjugate, Mode 2 society, can be conceived as providing some of the elements of an articulation system. This can be seen, for example, in terms of the role played by contact languages and trading zones in explaining how the multiple cultures involved in knowledge production can find a common working language that allow diverse interests to work together productively in the production of socially robust knowledge. The work of Dalitz and his colleagues may provide some common ground that might be able to link Mode 2, Triple Helix, and Mode 3 approaches.

Knowledge Production and Innovation Policy

The question that now needs to be addressed is the relevance of knowledge, whether Mode 1 or Mode 2, to innovation. In the current context, innovation has referred, somewhat narrowly, to the role that science and technology play in innovation in an industrial economy. The linear, or pipeline, model of innovation which regards discoveries in basic science as its source is still dominant among many researchers and some government policy makers. As has noted already, the publicly funded research, particularly university research, organized in Mode 1 forms, is regarded as essential to guarantee the generation of the knowledge and ideas to underpin the flow of innovations required for survival in the global economy.

A recent and robust example of this belief can be found in J. R. Cole's magisterial treatment of the growth of the American universities (Cole 2009). That growth is linked, in part, to the expansion of science in the universities that here has been labeled Mode 1 science. Cole argues that this research has provided the underpinnings for a stream of innovations. To provide some evidential support of this view and to drive the point home, Cole has produced a 152-page summary of some of these discoveries. The policy implications are simple: funding more science will inevitably lead to more innovation. However, the role of basic science in innovation, presented below, offers an explanation of why the pipeline view of innovation might be an oversimplification.

Transferring Science to Industry in Mode 1

To support the movement of basic science into the economy, both universities and government research laboratories have, for many years, operated technology transfer offices. Indeed, in the USA, the Bayh-Dole Act has recently increased the importance of patenting and licensing activities by granting to them ownership of intellectual property arising from publicly funded research that is carried out in their laboratories (Boettinger and Bennet 2006). The hope, then as now, is that protecting and then selling this intellectual property would not only provide a flow of new ideas to support innovation in industry but also provide the universities and government laboratories with an income stream. To some extent, in setting up distinct in-house R&D facilities, companies, too, work with a similar model. In each case, the linear model of innovation is operative.

The difficulty is that transfer mechanisms in which research is first carried out, protected, and then transferred requires that discrete elements of "knowledge" move across established boundaries, from one culture to another, say, from a laboratory to a product development team. Even if the laboratory and the product team are in the same company, the research and the development cultures will be different. As noted above, the appropriation of knowledge produced in one culture by another will be retarded due to the lack of an appropriate contact language.

Innovation in Mode 2

In Mode 2, knowledge is generated in a variety of organizational forms, may involve many participants, and may be located anywhere. In this mode, the principal end-users are involved from the outset. To say the least of it, early involvement by users is crucial to the development of contact languages and has the potential to reduce, if not eliminate, the traditional boundary-crossing difficulties mentioned above. Typically, in this mode of knowledge production, participants remain as long as it is useful and, when they leave, they can take with them what they regard as important for them. Traditional forms of intellectual property protection remain important but they tend to be pursued by firms after they leave the collaboration as each uses its own resources to protect that knowledge which is central to its own particular development of a particular paradigm.

Industrialists know from experience that stable technological paradigms will require inputs from many sources among which more science is only one. Integrating these perspectives into coherent research programs is what research centers, operating in Mode 2, are trying to do. By involving different interests, research centers can be sites for the generation of the socially robust knowledge that industrialists know must underpin any new product or process. In the current socioeconomic context, the production of socially robust knowledge is an imperative for companies for the simple reason that it can be a colossal cost for a firm to embark upon its expansion of a new technological paradigm only to find that it falls at the first hurdle, to discover late on that in fact the paradigm is not stable and that the collaboration has failed to produced socially robust knowledge.

Clearly, there is a tension between Mode 1 and Mode 2 in terms of the optimum way for government policy to support innovation. As has been indicated, Mode 1 has become associated with a linear model of innovation that relies on continuing and substantial funding of research as well as relatively primitive forms of knowledge transfer. However, Mode 1 is both expansive and expensive. It has expanded mainly in universities not only in the physical and biological sciences but the social sciences and the humanities as well. It has been clear for some time that this mode of knowledge production cannot go on expanding because there are simply not sufficient resources to support it. Moreover, Mode 2 forms of knowledge production as carried out in research centers has become popular with companies because it allows them to become involved in a process which requires a greater range of knowledge than any of them can possess singly. National funding agencies are also supportive of research centers because they provide a way to maintain some growth in the academic science base by spreading the financial burden through research centers that are partly funded by industry, foundations, and wealthy individuals. In current environment of intensifying global competition, Mode 2 forms can provide both governments and industry with more effective and cost-efficient ways to invest in innovation.

Conclusion and Future Directions

The Shape of Things to Come?

Technological paradigms perform a similar function in Mode 2 as Thomas Kuhn's scientific paradigms do in Mode 1. Once discovered and judged stable, researchers in industry, many of whom will have worked in the research center, take over and try to develop that paradigm in firm-specific ways. Much the same approach is taken by academic researchers as they strive to determine the limits of a particular scientific paradigm. In a similar manner, industrial firms use their own resources to exploit to the full the technocommercial potential of a paradigm, once its robustness begins to look promising. As scientific paradigms reach their limits, scientists continue to make small adjustments and theoretical and experimental refinements. In a similar manner, as technological paradigms approach their limits, incremental innovation dominates so that it often seems that latest versions of a product line, whether motor cars, washing machines, or computers, differ only marginally in color, design, and technical specification. For both, it is time to begin the hunt for another scientific or stable technological paradigm.

It may be helpful, therefore, to draw attention to an isomorphism between Mode 1 and Mode 2 and the model of innovation appropriate to each. As regards innovation, Mode 1 uses a linear model; Mode 2, a model of open innovation, as described, for example, by Chesbrough (Chesbrough et al. 2006). In this case, the isomorphism would be: Mode 1 is to the linear model as Mode 2 is to open model. But, as has been seen, linear and open models of innovation draw upon different knowledge production configurations in pursuit of innovation; the former is carried by the disciplines, the latter more open entities, that is, by transdisciplinary research centers. Thus, the single level isomorphism might be expanded as follows: the linear model is to Mode 1 as the open model is to Mode 2, as a university (or industrial) laboratory is to a research center, as reliable knowledge is to socially robust knowledge. Each mode has its particular take on the role of knowledge in technological innovation.

Finally, research centers of various kinds are finding homes in universities. Presidents value the prestige and resources that they bring while academics and some graduate students value the opportunities presented by the challenging environment of a research center, free from the administrative and teaching duties of normal university life. This development cannot leave the universities unchanged. Indeed, the research culture of centers may already be modifying the social function of universities not, it need hardly be repeated, by them becoming institutions for applied research but rather homes for the production of socially robust knowledge. To the extent that research centers do become located in, or associated with, universities, they can threaten to destabilize current Mode 1 forms of knowledge production. Indeed, some have argued that this tension has reached the point where it is driving fundamental change in the nature of universities.

In this respect, the distinguished American scholar Randolph Bourne pointed many years ago that, "the issues of the modern university are not those of private property but of public welfare," and that "irresponsible control by a board of amateur notables is no longer adequate for the effective scientific and technological *laboratories for the community* that universities are becoming." (Cole, op.cit. p. 352). Laboratories for community are fast becoming a primary function of universities, and research centers are their principal mode of knowledge production. To be sure, Bourne has grasped the ethos-changing nature the research centers have as the homes of laboratories for the community. To establish new research centers, support their development, and finesse the closure of older ones, and, most of all, to ensure the integrity of the research carried out within their institutions constitute a – if not the – principal challenge facing the academic leadership of universities in the future.

Such is the power of innovation but, as always, it cuts two ways. The demand for innovation not only provides the stimuli for the creation of new knowledge but it also alters the frameworks within which that knowledge is produced. Bourne was certainly correct when he observed that universities need to be "reimagined" if they are to meet the challenge of becoming laboratories for community. Perhaps the burgeoning of research centers will provide the catalyst to ignite that process.

Links to Other Entries in the Encyclopedia

Creativity Although this entry does not deal directly with C*reativity*, it is a key element of the performance Mode 2 organizations, particularly in the research centers elaborated herein. Likewise, research in the *Gestalt* and *Paradigm* entries will bring further specification to the internal evolution of stable technological paradigms. All three headings will add to the understanding of the inner working of Mode 2 research.

Invention Managing Creativity, particularly in research centers, is a key challenge in the emergence of technological paradigms which are one of the key objectives of research centers in Mode 2. *Managing Invention and Innovation* will provide insight into how research centers evolve toward larger, more formal organizations that are required as paradigms become stable. Entries under this heading will provide more detailed analysis of these aspects as innovation moves closer to the market place.

Innovation This aspect of the entry touches many diverse aspects of the organization of innovation that are developed more fully under the *Networks, Open innovation, and Triple Helix* entries. Further useful insights can be found in the entries under *Pasteur's Quadrant* and *Quadruple and Quintuple Helix*. As far as *R&D* is concerned, this entry suggests that the development of stable technological paradigms requires more open, porous, and flexible forms of research organizations and calls into question the function of a distinct research and development function within companies. The entries under *Paradigms* should be consulted for their contribution to a fuller understanding of stable technological paradigms. Entries under *Transdisciplinarity* will expand on this aspect of Mode 2 which is not much developed here beyond a brief description. These entries should help to clarify the distinction between trans-, and inter-, and multidisciplinary research. *Incremental Innovation* is relevant to the later stages in the development of a stable technological paradigm as a more formal organization is put in place to fine-tune technological possibilities to market conditions.

Cross-References

▶ Mode 3
▶ Organizational Creativity
▶ Quadruple Helix
▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
▶ Transdisciplinarity
▶ Triple Helics

References

Boettinger S, Bennet AB. Bayh-Dole: if we knew then what we know now. Nat Biotechnol. 2006;24:320–3.

Bush V. Science the endless frontier. Washington, DC: Office of Scientific Research and Development; 1945.

Carayannis EG, Campbell DFJ. 'Mode 3' and 'Quadruple 638 Helix': toward a 21st century fractal innovation sys-tem. Int J Technol Manag. 2009; 46(3/4):201–30.

Chesbrough HW, Vanhaverbeke W, West J. Open innovation: researching a new paradigm. Oxford: Oxford University Press; 2006.

Cole JR. The rise of the Great American Universities. New York: Public Affairs; 2009.

Dalitz R, Holmen M, Scott-Kemmis D, How innovation systems interact: evidence from seven Australian sectors. Camb J Econ forthcoming 2012.

Dosi G. Technological paradigms and technological trajectories. Res Policy. 1982;11:147–62.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from National Systems and "Mode 2" to a triple helix of university-industry-government relations. Res Policy. 2000;29:109–23.

Galison P. Image and logic: a material culture of microphysics. Chicago: University of Chicago Press; 1997.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage; 1994.

Kuhn TS. The structure of scientific revolutions. 3rd ed. Chicago: University of Chicago Press; 1996.

Nowotny H, Scott P, Gibbons M. Re-thinking science: knowledge and the public in an age of uncertainty. London: Polity Press; 2001.

Mode 1, Mode 2, and Mode 3 Knowledge Production Systems

▶ Epidemiology of Innovation: Concepts and Constructs

Mode 2

▶ Academic Firm

Mode 2 Knowledge Production

▶ Transdisciplinary Research (Transdisciplinarity)

Mode 3

▶ Academic Firm

Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Elias G. Carayannis[1] and David F. J. Campbell[2,3]
[1]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA
[2]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[3]University of Applied Arts, Vienna, Austria

Synonyms

Coevolution; Cross-employment and multi-employment; Democracy of knowledge; Innovation ecosystem; Linear and nonlinear innovation; Multilevel innovation systems; Networks and network governance; Public-private partnerships for research and technological development (PPP RTD); Republic of science; Society-nature interactions; Socio-ecological transition; Twenty-first century Fractal Research and Education and Innovation Ecosystem (FREIE)

Conceptual Point of Departure for Mode 3 Knowledge Production in Quadruple Helix Innovation Systems

Universities, or higher education institutions (HEIs) in more general, have three main functions: teaching and education, research (research and experimental development, R&D), and the so-called third mission activities, for example, innovation (Campbell and Carayannis 2013, p. 5). University research, in a traditional understanding, focuses on basic research, often framed within a matrix of academic disciplines, and without a particular interest in the practical use of knowledge and innovation. This model of university-based knowledge production also is being called "Mode 1" of knowledge production (Gibbons et al. 1994). Mode 1 is also compatible with the linear model of innovation, which is often being referred to Vannevar Bush (1945). The linear model of innovation asserts that first there is basic research in university context. Gradually, this university research will diffuse out into society and the economy. It is then the economy and the firms that pick up the lines of university research, and develop these further into knowledge application and innovation, for the purpose of creating economic and commercial success in the markets outside of the higher education system. Within the frame of linear innovation, there is a sequential first-then relationship between basic research (knowledge production) and innovation (knowledge application).

The Mode-1-based understanding of knowledge production has been challenged by the new concept of "Mode 2" of knowledge production, which was developed and proposed by Michael Gibbons et al. (1994, pp. 3–8, 167). Mode 2 emphasizes a knowledge application and a knowledge-based problem-solving that involves and encourages the following principles: "knowledge produced in the context of application"; "transdisciplinarity"; "heterogeneity and organizational diversity"; "social accountability and reflexivity"; and "quality control" (see furthermore Nowotny et al. 2001, 2003 and 2006). Key in this setting is the focus on a knowledge production in contexts of application. Mode 2 expresses and encourages clear references to innovation and innovation models. The linear model of innovation also has become challenged by nonlinear models of innovation, which are interested in drawing more direct connections between knowledge production and knowledge application, where basic research and innovation are being coupled together not in a first-then, but in an "as well as" and "parallel" (parallelized) relationship (Campbell and Carayannis 2012). Mode 2 appears also to be compatible with nonlinear innovation and its ramifications.

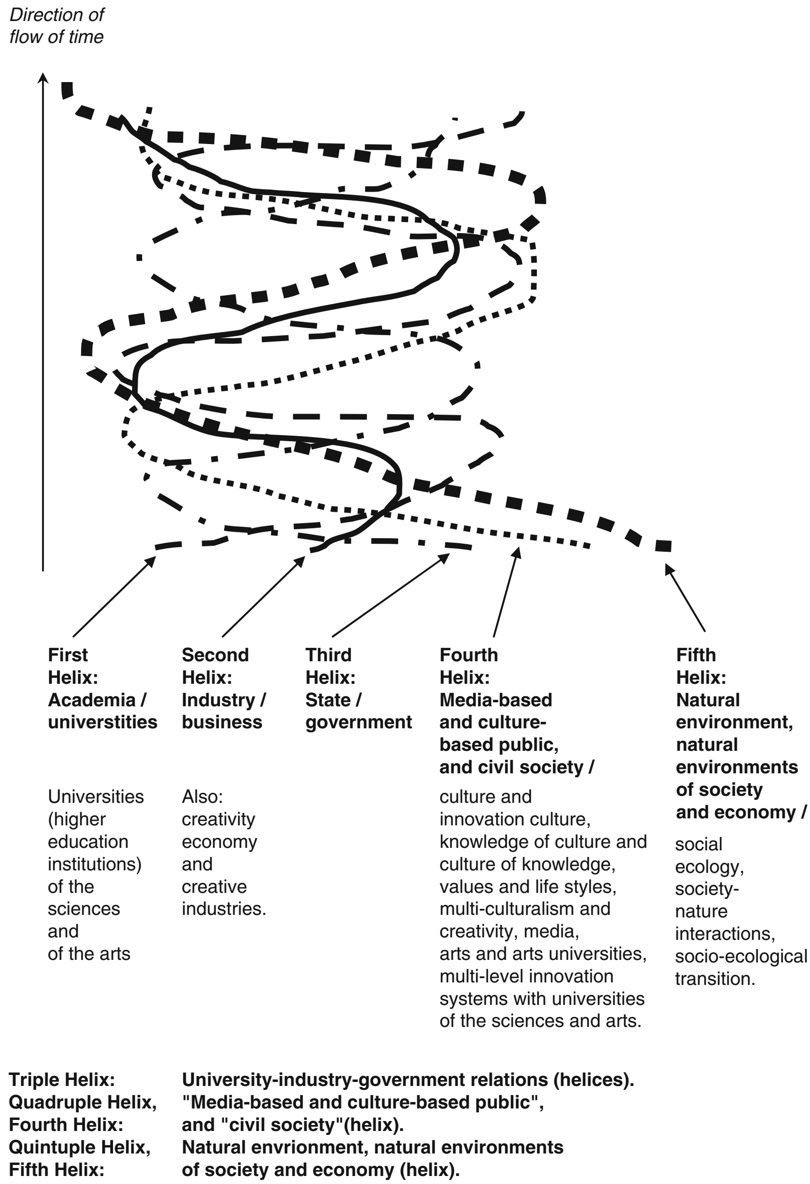
The Triple Helix model of knowledge, innovation, and university-industry-government relations, which was introduced and invited by

Henry Etzkowitz and Loet Leydesdorff (2000, pp. 111–112), asserts a basic core model for knowledge production and innovation, where three "helices" intertwine, thereby creating a national innovation system. As the three helices are being identified the following systems or sectors: academia (universities), industry (business), and state (government). Etzkowitz and Leydesdorff refer to "university-industry-government relations" and networks, putting a particular emphasis on "trilateral networks and hybrid organizations," where those helices overlap in a hybrid fashion. Etzkowitz and Leydesdorff (2000, p. 118) also explain, how, in their view, the Triple Helix model relates to Mode 2: The "Triple Helix overlay provides a model at the level of social structure for the explanation of Mode 2 as an historically emerging structure for the production of scientific knowledge, and its relation to Mode 1." More recently, Leydesdorff (2012) also introduced the notion of "N-Tuple of Helices."

The Conceptual Definition of Mode 3 Knowledge Production, Quadruple and Quintuple Helix Innovation Systems

Mode 1 and Mode 2 may be characterized as "knowledge paradigms" that underlie the knowledge production (to a certain extent also the knowledge application) of higher education institutions and university systems. Success or quality, in accordance with Mode 1, may be defined as: "*academic excellence, which is a comprehensive explanation of the world* (*and of society*) *on the basis of 'basic principles' or 'first principles', as is being judged by knowledge producer communities (academic communities structured according to a disciplinary framed peer review system)*". Consequently, success and quality, in accordance with Mode 2, can be defined as: "*problem-solving, which is a useful (efficient, effective) problem-solving for the world (and for society), as is being judged by knowledge producer and knowledge user communities*" (Campbell and Carayannis 2013, p. 32). A Mode 3 university, higher education institution or higher education system, would represent a type of organization or system that seeks creative ways of combining and integrating different principles of knowledge production and knowledge application (e.g., Mode 1 and Mode 2), thereby encouraging diversity and heterogeneity, thereby also creating creative and innovative organizational contexts for research and innovation. Mode 3 encourages the formation of "creative knowledge environments" (Hemlin et al. 2004). "Mode 3 universities," Mode 3 higher education institutions and systems, are prepared to perform "basic research in the context of application" (Campbell and Carayannis 2013, p. 34). This has furthermore qualities of nonlinear innovation. Governance of higher education and governance in higher education must also be sensitive, whether a higher education institution operates on the basis of Mode 1, Mode 2, or a combination of these in Mode 3. The concept of "epistemic governance" emphasizes that the underlying knowledge paradigms of knowledge production and knowledge application are being addressed by quality assurance and quality enhancement strategies, policies, and measures (Campbell and Carayannis 2013).

Emphasizing again a more systemic perspective for the Mode 3 knowledge production, a focused conceptual definition may be as follows (Carayannis and Campbell 2012, p. 49): Mode 3 ". . . allows and emphasizes the co-existence and co-evolution of different knowledge and innovation paradigms. In fact, a key hypothesis is: *The competitiveness and superiority of a knowledge system or the degree of advanced development of a knowledge system are highly determined by their adaptive capacity to combine and integrate different knowledge and innovation modes via co-evolution, co-specialization and co-opetition knowledge stock and flow dynamics*" (see Carayannis and Campbell 2009; on "Co-Opetition," see Brandenburger and Nalebuff 1997). Analogies are being drawn and a coevolution is being suggested between diversity and heterogeneity in advanced knowledge society and knowledge economy, and political pluralism in democracy (knowledge democracy), and the quality of a democracy. The "Democracy of

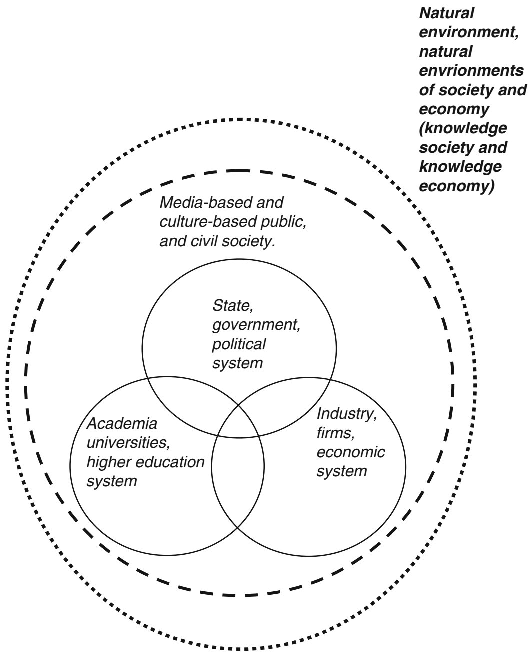


Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology, Fig. 1 The Quadruple and Quintuple Helix innovation systems Source: Authors' own conceptualization (Based on Etzkowitz and Leydesdorff (2000, p. 112), Carayannis and Campbell (2009, p. 207; 2012, p. 14), and Danilda et al. (2009))

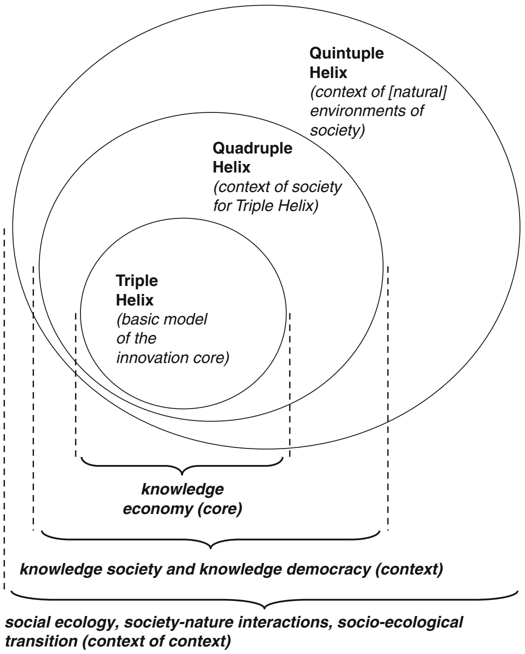
Knowledge" refers to this overlapping relationship. As is being asserted: "The *Democracy of Knowledge*, as a concept and metaphor, highlights and underscores parallel processes between political pluralism in advanced democracy, and knowledge and innovation heterogeneity and diversity in advanced economy and society. Here, we may observe a hybrid overlapping between the *knowledge economy, knowledge society and knowledge democracy*" (Carayannis and Campbell 2012, p. 55). The "Democracy of Knowledge," therefore, is further reaching then the earlier idea of the "Republic of Science" (Michael Polanyi 1962).

The main focus of the Triple Helix innovation model concentrates on university-industry-government relations (Etzkowitz and Leydesdorff 2000). In that respect, Triple Helix represents a basic model or a core model for knowledge production and innovation application. The models of the Quadruple Helix and Quintuple Helix innovation systems are designed to comprehend already and to refer to an extended complexity in knowledge production and knowledge application (innovation); thus, the analytical architecture of these models is broader conceptualized. To use metaphoric terms, the Quadruple Helix embeds and contextualizes the Triple Helix, while the Quintuple Helix embeds and contextualizes the Quadruple Helix (and Triple Helix). The Quadruple Helix adds as a fourth helix the "media-based and culture-based public" and "civil society" (Carayannis and Campbell 2009 and 2012, p. 14; see also Danilda et al. 2009). The Quintuple Helix innovation model even is more comprehensive in its analytical and explanatory stretch and approach, adding furthermore the fifth helix (and perspective) of the "natural environments of society" (Carayannis and Campbell 2010, p. 62) (see Figs. 1 and 2).

The Triple Helix is explicit by acknowledging the importance of higher education for innovation. However, it could be argued that the Triple Helix sees knowledge production and innovation in relation to economy; thus, the Triple Helix models the economy and economic activity. In that sense, the Triple Helix frames the knowledge economy. The Quadruple Helix brings in the additional perspective of society and of knowledge society. The Quadruple-Helix-innovation-system understanding emphasizes that sustainable development of and in economy (knowledge economy) requires that there is a coevolution of knowledge economy and knowledge society. The Quadruple Helix even encourages the perspectives of the knowledge society, and of knowledge democracy, for supporting, promoting, advancing, and excelling knowledge production (research) and knowledge application (innovation). Furthermore, the Quadruple Helix is also explicit that not only universities (higher education institutions) of the sciences, but also universities (higher education institutions) of the arts should be regarded as decisive and determining institutions for advancing next-stage innovation systems: The interdisciplinary and transdisciplinary connecting of sciences and arts creates crucial and creative combinations for promoting and supporting innovation; here, in fact, lies one of the keys for future success. The concept and term of "social ecology" refers to "society-nature interactions" between "human society" and the "material world" (see, e.g., Fischer-Kowalski and Haberl 2007). The European Commission (2009) identified the necessary socio-ecological transition of economy and society as one of the great next-phase challenges, but also as an opportunity, for the further progress and advancement of knowledge economy and knowledge society. The Quintuple Helix refers to this socio-ecological transition of society, economy, and democracy; the Quintuple Helix innovation system is therefore ecologically sensitive. Quintuple Helix bases its understanding of knowledge production (research) and knowledge application (innovation) on social ecology (see Fig. 3). Environmental issues (such as global warming) represent issues of concern and survival for humanity and human civilization. But the Quintuple Helix translates environmental and ecological issues of concern also in potential opportunities, by identifying them as possible drivers for future knowledge production and innovation (Carayannis et al. 2012). This, finally, defines also opportunities



Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology, Fig. 2 The Quintuple Helix (five-helix model) innovation system (Source: Authors' own conceptualization based on Carayannis and Campell (2010, p. 62))



Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology, Fig. 3 The Quadruple and Quintuple Helix innovation systems in relation to society, economy, democracy, and social ecology (Source: Authors' own conceptualization based on Carayannis et al. (2012, p. 4))

for the knowledge economy. "*The Quintuple Helix supports here the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society and democracy*" (Carayannis et al. 2012, p. 1).

Conclusion and Future Directions

The terms and concepts of Mode 3 and Quadruple Helix were first introduced to international academic debate by Carayannis and Campbell (2006 and 2009), and were later developed further (Carayannis and Campbell 2012). The same applies to the Quintuple Helix (Carayannis and Campbell 2010). Further ramifications of Mode 3 knowledge production in Quadruple Helix and Quintuple Helix innovation systems are:

1. *Multilevel innovation systems, the global and the local (GloCal)*: Lundvall was pivotal in introducing the concept of the "national innovation system." Lundvall (1992, pp. 1, 3) explicitly acknowledges that national innovation systems are challenged in permanence (but are also extended) by regional as well as global innovation systems. Here, Kuhlmann (2001, pp. 960–961) could be paraphrased and the assertion that as long as nation-states and nation state-based political systems exist, it is plausible to use the concept of the national innovation system. More comprehensive in its analytical architecture than the national innovation system is the concept of the "multilevel innovation system" (Carayannis and Campbell 2012, pp. 32–35). In a spatial understanding, multilevel innovation systems compare the national with the subnational (regional, local), but also with the transnational and global levels (see, e.g., Kaiser and Prange 2004; furthermore, see Pfeffer 2012). However, it is also important to extend multilevel-innovation-systems to the challenges and potential benefits and opportunities of a nonspatial meaning and understanding: "Therefore, multi-level systems of knowledge as well as multi-level systems of innovation are based on spatial and non-spatial axes. A further advantage of this multi-level systems architecture is that it results in a more accurate and closer-to-reality description of processes of globalization and gloCalization" (Carayannis and Campbell 2012, p. 35).
2. *Linear and nonlinear innovation*: Knowledge application and innovation are being challenged and driven out of an interest of combining and integrating linear and nonlinear innovation. Key to here are a diversity, heterogeneity, and pluralism of different knowledge and innovation modes, and their linking together via an architecture of coevolving networks. Firms, universities, and other organizations can engage (at the same) in varying and multiple technology life cycles at different levels of maturity. Another way "how to think nonlinear innovation" is being suggested by the concept of cross-employment (Campbell 2011). As a form and type of multi-employment, cross-employment emphasizes that the same individual person may be

employed by two (or more) organizations, where one organization could be located closer to knowledge production, and the other to knowledge application (innovation): are those organizations also rooted in different sectors, then cross-employment acts also as a trans-sectoral networking (Campbell and Caraynnis 2013, pp. 65, 68). What results is a "Mode 3 Innovation Ecosystem": "This parallel as well as sequentially time-lagged unfolding of technology life cycles also expresses characteristics of Mode 2 and of nonlinear innovation, because organizations (firms and universities) often must develop strategies of simultaneously cross-linking different technology life cycles. Universities and firms (commercial and academic firms) must balance the nontriviality of a fluid pluralism of technology life cycles" (Carayannis and Campbell 2012, p. 37; see furthermore Dubina et al. 2012). The relationship between networks, cooperation, and competition ("Co-Opetition") represents a challenge and sensitive issue, and allows for different creative answers and organizational representations and manifestations.

3. *Twenty-first century Fractal Research, Education and Innovation Ecosystem (FREIE)*: Here, the understanding of FREIE is: "This is *a multilayered, multimodal, multinodal, and multilateral system*, encompassing mutually complementary and reinforcing innovation networks and knowledge clusters consisting of human and intellectual capital, shaped by social capital and underpinned by financial capital" (Carayannis and Campbell 2012, p. 3).
4. *Linear and nonlinear innovation, and the causality of if-then and if-if relations*: The hybrid overlapping of linear innovation and nonlinear innovation displays also possible ramifications and draws associations to models of causality and their remodeling. "We can speculate, whether this parallel integration of linearity and nonlinearity not also encourages a new approach of paralleling in our theorizing and viewing of causality: *in epistemic (epistemological) terms, the so-called if-then relationships could be complemented by (a thinking in) 'if-if' relations*" (Carayannis and Campbell 2012, p. 24; see also Campbell 2009, p. 123).

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Academic Firm
- ▶ Ambidexterity
- ▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
- ▶ Artistic Research
- ▶ China's National Innovation System
- ▶ Creative Knowledge Environments
- ▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation
- ▶ Epistemic Governance and Epistemic Innovation Policy
- ▶ Global University System in World Society
- ▶ Higher Education and Innovation
- ▶ Innovation System of India
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Multi-level Systems of Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Nonlinear Innovations
- ▶ N-Tuple of Helices
- ▶ Palliative Care and Hospice - Innovation at End of Life
- ▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Systems Theory and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)
- ▶ Triple Helix of University-Industry-Government Relations
- ▶ University Research and Innovation

References

Brandenburger AM, Nalebuff BJ. Co-opetition. New York: Doubleday; 1997.

Bush V. Science: the endless frontier. Washington, DC: United States Government Printing Office; 1945 (http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm#transmittal).

Campbell DFJ. "Externe Umwelten". Außensichten auf das iff. In: Arnold M, editor. iff. Interdisziplinäre Wissenschaft im Wandel. Vienna: LIT; 2009. p. 99–134.

Campbell DFJ. Wissenschaftliche "Parallelkarrieren" als chance. Wenn Wissenschaft immer öfter zur Halbtagsbeschäftigung wird, könnte eine Lösung im "Cross-Employment" liegen. Guest Commentary for DIE PRESSE (February 2, 2011); 2011. (http://diepresse.com/home/bildung/meinung/635781/Wissenschaftliche-Parallelkarrieren-als-Chance?direct=635777&_vl_backlink=/home/bildung/index.do&selChannel=500).

Campbell DFJ, Carayannis EG. Lineare und nicht-lineare knowledge production: innovative herausforderungen für das hochschulsystem. Zeitschrift für Hochschulentwicklung. 2012;7(2):64–72 (http://www.zfhe.at/index.php/zfhe/article/view/448).

Campbell DFJ, Carayannis EG. Epistemic governance in higher education. Quality enhancement of universities for development, Springer briefs in business. New York: Springer; 2013 (http://www.springer.com/business+%26+management/organization/book/978-1-4614-4417-6).

Carayannis EG, Campbell DFJ. "Mode 3": meaning and implications from a knowledge systems perspective. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the united states, Europe and Asia. Westport: Praeger; 2006. p. 1–25.

Carayannis EG, Campbell DFJ. "Mode 3" and "quadruple helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manage. 2009;46(3/4):201–234 (http://www.inderscience.com/browse/index.php?journalID=27&year=2009&vol=46&issue=3/4 and http://www.inderscience.com/search/index.php?action=record&rec_id=23374&prevQuery=&ps=10&m= or).

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. Int J Soc Ecol Sustain Develop. 2010;1(1):41–69 (http://www.igi-global.com/bookstore/titledetails.aspx?titleid=38876 and http://www.igi-global.com/bookstore/article.aspx?titleid=41959).

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-Century democracy, innovation, and entrepreneurship for development, Springer briefs in business. New York: Springer; 2012 (http://www.springer.com/business+%26+management/book/978-1-4614-2061-3).

Carayannis EG, Barth TD, Campbell DFJ. The quintuple helix innovation model: global warming as a challenge and driver for innovation. J Innov Entrepreneur. 2012;1(1):1–12 (http://www.innovation-entrepreneurship.com/content/pdf/2192-5372-1-2.pdf).

Danilda I, Lindberg M, Torstensson B-M. Women resource centres. A quattro helix innovation system on the European Agenda. Paper; 2009. (http://www.hss09.se/own_documents/Papers/3-11%20-%20Danilda%20Lindberg%20&%20Torstensson%20-%20paper.pdf).

Dubina IN, Carayannis EG, Campbell DFJ. Creativity economy and a crisis of the economy? coevolution of knowledge, innovation, and creativity, and of the knowledge economy and knowledge society. J Know Econ. 2012;3(1):1–24 (http://link.springer.com/article/10.1007/s13132-011-0042-y).

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and "mode 2" to a triple helix of university-industry-government relations. Res Pol. 2000;29:109–123.

European Commission. The world in 2025. Rising Asia and socio-ecological transition. Brussels: European Commission; 2009 (http://ec.europa.eu/research/social-sciences/pdf/the-world-in-2025-report_en.pdf).

Fischer-Kowalski M, Haberl H, editors. Socioecological transitions and global change. Trajectories of social metabolism and land use. Cheltenham: Edward Elgar; 2007.

Gibbons M, Camille L, Helga N, Simon S, Peter S, Martin T. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.

Hemlin S, Allwood CM, Martin BR. Creative knowledge environments. The influences on creativity in research and innovation. Cheltenham: Edward Elgar; 2004.

Kaiser R, Prange H. The reconfiguration of national innovation systems – the example of German biotechnology. Res Pol. 2004;33:395–408.

Kuhlmann S. Future governance of innovation policy in Europe – three scenarios. Res Pol. 2001;30:953–976.

Leydesdorff L. The triple helix, quadruple helix, . . ., and an n-tuple of helices: explanatory models for analyzing the knowledge-based economy? J Know Econ. 2012;3(1):25–35 (http://link.springer.com/article/10.1007/s13132-011-0049-4).

Lundvall B-Å, editor. National systems of innovation. Towards a theory of innovation and interactive learning. London: Pinter Publishers; 1992.

Nowotny H, Scott P, Gibbons M. Re-thinking science. Knowledge and the public in an age of uncertainty. Cambridge: Polity Press; 2001.

Nowotny H, Scott P, Gibbons M. Mode 2 revisited: the new production of knowledge. Minerva. 2003;41:179–194.

Nowotny H, Scott P, Gibbons M. Re-thinking science: mode 2 in societal context. In: Carayannis EG,

Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the united states, Europe and Asia. Westport: Praeger; 2006. p. 39–51.
Pfeffer T. Virtualization of universities. Digital media and the organization of higher education institutions. New York: Springer; 2012 (http://www.springer.com/business+%26+management/media+management/book/978-1-4614-2064-4).
Polanyi M. The republic of science: its political and economic theory. Minerva. 1962;1:54–74 (http://sciencepolicy.colorado.edu/students/envs_5100/polanyi_1967.pdf and http://fiesta.bren.ucsb.edu/~gsd/595e/docs/41.%20Polanyi_Republic_of_Science.pdf).

Mode 3 University

► Academic Firm

Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Ralph Kerle
The Creative Leadership Forum, Willoughby, Australia

Synonyms

Benchmarking; Change management; Creative behaviors; Creative ecology; Creative leadership; Innovation; Innovation process; Management innovation; Measurement; Organizational culture; Organizational development; Statistics; Strategic innovation; Strategy

Executive Summary

This entry explores the organizational dilemma of intangibility in innovation and the consequences of ignoring it, proposes a case for a systems thinking approach to organizational creativity, reviews the emergence of organizational economics as a new field of research for analyzing intangibility in organizations, and offers a model for benchmarking and measuring organizational creativity, a prime resource for success for an organization or business in the twenty-first century.

Introduction

The Organizational Dilemmas of Intangibility and Creativity

In *How To Measure Anything – Finding the Value of Intangibles in Business*, author Douglas W. Hubbard, a former management consultant with Coopers and Lybrand, describes the tension he felt as a member of the organization's steering committee at which they were charged with accepting or rejecting new business investment proposals. The proposed investments ranged from IT to new product research and development and from major real estate development to advertising campaigns. What concerned Hubbard was the regular rejection of "soft" proposals. Proposals that contained language such as "reduced strategic risk" or "premium brand positioning" simply because they "were considered immeasurable."

As Hubbard states, "It wasn't as if the idea was being rejected because the person proposing it hadn't measured the benefit (a valid objection to a proposal): rather it was believed that the benefit couldn't be measured – ever. Consequently some of the most important strategic proposals were being over looked in favor of minor cost-saving ideas simply because everyone knew how to measure some things and didn't know how to measure others. Equally disturbing, many major investments were approved with no basis for measuring whether they worked at all (Hubbard 2007a).

In this statement, Hubbard is highlighting the fact that most companies see organizational creativity as being tactical. We have a problem, let us call a meeting and come up with as many ideas as possible to solve it. Yet if organizations base their strategic innovation on ideation then the records show they do so at their own peril. Generating lots of ideas without first understanding the organization's economic resources, constraints, and behaviors can result in a substantial waste of time with no apparent outcome, confirming the often negative experience of organizational creativity. "Just another idea workshop," "nothing came out of the last one," "they never follow through," and "a complete waste of time" appear regularly in the anecdotal responses to research collected from Management Innovation Index (The Management Innovation Index www.managementinnovation.net) surveys on innovation effectiveness.

The chief information officer of one of Australia's leading telecommunications companies recalls the expensive construction and application of an online suggestion box that was initially overloaded with ideas. The organization's management had not anticipated this response and had no real management processes or mechanisms in place to respond to the deluge. Time-poor as most senior managers are meant that decisions were deferred on how to deal with the ideas, and in many instances, no response was offered at all. Quickly, the ideas stopped coming, and the expensive online system now sits idly and unused on managers' browsers.

Worse, still, is the selection of the wrong idea to invest in, sending an organization or product on the path to oblivion with the resulting financial catastrophe.

Google's failed Google Wave project is one example.

The Rasmussen brothers, developers of the highly successful Google Maps app, convinced Google management that they could repeat their successful efforts – this time in communications. Their initial idea was vague and tactical in construct – a new communications model that embraced all previous forms of digital communications – and overhyped from the very first press release announcing the project (Google Wave: A Complete Guide. http://mashable.com/2009/05/28/google-wave-guide/). Here was an opportunity in Google's mind to catch-up and dominate in the social media market, not properly serviced by Twitter and Facebook and cluttered with a myriad of hopeful start-ups, using the power of their existing platform.

With an initial investment of $20million, Google Wave was hardly rudimentary prototyping. The company commenced by engaging 60 software engineers and general staff, housing them in an expensive new set of offices. Google Wave was launched officially in May 2009 and was dead by August 2010 because it was based on a badly articulated idea, imbued with nothing more than unbridled optimism – this team had been successful in the past, naturally it would be successful again!

You only have to search the web to read the comments from users to discover how badly Google Wave failed (Google Wave: A Case Study on Why Interactive Design Matters http://joannejacobs.net/?p=1818).

Most revealing is the press conference (TechCrunch. Schmidt Talks Wave's Death – We Celebrate Our Failures. August 2010 http://techcrunch.com/2010/08/04/google-wave-eric-schmidt/). Google CEO Dr. Eric Schmidt gave concerning, in part, Google's new product development process. When questioned about how it worked, he gave a far from convincing display appearing uncomfortable and tense at times in describing a rudimentary prototyping process steeped in tactical thinking lacking any strategic foresight. "When launching a new product, we wait to see how well it is initially adopted, followed by the tracking of the correlation between the number of initial launch adopters and the number of new user uptakes on the second iteration of the product to determine whether the product is going to work or not," he summed up.

Harvard Assistant Professor Karim R. Lakhani in his article "Google Wave Decision Shows Strong Innovation Management" (http://blogs.hbr.org/hbsfaculty/2010/08/google-wave-decision-shows-str.html) argues that as companies get bigger their latitude for employees to be creative meaningfully is often unfortunately drowned by more rigid management structures, philosophies, and protocols. These more rigid management structures and philosophies act as impediments to creativity rather than the facilitation of it, clouding and confusing important aspects of data gathering, sense making, and ultimately decision making.

Lakhani captures the unsurfaced apprehension leaders of the twenty-first century organizations now face and will start to face more frequently. Their deep concern in the new era of information and knowledge overload is how to facilitate meaningful creative thinking around the intangibility of services and organizational processes while seeking to coordinate and mitigate their risks successfully across a multitude of organizational systems, strategic alliances, and stakeholders to produce successful innovation.

Coincidentally, Google Australia reported a loss of $3.08 million in its accounts for the 2010 calendar year.

The Case for a Systems Thinking Approach to Organizational Creativity

Identifying organizational creativity, though, as a concept is highly problematic.

Metaphorically, an organization is a humanist environment driven by a series of cumulative behaviors. Subconscious in their formation, the cumulative behaviors, like the brain and creativity itself, are constrained by a system that supports and directs it for the benefit of the organization's existence.

These cumulative behaviors need to be identified and defined in order to enable meaningful measurements to model the system of creativity operating in an organization. In addition, if the measurements are to have any value, they need to be economically and behaviorally cogent in context and reflective of the organization as a whole. The ultimate test being whether through measuring organizational creativity, the organization will obtain a better knowledge of how it can become a more efficient, productive, and successful innovator, the driving force behind all successful organizations.

It may seem odd that the first clues in finding solutions to these quandaries do not come from a humanities discipline where you might expect a discussion on creativity to reside but from the total quality movement (TQM) and, in particular, work pioneered by the American author, statistician, and management consultant Dr W. Edward Deming during the post–World War II industrial expansion of Japan.

Largely unrecognized in his native US until much later in life, Deming died in 1993 the same year his most celebrated book, The New Economics for Industry, Government, Education, was published – a lifetime's work condensed into a management philosophy grounded in systems theory.

The underlying principle of Deming's theory, which he called a system of profound knowledge, (The 14 principles of the Deming System of Profound Knowledge http://en.wikipedia.org/wiki/W._Edwards_Deming#The_Deming_System_of_Profound_Knowledge) is that a system cannot understand itself and "any transformation (in it) requires an outside view – a lens – that I (he) call a system of profound knowledge. A map of theory by which to understand the organizations we work in."

Each organization, according to Deming, is composed of a connection of interrelated processes and people which make up the system's components. The success of all managers and workers within the system is dependent on the leaders' capability to orchestrate the delicate balance of each component for optimization of the entire system.

An essential element of Deming's theory was what he called *The Appreciation of a System* (http://en.wikipedia.org/wiki/W._Edwards_Deming). This "involved understanding how interactions (i.e., feedback) between the elements of a system result in internal restrictions that force the system to behave as a single organism that automatically seeks a steady state" (The Definition of A Steady State http://en.wikipedia.org/wiki/Steady_state). It is this steady state that determines the output of the system rather than the individual elements. Thus, it is the structure of the organization rather than the employees, alone, which hold the key to improving the quality of output (http://www.improvementandinnovation.com/features/articles/link-between-demings-theory-profound-knowledge-and-systems-thinking).

However, if the system's basic components are creative behaviors, notoriously chaotic, risky, uncertain, uncontrollable, intractable and intangible, how can we observe and describe how these human frailties combine to influence and cohere to produce a steady state of organization with a quality output?

While Deming was starting out on his journey of systematizing industrial production in Japan post–World War II, American sociologist C Wright Mills was expressing his concern about the potential of the corporation to dehumanize work.

In his book White Collar: The American Middle Class (1951) he contended that bureaucracies were now developing in a way that "overwhelmed the individual city worker, robbing him or her of all independent thought and turning him into a sort of a robot that is oppressed but cheerful. He or she gets a salary, but becomes alienated from the world because of his or her inability to affect or change it."

For Wright Mills, who was constantly trying to reconcile the individual and society, the ideal corporate environment was one in which "the labourer with a sense of craft becomes engaged in the work in and for itself; the satisfactions of working are their own reward, the details of daily labor are connected in the worker's mind to the end product; the worker can control his or her own actions at work; skills develop within the work process; work is connected with the freedom to experiment; finally family, community, and politics are measured by the standard of inner satisfaction, coherence and experiment in craft labour. . .."

This was a radical view at the time but could be the basic advertising copy for an employee job description for those wishing to join today's information, knowledge, and technological industries.

Sixty years hence, Wright Mills description of the idealized environment in which an individual's creative endeavors can be recognized, expressed, and encouraged is emerging as a vital consideration in the development and success of the twenty-first century organizations.

Important to Wright Mill's thinking is the notion of experimentation in the work context and its importance to the worker's identity.

Creativity is only ever understood through imagination (the what if) and experimentation (how), states that in turn are driven by a loop of practice, implementation and perception, and the conversations that occur around the perceptions of the genesis of the practice.

Through this process, the sense of craft associated with an individual's work endeavors develops along with his/her understanding of their practice and abilities.

The lasting legacy of Wright Mill's work is that it describes the humanity and value individuals are seeking to bring to their work in organizations in the twenty-first century with the resulting personal freedom that gives them, and the organizations or networks, within in which they work. The lasting legacy of Deming's philosophy is that it has been able to build an important connection between the mechanistic and logico-rationalism of the world of systems thinking and the human aspect of management.

But wait!! A prominent voice from the ghosts of the Industrial Age is questioning our hypothesis. Lord Kelso, British physicist and member of the House of Lords, 1824–1827, booms out almost sarcastically from the floor of the chamber. "When you can measure what you are speaking about and express it in numbers you know something about it. But when you cannot express it in numbers, your knowledge is a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the state of science, my friends" (Hubbard 2007b).

The Emerging Influence of Organizational Economics in Business

In the 1970s and 1980s, a new breed of economists began to realize the neoclassic view of economic theory based on the rules of a market economy was ignoring an essential component – the "black box" of production, i.e., the firm in which the capital and labor came together to produce the outputs for the market. With the rediscovery of Nobel Prize winning economist Robert Coase's article "The Nature of the Firm" (Coasce 1937), economists began to devise new analytical tools around concepts such as agency theory, transaction cost economics, and game theory to develop "a collection of ideas and models, with the potential to be integrated, to guide managerial activity, and to inform organization theory and behaviors."

These new analytical tools initially focused on issues such as information asymmetrics (the study of decisions in transactions where one party has more or better information than the other), opportunism, and behavioral constraints as opposed to the tools of traditional organizational studies, with their sociological biases, focusing on behavioral norms such as power and trust.

This new approach with its reliance on econometrics and theory building as opposed to the familiar mode of generalizing from empirical evidence and systemic data analysis was warmly welcomed by managerial theorists, who were not unfamiliar with economics and the use of formal mathematical modeling to explain economic theory and were suffering criticism about their one-dimensional focus on theory and the use of case studies to support the theory.

What began to emerge at the turn of the twenty-first century were organizational economists aided by the numbers contained in these new analytics, joining with their managerial theorists and organizational studies colleagues with their empirical studies to inform business directly in more meaningful ways.

Suddenly, business leaders found themselves able to engage with economists, examining the tasks of motivating and coordinating human activity; exploring the nature and effect of efficiencies; the processes of creating, sharing, and exploiting knowledge; designing incentives; constructing intellectual property rights and ways of disseminating; and processing information that structured productive processes and activities – all matters with the potential of adding substantially to an organization's bottom line, in this new era of valuing and commercializing the intangibles of knowledge and information.

Given this context, could it be possible, then, to use this new thinking in organizational economics and apply it to benchmark and measure the cumulative management innovation behaviors that drive an organization and, in the process, locate Deming's steady state of equilibrium from which a leader can begin to meaningfully reflect on and manage the intangibility of organizational creativity to drive sustainability, growth, and success?

A Methodology for Benchmarking and Measuring the Intangibility of Organizational Creativity

In a very practical way, the impact of creativity in an organization affects its success. Yet, creativity in any organizational system is fuzzy – intangible. Rather like a theatrical production, organizational creativity is the sum of all the inputs involved in the organization's system with the outputs being the organization in performance.

A method for modeling organizational creativity, the Management Innovation Index ™ (the MIX) has been developed to enable organizations to map, benchmark, and measure their management innovation performance in the process giving a tangibility to the organization's creative fuzziness.

Management innovation is made up of two elements – the creative inputs produced by the employees and the organizational sociology which supports or impedes the flow of their creative inputs.

Creative inputs in an organization evolve from a moment in time when a single thought manifested, picked up by a person who did not initiate the thought, coalesces into a concrete idea. Once this occurs, the idea has a life of its own and begins a never-ending journey that is dependent for its survival and acceptance on its flow within the system.

To ensure the idea is given a good chance to germinate regardless of its intrinsic merit, managers seek clarity around four elements of ideation:

- Purpose – I know why I am working on this idea and it has a chance of being developed within the system.
- Motivation – I am committed, passionate, ready to take a risk, go the extra mile to make new things happen. There is a flow in my work environment that means I am not impeded and I am supported, recognized, and rewarded for my ideas.
- Orientation – I am empowered to develop my own ideas. I know who to work with to advance them. I recognize where the constraints are around my ability to advance

them. I am OK with that and know how to resolve it.
- Implementation – My ideas will get implemented in some form or another.

A survey containing a series of questions administered across all levels of the organization enables sufficient raw data to be collected to grade managers' perceptions of these elements and using Deming's concept, to obtain an appreciation of the system and its feedback mechanisms.

The second element – the organizational sociology – seeks to discover the managers' cumulative perception of how the environment in which they operate influences the way they think and apply their creativity.

To observe this phenomenon, the MIX, again using data collected from the survey, benchmarks the organization's management innovation behaviors seeking to observe any biases in patterns that may strengthen or weaken the organization's overall strategic innovation capabilities.

The management innovation components benchmarked are as follows:
- The organization's culture and environment and its managers' skills in envisioning, leadership, communication, and reflection
- The organization's strategic leadership and thinking styles and its managers knowledge and understanding of the concepts of emergence, design, collaboration, and analysis
- The organization's practices in strategic implementation and its managers experience, skills, and techniques around strategic and tactical ideation
- The cumulative beliefs and traits of the organization's leaders and managers associated with their creative thinking styles and practices

The quantitative analysis, the mapping of the organization's creativity flows and the benchmarking of the management innovation behaviors, is supported by qualitative analysis through the collection of a series of anecdotal responses to questions around managers' current creativity and innovation experiences in the work place.

The results are compiled into a Management Innovation Assessment Report containing a series of management innovation benchmarks against the organization's culture, environment, strategy, strategic implementation, and cumulative management creative capabilities. Independent specialist innovation experts offer assessment and recommendations based on the benchmarks, the outcome being a simulation of Deming's map of profound knowledge, a lens – in this instance – onto the organization's creativity.

In this way, the MIX makes visible the organization's "steady state" of creativity. Once the steady state has been benchmarked, senior leaders have tangible evidence from which they can make informed strategic and tactical decisions about the future development and direction of the organization's innovation goals and objectives.

In a comprehensive interview on the MIX's strengths and weaknesses as an analytic, Harvey Wade, Manager of Strategic Innovation, Allianz UK, said "The way the collected data and details were interpreted and presented meant that it gave Allianz real numbers and measures, assisting them to re-enforce what they felt intuitively. The importance for the innovation team, though, was in obtaining real measures with genuine rigor as it represented the views of over 150 people across the business that gave meaning to their intuition. For example, its qualitative data revealed a blockage in middle management and the reasons for the blockage that had not been clear before.

The most important point of difference for the Management Innovation Index as a form of measurement was its clear perspective on the strategic dynamics of organizational creativity. Whilst it did recommend the use of tools and methodologies, like other providers, it was distinctly not the Management Assessment Report's main focus.

What the Management Innovation Index did was put innovation into a proposition that enabled focus" (The Creative Leadership Forum 2011).

How well this focus is understood, interpreted, and supported by senior leaders defines the organization's capacity to be creative, to change, to adapt, to produce, and to manage a system of continual creative inputs, the source of the organization's innovation – its growth and success.

The biggest challenge for leaders once the intangibles of organizational creativity have been benchmarked and measured is how to communicate and emphasize its strategic and tactical importance against all the other processes and forms of measurement in which the organization is currently engaged.

Do not expect creativity in an organization, if the lead indicators are driven by employee engagement and/or behavioral thinking style surveys.

These diagnostics impede the empowerment of managers to think differently – the lifeblood of creativity – and emphasize conformity – the coffin for creativity.

Conclusion and Future Directions

As the world becomes globalized and as a consequence market and economic conditions change even more rapidly, the twenty-first century organizations will need to have the internal management skills and knowledge capabilities to move in and out of markets rapidly to compete and survive.

The emphases on market competitiveness will no longer simple reside in the clichéd marketing slogan of "identifying and satisfying customer needs." Rather the competitive edge will focus on researching and defining problems that need to be solved. Resolving problems requires creative thinking and behaviors. Importantly, resolving problems creates business opportunities. Allianz UK's innovation team promotes the notion organizationally "When there is a problem and there is a solution, there is an idea." Those leaders that are able to harness and develop their organization's unique creative capabilities in a strategic manner to solve problems will gain competitive advantage in the twenty-first century.

The Management Innovation Index™, a way of modeling an organization's creativity, makes tangible the flow of creativity within the organization and benchmarks management innovation behaviors that drive the flow. Among other aspects, the MIX enables a leader to assess the organization's management innovation behaviors that present the best opportunity for strategic and tactical development in line with the organization's goals and objectives, reveals the organization's inherent creative strengths and weaknesses across all levels of management, and informs the leader as to where the impediments to the organization's creativity specifically occur.

With the knowledge obtained through this process, a leader has data and a set of numbers from which to commence making informed decisions about the future strategic direction of the organization.

Managers and teams have a clear sense of what they need to do to develop their creative practice contextually to facilitate meaningful contributions to the growth and success of the organization overall. Mills Wright's notion of the workplace as a social environment in which managers are openly applauded for being creative rather than conforming to policies and procedures, enhances the managers' personal skills, dignity, and well-being. Organizational and executive development can focus on alleviating creative blockages impeding the organization's "steady (and now continual) state" of innovation, while deliberately and incidentally developing creative leadership, skills and behaviors across the organization.

The MIT Sloan Management Research Report of Fall 2010 "Analytics: The New Path to Value" (IBM 2010) revealed senior executives now want businesses to run on data driven decisions. They want scenarios and simulations that provide them with immediate guidance on what best actions to take both when change and disruption occur and when planning the future.

Jeremy Trott, Head of Innovation, Allianz UK leads the way in that practice when he says "With the Management Innovation Assessment Report, the outcome of the MIX, we have enough information to really concentrate on shaping our strategic innovation plan over the next two or three months, that will drive the success of the business for the next five years!"

So when a leader asks about the value of creativity and says show me the numbers, there can now be a meaningful and tangible response.

Cross-References

- ▶ Creativity Management Optimization
- ▶ Entrepreneurial Capability and Leadership
- ▶ Knowledge Capital and Small Businesses
- ▶ Measurement of Creativity
- ▶ Strategic Thinking and Creative Invention

References

A Case Study of Innovation in a Mature Financial Services Organization – Allianz UK & the Management Innovation Index By Ralph Kerle, Executive Chairman, the Creative Leadership Forum © September 29, 2011

Coasce RH. The nature of the firm. Economica. 1937;4(16):386–405. New Series.

Deming DW. The economics for industry, government, education. Cambridge, MA: The MIT Press; 1994.

Drucker P. The practice of management. New York: HarperBusiness; 1954.

Hubbard DW. Chapter 1 intangibles and the challenge. In: How to measure anything – finding the value of "intangibles" in business. Hoboken, NJ: Wiley; 2007a. p. 4. ISBN 978-0-470-53939-2.

Hubbard DW. Quote from chapter 1 page 5 on intangibles and the challenge. In: How to measure anything – finding the value of "intangibles" in business. Hoboken, NJ: Wiley; 2007b. p. 4. ISBN 978-0-470-53939-2.

Hubbard DW. How to measure anything – finding the value of "intangibles" in business. Hoboken, NJ: Wiley; 2010.

IBM. Analytics: The new path to value how the smartest organizations are embedding analytics to transform insights into action by MIT sloan management review and the IBM institute of business value Research Report; Fall 2010.

Mills C. White collar: the American middle classes. New York: Oxford University Press; 1951.

Model of Dialectical Learning

Jeffrey G. Woods
School of Business, University of Indianapolis, Indianapolis, IN, USA

Synonyms

Cognitive conflict; Dialectical inquiry; Knowledge creation; Synthesis

The Philosophical Foundation of Dialectical Learning

Dialectical inquiry (DI) is an intellectual discourse that originated with the work of nineteenth-century philosopher G.W.F. Hegel (2010). Hegel contended that a higher level of understanding and insight could be achieved by creating the two most diametrically opposed viewpoints or explanations to a given situation or problem. Two opposing views (a thesis and antithesis) are developed in order to create direct conflict between two parties. Following a structured debate, a new collective view is pursued, forming a synthesis. The differing parties base their positions on identical databases. Points of view are influenced by underlying assumptions, value systems, and cognitive abilities (Boerner et al. 2003; Scott 2011). The Hegelian dialectic or the Hegelian inquiring system is the foundation of many of our political and legal processes (Van Gigch 1978). Hegel's philosophy has been a historic approach to problem-solving and an effective technique for clarifying opposing viewpoints.

More generally, DI is a creative problem-solving technique that requires an integration of previously dissociated ideas or facts for the purpose of gaining a deeper understanding of a problem or situation. An important implication of using the DI technique is the learning that occurs. As many management scholars have pointed out, learning occurs within the framework of dialectical processes (Nonaka 1994; Argyris 1999; Scott 2011).

Using Dialectical Inquiry in Strategic Management Applications

Research on the use of the DI technique began 40 years ago and was designed to improve corporate strategic decision-making, planning, and policy determination. An initial study was conducted by Mason (1969).

Mason (1969) developed and applied DI for the purpose of examining the assumptions of strategic planners in a "debate group" context. Two debate groups are involved in using the DI method. One group represents the thesis while the other group

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forms the antithesis. Mason suggested two criteria that DI should be able to discover in the planning process: (1) it should expose the underlying assumptions of a proposed plan so that management can reconsider them, and (2) it should suggest new and more relevant assumptions upon which the planning process can proceed. Mason believed that once management is made aware of these assumptions, it can reconsider or reformulate them. According to Mason:

> The principle theme of dialectical advise is that management learns about the fundamental assumptions of its planning problem and comes to understand them by observing the conflict between the plan and the counter-plan and their attendant world views. The vehicle for including this reflection is a structured debate. The structured debate consists of the most forceful presentation possible of the two most opposing plans, given the constraint that each side must interpret, in its entirety, the same organizational data bank. Following a statement of the problem, the structured debate begins with the advocate of the plan stating his world view or model of the situation. The advocate of the counter-plan does likewise. Then, as each item of data is introduced, it is interpreted by the opposing advocates to demonstrate that it can be interpreted as supportable evidence of their plan and negative evidence for their opponent's plan. This process continues until the data bank is exhausted.... Hegel's theory leads us to predict that the manager – observer of the conflict – will integrate and form a new and expanded world view (the synthesis). The synthesis includes exposing hidden assumptions and develops a new conceptualization of the planning problem the organization faces (1969, p. B408).

In Mason's (1969) initial field study, where he implemented the DI technique in a strategic planning exercise, one executive observed, "The two well-developed points of view pull you both ways at the same time. It becomes the vehicle for amalgamating the best plan of action you know how to develop." This result lent support to the formation of a synthesis using the DI technique.

The Dialectical Learning Process

Mason's research missed the critical theoretical link between the use of DI as a learning method and how this method activates the dialectical learning process. Activation of the dialectical learning process creates cognitive conflict for strategic decision-makers enabling them to create new knowledge from the growing insights that are discovered as a result of dialectical learning (Nonaka 1994; Davenport and Prusak 1998). Previously dissociated ideas and facts merge to create the best plan of action or decision. Dialectical learning increases strategic decision-makers' learning capacity, creating a greater number of strategic options (Boerner et al. 2003; Alajmi 2010; Scott 2011).

Dialectical inquiry activates the dialectical learning process using what in DI is referred to as debate groups who juxtapose information that has alternative interpretations of meaning. Conflicting information creates cognitive conflict in the learner/observer of the process. This learning process requires an assimilation or convergence of the conflicting information. The result of integrating conflicting information generates cognitive conflict creating new knowledge enabling strategic decision-makers to update their knowledge base. This learning process creates a new conceptualization of the problem (synthesis), leading to improved decision-making and strategic performance (Boerner et al. 2003; Scott 2011).

Because the use of DI has a potentially significant impact on improved decision-making, a more detailed explanation of how it affects strategic decision-makers' learning process is needed. This is because the use of DI and its impact on dialectical learning is particularly relevant to strategic decision-makers since their decisions will have an impact on an organization's long-term performance. Therefore, a better understanding of how DI can assist decision-makers in strategic management practices is highly valuable to learning organizations (Scott 2011; Mills 2011).

The aim of dialectical learning is to critically analyze new ideas by linking them to previous knowledge so a deeper understanding of problems can result. A structured debate format using the DI method is highly desirable because it provides opportunities for tangible learning experiences that can become a formalized part of an organization's strategic decision-making process. Strategic decision-makers can develop greater insights pertaining to problems when opposing ideas are formally debated rather than being ignored. It is important that learning occurs during the strategic decision-making process and not only after decisions are made. Strategic decision-makers who participate in the dialectical learning process develop insights and learn from using the DI method by observing debate group interaction. Therefore, in the context of dialectical learning, organizational members who comprise the debate groups become the agents for the transfer of learning (Argyris and Schön 1978).

A Model of Dialectical Learning

The model of dialectical learning focuses on individual learning. In the context of using the DI method, the use of debate groups serves as the learning source while the strategic decision-maker is the learning recipient. Ultimately, improving the knowledge base of key decision-makers is expected to result in improved organizational performance (Simon 1991).

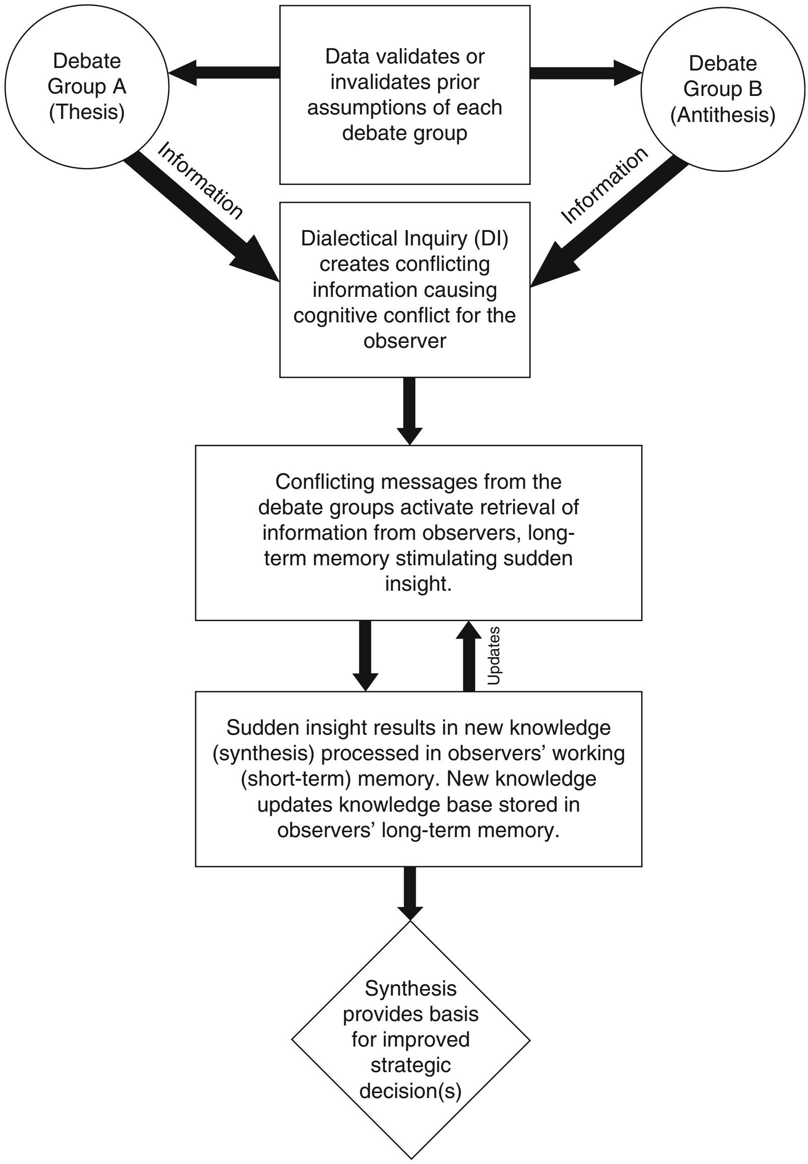
Many management scholars have pointed out that prior experiments using DI do not capture the richness of learning, the group processes at work, and their significance (Mitroff 1982). Gaining a better understanding of the dialectical learning process of strategic decision-makers would help shed light on the effectiveness of DI as a learning technique.

Dialectical inquiry may be viewed as a "trigger strategy" in the sense that opposing viewpoints create cognitive conflict providing a trigger or catalyst for dialectical learning to take place. Observing conflicting information generates the cognitive conflict needed for stimulating the dialectical learning processes of decision-makers for the purpose of producing systematic knowledge.

Dialectical inquiry creates cognitive conflict providing the stimulus for learning to occur. The structured debate groups serve as the learning source. Assumptions are determined from the content of the plan or exercise and each group's collective experience. These assumptions or prior beliefs may be viewed as the foundation of each group's initial position (Boerner et al. 2003). The initial position each group takes composes the thesis for one group and the antithesis for the other. Each debate group will interpret identical data to support its collective position. Data which can be qualitative or quantitative are the raw material provided to each debate group and, in their simplest form, are "discrete, objective facts about events" (Davenport and Prusak 1998). Data by themselves are not very useful for each debate group until they are put into context (Davenport and Prusak 1998). Ultimately, data validate or invalidate each debate group's assumptions, creating conflicting information observed by decision-makers (Scott 2011). David and Foray (2003) define information as structured and formatted data that remain passive and inert until used by those with the knowledge needed for interpretation and processing. Here, knowledge is defined as true and justified beliefs acquired empirically (Nonaka 1994). It is actively constructed in the human mind and is the most strategically important resource an organization possesses (Grant 1996).

Debate groups produce a flow of conflicting messages causing cognitive conflict in strategic decision-makers (Nonaka 1994). This learning stimulus activates the cognitive learning processes of the decision-maker accessing his knowledge base stored in long-term memory. If the problem is ill structured (a common occurrence in strategic planning), reliance on the resources of long-term memory can be extensive (Simon 1991). Thinking and learning occur in the observer/decision-maker's working (short-term) memory. Prior knowledge stored in long-term memory provides a context for synthesizing conflicting information transmitted from debate groups' interaction. The new knowledge created in the working memory updates the knowledge base in the strategic decision-maker's long-term memory (Derry 1996).

For DI to be an effective learning strategy, it should create enough cognitive conflict in the



Model of Dialectical Learning, Fig. 1 A model of dialectical learning
Source: Woods (2012)

strategic decision-maker to foster the retrieval of information from long-term memory helping to stimulate sudden insight. This new insight alters the whole character of the problem and transforms it into one that can be solved more creatively. The strategic options generated from dialectical learning are a function of the strategic decision-maker's learning capacity (Boerner et al. 2003; Alajmi 2010; Scott 2011). Figure 1 illustrates and summarizes the model of dialectical learning.

Implications of Dialectical Learning for Research and Practice: The Role of Cognitive Conflict

Strategic decision-makers must understand the process of dialectical learning in order to successfully implement DI as a formal part of their organization's strategic decision-making process. Their understanding of the dialectical learning process will enable them more easily to explain the benefits of this learning process to debate group members. The benefits of creating cognitive conflict for strategic decision-makers, i.e., knowledge creation, must be explicitly linked to improved strategic performance and the achievement of organizational goals.

The application of the DI method of learning to the dialectical learning process in strategic decision-making can be an intellectually satisfying endeavor for strategic decision-makers. Though DI has the ability to generate new knowledge critical for improving strategic performance, it has not been widely adopted. This is unfortunate as strategic decision-makers who collect extensive information before making strategic decisions will have more accurate perceptions of environmental conditions which have been shown to relate to improved organizational performance (Bourgeois 1985). Further, Burgelman (1991) has argued that creating an atmosphere where strategic ideas can be freely championed and fully contested by anyone with relevant information may be a key factor in generating viable organizational strategies. Organizations have the power to influence the success of strategic decisions through the processes they use to make key decisions (Dean and Sharfman 1996). It is likely that the dialectical learning process has been underappreciated because DI requires the use of conflict to serve as a catalyst for learning. If organizations perceive conflict as something to avoid in strategic decision-making, the benefits of implementing DI will never be realized. Avoiding conflict could potentially reinforce the status quo. One major problem is that organizations may confuse cognitive conflict with affective conflict. Cognitive conflict is task oriented. This type of conflict should be encouraged because it can enhance organizational performance (Amason 1996). Cognitive conflict must be viewed as the fuel that drives learning and enables innovative strategic solutions. It is an energy source for strategic decision-makers creating opportunities for growth and change (Andrade et al. 2008).

Affective conflict is personalized disagreement and can be destructive (Amason 1996). It is critical that debate group members understand their role in DI so as to minimize any affective conflict that could result during debate group interaction. Therefore, before experimenting with DI, there are some emotional aspects of information generation between debate groups that must be considered. These aspects of the dialectical learning process need to be considered an important part of a proposed research design. Dialectical inquiry can be an emotional experience for some members of debate groups, so it is worth discussing this limitation.

The effective use of opposition or contradiction by individuals is related to psychological health and creativity (Williams 1983). Observing the dialectical process is a form of higher-level (deep) learning involving a substantial amount of cognitive effort on the part of the strategic decision-maker. However, if DI creates affective conflict between some members of debate groups, dysfunctional behaviors could result (Fiol and Lyles 1985). Cognitive conflict can improve strategic decision-making, but affective conflict may weaken the ability of debate groups to work in the future. In order for groups to effectively debate in ways that promote respect, consideration, and understanding while incorporating other people's perspectives, it would seem that a great deal of maturity would be required. Debate group members need to be able to support their position while preserving their working relationships (Tjosvold et al. 1981; Nonaka 1994).

There are at least six potentially negative outcomes of conflict as it relates to debate- group interaction (Schmidt 1974):

1. Some people will feel defeated and demeaned.
2. Distance between people could increase.
3. A climate of distrust and suspicion could develop.
4. People and departments that need to cooperate may only look after their own narrow interests.
5. Resistance – active or passive – could develop where teamwork is needed.
6. Some people may feel left out because of the turmoil.

Clearly, because of these limitations, the implementation of DI as a structured source of learning for strategic decision-makers would require training. When a learning intervention is managed skillfully, Tjosvold et al. (1981) found that conflict in decision-making can have constructive consequences. Their study found that conflict can be used to facilitate the exchange of information when participants become skilled at disagreeing while confirming each other's competence and expressing acceptance of each other as a person.

Conclusion and Future Directions

The learning implications of DI provide the critical link between debate group interaction and the achievement of a synthesis in strategic decision-making. Conflicting information associated with debate groups' contradictory positions creates cognitive conflict in the strategic decision-maker which is a necessary component of dialectical learning. The implication is that information cannot be completely understood unless juxtaposed against alternative poles of meaning used to support the assumptions of each debate group (Slife 1983). It may be difficult to conceptualize many ideas needed to solve problems and make strategic decisions without an opposite interpretation of meaning.

The complexities associated with dialectical learning will call for some innovative research designs. Interdisciplinary researchers should collaborate to further develop this research area.

It is also hoped that practitioners will view dialectical learning as a powerful strategic decision-making model they can use to improve the quality of strategic decisions. The implementation of the DI learning technique will require extensive training and careful selection of debate group members. This training must focus on how DI can be used to improve organizational performance while minimizing any potential dysfunctional behavior between debate groups resulting from affective conflict. Because organizations learn through their members, DI is an important learning method for activating the dialectical learning process of strategic decision-makers for the purpose of improving organizational performance.

Cross-References

- ▶ Business Creativity
- ▶ Cognition of Creativity
- ▶ Creative Knowledge Environments
- ▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Psychology of Creativity
- ▶ Strategic Thinking and Creative Invention

References

Alajmi B. Intentions to share: investigating information professionals' knowledge sharing behavior. In Knowledge work. The Knowledge Institute, School of Communication and Information. Rutgers University, New Jersey, 2010.

Amason AC. Distinguishing the effects of functional and dysfunctional conflict on strategic decision-making. Acad Manag J. 1996;39:123–48.

Andrade L, Plowman DA, Duchon D. Getting past conflict resolution: a complexity view of conflict. Management Department Publications, University of Nebraska, 2008, 10, pp 23–38.

Argyris C. On organizational learning. 2nd ed. Malden: Blackwell Publishers; 1999.

Argyris C, Schön DA. Organizational learning: a theory of action perspective. Reading: Addison-Wesley; 1978.

Boerner CS, Macher JT, Teece DJ. A review and assessment of organizational learning in economic theories. In: Dierkes M, Antal AB, Child J, editors. Handbook of organizational learning and knowledge. Oxford: Oxford University Press; 2003. Chapter 4.

Bourgeois III LJ. Strategic goals, perceived uncertainty, and economic performance in volatile environments. Acad Manag J. 1985;28:548–73.

Burgelman RA. Intraorganizational ecology of strategy making and organizational adaptation: theory and field research. Org Sci. 1991;2:239–62.

Davenport T, Prusak L. Working knowledge: how organizations manage what they know. Boston: Harvard Business School Press; 1998.

David PA, Foray D. Economic fundamentals of the knowledge society. Policy futures in education, 2003, 1: Special Issue: Education and the Knowledge Economy.

Dean JW, Sharfman MP. Does decision process matter? A study of strategic decision-making effectiveness. Acad Manag J. 1996;39:368–96.

Derry SJ. Cognitive schema theory in the constructivist debate. Educ Psychol. 1996;31:163–74.

Fiol MC, Lyles M. Organizational learning. Acad Manag Rev. 1985;10:803–13.
Grant RM. Toward a knowledge-based theory of the firm. Strat Manag J. 1996;17:109–22.
Hegel GWF. Science of logic. Reprint Edition, Nov. 2010. London: Routledge. Originally published in 1812.
Mason RO. A dialectical approach to strategic planning. Manag Sci. 1969;15:B403–14.
Mills JH. Organizational learning and the learning organization: a critical review. Acadia University. [On-line]. Available http://group.aomonline.org/cms/Meetings/Seattle/PDF/14352.pdf (2011). Accessed 25 March 2011.
Mitroff II. Talking past one's colleagues in matters of policy. Strat Manag J. 1982;3:374–5.
Nonaka I. A dynamic theory of organizational knowledge creation. Org Sci. 1994;5:14–37.
Schmidt WH. Conflict: a powerful process for [good or bad] change. Manag Rev. 1974;63:5.
Scott BB. Organizational learning: a literature review. Discussion paper 2011–02, IRC Research Program, Queen's University, 2011.
Simon HA. Bounded rationality and organizational learning. Org Sci. 1991;2:125–34.
Slife BD. Educational applications of the dialectic: theory and research. Paper presented at the annual convention of the American Psychological Association, Anaheim, 1983.
Tjosvold D, Johnson D, Lerner J. Effects of affirmation and acceptance on incorporation of opposing information in problem-solving. J Soc Psychol. 1981;114:103–10.
Van Gigch JP. Applied general systems theory. 2nd ed. New York: Harper and Row; 1978.
Williams RN. Dialectics and meaning: the effects of opposition in cognition and learning. Paper presented at the annual convention of the American Psychological Association, Anaheim, 1983.
Woods JG. Using cognitive conflict to promote the use of dialectical learning for strategic decision-makers. Learn Org. 2012;19(2):134–47.

Model of Quadruple Helix Structures

► Quality of Democracy and Innovation

Model Repertoires

► Multiple Models of Creativity

Models for Creative Inventions

Dirk Ifenthaler
Department of Educational Psychology,
University of Oklahoma, Norman, OK, USA

Synonyms

Internal model; Mental model; Pattern

Key Concepts and Definition of Terms

A model is characterized by representing objects, phenomena, or processes of the world. Stachowiak (1973) introduces three key features of models: imaging feature, reduction feature, and pragmatic feature. Creativity can be defined quantitatively or qualitatively and has three directions of impact (Hanke et al. 2011): the creative product, the creative process, and the creative person. In general, creativity is referred to the creation of novel and useful artifacts (Mumford 2003). Models for creative inventions are representations of the world that are novel, i.e., different from already existing representations, and originate after an iterative model-building process.

Theoretical Background

Taking into account that creative inventions are understood as artifacts that are new as well as useful and are created by a divergent way of thinking, this requires an iterative process of model building (Ifenthaler and Seel 2011). According to mental model theory (Seel 1991), this process is characterized by creating, revising, and testing models of inventions. First, a model of an invention is regarded as an image or representation of the novel idea which may also function as a model itself (Stachowiak 1973). Second, a model of an invention is regarded as a reduction of the novel idea, i.e., it does not include all attributes of the represented original invention, but such that are relevant for the inventor (Stachowiak 1973). Third, a model of an invention is regarded as pragmatic, i.e., if they are not explicitly conjugated with the original invention.

Accordingly, creative inventions are guided by explanatory mental models designed with a specific end in mind. The inventor explores these internal models by developing hypotheses and then varying input parameters to investigate how well his or her conjectures align with the models. More generally, creative invention presupposes that people actively construct meaningful representations, such as coherent *mental models*, that represent and communicate subjective experiences, ideas, thoughts, and feelings. By means of such representations, an individual is also able to simulate real actions in imagination (in the sense of thought experiments) in order to create an invention (Seel 2003). In this context, mental models fulfill several functions (Seel et al. 2009): (1) They guide the comprehension of the invention as well as the concrete operations with it; (2) they allow the invention's states to be explained; and (3) they allow predictions about the invention's behavior and the effects of intervention in the invention to be derived (Greeno 1989).

Creative invention requires iterative steps of hypothesis testing as well as an increased time for constructing *appropriate* mental models. However, the generation of hypotheses within a creative invention process is a challenging task (de Jong and van Joolingen 1998). Insufficient prior knowledge could also lead to incorrect and insufficient hypothesis statements (de Jong and van Joolingen 1998). Learners' prior knowledge becomes evident through their preconceptions and naive theories. These preconceptions are not isolated units but rather parts of conceptual structures which provide a sensible and coherent comprehension of the world. Therefore, preconceptions are not easy to modify or to change if a subject is convinced of their plausibility (see Smith et al. 1993). Overall, the development and successful application of a mental model often requires quite a lot of time and mental effort due to basic processes of analogical reasoning or internal simulations.

According to Jonassen (1999; Jonassen and Cho 2008), this mental effort may be reduced and the conceptual understanding may be facilitated through mindtools (computer-based modeling tools), because these tools enable the externalization of the internal simulation processes. Besides computer-based modeling and simulation tools for the *construction* of externalized models of inventions, there are also tools which focus on the *exploration* of the underlying model of an invention (Clariana and Strobel 2008). This second type of computer-based modeling tools for the exploration of underlying models of inventions may be differentiated further into (1) black-box and (2) glass-box systems. In a *black-box simulation*, all computations are hidden from the user. Such systems include adjustable parameters and a large variety of process visualizations which become available after the actual action of the simulation is completed. On the other hand, *glass-box simulations* expose the underlying mathematical and logical simulation model. This can be realized by revealing the underlying equations, connections, and interdependencies between variables and changing variables, parameters, or equations (see Murray et al. 2001).

Conclusion and Future Directions

Imagine you want to create an ultracompact espresso maker for on the road. First, you would create a model of such a kitchen appliance by using your existing knowledge on espresso makers. Your prior knowledge on espresso makers will enable a simulation of various components which constitute the ultracompact espresso maker for on the road. Specific elements of the appliance will be revised through iterative simulation processes. Using a computer-based modeling tool for externalizing the internal simulation process might take off your cognitive effort and might highlight specific problems when designing your creative invention. Accordingly, creative inventions might be more successful when using tools for externalization. This hypothesis might be tested in future research on models for creative inventions.

Cross-References

▶ Imagery and Creativity
▶ Innovation
▶ Mental Models and Creative Invention

References

Clariana RB, Strobel J. Modeling technologies. In: Spector JM, Merrill MD, van Merrienboer JJG, Driscoll MP, editors. Handbook of research on educational communications and technology. New York: Taylor & Francis Group; 2008. p. 329–44.
de Jong T, van Joolingen WR. Scientific discovery learning with computer simulations of conceptual domains. Rev Educ Res. 1998;68(2): 179–201.
Greeno JG. Situations, mental models and generative knowledge. In: Klahr D, Kotovsky K, editors. Complex information processing. Hillsdale: Lawrence Erlbaum; 1989. p. 285–318.
Hanke U, Ifenthaler D, Seel NM. Modeling the world of instruction: creative insight or learnt by advise? Open Educ J. 2011;4(Suppl 1:M10):113–9.
Ifenthaler D, Seel NM. A longitudinal perspective on inductive reasoning tasks. Illuminating the probability of change. Learn Instr. 2011;21(4):538–49. doi:10.1016/j.learninstruc.2010.08.004.
Jonassen DH. Computers as mindtools for schools: engaging critical thinking. 2nd ed. Englewood Cliffs: Prentice Hall; 1999.
Jonassen DH, Cho YH. Externalizing mental models with mindtools. In: Ifenthaler D, Pirnay-Dummer P, Spector JM, editors. Understanding models for learning and instruction. Essays in honor of Norbert M. Seel. New York: Springer; 2008. p. 145–60.
Mumford MD. Where have we been, where are we going? Taking stock in creativity research. Creat Res J. 2003;15:107–20.
Murray T, Winship L, Bellin R, Cornell M. (2001). Toward glass box educational simulation. Reifying models for inspection and design. AI-ED Workshop. External Representations in AIED: Multiple Forms and Multiple Roles; San Antonio, TX; 2001.
Seel NM. Weltwissen und mentale Modelle. Göttingen: Hogrefe; 1991.
Seel NM. Model-centered learning and instruction. Technol, Instr, Cognit Learn. 2003;1(1):59–85.
Seel NM, Ifenthaler D, Pirnay-Dummer P. Mental models and problem solving: technological solutions for measurement and assessment of the development of expertise. In: Blumschein P, Hung W, Jonassen DH, Strobel J, editors. Model-based approaches to learning: using systems models and simulations to improve understanding and problem solving in complex domains. Rotterdam: Sense Publishers; 2009. p. 17–40.
Smith JP, diSessa AA, Roschelle J. Misconceptions reconceived: a constructivist analysis of knowledge in transition. J Learn Sci. 1993;3(2):115–63.
Stachowiak FJ. Allgemeine Modell theorie. Berlin: Springer; 1973.

Modernization

▶ Joseph A. Schumpeter and Innovation

Modification

▶ Product Innovation, Process Innovation

Modularity

▶ Academic Firm

Mood

▶ Creativity and Emotion
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving

Moral Hazard

▶ Information Asymmetry and Business Creation

Motivational Components of Creativity

▶ Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity

Multidisciplinarity

▶ Interdisciplinarity and Innovation
▶ Interdisciplinary Research (Interdisciplinarity)

Multi-employment

▶ Cross-Employment

Multilevel Innovation Systems

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Multi-level Systems of Innovation

Robert Kaiser[1] and Heiko Prange-Gstöhl*[,2]
[1]Seminar of Social Sciences, University of Siegen, Siegen, North-Rhine Westphalia, Germany
[2]DG Research & Innovation, European Commission, Brussels, Belgium

The Institutional Embeddedness of Innovation Across Multiple Levels

A multilevel system of innovation (MLSI) describes a configuration that is characterized by the distribution of resources, competences, and institutions needed for the generation of innovations across different territorial and sectoral levels.

Since the mid-1980s, several authors (e.g., Freeman 1992; Lundvall 1992; Nelson 1993) have developed the concept of the "National System of Innovation" (NSI) in order to study the interrelations between technological development and the institutional embeddedness of innovative organizations. Lundvall proposed several basic indicators, which should mirror country-specific differences in national innovation systems. The focus on national systems, he claims, "reflects the fact that national economies differ regarding the structure of the production system and regarding the general institutional set-up" (Lundvall 1992, p. 13). The internal organization of firms, the interfirm relationships, the role of the public sector, the institutional set-up of the financial sector, as well as the intensity and the organization of research and development should reflect national idiosyncrasies.

Since the early 1990s, this approach has been diversified by studies that recognized the evolution of autonomous systems of innovation at the local, the regional, the European, and even the global level (e.g., Borras 2003; Cooke 2002; Mytelka 2000). Whereas a first group of scholars stressed the importance of local institutions and networks, transfer mechanisms, regional labor markets, as well as specific sociocultural environments, a second group pointed to the internationalization of markets, technologies, and corporate activities as well as the ongoing Europeanization of public policies. Consequently, tensions for NSIs arise both from globalization and regionalization resulting first of all from increasing cross-border technological alliances of multinational enterprises (Nelson 1993). Additionally, international science, innovation, and diffusion networks turn nationally based systems of innovation into open systems (Galli and Teubal 1997).

Arguments in favor of the existence of European or global systems of innovation refer mainly to two developments: first, the effects of national policies are diminishing due to the increase of transnationally organized technologies and businesses; second, a growing number of policy areas are coordinated by the European Union or other regional integration agreements. For some authors, the establishment of postnational institutions in the area of the science infrastructure, such as European science funding, innovation and technology transfer, and European programs for

*Views expressed in this paper are purely personal and do not reflect the position of the European Commission.

education and training are clear signs to believe in a European innovation system (e.g., Caracostas and Soete 1997).

Much attention has been paid to the concept of regional or local innovation systems (e.g., Cooke 2002; De la Mothe and Paquet 1998). Cooke (2002) has argued that the national innovation system cannot function well without regional innovation systems “in respect of the enterprise and innovation support infrastructure, specialized human capital, leading edge basic and applied research and the varieties of network relationships that function most effectively in the relatively close proximity of regional clusters.” As it is obvious that regions within a national innovation system often develop quite differently, one can conclude that specific regional or local characteristics and structural patterns exist which have a deep impact on the competitiveness of regions.

However, these concepts largely fail to show in how far the totality of NSI elements has been established on the international, European, or regional level and to what extent they are still embedded in national systems of innovation or exist separately from them. They also called the dominance of national institutions into question as they emphasized the growing importance of institutional arrangements below and beyond the nation-state level.

In contrast, the concept of multilevel systems of innovation is based on the identification of those features within a national system of innovation that have been territorially reconfigured along European/international lines or regional/local lines. Since reconfiguration processes take course in both territorial directions, beneath and above the nation-state, the growing meaning of the regional as well as the international level can be thoroughly explained. Consequently, the MLIS approach focuses on the dynamics of the reconfiguration of NSIs, rather than just describing autonomous innovation systems on one specific territorial level. Moreover, despite processes of internationalization and regionalization, the MLSI concept does not neglect the meaning of the national environment for the generation of innovation continues to be important. National patterns of economic specialization remain. This means that national systems of innovation significantly vary, for example, according to the direction of public science and technology policies, the distribution and the success of public R&D financing, the technological orientation of industrial research, and the level of the enterprises’ technological development.

Theoretical Sources of the Concept

The MLSI concept integrates two different social science theories, namely, the multilevel governance approach, which became quite prominent in European integration research, and systemic innovation concepts, which have been developed since the end of the 1980s in innovation-related economic research.

The systems of innovation approach detected that innovative activities of enterprises do not only depend upon intrafirm organizational capacities but are fundamentally shaped by the organization’s institutional environment as well as through specific technological or scientific patterns in which innovation processes are embedded. Thus, national or regional differences in technological performance can be attributed, at least to a significant extent, to variations in the institutional environment. Studies about systems of innovation usually referred either to one specific “territorial level” (e.g., “national systems of innovation,” “regional systems of innovation,” “European system of innovation”) or to one specific technology or industrial branch (“sectoral systems of innovation”). Due to processes of political decentralization, economic globalization, and paradigmatic changes in certain technological field, however, the borders of such systems have become blurred, as more and more of its functions (e.g., financing, regulation, policies) can be located across various territorial and sectoral levels. As a result of these dynamics, innovation systems at a specific territorial or sectoral level have undergone a process of reconfiguration conceived as a process that generates new modes of coordination and new constellations of actors among established or new organizations.

In view of the territorial dimension, this process has become most prevalent within the

European Union, which has emerged since the early 1980s as a key player in the field of innovation, research, and development as well as education. In Europe, many related public policies became part of a multilevel governance system, which is characterized by institutional incentives or framework conditions provided by various actors that share responsibilities across territorial levels. The concept was first introduced in the early 1990s and provided an innovative explanation for the progress of integration in Europe which was conceived as a polity creating process in which authority and policy-making influence are shared across multiple levels of government (Hooghe and Marks 2001). Considering the research on multilevel governance, a multilevel system of innovation is characterized by three institutional peculiarities: (1) actors at different territorial levels share decision-making competencies, (2) actors and decision-making arenas are not ordered hierarchically as in traditional intergovernmental relations, and (3) actors rely mostly on consensual or nonmajoritarian decision-making rules.

With regard to the sectoral dimension, systemic reconfigurations have taken place as a consequence of paradigmatic shifts in an increasing number of technological fields. The most relevant dynamic that led to the emergence of so-called science-based industries (biotechnology, nanotechnology, multimedia, etc.) has been the dramatic change of basic scientific concepts, methods, and procedures that forced many traditional industries to reorganize their innovation processes. While the generation of innovations increasingly depends on the integration and absorption of transsectoral knowledge, many of the most successful innovations in recent decades were developed at the "borders" of traditional sectors.

Implications of the Multilevel Perspective for Theory and Practice

Understanding the dynamics within multilevel systems of innovation requires a thorough analysis of those indicators that have been developed in the literature to describe the characteristics of NSIs: regulation, public technology and innovation policies, the research and education systems, the financial system, and corporate activities (Kaiser and Prange 2004).

With regard to the first variable, a MLSI would mean that market and product regulation in different technology areas would become more and more organized across various territorial levels. Such development might lead to supplementing or even replacing the national level at least in terms of the framework for setting harmonized regulations. Public technology and innovation policies mirror regional, national, and international public policy programs, their importance with regard to financial resources, and the openness of programs for third parties. New public innovation policy initiatives are often crucial for a technological catching-up process. Those initiatives might not only originate from the national but also from the regional and European level. In relation to research and education systems, a MLSI would see territorial reconfigurations, for example, through reforms in the higher education system, global university networks, or patenting. A reconfiguration would especially be triggered through science-based industries where the research and education systems play a significant role both for the provision of qualified personnel and for the commercialization of scientific knowledge. Finally, corporate activities should range from the local to the international as in the pharmaceutical biotechnology sector, for example, small- and medium-sized research companies are heavily engaged in partnerships and alliances with local knowledge providers and national as well as international pharmaceutical companies. While some activities might, at least partly, depend upon the local innovation milieu, others, however, – such as R&D and trade in high- and medium-high-technology intensive products – are to an ever-growing degree internationalized.

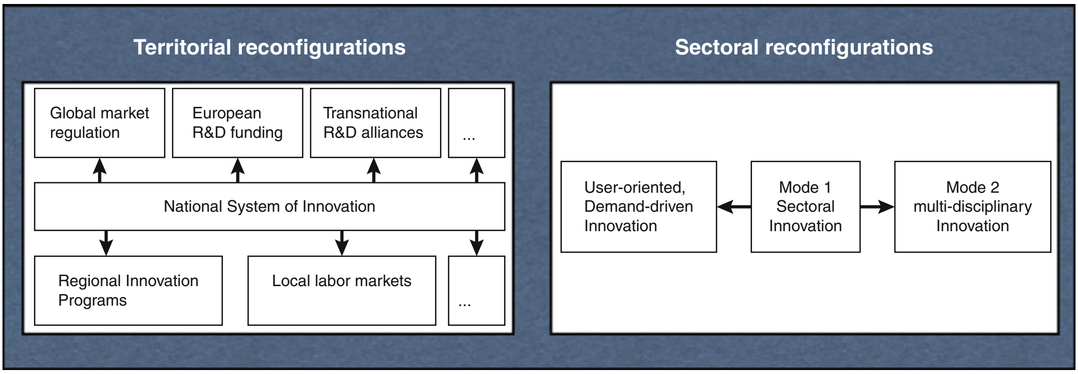
In MLSIs, some of those functions described above become part of a multilevel governance system in which institutional incentives and framework conditions are provided by various actors who share responsibilities across territorial levels. By proposing such a multilevel approach, the concept bridges the gap between innovation system approaches that analytically focus on one specific territorial level only. The MLSI concept does, however, not deny that the national institutional framework is still important even in federalized or decentralized countries, in which subnational regions and localities do not only provide incentives or create framework conditions autonomously, but also in a coordinated manner with the national and the international level. Europeanization has an important impact on the institutional environment in which innovative actors are embedded. Especially, systemic functions such as regulation, public R&D financing, and public innovation policies are increasingly integrated into a European multilevel governance system, while the financial or the research and education systems still reflect mainly national and regional patterns of specialization.

In turn, however, this also means that a more coordinated – or even integrated – multilevel innovation system is likely to increase tensions between actors who mainly interacted within national borders. At least for three reasons, the European Research Area is quite a good example of the contradictions such a multilevel setting may produce (Kaiser and Prange 2005):

1. As long as elements of an innovation system are mostly in the competence of regional or national administrations (e.g., research and education policies), it is quite unlikely that more integrated (or stronger coordination) efforts at European level are successful, especially since regions with legislative and budgetary powers are generally quite reluctant to further centralize policies and competences.
2. The significant variations of institutional settings, of innovative performances, of industrial structures, and of patterns of technological specialization in Europe restrict "policy transfer" and "policy diffusion" through a process of mutual learning to a very limited number of areas in which regions or member states share similarities.
3. Even if innovation policy coordination abstains from centralization, a more coordinated European research and innovation policy is unlikely if coordination efforts intervene into the competition of actors. Member states consider R&D expenditures as critical investments enhancing the competitive position of companies that offer employment opportunities in the member state.

The multilevel innovation system approach also provides for explanations of the dynamics that have emerged in specific innovation-related institutional arrangements. The triple-helix configuration of academia, industry, and government (Etzkowitz and Leydesdorff 2000), for example, has become subject to various forms of transitions, exactly because of the asynchrony in which these organizations engaged in processes of regionalization and internationalization. Long-term stable relations between governments and (formerly public) infrastructural companies in the telecommunications or energy sector have dissolved as a consequence of global market liberalization processes. Traditional R&D collaborations between firms and universities lost importance when especially multinational companies established research centers in the leading innovation hotspots around the globe.

In terms of the sectoral dimension, the concept of the "mode 2 knowledge production" (Gibbons et al. 1994) pointed to the increasing importance of multidisciplinary and "context-driven research" which is focused on problem solving instead of technological advancement along disciplinary trajectories. As such, mode 2 knowledge production supports the steady growth of interorganizational relations, the diversification of knowledge sources and the partial redefinition of institutional arrangements for the exchange of knowledge. A good example of current sectoral reconfigurations therefore is the parallel existence of different "knowledge regimes" within the same industrial sector where, as in the pharmaceutical industry, the protection of knowledge through patenting is crucial for the generation of profits from innovations while, at the beginning of the innovation process, an "open innovation" environment seems to provide the best conditions for the accumulation of promising new drug candidates. Sectoral reconfigurations also emerged from a new understanding of the role of the customer for innovations. While the linear model of innovation took customers' benefits from and customers' interest in innovations more or less for granted, more recent concepts highlight the role



Multi-level Systems of Innovation, Fig. 1 Logics of reconfiguration of innovation systems and the emergence of the multilevel innovation system (Source: Authors)

of demand-driven innovation processes. Moreover, it is not only that customer orientation changes the logic of innovation processes, it also establishes a new institutional understanding of the framework conditions under which the generation of innovations is most dynamic. In this respect, the lead-market concept gained attention both in scientific discourses as well as within the innovation policy community as a framework for the understanding of why innovations emerged first and were dynamically absorbed by users and customers within specific institutional settings.

In sum, the MLSI concept opens up an empirical as well as a theoretical perspective. Empirically, it helps to disclose the changing logics of innovation systems by tracing back the reconfiguration of established systemic variables both in territorial and sectoral perspectives. It helps to understand when and why multilevel innovation systems appear revealing that the reconfiguration of national innovation systems is closely connected to transformation processes of national political systems while the reconfiguration of sectoral innovation systems is related to new modes of knowledge production and a novel perspective of the role of users and customers for the generation of innovations (see Fig. 1).

Conclusion and Future Directions

Taking both the territorial and the sectoral dimensions into account, the concept of the multilevel system of innovation provides an analytical grid for the analysis of systemic reconfigurations and the institutional consequences, which arise as a result of these reconfigurations. The multilevel perspective allows for the recognition of various coordination problems that exist if actors have to decide on resources and action across territorial and sectoral borders. A multilevel system of innovation does not fully replace the existing institutional frameworks, but it adds another layer to an established system with highly persistent actor constellations and modes of coordination.

The emergence of a multilevel system, therefore, inevitably increases the complexity of the innovation process and thus produces both new opportunities and obstacles for actors involved in the generation of innovations. In order to better understand the consequences of increasing complexity, the concept of the multilevel system of innovation explicitly applies an empirical governance perspective, taking into account both the effectiveness of the novel rule- and decision-making structures that have been established among innovative actors as well as the changing institutional environment in which these actors are embedded.

Cross-References

- ▶ Innovation Policy Learning
- ▶ National Innovation Systems (NIS)

▶ Nonlinear Innovations
▶ Triple Helics

References

Borras S. The innovation policy of the European Union. Cheltenham: Edward Elgar; 2003.
Caracostas P, Soete L. The building of cross-border institutions in Europe: towards a European system of innovation? In: Edquist C, editor. Systems of innovation. Technologies, institutions, and organizations. London: Pinter; 1997. p. 395–419.
Cooke PH. Regional innovation systems: general findings and some new evidence from biotechnology clusters. J Technol Trans. 2002;27(1): 133–45.
De la Mothe J, Paquet G, editors. Local and regional systems of innovation. Norwell: Kluwer Academie; 1998.
Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and 'mode 2' to a triple helix of university-industry-government relations. Res Policy. 2000;29(2):109–23.
Freeman C. Formal scientific and technical institutions in the national system of innovation. In: Lundvall B-Å, editor. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992. p. 169–87.
Galli R, Teubal M. Paradigmatic shifts in national innovation systems. In: Edquist C, editor. Systems of innovation. Technologies, institutions, and organizations. London: Pinter; 1997. p. 342–70.
Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage; 1994.
Hooghe L, Marks G. Multi-level governance and European integration. Lanham: Rowman & Littlefield; 2001.
Kaiser R, Prange H. The reconfiguration of national innovation systems – the example of German biotechnology. Res Policy. 2004;33(3): 395–408.
Kaiser R, Prange H. Missing the Lisbon target? Multi-Level Innovation and EU policy coordination. J Public Policy. 2005;25(2):241–63.
Lundvall B-Å, editor. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992.
Mytelka LK. Local systems of innovation in a globalized world economy. Ind Innov. 2000; 7(1):15–32.
Nelson RR, editor. National systems of innovation. A comparative analysis. Oxford: Oxford University Press; 1993.

Multiple Models of Creativity

Richard Tabor Greene
De Tao Master's Academy, Beijing, China
System Design & Management, Keio University, Tokyo, Japan

Synonyms

Creativity models; Fractal pages; Innovation models; Model repertoires; Structural cognition

The Idea of Novelty and Creativity Sciences

This entry introduces (1) the novelty and creativity sciences (creativity, invention, innovation, design, composing, business venturing, and others), (2) the idea of multiple models of each, (3) with example multiple models (meta-models) of creativity and innovation, and (4) more detailed models than are usual (here, a 64-item model of the most creative process known – natural selection). The model of creativity models that this entry presents is the most comprehensive and detailed such model yet published, at the time of this writing – a prior article on 42 models and book on 60 exist (Greene 2001, 2005). This entry also presents four size scales (compared with **levels of invention** in this *Encyclopedia)* as contexts around and under creativity and novelty sciences: excellence sciences (scale 1), some of which are novelty and creativity sciences (scale 2), one of which is creativity (scale 3), 120 models of which are presented here, and another of which is innovation (scale 3), [54 models of which are presented here. Finally, 64 dynamics of one of those 54 innovation models (scale 4) of the single most creative process known, natural selection, are presented].

Rather than summarizing the other creativity models in this *Encyclopedia*, this entry presents an intellectual tradition, centered on developing large diverse repertoires of models, and tools specially invented to support the development and use of such repertoires. One such tool,

The novelty and creativity sciences

Study of all the ways the *new* gets into society *in relation to* each other:

Versions of	**Levels of**	**Liberal/social arts of**
Creativity/discovery	Educated persons (created selves)	History of all 16 in 1st 2 cols.
Design/invention	Creating selves	Literature of
Innovation	Creating careers	Philosophy of
Founding tech ventures	Creating systems	Politics of
Fashion	Creating others (leading)	Culture of
Evolution	Creating cultures	Design of
Composing stories, games, etc.	Creating quality	Economics of
Performing/exploring	Creating knowledge	Practice of

(from Greene 2011 and De Tao Master's Academy 2011)

Multiple Models of Creativity, Fig. 1 The Novelty & Creativity Sciences

a proposed replacement for prose itself, is presented at this entry's end (the model, from Michod, of 64 natural selection dynamics).

Academia educates creator-designer practitioners into a tradition of one right-y model, righter than all others. The multiple models tradition in this entry contradicts those practices and their academic source. In the history of science (Eamon 1996) European worldwide collecting produced collections categorized in museums that later scholars "explained" via causal models. Modern journals refuse categorical models (and the size of article they require). This entry attempts to open up the following: (1) multiple novelty and creativity sciences and (2) multiple models of each of them, (3) highly detailed such models – as new contexts and frontiers for practice and theory. The costs of our mania for single right-y models and benefits of switching to repertoires of diverse models are included here. Figure 1 shows one pattern among the novelty and creativity sciences (also see ► Creativity from Design and Innovation Perspectives).

Tools for Non-narrow: Thinking, Professions, Academe, and Outcomes

Herbert Simon wrote that exponential increase in knowledge volume meant professions, disciplines, theories, and professional people were, relative to the totality of that knowledge, becoming smaller and smaller fractions, with severe effects, namely, that *all* our major problems fell in the cracks between our increasingly narrow persons, professionals, and disciplines (Simon 1996). System science failed as a solution (Bartanlanffry 1969). Total quality worked better – horizontal processes replacing vertical ones, continuous improvement replacing giant innovation leaps, kansei engineering of delight quality frontiers of customer imaginings of future requirements, and statistical measures replacing management by rank opinion (Greene 1993; Lillrank and Kano 1989; Ishikawa 1991; Cole 1995, 1999). Lately, systems engineering has arisen as design of systems of systems (Maeno et al. 2010; plus ► Creativity and Systems Thinking in this *Encyclopedia*). From these "binding" other fields or meta-fields, tools for handling plural diverse models have arisen (Greene 2010; Nakano 2011).

Structural cognition (Zwicky 1969, Kintsch 1998; van Dijk 1997, Meyer 1982) is another meta-field that addresses this issue of ever narrower people and professions in a world where problems are wider and wider. Where ordinary science seeks one right-y model, structural cognition identifies diverse repertoires of models that explain a phenomena, with each model in each repertoire of models compensating for weaknesses of the other models. In doing this, structural cognition sees itself as midway between Asian causality

(10,000 bee stings to move an elephant) and Western causality (find the one tipping point in a system where slight inputs have huge outcomes). Both aim at predictive capability – but one seeks a single model, while the other seeks diverse well-balanced repertoires of models.

Structural cognition tools are especially suited to crowd-source and swarm intelligence arrangements on the web. The tools encourage application of blends of diverse models, enabling:

1. More comprehensive coverage of a phenomenon
2. More diverse aspects of a phenomenon distinguished from each other
3. More detail handled at the same time as more comprehensiveness is achieved
4. More accurate and localized diagnosis, assessment, and strategic direction done
5. More adaptive alternative responses and ways to go at crisis points
6. More common ground possibilities for reducing first apparent conflicts/differences

A Creativity Theory Support of Many Diverse Detailed Creativity Models

Torrance (Torrance 1974) in his famous work to measure creativity chose three mental capabilities:

1. Fluency – the total number of interpretable, meaningful, and relevant ideas generated in response to a stimulus
2. Originality – the statistical rarity of the responses generated
3. Elaboration – the amount of detail in responses generated

We might, then, ask these three traits of our models of creativity: (1) How many models do we have and use? (2) How rare are these models? How diverse from each other are they? (3) What is the level of detail of elaboration of each model? *Creative modeling of creativity*, it would seem, would involve us in having (1) many, (2) diverse, and (3) highly detailed models, not single right-y models of great abstraction lacking detail and specificity. This little exercise makes us clear that academia's aim for "rightness" of model gets in the way of "creativity" of model. Perhaps, mono-theism drifts into mono-theory-ism, culturally.

The Idea of a Novelty and Creativity Sciences School

Colleges and corporations today split the novelty and creativity sciences into different departments, centers, sites, and degree programs. No journals reach all creativity sciences. Therefore, each novelty and creativity science is being learned, studied, presented, and applied on its own, for the most part. What might improve was they all studied, taught, applied together. That is the concept behind creating a novelty and creativity sciences school (and research center).

The few initial experiments in this direction – primarily at De Tao Masters Academy in China and Keio in Japan – show these results:

- Intense formats – Nine creativity and novelty sciences taught in one 18-day period via 2 consecutive days per course (so interactions among them are intense).
- The graduate student insight – Students *get,* after initial frustration of their habit of seeking one rightest model, the insight that *no one model* is powerful, unbiased, comprehensive, or accurate enough to be trusted.
- Discovery of mental hiding places – Instead of all teams depending on "brainstorms" and all individuals depending on "insights" (see ► Brainstorming and Invention and ► Role of Intuition in Creativity), dozens of particular new ways for new ideas to enter life and work are found (social design automata, stratified responding, and others).
- What one novelty-creativity science teaches others – We ask designers to invent, and they find "over-specification" a problem; we ask inventors to design, and they find "under-specification" a problem – each develops wider new approaches, stretched by experiencing someone else's ways.

54 excellence sciences

Routes to the top of 63 professions in 41 nations from 8000+ respondents

Combining tacit knowing, practical intelligence, knowledge evolution dynamics, declarative & procedural knowledge, theory and practice knowledge. items with an * have books presenting sets of capabilities that define them

Source De Tao Masters Academy Creativity & Novelty Sciences Studio Plan, 2012)

	Person		Performance		Adaptation		Diversity		Reflection		Compilation	
Basics	Self	Educatedness*	Reality	Diversity* (handling it)	Model	Structure* (social & cognitive)	Experience	Cases	Meta-knowing	Humanities & arts of knowing	Knowledge traits	Between knowledge formats
		Effectiveness*		Complexity (handling it)		System*		Theories		Natural & social sciences of knowing		Between knowledge categories
		Creativity*		Error (handling it)		Quality		Expertise		Professions & engineering of knowing		Across knowledge explicitness & consciousness
Productivity	Manage	Management functions*	Produce	Leading & innovating*	Style	Artfulness (handling constraintlessness)	Globality	Global effectiveness (western, eastern, both)	Meta-disciplines	Humanities & arts of 1 discipline	Knowledge locales	Across cultures
		Management levels*		Composing/ design*		Coping (handling constraints)		Power types		Natural & social sciences of 1 discipline		Across selves/ personalities
		Management domains		Performing*		Paradox (handling incongruency)		Morality (establish solace systems)		Professions & engineering of 1 discipline		Across systems
Transform	Influence	Influence	Discover	Data (collecting & analysis)	Learning	Entrepreneurship sources*	Change	Fashion (idea/method)	Meta-practices	Practice: liberation	Gaps	Across knowledge context & size gaps
		Careers* (+job finding)		Research (processes)		Manage by events		Ecosystems & clusters (of ideas & practices)		Practice: freedom & historic dreams		Across knowledge sequence gaps
		Technology (social life, etc.)		Venture (founding)		Organizational learning		Practices (movements of change)		Practice: novelty conserved novelty		Across knowledge surprises & noticings

(from Greene 2011 and De Tao Master's Academy 2011)

Multiple Models of Creativity, Fig. 2 54 Excellence Sciences

Multiple Models from the Practitioner's Point of View

Industry CEOs find two great weaknesses in single right-y models: one, it is too risky to assume that "our" present consultant-academic's model is *the* right one and all others are wrong; two, the best most statistically valid single right-y models, when fully, expensively, and sincerely applied by competent private sector organizations, produce laughably tiny improvements in creativity. A recent Harvard (Amabile, 2009) article reported copying a Japanese hit product 8 years later as the *creative* result from changing 40+ environment variables to create a "creative" and "innovative" environment (see ▶ Measurement of Creativity). Delayed copying is not a robust useful result. Single models however right-y are usually useless or very nearly so.

Six Meta-Models

Below, four levels of repertoires of models (meta-models) are presented, without discussion – 54 excellence sciences (Fig. 2),

The 18 novelty and creativity sciences
Creativity generates novelty which generates selves, knowledge, discovery, invention, and exploration

Source De Tao Masters Academy Creativity & Novelty Sciences Studio Plan, 2012)

(1) The liberal arts of each novelty science come from the evolution, natural selection dynamics of each (2) Novelty comes into the world via five types of creation and twelve levels of creation				Evolution in (natural selection dynamics of)	Story comedy history philosophy of
Creativity	Novelty	Selves	Educatedness (self-creating persons)		
			Careers		
			Creating others (leadership, parenting)		
		Knowledge	Systems		
			Cultures		
			Quality		
		Experiment & discovery	Innovation		
			Ventures		
		Art & invention	Design		
			Compose		
		Expression & Exploration	Fashion		
			Perform		

(from Greene 2011 and De Tao Master's Academy 2011)

Multiple Models of Creativity, Fig. 3 The 18 Novelty & Creativity Sciences

many of which are 18 novelty and creativity sciences (Fig. 3), two of which are 120 models of creativity (Fig. 4), and 54 models of innovation (Fig. 5), one of the innovation models being 64 dynamics of natural selection (Fig. 6). This demonstrates both vertical and horizontal dimensions of the structural cognition program of tools for thinking as broadly as our problems without losing specificity and application power. All the models come from 8,000+ people from 41 nations and 63 professions interviewed over a 6-year period, the resulting capability models linked to nearest match theories from 4,000 research books on novelty and creativity sciences. At first redoing Plato by asking high performers in many fields who were top in their field and how they got to the top, produced 54 excellence sciences in the below table, many of which were novelty and creativity sciences. The same data also defined capabilities of highly creative people, great innovators, great designers, and for the other sciences. Total quality and AI software techniques generated interview & questionnaire items (Giarrantano and Riley 2004; Ericcson and Simon 1993; Laguna and Marklund 2004; Hammer and Champy 2003).

Meta-Model One: 54 Excellence Sciences, Some of Which Are Novelty and Creativity Sciences Too

Meta-Model Two: 18 Novelty and Creativity Sciences

Figure 3 presents 18 novelty and creativity sciences in rough order, showing top level relations among them. Creativity is the root of them all because it is what generates novelty into them all. The structure of the table below suggests:

1. That evolution goes on in all novelty sciences and that narration and other liberal-social arts of each novelty science derive from evolution dynamics in each
2. That multiple models of creativity apply to all other novelty sciences
3. That selves and knowledge together capture the levels novelty sciences apply to

120 models of creativity **from 150 creators, 8000 eminent people, & 4000 books and research articles** **People from 63 diverse professions and 41 nations were sources below** [A book of detailed models for 60 of the models below is available from scribd.com] Academic models that correspond with each empirical model below are noted in each box This model of models is the basis of a 4-semester course at KEIO SDM in creativity models **Source De Tao Masters Academy Creativity & Novelty Sciences Studio Plan, 2012)**			
The comprehensive first 60 models Each model below purports to explain ALL of creativity Note: a book on all below was published (Greene 2000)		The partial second 60 models Each model below purports to explain some kinds of creativity Note: the below are being tracked closely for eventual generality	
The socialities of creating	**The mentalities of creating**	**Brain management**	**Mind extensions outside brains**
Catalog	**Experiment**	**Seek exception**	**Entool mental operators**
Recommendations create creative life (by making interior & exterior room, and embracing paradox enough to enable mental travel), accumulate subcreations till they become creation machine; your creative life uses your creation machine to create **Gardner, Simonton, Sternberg, Root-Bernstein**	Solution culture creators articulate to themselves their chosen field as a failure culture; then they reverse all dimensions that characterize that failure culture to invent a solution culture, which they then apply to realize aims the field has failed thus far to attain. **Jonathan Feinstein, Greene, Marx, Arendt**	Everyman scientists, hypotheticality (BAYES) creators become aware of limitations and tendencies in how they view the world (what they notice and miss); they consciously seek frameworks for getting beyond those limits in self and others; they develop exquisitely precise and unusual hypotheses, then invent ways to test them; artists do science. **Bayes, Judea Pearl, Bunge, Sloman, Eamon**	Decentralize intuitions each group and era has its own characteristic intuitions, which creators notice and reverse or change; when central control by leaders is assumed, creators imagine many actors self-organizing without central exchanges and specially designated leaders; **Resnick, Papert, Minsky, MacDermott**
Traits creators vary via being ingenue, problem seeking, violating bounds, bricolage, then they combine ideas via metaphor, abstraction, indexing, and multiple worlds mappings, then they select combines via finding saturated fields, countering intuitions, articulating, applying aesthetic rules. **Guilford, Sternberg**	Policy by experiment creators take all that exists as hypotheses not established truths; they play around with, experiment with what now is, including present trends and thoughts; they structure work not to make systems work but to learn from whether they work or not, how the universe functions. **Deanna Kuhn (us as intuitive scientists)**	Endish means creators embed ends they aim for in the means they use to seek those ends, so that trying for goals, incrementally actualizes them; they liberate themselves from past ways, then in no man's land seek out other ones liberated from the same realities, with some of whom they dream dreams of a replacement for old ways. **Mao Tse Tung, Joseph Campbell**	Change mind map topology creators assimilate ideas into models and arrangements on paper or in their minds, but they take another step and transfer whole models of ideas from one geometry type to another, viewing the same set of ideas from diverse frameworks **Herman Hesse, T.S. Eliot, Foucault, Parsons**

Multiple Models of Creativity, Fig. 4 (continued)

Question finding creators find vital tipping point questions via finding gaps (reverse trends, depersonalize, undo successes, expand models), via finding points of high leverage (fully represent, socially index, seek intersections, change models), via changing representations of situations (change: measures, scales, causes/effects, models), via changing logic (relate, imply, unify, cross domains) **Einstein and Infeld 1938, Runco**	Creation events creators turn distributed sloppy unorganized latent processes of thinking into intense, events, either of two ways, by tweaking in parallel several emerging processes and getting them to interrelate, or by getting the right parties together in the right context and roles. **Greene**	Extreme concentrations creators do normal thoughts, feelings, and actions but continue them to ridiculous extremes which cause them to attract great attention and change frameworks and expectations of others, being declared "creative." **Arnold Ludwig**	Bridge competing nets creators just do social work in this model: they put networks of people and thought into contact that before were not at all in contact, and by how much contact, where, of what sort, creators create a particular flow of ideas. **Ron Burt, Gladwell**
Darwinian systems creators vary, combine, select, and cause idea reproduction across persons, creative works, fields, and domains (so persons, works, fields, and domains all 4 can either foster or hinder creativity, by supporting or hindering the 4 functions: vary combine, select, reproduce) **Finke (pre-inventive forms)**	Fractal model expansion creators map all that is known and tried about some idea or topic in highly organized and regular diagrams, so nothing already tried is omitted or distorted; then they regularize these maps to make what is vital and what is peripheral visually self-evident; finally, they expand the dimensionality of the diagram on all size scale, so they imagine new items associated with each past item. **Abbott**	Idea farming creators plant in minds, their own and collaborators' possible new ideas, then nurture them in various ways, letting them compete as they grow, till some of them tower over the others as more interesting or powerful or unusual; that means creators multitask among diverse ideas planted. **Edison, Kurzweil**	Avatar worlds creators in imagination or using new media see themselves or their favored ideas in alternative worlds relating in ways not of this world to other ideas and persons; exploring new contexts around and relationships with ideas in these other imagined world contexts, reveals aspects of ideas, combinations of ideas,. **Dashavatara, Chip Morningstar**
Combined thought types creators create by combining 16 distinct types of thought: getting inputs via empathy, doubt, observation, and pattern recognization, abstracting by associating, arranging, playing with, and representing ideas; grounding ideas by abstracting from cases, concretize idea in cases, extracting from routine, and creating new routines from ideas; outputting creative works by generation of—images, analogies, syntheses, and causal models. **Root-Bernstein**	Social automata, This is creating by tuning interactions of populations of entities, varying their connectedness, diversity, depth of contact, neighborhood size, till creations emerge. **Greene, Scott Page, Gilbert, Melanie Mitchell, Wolfram**	Use/make across scales creators attend to and act on smaller and larger size scales of space and time than others, **Root-Bernstein, Margulis (and Sagan spouse, she small, he large scale)**	Meta-creation = recursive innovation creators study how other creators create and modify their own ways of creating competitively based on those observations; this includes making a science out of things other creators treat as arts. **Flavell, Demetriou**
Garbage can creators establish and notice 4 cycles: new tools enable new thoughts inventing newer tools; successful works change self/other expectations making more boldness making more success and two other cycles. **Amabile, Baer & Kaufman**	Create by balancing creators map all the dynamics of an area on polar dimensions, often many at a time, and notice what poles are now emphasized and aimed for and which are slighted or missed; **Greene**	Synchronic diachronics creators study the past, map its sequences of innovation, express those as movement along abstract dimensions, then create new things by adding other dimensions, going to extremes not done thus far on past dimensions, and interpolating between	Interface evolution most interfaces and bodies of knowledge, most teaching and explanation are organized by past categories and fit new things into those layers of accumulated past context; creators create new interfaces re-contexting all we know **Liskov, Norman, Talcott Parsons**

Multiple Models of Creativity, Fig. 4 (continued)

		items of past dimensions; Altshuler did this to patents to invent the TRIZ system. **Altshuller**	
Blend	System	Japanese Aesthetics	Repetition power, software
Culture mix many perhaps all creations are done, without anything creative happening as far as the creator is concerned-the creator simply operates in another culture doing what is perfectly easy and normal in his or her own culture, but those in the culture around him are amazed declaring the results "creative"-**Holyoak & Thagard, Koestler, Richard Florida, Gordon**	Nonlinear system creators set up systems of ideas, persons, works, groups, domains that involve many things interacting, they create and tweak parameters of those populations and their interactions, or they set them up to reflect on and tune themselves; the world outside of creators is such populations of things interacting nonlinearly, and the world inside each creator's head is also such a population of things interacting **Par Bak, Gladwell, Cowan, Casti, Kaufmann**	Deliberate imprefection create to make world world not to make world mind or mind world; AWARE (ah-ness of things, empathy toward things, sensitivity to impermanence of things, MUJO (impermanence of things), WABI, SABI appreciation of emptiness) **Sen, Rikyu, Okakura**	Isolate function from means modules encapsulation; creating modules is a constant in all forms of creation-isolating the behavior or effect we want from how it is produced; this allows, encourages exaptation and bricolage. **Mitchell & Plotkin (existential types, modules)**
Discipline mix creators often perhaps always are ones who come from one domain to handle issues in another domain-here too they can be creative without trying hard or doing anything that is not easy and natural to them, in their original domain; **Koestler, (Heilman, Nadeau, & Beversdorf, 2000)**	Darwinian the most creative single process in the universe is the one that created life, and us, humans, that is natural selection; common images of natural selection are nearly 100% wrong; correct models, include collecting neutral traits libraries till some are found adaptive when environment shift substantially, **Simonton, Melanie Mitchell, Dawkins**	Beauty of belonging & not belonging is created by showing the inness of outs, and the outness of ins; seijaku (lost in one's thought but more lost in reality, in a scene), IKI (a clear, stylish manner and blunt, unwavering directness), fukinsei (unbalanced, nonsymmetry, datsuzo (freedom from habit, tradition; koukou (the majesty transmitted from past greats by withered remnants) **Donald Keene, Saito Yuriko**	Reuse & specialize taking something and its effects and behaviors and relationships and making larger or smaller, faster or slower versions of it-v **Dahl & Nygaard (simula)**
Tuning creating is a tuning operation of finding precise delicate mid-value along poles of opposite value-too much of X and too little of X and you get not creativity, but some mid-value causes creativity-this is the inverse U function of creativity. **Sternberg**	System effects creators seek unplanned emergent delayed distributed system effects, inventing by building ways to deliberately provoke and benefit from them. **Schelling**	Hide what you show indicate not express, hint not display; ushin (discrimination, exquisite distinction), shibui (beauty that appears only when gazes linger); yabo (the ugliness of the court of Louis ! 4th in France-the ugliness of directness, opposite of IKI), jo-ha-kyu (slow, break, sudden), EN **Haga Koshiro, Tadao Ando**	Exapt: reuse in new contexts every new thing every creator invents can recombine with all past things, some of which combinations will themselves be creative: especially when deployed in distant remote unlikely new contexts and environments **Levi-Strauss, Root-Bernstein**
Paradox door creators seek out anomalies, paradoxes, contradictions, things that are not working-they struggle to make sense of them and have to let go of their own selves and	Surprise creators surprise others after surprising themselves and their own minds, via liberating from what all consider essential, combining with others thusly liberated, to invent	Presence of nothing creates by minimal wordless suggestion miyabi (things polished so anything vulgar is removed); yugen (dim, deep, mysterious; fully recall from slight hint of	Code inventing code creators that create things that create, that combine, that fuse, that split, that invent, multiply their variation, combination, selection. They make

Multiple Models of Creativity, Fig. 4 (continued)

attitudes and educations into new views in order to handle them-paradoxes et al. are doorways to getting beyond what is in oneself. **Michael Parsons, Kegan, Marianne Lewis**	replacements that need protecting from established old ideas-forces **Arendt, Rollo May, Wildavsky, Fiske**	of things), honshitsu (the felt not thought essence of things), **David Oden, Onishi Yoshinori**	themselves more creative. Creators deploy initiative and creating/designing from their own selves into embeddings in what they create, so what they create creates. **Shannon, von Neuman, Turing, Kaufmann**
Scale blend creators use or invent new tools to expose phenomena on new size scales, larger or smaller-they track results on other scales-trying to invent an all scale result or theory that explains or generates the two-scale and single-scale results. **Root-Bernstein**	Adjacent beyond the universe itself invented natural selection the most creative process we know- so do/can humans create the same way the universe creates? Each new creative work combines with all prior ones making exponentially more combines-a self-scaffolding process. **Kaufmann, Boden**	Subworlding living your fantasies in order to invent bridges ukiyo (the fantasy only world, of pure unhindered human desires), anime (the sudden decisive make of a feeling in a reader by one stroke), otaku (the culture of narrow development from self out not social constraints in); cosplay (putting on lives via putting on clothes) **Nobuyuki Takahashi, Shimokawa Oten, Seitaro Kitayama**	Operate on prior results Similarly, recursion power: creators who apply operations not to similar inputs but to the results of that or other operations, extremeize, catapult beyond norms and expectations = create. **Turing, Von Neuman**
Idea marketing creators market ideas and possible solutions to their own minds, and use creative works to market ideas to their own field of people, and market that to the history. **Palombo, Noice & Noice**	Population automaton creators set up populations of things interacting nonlinearly whose interactions they tune, till better than planned results/patterns emerge, on four levels: thoughts, solutions/works, creators, domains interacting thusly. Each level has its own generator of paradoxesnegation, hubris, feedbacks, focus from parallel engagements Duncan Watts, Svyantek & Brown, Gavriel Salomon	Subspaces create sacred secular spaces where the essential nothingness of things is unobstructed. sakura (the dependable annual transience of things), sado (a special exceptional world within our world where rank and crude exaggeration have no play), muge (the ultimate beauty of full meaning no longer blocked by ego, and worldly shallownesses) **Bodhidarma(Bloodstream sermon), Gautama Buddha (flower sermon), Huike, Huineng, Myoan Eisai**	Operate on structures of data creators who apply operators whether physical, emotive, or cognitive not to single items but to ordered patterns of such items, multiply effects in variety, scale, and scope and may end up creating as a result. **N. Wirth**
Group	**Purity**	**Sense extrema**	**Democratize media**
Community of ideas creators put together ideas into community dynamics, among those ideas- associations, conferences, arguments, taxonomies, processes, sequences, events, fusings, branchings, and many more; they control these idea community dynamics via meta-cognition operators. Minsky, Hewitt, Montuori & Purser	Subcreations creators, before they make their big famous works accumulate lots of tiny inventions of tool, facility, aim, inspiration, link that grow and interact till a huge final creation emerges J. R. R. Tolkien, L. Konzack (games)	Constraint acceptance creators study and organize constraints, seeing how others overcame similar ones and finding new constraints to add to force unseen-before answers. Jon Elster	Customers as own suppliers-APPS-creating is making customers the makers not mere consumers; it is making things that turn everyone alive into a designer, producer, performer, creator; creating is inventing pre-inventive subcreations that users use to become invention. Jobs

Multiple Models of Creativity, Fig. 4 (continued)

System model creators are not all that create in this model-creation comes from a creator person interacting with creative works (past, present, and imagined future), with creative people in a field, and with the knowledge of his or her chosen domain; more than that creators interact in and across fields, creative works interact, creative fields of people interact, and creative domains of knowledge interact; so people, works, groups of people, and idea domains can foster or hinder creativity **Csikzentmihalyi, Feldman; Styhre & Sundgren**	Productivity creativity is a side-effect of immense productivity in this model; one of the first battles any creator has and wins is the battle for free time often won by personal inventions to free up time for creating; statistics show that the historically most famous creators are often even usually the most productive too. **Simonton, Wishbow 1988 (poets 5 years prep), Hayes 1970 (painters-6 years prep)**	Map past dimensions creators create by mapping all past creations and inventing unique frameworks for ordering and interpreting them; creating is simply an operation on all past creations, understood and represented very abstractly, revealing dimensions in their evolution never noticed before. **Ritchey, Zwicky**	Customers as own supplier-info wiki creators create shared spaces where ordinary people in crowds can design and invent what formerly was designed and invented by central elites; creators invent tools that allow entire populations to create, tools that make readily fusable and usable the diversities of mass populations; **Jimmy Wales, Malone**
Social computation creativity in this model is a computational process among a group of people; one way to see this is as a complex flow of parallel intersecting steams of small events/meetings where people meet people, ideas meet ideas, funders meet people, with some events spawning, shutting down, and coordinating other events, **King and Anderson, Payne, Montuori & Purser**	Performance creativity is ideas performing in this model, at first performing inside a mind for your own self, then for imagined competitors, imagined heroes of your own field in past and future, failed ideas perform in your mind for you to see patterns among them that hint at solutions; possible works perform in your mind; **Sawyer, Stanislavski, Stella Adler, Lee Strasberg**	Vacuum power this is Lao Tsu's style of painting in ancient China-painting spaces not objects, breaking perfections-symmetries-balances deliberately; creation is pure negation in this model-it is non participation in the habits, views, and enthusiasms of a field or tradition; **Ando, Lao Tsu, Merleau-Ponty, Marx**	Customers as own suppliers-things creators invent things that serve as tools and devices that encourage and enable ordinary people to create; this involves changing all products and services in this world so that their final form and next version comes from how people use them **MIT Fab Labs, Malone, Toffler**
Social movement creators find whistle points, where slight inputs change entire systems, then they design seeds that release the forces in such whistle points in a society or profession and manage via public and private dialog tactics what emerges from the movement that results; **Thomas Kuhn (paradigms), Christensen**	Influence creating is a social process of amazing a group of people via usual influence mechanisms, context setting, and selling avenues; varied types of person combine to create/influence a field-pioneers, translators, scholars, tinkerers, network hubs, glib salespersons, **Kuhn, Eamon**	Isolate senses by seeing along one sense only you lose habitual constraints from other senses and see aspects of reality not noticed before; it is Einstein seeing the speed of light as a final speed limit in the universe (as Maxwell in 1882 suggested) and working out what that one seeing changes (it changes all of physics it turns out). **Ramachandran, Suzuki, Zeami**	Customers as publishers creators invent media by which all ordinary people can perform for others, can compose for others, can invent for others, can entertain others; creators spread creating from central elites to entire populations; **John Milton Aeropagitica 1644**
Space share creativity emerges when a certain intensity of sharing of intellectual space happens, in analogy to nuclear fusion happening when particle interactions are "confined" enough for a certain density of interaction energy to be reached, causing central elements, stripped of peripheral ones, to fuse. **Segel, Schrage, Perkins, Zwicky, Gruber & Wallace**	Investing creating is investing in idea streams in this model; you create by managing a portfolio of interests, some of which you develop into ideas and actions; you invest interest, research, imagination, tool invention, collaboration, and more; **Runco and Rubenson (psychoeconomic model), Sternberg and Lubart, Hayak, Penrose**	Inner/outer reversals this going out and finding that changes what you notice inside and going in and finding that opens out new outsides to understanding-is the method of all creating, in this model; creating is going in to make new outs and going out to make new inside models and ideas and ways **Joseph Campbell, Jung**	Social doers creators make devices works and tools that enable groups to see and do what formerly only individuals saw and did; creating is taking the heroics out of creating by accumulating mass population steps and insights into stunning inventions; **MIT Fab Labs, Malone, Toffler**

Multiple Models of Creativity, Fig. 4 (continued)

Participatory art & design you create by liberating people, ideas, devices, or the world from central controls and mass media messages controlled by central elites; creation is making audiences into performers, and reversing message flows. **Shina Minoo**	Info design creators create by operating on information-representing information, modifying info types (causal, qualitative, etc.) and info topologies (logic, hierarchies, networks, etc.) **Shriver, Tufte**	Observe self others creators merely observe more and differently in this model; they pay more attention and high quality attention to things not attended to before; creating is watching without getting sucked into as others are-it is highly detached comprehensive reflective watching. **Carravagio, Brad Blanton**	Parallel media universe creating is a set of tools that liberate all from boring jobs and work and into full time creating-6 billion TV producers, virtual work worlds, creators entool every last person alive till everyone is creating all the time for each other; **Toffler (de-massifications)**
Social	**Self**	**Brain adjustment**	**World mixes**
Mass solving creating is always the gradual deployment of a particular kind of mental protocol-a solving process-across a large population from whose variety innovation possibilities arise as the common process spreads; you can imagine Newton, Leibnitz, and others exchanging letters and bits and steps of that eventual solving process spreading among them **Ohno, Kano**	Courage creators have a drive for truth that thrusts them into intense encounters with reality aspects poorly explained by current systems and knowledge, and creators practice courage of reaching beyond normal beliefs to raw phenomena, for truth. **Rollo May, Betty Cannon, Tillich**	UN-index creators see raw reality by shutting down the outer cortex of the brain which usually indexes what we see so we see, tiny fractions of what our senses get, and we see only meaningful entities not raw inputs: certain autistic people lack the index around brains and directly access raw sensory inputs-these become savants, **Mark Batey; Ken Heilman; Alan Snyder**	Raising not programming creators do not specify correct procedures but instead create entities and tools that themselves learn the world and how to operate it and by doing it anew without human attributes, discover or invent, design or make creative outcomes humans would miss; you create by not creating but by making things that interact to themselves create in this model. **Rodney Brooks, Minsky**
Process deployment creativity is the spread of other or any protocols (not just solving ones) in this model. The variety of what you spread the protocol over generates the variations from which the group selects influenced by steps in the protocol they all share. **Kano, Akai**	Anxiety channel creators unleash anxieties of existence normally hidden from, fled from and use that energy to see their chosen fields deeply and newly, **Rollo May, Kegan, Betty Cannon, Joseph Campbell, Tillich**	Shut modules monks who shut down in meditation the brain module for being in one's own body, fly. Creation is what you get when you work on something with key parts of your-self and mind shut down. That is why people report semi conscious states of mind as fostering creation the most. **Davidson & Dalai Lama**	Manage population emergences designing populations of intelligent interacting agents from whose interactions emerge, unplanned, designs is how you create in this model; creating and designing and inventing are operations to tune the interactions of intelligent populations-whether software, robots, or people-in this model; **Casti, Cowan, Holland, Kaufmann**
Optimize ideal flow creativity comes from designing work, processes, and systems so that energy flows only in intended directions, so that the ratio of that energy over side effects is optimized, and so that it is optimized over a linear function of values not single point values, so results can be tuned without loss of generality; Einstein designed all of physics optimized around the speed of light as an ultimate **Genichi Taguchi, Collcutt**	Extend self development creating is something every human does-creating their own self-but only a rare few reject the self they inherited and replace parts with better things of their own invention or choosing (educated people); creators are people who extend this process from creating a self themselves to making the self they create a creative self, **MacKinnon 1961**	Watch mind Some meditation regimes involve sitting and merely watching your own mind at work; months or years of this result in despair of ever reaching insight or happiness while led around by your own mind; despair at your own mind leads to practice bypassing its signals and categories-this leads to immense creativity **Davidson & Dalai Llama, Rex Jung; Ken Heilman; Alan Snyder**	Prosthetics the Borg in Star Trek II are what this model is about-adding machinery into brains that allow new sensations never in biology before and the opposite adding bio stuff inside brains similarly-all creating is just extending mind operators with tools outside of brains in this model. **E. E. Smith(lensman, 1933), Project Pitman at Los Alamos**

Multiple Models of Creativity, Fig. 4 (continued)

Meta-cognition creativity comes from deft changing of approach, aim, method, what is noticed throughout the creator process of creating, due to this dual-being in but not of their process of creating. **Flavell, Fisher, Shimamura; J. Feinstein**	Interest ecstasy creators create interest in things no one else is interested in-they invest their intense beam of woven interests in tipping point places where slight inputs can have huge outcome effects; **Csikzent-mihalyi, Ypma; Jonathan Feinstein**	Input extrema creativity comes from exploring to find the extremes of what each sense and cognitive facility can handle-the lowest possible light visible, the most complex possible pattern to imagine. **Ramachandran**	Smart dust creating is distributing over the entire universe communicating thinking imagining entities or extensions of human such functions till human mentality and all that exist think, feel, see, imagine, make together. **Pister**
Social connectionism creators get ideas in frame contexts (idea solids = every idea a defined fixed place), by getting them into intense interacting; those frames are stripped off, so ideas flow between frames (liquid phase), till ideas form a frame less gas, till the ideas lose peripheral contexts/ associations to become an idea plasma, coalescing into entirely new frames = creation; **J. S. Brown, Duguid, Lave, Wegner**	Career invent creating is merely inventing your own career rather than moving along a career path invented by someone else; they do this for the career that individual ideas have, that individual traits inside creative works have, that creative works have, that creators have, that people have; **Klar et al, Ghiselin**	De-conceptualize creators do what we all do except they refuse the categories we all use-they categorize anew from zero in all matters of interest; **Zeami, Rikkyu, Lao Tsu; Ken Heilman; Alan Snyder**	Brain amplifiers machines inside or around brains that amplify what they can do or react to = all in culture and all in civilization; creating is amplifying this or that operator in brains, with social, intellectual, cultural, physical tools and systems; all of civilization is such a tool in this model **Simon Hooper (cyberware)**
Demystification creators demystify-that is all; that means they recover powers given to aspects of the world while growing up; assumptions made, limits on alternative ways imagined, filters, so we miss parts of reality, hidden selfish motives and interests behind public services and boons, **Illych, Foucault**	Performance creativity creators set up nine performances: ideas in minds, traits in works, works in fields-those 3 repeated in 3 levels: in the creator's own mind, others enacting the creator's ideas as performance, and third, audiences experiencing these three; when all 9 performances happen at once, creativity occurs, and the secular is made doorway to the divine; **Alice Isen, Mattis, Poincare; Sawyer (improv)**	Jiggle (add noise) creators jiggle mental frameworks and reality dynamics, inducing noise and random-ness to unseat concepts and phenomena from their habitual contexts and settings; this resembles super-renormalization group operators in physics. **Ramachandran, Remy Lestienne**	Informated places & times creators are a history-long process of taking the all from everywhere and making it applicable in each local time and place; **Zuboff, Altman & Sivo(Loopt)**
Knowledge evolution	**Mind**	**Scale extrema**	**Radical subcreations**
Dialectics creation is a generational process in all fields-the younger people to overthrow the dominant old people, go back to what was conquered and subsequently belittled in the past, resurrecting those ideas in new contexts to dislodge established ideas and powers in their chosen field. **Marx, Hegel, Abbott**	Insight alternating deta-chment and engagement on more and more abstract representations of what does not work results in accumulating a failure index, the inversion of which specifies what even-tual solution has to be like till creation suddenly occurs as sheer insight. The despair doorway is opened by losing hope that who you now are, how you now think, will ever solve this X-*then* a pattern in your failures shows solution. **Wallace Guilford Hadamard;**	Extend substrates you create by standardizing new substrates so that hundreds can study and combine them and learn from each others' experiences (bio fab copying wafer fab); you create by inventing substrates that many can use instead of just a few. **Langton (alife)**	Structural cognition tools (cognitive list limit expansion) creators learn to apply ordinary mental operators to many times more ideas at a time than others-they invent tools for enabling them to do this and do their thinking, designing, solving work at many times the per time unit of productivity of others. **Entwhistle, Pask, Kintsch, van Dijk, Meyer, Flowers & Flowers**

Multiple Models of Creativity, Fig. 4 (continued)

Compilation cycle you create by compiling knowledge from one model to another, from one level of aggregation to another, from one level of explicitness to another, from one level of consciousness/ unconsciousness to another-such changes of format and form reveal gaps and patterns hithertofore unnoticed = creations **Nonaka and Takeuchi**	Cognitive operator extremes creators apply normal mental operators to ideas but at extreme levels and degrees; the scale, force, agility, unconventionality, bias, expression, packing of mental operators can all be carried to extremes; **Weisberg**	Tackle impossibles you create by tackling impossibles-ending death-knowing that steps in such bold directions will, by being outside of all extant realistic contexts surprise, amaze and perhaps, be powerful creations in some other context than the context that generated them **Kawasaki, Jobs, Kurzweil**	Radical increases in social indexing creators notice that all current ways and societies operate with people knowing and using tiny fractions of the needs, interests, and capabilities of people around them-and they pioneer tools that expand how many of the needs, interests, and capabilities of those around them, people can notice, remember, and use; **Thomas Vander Wal (web tags)**
Relocating idea ecosystems transplanting whole sets of inter related ideas from one idea ecosystem to entirely different ones and making analogous and new links with the ideas in that context results in creation. **Fauconnier & Turner (conceptual blending), Thomas Ward**	Making sense by observing critically and skeptically human systems of belief, expecting many of them and much of them to be built on sand, creators by spotting the ones of weak foundation find towers of illusion and delusion to puncture with single well-placed actions and works-creating is puncturing perpetual human towers of self-supporting delusion **Drazin**	Extend doer scale new technologies and substrates change the cost and expense in money, attention, effort, resources, and time of doing certain functions-creators are those who organize people to operate at new speeds and size scales based on these capabilities **Jeff Howe (crowdsourcing), Beni and Wang (swarm)**	Culture penetration as insight process creators penetrate the culture of eras, fields, theories, problems-that is, the same alternating of detachment with engagement on successively more abstract representations of that culture that all insight processes are and that is the same gradual accumulation of failures that when abstractly indexed specify what a solution must be like, more and more till a solution is suddenly found **Bohannan(anthro)**
Idea waves sets of ideas pass in 8-year periods across all fields, finding great creative applications in some and no creative applications in others; creators are people who first notice such waves and who deploy their idea contents to appropriate parts/problems of their domain; **Huczinsky**	Percept invent creators invent new ways to perceive and new things to perceive-they create and invent by seeing what no one else sees-they do this by varying frameworks, levels of detail, associations, and other things that allow them to see realities no one else sees, **Tomasello, Wittgenstein, Merleau-Ponty**	Invent new humans creators see and solve the future now-so they use stem cells and DNA knowledge to design new forms of human body for when we all have to live on the moons of jupiter after our sun expands to red giant size; creators operate under bold constraints others will not face for generations; **Kurzweil**	Social structural automata creators set up automata like protocol processes, among existing groups and structures and events in their field or society-till creations appear. **Epstein & Axtell, Prietula & Carla**
Fractal recurrence victor ideas incorporate loser ideas as components till later generations of youth revive them to overthrow old dominant ideas; creators learn these idea dynamics in their field and with great timing lead one or more of the forces that produce such repeated idea patterns. **Abbott**	Experience realization creators make a hero story for themselves and their culture: they launch fields on the hero journey of going beyond past ways into no man's land, fighting monsters till they realize the monsters come from inside them, then they come back to their field bearing magic powers from self transformation; **Einstein, Picasso**	Extend target scale creators take all we have and imagine them a million times bigger, a million times smaller, a million times faster, a million times slower-they wonder what we "get" if things are done at other scales and speeds; the US military is paying for bird sized autonomous flying devices then insect sized ones, then bacteria sized ones-intelligent dusts, for example; **Hayes et al 1987 writers**	Revolutionize older media creators examine the oldest most assumed and used media and from entirely current and future perspectives redo reinvent them-so all the basics of thinking, feeling, and acting are revolutionized-creators replace prose, replace meetings, replace discussions, replace feelings **Eamon, McLuhan, Negroponte, Maeda**

Multiple Models of Creativity, Fig. 4 (continued)

Simple programs creators invent the smallest, simplest, fewest interacting components to generate all the complexity of some phenomenon in their field they create by controlling, predicting, modeling the most with the least. **Wolfram, Klahr(machine inventing)**	Substrate update the world is an ever faster series of new substrates for doing basic functions better faster cheaper easier and for doing functions never possible in history before-creators are those who are first to redo a key function of their field on new substrates and the first to discover entirely new field functions made possible by such recently installed new substrates. **Isse Miyaki, Stephane Leducs, Arber Nathans & Smith (nobel)**	The calculus move finite elements, renormalization groups, cellular systems, grid computing, cloud computing-all these are breaking something into millions of simple pieces and accumulating calculations simple for each piece into complex bigger scale shapes impossible to calculate directly-all creating is calculus of a sort; **Leibnitz, Newton, Hrennikoff & Courant; (finite element); Ernst Stueckelberg and Andre Petermann in 1953**	Stratify responding creators slow down and separate each within-the-mind layer of reacting-what do we notice; what feeling does each noticing evoke, what association does each feeling evoke; what framework comes with each noticing and how does it determine how the noticing makes us feel; what new framings are conceivable, possible, optimal, inventable; and what new noticings, feelings, framings, meanings do they generate-creators refeel the world **Freud, Betty Cannon, Husserl, Ellis & Beck, Ken Heilman; Alan Snyder**

(from Greene 2011 and De Tao Master's Academy 2011)

Multiple Models of Creativity, Fig. 4 120 Models of Creativity (from Greene 2011 and De Tao Master's Academy 2011)

4. That experiment and discovery, art and invention, and expression and exploration capture what is applied to those levels (each of those pairs expressed via multiple models of creativity involved in them)
5. That eight novelty sciences (creativity, evolution in, story-comedy-history-philosophy of, selves, knowledge, experiment and discovery, art and invention, expression and exploration) somehow support and apply to 12 other novelty sciences (educatedness, careers, creating others, systems, cultures, quality, innovation, ventures, design, composing, fashion, performing)
6. That it is *all* about novelty in the end – each novelty science is about bringing the new into our world
7. That each novelty science differs from others in having a sort of basic direction:
   (a) Tries – in the experimenting and discovery involved in innovation and venture building
   (b) Builds – in the art and inventing involved when people design and compose
   (c) Roles – in the expressing and exploring of self and other involved in fashion and performance
   (d) Formats – in the flows of knowledge in systems, cultures, and quality achievement
   (e) Persons – making and made in educatedness, careering, and leadership

Meta-Model Three: 120 Models of Creativity

The table below presents 120 models of creativity. These came from three sources: 150 eminent creators in 63 professions and 41 nations, 8,000 eminent people similarly distributed, and 4,000 books and research articles on creativity from academics.

There have been some meta-models of creativity model types: (Harnad 2006) method, memory, magic, and mutation types of creativity theories and (Styhre and Sundgren 2005) 4P creativity model types – process, person, product, and place (see ▶ Four Ps of Creativity). However, the model below of 120 creativity models is the only published model, derived from empiric data from creators, yet with nearest match academic models indicated for each, this comprehensive and detailed. Remember each of the models named below, in its full form, printed elsewhere, has 20–60 well-ordered components (Greene 2006).

54 models of innovation How people make creations impact society and real human needs & situations Academic models that correspond to the empirical ones below are indicated in each box Note: a version of the below just as detailed as the one for 120 creativity models exists but it is not presented in this entry for reasons of space This model of models is the basis for a four-semester course at KEIO SDM on models of innovation Source De Tao Masters Academy Creativity & Novelty Sciences Studio Plan, 2012)					
Future present fight		**Idea socialities**		**Idea Ecosystems**	
Catastrophe spotting	**Pattern spotting**	**Trend riding**	**Social Physics**	**Living innovations**	**Idea farms**
Abstraction	**Inversions**	**Inhabit the future**	**Code changing action factors**	**Educatization**	**Silicon Valley clusters**
Disruption missing competitor caused disruption-Christensen	Success fails core bribes firm to ignore periphery = future-Bower	Career step moving one's career forward not by competing for established fixed positions and roles but by inventing the entirely new-Greene	Ride knowledge dynamics using knowledge dynamics, dialectics, pole-swings, loser enbeds-Abbott	Go out = go in globals invade locals, locals invade globals = all locals global-Jun & Wright	Automate invention-nurture circuits among in-process projects, power of absurd concentration; many tries, many fails = many invents-Edison
Search search in possibility spaces-Perkins	Valley inside Silicon Valley introject (inside you)-Nevens & Lee	Sell passion venture as enthusiasm package & presentation-selling motivation-Kawasaki	Movement successive successor-contexting social movements-elch at GE	Self build angst educativeness burden of daily life+self-build= flee to what fled from (authority)-Giddens	Valley-flows of ideas, people, funds, techs seeking home to love them + tiny, fast, smart, adaptive coalitions of specialties-JSBrown
Customer inventors democritize innovation= empower lead customers-Hipple	Success riding niches finding/ riding niches-Greene	Trust banks ethnic-immigrant trust-bank ventures-Granovetter	Social revolution social revolution via liberty, free invents, public happiness, historic dream, conserve novelty-Arendt	Demassify demasify=global standard items make locals globally diverse make institutions not fit-Toffler	Venture-anti-big, anti-East, from zero = new ways with new techs; anti-passive, anti-money-Greene, Jobs,
Sociality	**Social cognition**	**Co-evolution**	**Co-adaptation**	**Social grammar**	**Natural selection**
Practice geography social life of info-Brown & Duguid	Unorganize innovating = de-organizing-Sutton	Fit type menu info ecosystem device species prolifera-tion Davenport & Huber	Investment culture culture of development: reliable near future-Grondana	Resocialize social relation type mixes: share, rank, reciprocate, price-Fiske	Recursions-natural selection systems within natural selection organisms-exaptations-Michod
Network inventor net not individual hero-Hargadon	Spread one home run insight mental practices of inventors-Schwartz	Tap global diversity open business, invention outsourcing-Ches bough	Culture farms culture farming-raising ecosystems of evolving cultures-Darwin, Boyd & Richerson	Leverage diversities use diversities: un-see un-do, balance in space in time diffce type/task type-Greene, Page	Levels-evolve repertoires of neutral traits, till envt. change makes some vital; evolve levels not fitnesses-Kimura
Follow problems across radical innovation=mix frame, anomaly, tool, crisis research; patron research mixed with cllent research=combine artists, scientists, designers, engineers-Steffik	Re-see past from future invent by managing mental models-Wind & Crook	Producer customers media microcosmization = all consume all produce in all media -Jenkins	Miscopying orthogonal copying in new context = invention-Westney, Roehner, Syme	Attract creative elite tech, talent, tolerance = attract creative elites- city-fy as insight process-Florida	Soft-hard levels-egg computer, DNA program, junk DNA control statements, wrapping modules; behavior to software, firmware, hardware-compile unchanged to hardware-Gould, Dawkins

Multiple Models of Creativity, Fig. 5 (continued)

Non linear dynamics	Emergence	Wave catching	Universal inventivity	Non linearity	Interface media reinvent
New ways aims tech at once tech life histories, firms fail by adding new means to old ways/aims-Wheelwright	Position in societal enthusiasms society lust-Lienhard	Not enough idea homes maximize creations without maximizing failures = R&D, finding fits, trashing non-fits-Matheson	Tweak con-nectedness till take-off self organizing criticality-manage social automata till critical points-Bak, Gladwell	Other scale side-effects unplanned order emerges = goods from bads (Mandeville) bads from goods (Schelling)-Krugman	Replace prose ractal page formats replace prose-see count, names, order at a glance, read and write structures-Greene
Network economies increasing returns to scale (net economies)-Arthur	Span holes spanning network holes-Burt; policy as experiment-structure for tries and data on tries-Thomke	Increase & venturize frustra-tions manage knowledge by capturing frustrat-eds in org earnings + ventures-Greene & Blackwell	Adjacent beyond each invention increases expo-nentially combines with past ones-Kaufmann	Population of fluxing coalitions lowered coordination costs= tiny venture coalitions on web, big firm dissolve into market outsources, giant firm coalitions-Malone	Replace meetings social automata replace meetings & discussions = missing micro level = using humans in arrays, assigned cognitive/social functions as if CPUs in cloud computer network-Greene, Ignatius
Spot pre-rational hints technology tipping points via gap detection-Burgelman	Recrudesing ideas historic necessity+ function lust + emergent process-Van de Ven. Wood-man	Design as prouning from intruding Platonic forms design to pruning away detritus design, androgy style-Postrel	Simple programs simple programs = iterative idea tries in neighboring environments till homes found-Wolfram, J.S.Brown	Inner/outer tipping points non linear society net/web dynamics+ non linear within mind message-stick dynamics = tipping points-Gladwell	Replaces processes events replace process replace bureau = evolution from fixed to flex-stratified responding, to response to response, to structural cognition-Greene

(from Greene 2011 and De Tao Master's Academy 2011)

Multiple Models of Creativity, Fig. 5 54 Models of Innovation (from Greene 2011 and De Tao Master's Academy 2011)

Meta-Model Four: 54 Models of Innovation

Another novelty science is innovation. Plural models of it can be obtained from both academics and from innovation practitioners, as described above.

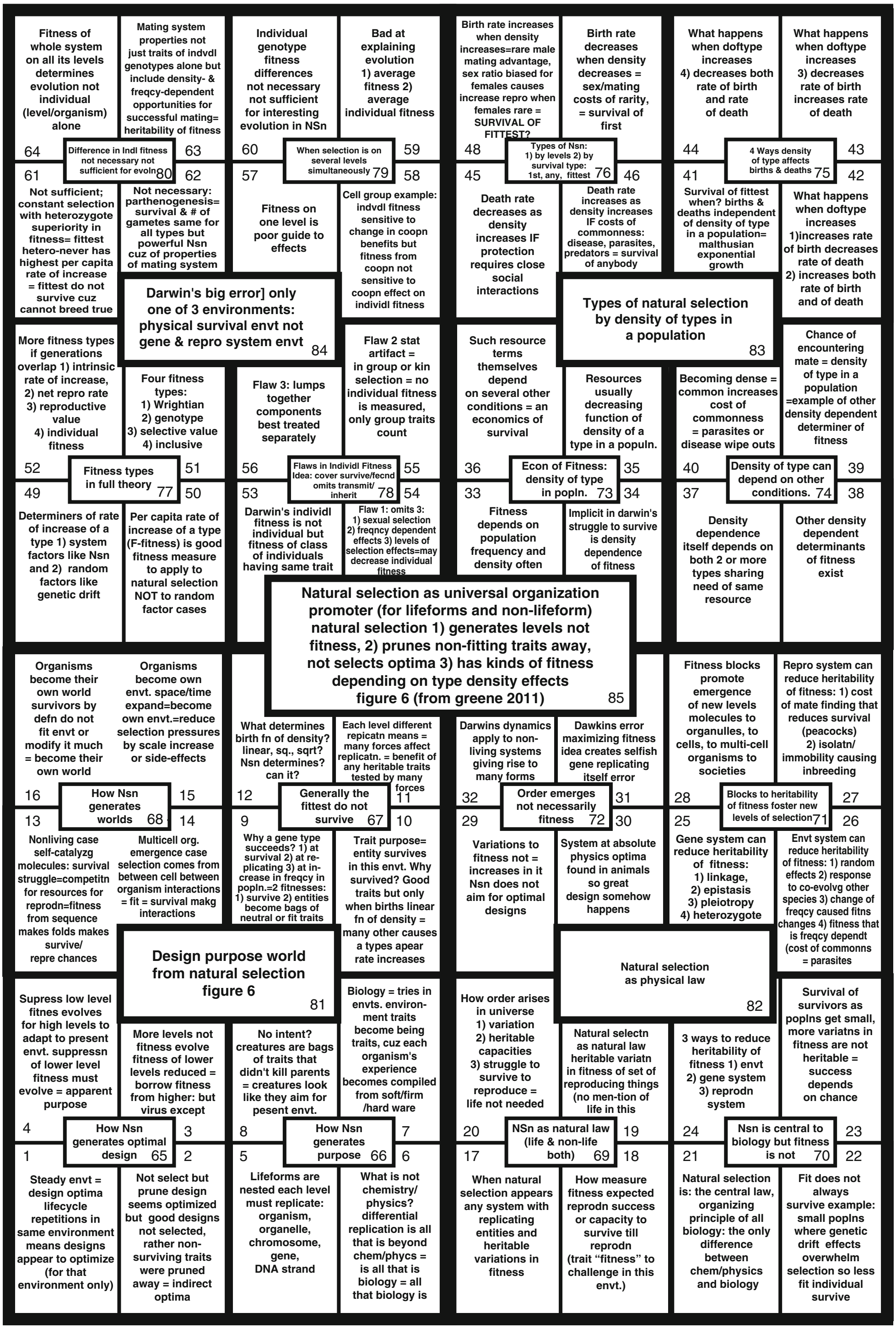
Meta-Model Five: A Comprehensive Version of One of the 120 Creativity Models – Natural Selection

The case for including in this entry a model of Darwinian natural selection is easy to make – it is the most creative single process known in the universe – the process that invented life itself, and then went on to invent all the life forms that we know of, including ourselves. The model here comes mostly from Michod (Michod 2000) with enhancements from others (Crutchfield and Schuste 2003; Nowak 2006; Page 2008).

Meta-Model Six: A Replacement for Prose Itself – Fractal Page Formats

The natural selection model just described above and presented here is two things: one, a summary of one-fourth of Michod's overall model of natural selection dynamics, and two, a demonstration of a viable replacement for prose itself. One structural cognition tool, for handling plural models, is a replacement for prose called fractal page formats. *Why does prose need replacing?* First, it is a very old interface, virtually unchanged for 8000 years. Second, it hides the structuring of its points, so elaborate encoding and decoding are needed. *Third, it lacks apparent visual scaling to* handle the drill down drill up expand-breadth focus-narrowly operators we all do on the Web. In research terms, it hides the count, naming, and ordering of its point contents. The natural selection model here makes visually evident in an instant the count (how many points), the names of points, and their principle of ordering. It bridges Web and older media nicely.

Replacing prose with fractal page formats, meetings with scientific rules of order, discussions with stratified respondings, brainstorms with social design automata, and classes and work processes with mass workshop events are



Multiple Models of Creativity, Fig. 6 Natural Selection As Universal Organization Promoter five basic interfaces of daily life that can be changed *to use and handle plural models not single right-y models*.

Conclusion and Future Directions

The webization of all industry expands who does things and what they do. Perhaps our mania for single right-y models is a relict of our tools, precomputer eras, and habits of mind. Now that everyone has several computers at hand, handling plural diverse evolving models can be managed practically, making our mania for top, elite, static, highest *ones* go away.

Some future research directions coming easily from this entry's plural diverse model perspective might be in order before closing. The items below are expatiated at some length in other publications (Greene 1993, 1999, 2003, 2006, 2007, 2009, 2010, 2011; Brown and Duguid 2005; Page 2008; Kenney 2000; Flavell 1976; Taura and Nagai 2010):

1. **Process singularities** Singularities in design process may be where two or more models of creativity conflict.
2. **Apply omitted models** Groups favor some models omitting others, so using omitteds may improve creativity greatly.
3. **Evolve among models** Particular designers, creators, and innovators may learn and prefer some creativity models early in their career and evolve into others at later phases – Why and which ones?
4. **Find best models** People and groups who create using some models may end up more creative than creators who use other creativity models.
5. **More models more creativity?** Organizations that support and use more models of creativity may get more creative outcomes than organizations that support and use fewer models.
6. **Model conflicts** Conflicts in long-term projects and creative collaborations may come from different parties and professions in them habituated to different models of creation.
7. **Meta-creativity powers** People who study which creativity models they use may, after that study, become more creative.
8. **Model diversity powers** People who are exposed to more diverse creativity models that they do not now use may, after that exposure, become more creative.
9. **Model trade-offs** *Models of creativity may be in negative trade-off relations to each other so that supporting or doing one more may hinder doing others – environment supports for doing one may shut down many others, hence reduce total creativity levels in a person or organization*. The mania for single right-y models of creativity, thereby, may harm creativity in practice more than they help it.

These are some research directions with strong implications for creative practice that come from the plural diverse models of creativity perspective of this entry. Notice that quite a few models (Kenney 2000; Brown and Duguid 2005) of Silicon Valley dynamics (see here ▶ Social Psychology of Creativity) mention the number, diversity, depth, detail of models of innovation, design, creating that come together, interact, blend, and evolve new forms there (so this entry *may* constitute how to generate replications of Silicon Valley to some extent [51]). Note that a new kind of university, funded by leaders in China, based on the plural models approach in this entry is being built as this is being written (compare with **Higher Education and Innovation**).

Dr. Deming, (Deming 2000) the quality guru, said to make one problem go away permanently, one had to throw 5 solutions at each of 5 root causes for each of 5 root problems equals 125 changes installed to fix anything. Maybe creating, designing, innovating, etc., are similar; single right-y models may be fun and easy to think about and test but have little impact compared to balanced repertoires of diverse models deployed wisely in particular cases.

References

Amabile T. Corporate new ventures at Procter & Gamble. Harvard Business School Case 897–088; 2009.

Bertalanffry L. General system theory: foundations, development, applications. New York: George Braziller; 1968.

Brown JS, Duguid P. The social life of information. Boston: Harvard Business Press; 2005.
Clover C. Elephants are scared of bees, scientists say. The Telegraph. 2011. http://www.telegraph.co.uk/earth/wildlife/3309619/Elephants-are-scared-of-bees-scientists-say.html.
Cole R. Death and life of the American quality movement. New York: Oxford University Press; 1995.
Crutchfield JP, Schuste P, editors. Evolutionary dynamics: exploring the interplay of selection, accident, neutrality, and function. Oxford: Oxford University Press; 2003.
De Tao Master's Academy. (2011). http://www.detaoma.com/newsds.asp?nid=1282.
Deming WE. Out of the crisis. Cambridge, MA: MIT Press; 2000.
Eamon W. Science and the secrets of nature. Princeton: Princeton University Press; 1996.
Entwhistle N. Understanding student learning. London: Croom Helm; 1982.
Ericcson KA, Simon HA. Protocol analysis. Cambridge: Bradford/MIT Press; 1993.
Flavell JH. Metacognitive aspects of problem solving. In: Resnick LB, editor. The nature of intelligence. Hillsdale: Erlbaum; 1976.
Giarrantano JC, Riley G.Expert systems: principles and programming. 4th ed. Course technology. 2004.
Greene RT. Global quality. New York: ASQ & Irwin Professional; 1993.
Greene RT. Are you creative? 60 models. 2003. www.youpublish.com.
Greene RT. Are you creative? 60 models. 2006. www.youpublish.com.
Greene RT. Are you effective? 100 methods. 1999. www.youpublish.com.
Greene RT. Brain powers. 2009. www.youpublish.com.
Greene RT. Excellence science: 54 routes to the top of any field. 2007. www.youpublish.com.
Greene RT. Getting real about creativity in business. 2009. www.youpublish.com.
Greene RT. Managing self. 2009. www.youpublish.com.
Greene RT. The novelty sciences school. De Tao Master's Academy. 2011.
Greene RT. What if creativity were 60 things not one, towards a grammar of design: design creativity 2010. Springer; 2010.
Greene RT. Your door to innovation, Keio Class notes and forthcoming. De Tao Masters Academy Press; 2011/2013.
Hammer M, Champy J. Re-engineering the corporation; Collins business essentials. 2003.
Harnad S. Creativity: method or magic?. Hungarian Studies 2006; 18(2).
Ishikawa K. What is total quality control – the Japanese way. New York: Prentice Hall; 1991.
Kenney M. Understanding silicon valley. Stanford: Stanford University Press; 2000.
Kintsch W. Comprehension: a paradigm for cognition. Cambridge/New York: Cambridge University Press; 1998.
Laguna M, Marklund J. Business process modeling, simulation, and design. Upper Saddle River: Prentice Hall; 2004.
Lillrank PM, Kano N. Continuous improvement: quality control circles in Japanese industry. Ann Arbor: University of Michigan; 1989.
Maeno T, Nishimura H, Ohkami Y. Graduate education for multi-disciplinary system design and management. Synthesiology. 2010;3(2):124–39.
Meyer B. The structure of text in Handbook of reading research. 1984. googlebooks.com.
Michod R. Darwinian dynamics. Princeton: Princeton University Press; 2000.
Nakano M. A conceptual framework for sustainable manufacturing by focusing on risks in supply chains. APMS. 2011;2009:160–7.
Nowak M. Evolutionary dynamics: exploring the equations of life. Cambridge, MA: Harvard University Press; 2006.
Page S. The difference: how the power of diversity creates better groups, firms, schools, and societies. Princeton: Princeton University Press; 2008.
Pask G. A brief account of work on adaptive teaching and measuring systems. Kybernetika. 1966;2(4):287–99.
Pritzker SR, Runco MA, editors. Encyclopedia of creativity, vol. 2. San Diego: Academic; 1999.
Simon H. Sciences of the artificial. 3rd ed. Cambridge, MA: MIT Press; 1996.
Simonton DK. The origins of genius. New York: Oxford University Press; 1999.
Sternberg R. Handbook of creativity. Cambridge: Cambridge University Press; 1998.
Styhre A, Sundgren M. Managing creativity in organizations. Lavoisier; 2005.
Taura T, Nagai Y, editors. Design creativity. London: Springer; 2010.
Torrance EP. Torrance tests of creative thinking. Princeton: Personnel Press; 1974.
van Dijk TA. Discourse as structure and process. London: Sage; 1997.
Zwicky F. Discovery, invention, research through the morphological approach. New York: Macmillan; 1967.

Musical Composition

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Mutilated Checkerboard Puzzle

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

N

National Culture

▶ Entrepreneurship and National Culture (According to Hofstede's Model)
▶ Microfirms

National Innovation Systems (NIS)

Björn Johnson and Bengt-Åke Lundvall
Department of Business and Management, Aalborg University, Aalborg, Denmark

Synonyms

National learning systems; National production systems; National science systems; Regional innovation systems; Sectoral innovation systems; Social innovation systems; Technological innovation systems; Triple helics; Varieties of capitalism

Key Concept and Definitions of Terms

Basic Ideas

The notion of an "innovation system" builds on the observation that in the modern economy, innovations are not rare acts of individual creativity, but ubiquitous and the outcome of interaction among individuals and organizations. It views innovation as processes over time rather than as isolated events, which can be uniquely dated. The notion of an innovation system usually also includes the idea of ongoing innovation as being rooted in different kinds of "learning relationships" between users and producers, between people with different type of competences, between different departments in the firms, and so on. Learning is always, in some sense, interactive and, hence, innovation is "systemic."

In markets where new products are introduced, users and producers need to communicate in other ways than by sending price signals to each other, in order for producers to discover new user needs and for users to get qualitative information about new products. Durable user-producer relationships are frequent and important. But they are only one of several examples of relationships, which affect innovation in a modern economy. Other examples are network relations, partnership relations, R&D collaboration, long-term relations between firms and financial institutes, long-term relations between firms and universities, etc. Within organizations, the interaction between departments (production, R&D, sales, etc.) is fundamental for the outcome of innovation processes.

Learning possibilities are not evenly distributed over the economy but differ between sectors. Innovation is therefore deeply affected by the structural composition (especially the specialization pattern) of the economy. Learning is also crucially influenced by the institutional framework of the economy. Institutions are here defined as the laws, regulations, norms, and

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
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practices, which shape patterns of behavior and determine how people, firms, and organizations relate and interact with each other. To the extent that learning is interactive, institutions thus partly determine learning and innovation.

Broad and Narrow Interpretations

On this background, innovation systems have been defined as including all parts and aspects of the economic structure and the institutional setup, which affect learning and innovation. The essence of the notion of a system of innovation is that the innovation performance of an economy depends not only on the capabilities of its individual firms but also on how they interact with each other and with the public sector and the financial sector. This is the notion of an innovation system in the broad sense. One reason for using such a broad definition is that it makes it possible to establish a link from innovation to economic growth.

There is, however, also a narrower conceptualization of innovation systems, which focuses especially on innovation in science-based activities in high-technology sectors under the assumption that these are especially important for the innovation performance of the economy as a whole. Another related delimitation is to focus on specific types of production and define sectoral or technological systems of innovation like the innovation system of the automobile industry, pharmaceuticals, financial services, and so on. In the following, we will concentrate on the broad version of the notion of innovation systems and on geographical or territorial delimitations rather than referring to specific sectors.

In this entry, the focus is on national innovation systems. Both sector composition and institutional setup differ across countries. This puts national stamps on innovation processes and makes national innovation system important. Further, most relevant public policies (research, education, labor market, social policy, and economic policy) operate at the national level.

But the analysis of national innovation systems must take into account that innovation systems of different geographical scale coexist and that the relevance of a particular scale is determined by the problem to be addressed. For example, the impact of national investments in R&D will affect the capacity to absorb scientific knowledge from abroad.

Theoretical Background and Open-Ended Issues

The Recent History of the Concept

The notion of a national innovation system was introduced in the 1980s to emphasize the interdependence between technical and institutional change. More specifically, it emerged as a reaction to the long crisis in the world economy, which started in the beginning of the 1970s and lasted well into the 1980s. The crisis was characterized by widespread balance of payments disequilibria, low growth rates and high rates of unemployment, and inflation.

This particular combination of macroeconomic problems puzzled mainstream economists. The inability to convincingly explain the crisis and show a way out of it stimulated the development of the notion of national innovation systems. National strategies for increasing competitiveness through reducing wages or through devaluation of the currency turned out to be ineffective. It became evident that to understand differences in national economic performance between countries, it is necessary to understand how it is rooted in innovation. The relations and interactions that feed learning and innovation come into focus (Freeman 1981).

Sharif (2006) has traced the roots of the concept national innovation system by interviewing those who developed and launched the concept. It is clear from his analysis that scholars such as Freeman and Lundvall intended the concept to help establish a different kind of basis for economic policy other than the advice coming out of neoclassical macroeconomics.

The Concept of National Innovation Systems May Be Used in Different Ways

The notion of innovation systems has been used in two complementary ways. First, it serves as a practical tool for both researchers and policy makers. It helps them to form a systematic overview of the actors and processes of innovation and the means and ends of innovation policy at the country level. The broad conceptualization of national systems of innovation covers both incremental and radical innovation and gives more attention to the role of learning processes than US-based innovation research focused upon science-based innovation.

Second, the national system of innovation may be used as a heuristic concept and focusing device. In this case, it is situated within a specific (evolutionary) theoretical approach used to study modern market economies, with a shift of attention away from resource allocation toward resource creation through learning and innovation. This draws attention to the existence of different types of knowledge, experience based as well as science based, and the different forms of learning, which creates and diffuses them.

Used in these ways, both as a practical tool and as a focusing device, the national system of innovation has become a useful notion. It introduced a new trend in the literature on innovation. Earlier, the focus was on the level of the firm. It also gave a different perspective on national science and technology policies other than "the linear model" where investments in science are assumed automatically to result in technical innovation. It offered a more holistic and systemic approach, which emphasizes the interactions between firms, organizations, and policy makers.

The concept has been criticized for being too broad and imprecise (Edquist 2005) and as being an unsound mix of analysis and political rhetoric (Miettinen 2002). Lundvall (1992/2010) responds to this criticism and recognizes serious weaknesses in the way the concept has been used.

Roots in the History of Economic Theory

Even if the concept of national innovation system mainly was developed in the 1970s and 1980s, its theoretical roots go far back in the history of economic thought. Basic ideas behind the concept go back to the nineteenth century and Friedrich List (1789–1846). His concept "national systems of production" took into account national institutions related to education and training as well as infrastructures such as networks for transportation of both people and goods. More generally, innovation as an economic activity was given more attention by classical economists than in modern neoclassical economics.

Adam Smith (1723–1790) discussed, for example, how improvements of machinery came about in very different, both experience-based and science-based ways, and Karl Marx (1818–1883) made new technologies and technical change (which he called "development of the productive forces") into driving forces in the development of the economy and society. Later, Alfred Marshall (1842–1924) linked innovation to the institutional setup of the economy as a whole as well as to management competences in the individual firms.

But it is Joseph Schumpeter (1883–1950) who is generally regarded as the founder of modern innovation theory. He saw innovation as the major force behind economic development and discussed the role of both individual entrepreneurs and R&D departments in large firms. But the analysis of national innovation systems transcends Schumpeter's perspective in important respects. While his analysis was biased in giving attention only to the supply side, the system's perspective takes into account the demand side and the interaction between supply (producers) and demand (users).

The modern literature about national innovation systems was above all developed by three scholars: Freeman (1987), Lundvall (1992/2010), and Nelson (1993). Following these contributions, there has been a very fast and wide diffusion of the concept. This has coincided with a general increase in the interest in innovation. The holistic and systemic characteristics of the national innovation systems literature have drawn attention to the role of innovation not only in the field of economics but also in other disciplines such as planning and development, geography and environment, and public administration.

Challenges

The main challenge for the research about national innovation systems is to contribute to a better understanding of learning, capability building and innovation as the main forces behind economic growth and development. Quite generally, to take the interactive and systemic character of innovation into account is a way to broaden the understanding of the process. To proceed with this approach requires a better understanding of the dynamics of the knowledge-based economy (or perhaps better, the learning economy). How do different factors interact in development, and more specifically, how can different kinds of learning be combined?

A promising research topic is to distinguish between innovation processes at the level of the firm on the basis of the "learning mode." It is possible to draw a distinction between learning processes where codified, science-based knowledge plays a major role and others that come out of processes dominated by practical experience with strong elements of tacit knowledge. Empirical data indicate that firms, which have combined these two modes, are more innovative than other firms (Jensen et al. 2007).

A second challenge is to get a better understanding of how the organization of work affects innovation. There is a clear correlation between having traits of being a "learning organization" (e.g., job rotation, interdisciplinary work groups, integration of functions, problem solving on the job, degree of freedom for the worker to organize his work, and close interaction with customers) and innovation performance. Since work organization differs significantly across countries, this is a central topic within national innovation systems research.

A third challenge is to improve the understanding of welfare and inequality in society. A capability-based approach to welfare as developed by Amartya Sen implies that it is not what we can buy or own that constitutes welfare but rather what we can do, that is, our capabilities. The learning capability is the most dynamic of the human capabilities, and it is conditioned by national institutions, including the prevailing forms of work organization. Learning has both instrumental value (it supports innovation and productivity growth) and substantive value. Therefore, an uneven access to learning and competence improvement is a central dimension of inequality. This dimension of the national innovation system deeply affects the distribution of welfare.

A fourth challenge is to contribute to a better understanding of the situated character of knowledge and learning. Within national innovation systems, regional and urban systems of innovation play a key role in determining national economic performance. Urbanization and economic growth are inextricably linked. Those countries that experience economic growth also tend to urbanize quickly, and those urbanizing faster typically experience higher rates of economic growth. Innovative cities are crucial parts of national innovation systems, and the interactions between the regional and national levels are important for both regional and national growth and development. Research on the creativity and innovativeness of cities would have to analyze the topics of distance, density, and diversity, and the interactions between them.

Finally, the innovation system research shares with other parts of innovation studies a certain bias to regard innovation as progress. There is a need to develop the analysis of innovation systems to capture situations where the institutional setup or power structure gives rise to innovations that do not respond to the needs of users or to the need of society. Empirical studies show that not all innovation activities end up with attractive solutions for users or for society as a whole. Many of them fail for technological reasons, while others fail because they do not respond to user needs. Some constellations of user-producer relationships and institutional settings may lead to unsatisfactory paths of innovation. Such forms of "system failure" may require government intervention and can only be addressed by institutional reform.

Implications for Theory, Policy, and Practice

Economic Growth Theory

The evidence is overwhelming that the most important driving force behind the increase in production and income over the past few centuries has been the advance of technical and organizational knowledge. Given that innovation is about how new knowledge is introduced into the economy, it is obvious that to understand economic growth, we need to understand innovation.

The mainstream theory of economic growth has shown an increasing interest for technical change and has moved away from treating it as an exogenous factor toward making it endogenous in its models. But it has not accepted the notion of national innovation systems.

This reflects that the theoretical foundation for national innovation systems is quite different from the one used by neoclassical economics. This is certainly true both for the neoclassical focus upon rational behavior and for its use of equilibrium analysis. The assumption of rational behavior cannot be applied since you cannot foresee the outcome of the innovation process. If you could, it would not be an innovation. Equilibrium analysis, central for standard economics, is incompatible with the elementary insight that innovation is ubiquitous and continuous in capitalism.

Theory of Economic Development

The notion of national innovation systems has made more impact on development theory than on growth theory. Development scholars have found it easy to take onboard the holistic, broad approach of national innovation systems thinking, in which also, everyday innovation in low- and medium-tech sectors play important roles.

This may to some extent be explained by a common theoretical heritage. While the concept of national innovation systems was developed mainly in the North, some of the most important elements actually came from the literature on development problems in the South. The importance of institutions, the accumulation of knowledge, and the interdependence between sectors, which are important aspects of national innovation systems, have been recurrent themes in development theory.

It has been necessary to adapt the concept national innovation system from the North to the South. From the beginning, it referred to relatively strong and diversified systems with adequate institutional and infrastructural foundations of the process of innovation. When applied to the South, the focus has shifted to policies and strategies for building and improving innovation systems, creating interactive learning spaces, bringing in new actors (like NGOs, farmers, small family businesses, intermediaries, and so on), changing the role of universities, strengthening cooperation between the formal and the informal sector, taking sustainability issues onboard, etc. (Arocena and Sutz 2000).

Innovation Policy

In the 1990s, a wide diffusion of the concept of national innovation systems took place among policy makers. At the beginning of the 2000s, most OECD countries had adopted the notion to help in the design of innovation policy. This has only partly been successful. There is still a bias in the favor of supporting science and R&D, often delimited to specific selected sectors or technology areas (ICT, biotechnology, nanotechnology, etc.) in the hope that the introduction and diffusion of new knowledge in the economy, that is, innovation, will follow more or less automatically. The combination of innovation system analysis with neoclassical economics in organizations such as OECD and the World Bank has contributed to this narrow and biased use of the concept.

The broad version of national innovation system with attention also to incremental and experience-based innovation in low- and medium-tech activities has not reached policy makers to the same extent. There is also a bias in policy making in favor of stronger intellectual property rights. This is not founded in a national innovation system approach – at least not in the broad version of the concept in which the importance of the tacit aspects of knowledge as well as the many difficulties with treating knowledge as a simple commodity are recognized.

Policy Learning

The national innovation system approach makes it clear that also policy making may be regarded as a process of learning and innovation. Policy learning related to innovation policy may support the development of the innovation capability of the economy by forming visions about it as an environment for innovation and development and forming the value premises of innovation policy.

An important aspect in this context is the development of new concepts, data, and theories of innovation and systems of innovation and the role of innovation in growth and development. To move the focus in economic policy away from the traditional preoccupation with short-term allocation of given resources and stabilization of the economy toward long-term processes of learning and innovation would be an important improvement of the policy agenda in most countries.

Policy learning may also focus on institution building to stimulate regional and local experiments in policy areas, which are in need of reform, and to develop methods to evaluate the outcomes of such experiments that take into account learning effects. Institution building, which supports the production and reproduction of human and social capital and which diffuses international, regional, and local “good practices” in a given field, is another basic topic in policy learning.

Economic growth and structural change call for ongoing policy learning, which focuses on building competencies and skills in all parts of society and on integrating perspectives and strategies from different policy areas.

Conclusions and Future Directions

The modern version of the notion of national innovation systems was quickly accepted quite broadly among scholars and policy makers, first in the North and now increasingly also in the South (Lundvall et al. 2009). This reflected a need to introduce and develop new perspectives on the long-run process of growth and development.

Both as a heuristic concept and as a practical tool for researchers and policy makers, national innovation system approaches emphasize the importance of learning, competence building, and innovation, and the interactive, systemic character these processes. To continue in this direction is a major challenge for research as well as policy making.

One important challenge for the future is to draw the wider implications of the understanding of the national economy as an innovation system for economic theory and economic policy. This was the original intention among those who launched the concept 30 years ago. But it has not yet happened. While policy makers refer to the concept, they are reluctant to draw the full implications. Here, the dominance of neoclassical economics constitutes a barrier.

Another major challenge comes from the process of globalization. There is a growing need for international and transnational innovation cooperation. How can national innovation systems be transformed so that they respond to global problems of poverty, global warming, and uneven population growth?

Cross-References

- ▶ Creative Destruction
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity and Systems Thinking
- ▶ Innovation and Entrepreneurship
- ▶ Innovation Policy Learning
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Multi-level Systems of Innovation
- ▶ Social Innovation

References

Arocena R, Sutz J. Looking at national systems of innovation from the south. Ind Innov. 2000;7(1):55–75.

Edquist C. Systems of innovation – perspectives and challenges. In: Fagerberg J, Mowery D, Nelson R, editors. The Oxford handbook of innovation. Oxford: Oxford University Press; 2005. p. 181–208.

Freeman C, editor. Technological innovation and national economic performance. Aalborg: Aalborg University Press; 1981.

Freeman C. Technology policy and economic performance: lessons from Japan. London: Pinter Publishers; 1987.

Jensen MB, Johnson B, Lorenz E, Lundvall B-Å. Forms of knowledge and modes of innovation. Res Policy. 2007;36:680–93.

Lundvall B-Å, editor. National systems of innovation: towards a theory of innovation and interactive learning. London: Anthem; 1992/2010.

Lundvall B-Å, Chaminade C, Joseph KJ, Vang Lauridsen J (Eds.) (2009). Handbook on innovation systems in developing countries. London: Elgar. http://vbn.aau.dk/research/handbook_on_innovation_systems_in_developing_countries(11297098)/.

Miettinen R. National innovation system, scientific concept or political rhetoric. Helsinki: Edita; 2002.
Nelson RR, editor. National innovation systems: a comparative analysis. Oxford: Oxford University Press; 1993.
Sharif N. Emergence and development of the national innovation systems concept. Res Policy. 2006;35(5): 745–66.

National Learning Systems

▶ National Innovation Systems (NIS)

National Production Systems

▶ National Innovation Systems (NIS)

National Science Systems

▶ National Innovation Systems (NIS)

National System of Innovation

▶ China's National Innovation System
▶ Clusters, Networks, and Entrepreneurship

Nature of Creativity

Alfonso Montuori
Department of Transformative Inquiry,
California Institute of Integral Studies,
San Francisco, CA, USA

Synonyms

Imagination; Innovation; Inventiveness; Originality; Vision

Definition

Creativity has traditionally been defined as the ability to respond adaptively to the needs for new approaches and new products, or as the ability to bring something new and valuable into existence purposefully. The modern concept of creativity emerged in the Renaissance and has expanded and changed in the last few decades. Postmodern scholars have problematized such basic concepts as originality and "the author" or creative person. The rise in networked information technology has led to an increased awareness of collaborative and networked creative processes. In the sciences, the machine/clockwork view of the universe was unable to account for creativity. Today, it is being challenged by a view in which creativity is increasingly viewed as intrinsic to the very nature of the universe and an emphasis on interactions and emergence rather than essentialism and an exclusive focus on the individual. A new emphasis on "everyday, everywhere, everyone" and "networked" creativity is shifting the focus from creativity as a phenomenon confined to the rare individual genius to one that also includes collaborative creativity in everyday life, with implications that are only beginning to be explored.

Theoretical and Historical Background

In the West, the concept of creativity as we know it today emerged in the Renaissance. The emergence of creativity coincided with the birth of humanism and individualism. It blossomed with the genius myth of Romanticism in the late eighteenth century. Until the 1980s, research on creativity in the West was situated mostly in psychology and focused primarily on what were known as the three Ps: person, process, and product (Runco 2007). In the romantic mythology underlying this atomistic, individualistic view, the creative person was mostly a lone, often eccentric, genius. The unit of analysis was almost exclusively the exceptional or "eminent" individual.

The "how" of creativity consequently occurred exclusively "inside" this individual, the creative person. The classic image of the creative process was of a light bulb going on over the creator's head during the "Eureka" moment. The creative process was viewed as a solitary one, initially with mystical or divine sources, and then increasingly associated with unusual mental states and psychopathology. The "what" or creative product was associated with "big bang," earthshaking insights, and products (Montuori and Purser 1999; Runco 2004, 2007).

In the dominant PPP model, the "who" of creativity could therefore by definition only be an individual person. Groups, organizations, cultures, and relationships were popularly depicted as representatives of conformity and compliance and mostly viewed as potential obstacles for the creative person. The implications of this individualistic/atomistic model for creativity are considerable. Interventions to foster creativity based on this model are directed toward developing cognitive capacities, most popularly through processes like "lateral thinking." Little or no attention paid to the role of relationships, organizational systems and structures, rewards, obstacles, and other environmental factors (Montuori and Purser 1999).

In the academic research, almost exclusively in the discipline of psychology, these "social" dimensions were generally ignored until the mid-1980s, when a critique of individualism within psychology was coupled with an emerging interest creativity in organizations. The individualist approach to creativity, and indeed the very concept of creativity itself, has been challenged by postmodern scholars who have problematized the role and nature of the "author" and the possibility of originality (Kearney 1988, 1999; Pope 2005). Postmodern scholars argue that the concepts of self, originality, and "creativity" are all socially constructed, and women and people of color are noticeably absent from the discourse of creativity. Likewise, the notion of the creative genius has been constructed and manipulated for commercial ends in order to make a product look more exceptional and desirable because it was made by a "genius." Genius is nothing more than a label placed on certain people for marketing reasons.

Creativity, Modernity, and the Machine

Creativity has had a peculiar role in the modern world. Creative artists and scientists were praised and even idolized and mythologized (e.g., van Gogh, Picasso, Einstein, Feynman). The phenomenon itself was not well understood and could not be accounted for in the prevailing paradigm. The modern scientific worldview was based on a Newtonian/Cartesian machine or clockwork metaphor in which the world was fundamentally objective, rational, linear, deterministic, and orderly. Creativity was associated with subjective experience, with the irrationality of mystical insight and inspiration and a breakdown in order. It was therefore viewed as closely aligned with disorder, whether social or personal (revolution, mental illness). Creativity was viewed as contingent and subjective, not as a lawful, orderly, and objective phenomenon worthy of scientific study. Creativity also appeared to be fundamentally antiauthoritarian because it disrupted the established order and stood for novelty, change, and individual expression. Romanticism, on the other hand, celebrated and mythologized creativity and imagination through literature, poetry, and the arts. Consequently for 200 years, the discourse of creativity was dominated by romantic images of inspiration, exceptional individuals, struggles against the oppressive forces of society and "the system," and artistic *Sturm und Drang*. If it was accepted that creativity in the arts was deeply subjective and mysterious process, this view of a disorderly process and self-absorbed artistic "creatives" made creativity very suspect in the (allegedly) orderly and efficiency-oriented world of organizations.

At the beginning of the twentieth century, in the business world, efforts were made to use the latest science to design and run efficient organizations. This was the so-called scientific management of Frederick Taylor (1856–1915). Scientific management captured the essence of the machine metaphor applied to organizations with "command and control" management. This included putting power and discretion in the hands of the manager, away from personal initiative and work groups, using "scientific principles" to replace the judgment of the workers, and the assumption that individual tasks are best performed in the greatest possible isolation because when men work in "gangs," as Taylor called them, their performance is lowered.

Organizations combined the machine metaphor of scientific management with traditional authoritarian, hierarchical structures and top-down control. The stress was on order and a system of division of labor closely tied to the notion of "divide and rule," with the manager in a command and control role to ensure that the system is enforced. This kind of authoritarian management with a rigidly hierarchical organization was designed to actively suppress any form of deviation from the rules, any personal initiative, and any collaboration. It was therefore also designed to eliminate anything that we might call creativity because creativity involves novelty and deviation from the norm.

The machine metaphor foundation of scientific management has particular implications for creativity, since the machine itself is not creative: it is the product of an external creator. Science could explain the workings of the machine but not of the creator – it could not account for novelty. God was outside or beyond the world. The creative force behind an organization (the inventor or entrepreneur figure like Edwin Land of Polaroid) developed the organization to make his or her vision a reality but was by his very nature outside or beyond to day-to-day workings of the organization. In society, creative individuals in the arts and sciences were outsiders, often considered to be close to madness: the self-destructive artist, the mad professor. These cultural images militated against the acceptance of creativity in organizations because they always presented creativity as an external phenomenon, not intrinsic to the system in question.

Creative individuals did not fit into machine organizations. In business, they were either successful entrepreneurs, who had started a company, or "creative types" that were hired out of necessity in R&D labs, marketing, advertising, and so on. Their approach was considered disordered, unreliable, eccentric, and regarded with some suspicion. With a rapidly changing interconnected world and with new developments in science such as chaos and complexity theories, the machine metaphor would seem to be outdated (Peat 2002). But in fact even though it has been severely challenged, it is still a dominant underlying metaphor, and many of the obstacles to creativity can be traced to deep-seated assumptions about the nature of organizational practices originating in the authoritarian machine model because the "well-oiled machine" and "command and control" are still the driving image and metaphor of what an organization and management should ideally look like, particularly during recessions and financial difficulty (Amabile 2010; Pfeffer and Vega 1999; Pope 2005).

Characteristics of Creativity

Creativity is associated with such personality characteristics as independence of judgment, preference for complexity, and tolerance for ambiguity (Barron 1968; Runco 2007). The characteristics point to an openness toward opportunity and alternatives rather than a desire to conform and superimpose existing interpretive frameworks. The characteristics associated with creativity are contrasted with preference for simplicity, conformity, either/or thinking, and rigidity. Intrinsic motivation is a key factor in creativity (Amabile 1996). Intrinsic means "from within." Intrinsic motivation means that we are moved from within to do something. The intrinsically motivating factors can include fascination for the subject, enjoyment while performing the task, or a feeling of accomplishment. Intrinsically motivated people enjoy what they do, and they do so because they find the task itself rewarding. Extrinsic motivation is motivation that comes from external sources rather than the pleasure of the task itself. Financial incentives and social approval are examples of extrinsic motivation. Extrinsically motivated individuals perform a task because there is an external reward attached to it. The task itself is not what they enjoy; it is the reward (financial or otherwise) that provides the appeal.

Paradox is a recurring characteristic of creativity at all levels of granularity (Montuori 2011b). It can be found in research on creative individuals, creative groups, and in the creative process. The term is used most frequently to refer to two characteristics that are usually not found together, are contrary to received opinion, or even considered contradictory.

Highly creative individuals have paradoxical qualities. For instance, they can be both energetic and quiet, smart and naïve, playful and disciplined, extroverted and introverted, rebellious, and conservative, and they escape rigid gender stereotyping. Most dramatically, perhaps, it has been suggested that they are both "crazier" and "saner," scoring higher on measures of psychopathology but also on measures of mental health (Barron 1995; Csikszentmihalyi 1996; Hampden-Turner 1999).

Research on creative groups in R&D has indicated that successful researchers are both more autonomous and more collaborative, engage in both basic and applied research, and are focused but also avoid narrow specialization. As with the paradoxical characteristics of individuals, we find that whereas conventionally these terms are mutually exclusive, in the case of creativity, they seem to be connected (Pelz 1967; Pelz and Andrews 1976).

The creative process involves both divergence and convergence, idea generation and idea selection, and being open and being critical (Runco 2007). The ability to entertain what on the surface appear to be opposing thoughts or concepts seems central to creative thinking. In fact, many creative insights and breakthroughs in the arts and sciences have been attributed to this ability, sometimes called "Janusian thinking" (Rothenberg 1979). The term for this form of paradoxical thinking is taken from the image of the Greek god, Janus, who has two faces looking in opposite directions. It is characterized by the capacity to entertain two opposite or contradictory ideas, holding each to be valid or true simultaneously. Creative individuals utilize this form of cognition that transcends ordinary logic, resulting in resolutions to complex problems that are novel and original. Such formulations are often creative because of this capacity for embracing opposites; two conditions that appear initially to be mutually exclusive or antithetical can be held in tension, and can lead to a breakthrough or insight (Arlin 1990; Yan and Arlin 1999).

Cybernetics offers a different way of thinking about paradoxical phenomena in creativity (Hampden-Turner 1999; Montuori 2011b). A static logic of either/or is replaced by a fluid process of ongoing navigation between two terms that are normally framed as contradictory. Paradoxical characteristics therefore reflect a cybernetic relationship that involves a both/and logic, whereby the terms can alternate at different times, as with introversion/extroversion, rebelliousness/conservatism, or divergence/convergence.

Environments that Support Creativity

Some environments promote creativity; others can inhibit it. Authoritarian systems were not designed to foster creativity. On the contrary, the focus was on conformity and predictability, and the main metaphor for an organization was the machine. Considerable changes have occurred in more than 100 years since Frederick Taylor articulated his model of "scientific management," but it is telling that it has only been in the last 2 decades that there has been any sustained research into environments that foster creativity and creativity in the workplace (Amabile 1983; Montuori and Purser 1999; Purser and Montuori 1999). The environments that favor creativity turn out to be diametrically opposed to authoritarian environments because, among other things, they promote independence of judgment, problem finding, and flatter organizational structures. The characteristics of creative environments are often paradoxical or "cybernetic" as they involve navigating between "creative tensions" such as being too challenging or too boring, specialization and a broad outlook, autonomy and the need for respect and approval, personal satisfaction and organizational needs, and so on.

If tasks are not challenging enough, they are not likely to elicit intrinsic motivation and creative thinking. On the other hand, too much challenge can result in people feeling overwhelmed and in "over their heads," creating a high level of anxiety that inhibits the capacity for creative thought. Csikzentmihalyi (1997) has identified the "flow state," a condition of high performance that is just challenging enough to push the person beyond their comfort zone but not far enough that they are overwhelmed by anxiety. The original research on flow state was with individuals, and recent research has suggested that particularly high-performing groups may also experience a collective flow state (Sawyer 2003, 2008). An important element in enhancing creativity in organizations is to match peoples' interests and skills with the right assignments. A good match requires knowledge about the parties involved and the nature of the assignment. The jazz big-band leader Duke Ellington is said to have made sure he even knew how his musicians played poker. He wanted to know all about them in order to be able to match them with solos in the right songs. That way he could write music that reflected the musicians' passion and ability and find a fit between individuals and the larger whole.

Creative environments do not stress overspecialization. They give freedom to move around in several disciplines and knowledge bases. Many innovative new ideas come from individuals who are not overspecialized and bring in information or ways of approaching problems from other disciplines or areas of research. Creative individuals tend to be autonomous and nonconforming, but this does not mean they do not care at all what others think of them. They do want to work in an environment in which they are appreciated and respected by their peers. It is a disincentive for them not to know how they are being assessed by their peers and not having any way of gauging how their own contribution is being received. Knowing that one's views will not be ignored and be given a serious hearing also helps to build an environment supportive of creativity.

Environments where the fear of failure is high and where failure is strongly penalized inhibit creativity (Berns 2010). Fear of failure inhibits risk taking, and with it, the likelihood that something new and creative will be uttered, let alone tried out. Environments that support creativity provide "champions" for creative ideas – whether they come from teams or individuals – that provide external support and advocacy and help them navigate the organizational bureaucracy.

Micromanagement is not conducive to creative environments and creative work. Amabile (1998) usefully differentiates between tasks that are algorithmic, and tasks that are heuristic. Algorithmic tasks involve specific, preestablished steps that have to be followed very closely, with one right way to do things, and there is no room for creativity. Heuristic tasks involve clear expectations but also considerable autonomy in how the task is to be performed, are much more likely to lead to creativity.

Creativity involves periods of relative isolation, meditation, and reflection. Along with freedom from external constraints, creative individuals often need the time to be alone with their creative process and not be interrupted. This is not to say that they do not also need time for vigorous exchanges and interactions. The creative process requires both isolation and interaction and environments that permit both those "moments" in the process (Runco 2007).

Environments that support creativity encourage creative dissent (Catmull 2008). They allow for vigorous exchanges of ideas, challenging assumptions, and discourage conformity. Creative individuals may not, and often do not, fully share the goals and interests of higher management. What sets them apart is that they are open to listening and will take direction, if they know they are also being listened to and respected for their opinions. At the same time, in order to support creativity, it is also important to be able to allow ideas to emerge and not attack them and test them before they are fully formed. Creative ideas may initially seem bizarre or wrongheaded.

The Future of Creativity

There are strong indications that in the twenty-first century, the discourse and practices of creativity itself may be changing (Montuori 2011a; Pachucki et al. 2010). The emerging research on and practices of creativity can be summarized as proposing that:

(a) Creativity is the fundamental nature of the universe, the process of creation itself, rather the spark of an occasional (C)creator, and is therefore a basic "everyday, everyone, everywhere" human capacity.

(b) Creativity is a networked, ecological, and relational process rather than an isolated phenomenon.

(c) Creativity is paradoxical; in the characteristics of the creative person, process, product, and environment are found seemingly incompatible terms: creativity requires *both* order and disorder, rigor and imagination, hard work and play, idea generation and idea selection, times of introspection and solitude, and times of interaction and exchange.

(d) Creativity is an emergent, "bottom-up" process arising out of interactions of a given system and therefore unpredictable.

From the modern individualistic focus oriented to "eminent" or uncontroversial creatives producing exceptional products (Einstein, Picasso, etc.), there has been a shift toward a more collaborative, "everyday," ecological understanding and practice of creativity. The focus is on generative interactions in a variety of mundane or everyday activities and contexts, rather than the individual lone genius working on a major contribution. Millennial college students associate creativity with everyday activities and with social interaction (Pachucki et al. 2010).

Many of the most interesting social innovations of the last 20 years or so have been about networking, participation, and grassroots efforts. These innovations are connected to the emergence of the Internet, of social media, and of a networked society. YouTube, Etsy, Facebook, Wikipedia, WebMD, Lord of Warcraft, farmer's markets, artisanal foods and the Slow Food Movement, MySpace, blogs, vlogs, Twitter, Britain's Got Talent, independent music labels and movies, GarageBand, DIY culture including DIY education, Yelp, TripAdvisor, Craigslist, Dancing with the Stars, American Idol, and reality television are all examples of new forms of expression and networked organizations that involve a much greater degree of grassroots participation than before. The traditional role of the critic, the artist, the record label, the audience, the reader, the novelist, the journalist, the photo reporter, and the newspaper is all being supplemented (and in some cases seriously threatened) by this ability individuals have to connect, participate, and even create. The traditional top-down, one-way communication from author to reader, from performer to audience, from star to public, from producer to consumer, and from leader to follower is changing with the emergence of a participatory culture (Jenkins 2009). Phenomena such as the Arab Spring and Occupy Wall Street are examples of social movements that have used a form of "swarm," or networked creativity (Montuori in press). Aided by social media and a focus on collaborative processes, they have developed new and unusual solutions to address the problems faced by social activist protesters in getting their message across.

The implications of these emerging views of creativity are considerable. "Everyday, everywhere, everyone" creativity points to the possibility of a much more widely distributed creativity throughout organizations and society. Creativity is no longer limited to a few clearly defined areas, such as the development of new products. It can be brought to bear on simple human interactions, work processes, and other areas where it was formerly not valorized. One emerging concern is that this "democratization" of creativity will lead to a "cult of the amateur," where quality and criteria will be lost (Keen 2008).

The new, contextual, and collaborative approach to creativity by the younger generation is matched in the research by a new research interest in the social dimensions of creativity. There is a move away from an essentialist view of creativity to one that is relational and contextual. Organizations that focus on innovation and adaptation to rapid change are increasingly flatter and less hierarchical. They also require more initiative from individuals, ability to make decisions and respond to unforeseen situations. The connection between creativity and improvisation is also an area of emerging research. The root of the term improvisation is the Latin term "improvisus" or unforeseen: improvisation is the ability to respond to, as well as generate, the unforeseen (Montuori 2003).

Conclusions and Further Directions

Creativity is a complex phenomenon with substantially changing discourse and practices. The initial focus on exceptional eminent individuals is being challenged by a more distributed, collaborative understanding of creativity. New complexity and network-oriented approach show great promise in the development of new conceptualizations of creativity that can accurately describe these new forms of creativity. In industries where innovation is essential, latter, less hierarchical and more adaptive organizations will be required, and creativity will be a key resource.

Cross-References

- ▶ Creative Personality
- ▶ Divergent Versus Convergent Thinking
- ▶ Imagery and Creativity
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Mental Models and Creative Invention
- ▶ Models for Creative Inventions
- ▶ Strategic Thinking and Creative Invention

References

Amabile T. The social psychology of creativity. New York: Springer; 1983.

Amabile T. Creativity in context. Boulder: Westview Press; 1996.

Amabile T. How to kill creativity. Harvard Bus Rev. 1998; Sept–Oct:179–89.

Amabile T. The three threats to creativity. HBS Faculty, from http://blogs.hbr.org/hbsfaculty/2010/11/the-three-threats-to-creativit.html. Accessed 1 December 2010.

Arlin PK. Wisdom: the art of problem finding. In: Wisdom. its nature, origins, and development. New York: Cambridge University Press; 1990. p. 230–43.

Barron F. Creativity and personal freedom. New York: Van Nostrand; 1968.

Barron F. No rootless flower: towards an ecology of creativity. Cresskill: Hampton Press; 1995.

Berns G. Iconoclast. A neuroscientist reveals how to think differently. Boston: Harvard Business Press; 2010.

Catmull E. How Pixar fosters collective creativity. Harvard Business Review. 2008; (September), pp. 65–72.

Csikszentmihalyi M. The creative person. Psychology Today. 1996; 36–40.

Csikszentmihalyi M. Creativity: Flow and the psychology of discovery and invention. New York: Harper Collins; 1997.

Hampden-Turner C. Control, chaos, control: a cybernetic view of creativity. In: Purser R, Montuori A, editors. Social creativity, vol. 2. Cresskill: Hampton Press; 1999.

Jenkins H. Confronting the challenges of participatory culture: media education for the 21st century. Boston: MIT Press; 2009.

Kearney R. The narrative imagination. In: Montuori A, Purser R, editors. Social creativity, vol. 1. Cresskill: Hampton Press; 1999. p. 61–79.

Kearney R. The wake of imagination: towards a postmodern culture. Minneapolis: University of Minnesota Press; 1988.

Keen A. The cult of the amateur: how blogs, MySpace, YouTube, and the rest of today's user-generated media are destroying our economy, our culture, and our values. New York: Crown; 2008.

Montuori A. The complexity of improvisation and the improvisation of complexity. Social science, art, and creativity. Hum Relat. 2003;56(2):237–55.

Montuori A. Beyond postnormal times: the future of creativity and the creativity of the future. Future J Policy Plan Future Stud. 2011a;43(2):221–7.

Montuori A. Systems approach. In: Runco M, Pritzker S, editors. The encyclopedia of creativity, vol. 2. San Diego: Academic; 2011b. p. 414–21.

Montuori A. Creativity and the Arab Spring. Critical Muslim, 1 (in press).

Montuori A, Purser R, editors. Social creativity, vol. 1. Cresskill: Hampton Press; 1999.

Pachucki MA, Lena JC, Tepper SJ. Creativity narratives among college students: sociability and everyday creativity. Sociol Quart. 2010;51:122–49.

Peat FD. From certainty to uncertainty. The story of science and ideas in the 20th century. Washington, DC: Joseph Henry Press; 2002.

Pelz DC. Creative tensions in the research and development climate. Science. 1967;157:160–5.

Pelz DC, Andrews FM. Scientists in organizations: productive climates for research and development. 2nd ed. Ann Arbor: University of Michigan; 1976.

Pfeffer J, Vega JF. Putting people first for organizational success. Acad Manag Exec. 1999;13(2):37–45.

Pope R. Creativity. Theory, history, practice. New York: Routledge; 2005.

Purser R, Montuori A, editors. Social creativity, vol. 2. Cresskill: Hampton Press; 1999.

Rothenberg A. The emerging goddess: the creative process in art, science, and other fields. Chicago: University of Chicago Press; 1979.

Runco M. Creativity. Annu Rev Psychol. 2004;55:657–87.

Runco M. Creativity. theories and themes: research, development, and practice. Amsterdam: Elsevier; 2007.

Sawyer K. Group creativity: music theater, collaboration. Mahwah: Lawrence Earlbaum Associates; 2003.
Sawyer K. Group genius. The creative power of collaboration. New York: Basic; 2008.
Yan B, Arlin PK. Dialectical thinking: implications for creative thinking. In: Runco M, Pritzker S, editors. Encyclopedia of creativity, vol. 1. San Diego: Academic; 1999.

Network Absorptive Capacity

► Academic Firm

Network and Entrepreneurship

Yvon Pesqueux
Conservatoire National des Arts et Métiers, Développement des Systèmes d'Organisation, Paris, France

Synonyms

Nexus; Reticulation; System of connections; Web

Definitions

Social Capital

Social capital refers to the understanding and measuring of the influence of social relationships on social agents and, broadly, the firm's economic performance.

Entrepreneurship

Entrepreneurship is an activity involving the discovery, evaluation, and exploitation of business opportunities in order to introduce new goods and services, new organizational structures, markets, processes, and materials using resources that may not have existed before.

Network

A network is a twofold system (an exchange system tied in with a technical infrastructure). It is not a hierarchy per se but a structure of exchange and flow as well as a representation common to heterogeneous organizations interconnected through space).

Background and Discussion

To address the connections between "network" and "entrepreneurship," one needs to begin with the focus on social capital. With regard to social capital, the prevalence given to exchanges is a common trait to these two notions, an aspect that may establish lasting relationships and helps understand what entrepreneurship is about. Another source of social capital may stem from benefits related to the possession of information insofar as the potential asymmetry it tends to generate, its preservation and exchange builds relationships and entrepreneurial opportunities alike. A third source comes from social norms, which condition individuals' behavior and thereby make them predictable and even reliable, building an environment favorable to entrepreneurship.

The analytical framework of networks provides a heuristic for examining the relational structures around entrepreneurship, as in clusters, for example. By extension, the network can be considered as a tool for structuring configurations likely to create social capital (Ferrary and Pesqueux 2011).

The focus on the notion of intellectual capital (or human capital), along with social capital (as represented by institutions, including those of knowledge societies) furthers the reference to networks by contrast to the two other forms of "capital" established by the World Bank (natural capital, e.g., ecological footprint, manufactured or techno-economic capital, e.g., the firm and/or "traditional" processes) – and despite consistent emphasis on the interplay between these forms and these capitals being contributing factors to the birth and development of entrepreneurship.

Two major trends refer to the notion of social capital (Ponthieux 2006), one that refers to the individual as the instigator of the construction of this type of capital and one that refers to the notion as an institutional attribute:

– The first perspective was founded by J. Coleman (1988) who draws on economic behavior, the pursuit of individual interest and exchanges based on rational calculations prone to establishing lasting relationships that ultimately become institutionalized.
– The second perspective is the one singled out by the World Bank. While the individual-based perspective refers to the notion of obligations and expectations in social relationships or even the capacity of a "well-positioned" individual to possess and acquire specific information and knowledge, a third form exists, namely, social norms, which make social behavior predictable. The first trend of the macro-social perspective refers to network sociology and the socially anchored nature of any action, hence the importance of the position one holds and the frequency of relationships with other social agents. The intermediate position – resulting from weak ties between two agent groups – is one that generates human and social capital. Another form of social network is the struggle to preserve (or reach) a beneficial position, as preservation is easier than access due to the "favored" category's "cultural" knowledge of the rules of the social game (see Bourdieu's definition: a network of social connections available to an individual or a group, which may translate into friendships, kinship, or knowledge in key fields – 1970; 1979; 1989). This network consists of investments but also legacies. The social area is then considered as a field of power between agents with different types of social capital struggling to define its important features, and that is the power and right to define or at least influence the rules of the social game. By contrast, R. Putnam (1993, 2001) emphasizes the importance of intermediate institutions in how they build the social mesh and contribute to the economic performance of an area. Thus, human capital and social capital tie in implicitly with a geographic area, which anchors the activity of these intermediate institutions. A possible criticism of this view is that it tends to homogenize the relationships developing with intermediate institutions regardless of their nature: an outreach agency becomes essentially the same as a NGO, a football club, or a union in the sense that the concept of trust is linked to social capital almost irrespective of the sources of that trust. In fact, the importance of cooperative behavior is held to be the significant factor in possessing social capital.

Building on this reference to social capital, M. Granovetter (1985), Granovetter and Swedberg (1992) proposes an alternative to the rational and selfish individual of standard microeconomics as well as the oversocialized man of structuralism: one given position, partly predefined itself, presupposes the construction of a social network around the individual. Based on this assumption, Granovetter examines strong ties (in fact, the smallest proportion,) and weak ties (shared belonging to social networks) and highlights "structural holes" and the privileged place some individuals may hold in retrieving or circulating (or not or poorly) information that others do not have.

To discuss networks is to stress the importance of the reference to an organizational mode from an understanding and predictive perspective. The notion of network, in its technical dimension, has gained legitimacy in the technological field through the "improvements" it contributes to social agents' formal decision and coordination processes. Information and communication technologies as well as the Internet are the two technical figures grounding its technological and scientific legitimacy.

Historically, the concept of network does not originate from technologies or any reference to biological or social structures. It grows out of the notion of net (weaving – popular referent). It was originally used in a medical and metaphorical sense from the mid-nineteenth century and conceived of as "any object." The notion then emerges as a median figure in between the organic and telecommunications, providing a metaphor for entering a twofold system of flow and stability. The notion of network has been used extensively since the 1970s, particularly in industrial economics, with regard to industrial organization and technological cooperation. The early 1980s saw a plethora of engineering science research on infrastructure networks (in particular computer networks, telecommunication networks, road networks, and transportation networks), which cemented its characterization as a technical, social, and economic system. In the 1990s, other studies addressed the issue of interactions. By the mid-1990s, studies started to bridge the gap between these two contributions.

On Networks

As a technical representation, the network reveals a structure through an image of several interconnected lines and raises the issue of "point to point" optimization, in other words the issue of efficient management – achieving optimal outcomes locally – and how to manage a system (e.g., joint development of railroad and telecommunication networks).

Network organization gives rise to a figure that addresses simultaneously the oneness and distinctiveness of the organization model involved, as it is both a kind of structure and a system within an organic representation. It provides a representation of the technical principle of interconnection (the technical existence of networks requires addressing its organization and management).

The reference to a network is built around three tightly interlocked foundations: the fact that it is a technological object, the fantasies it appeals to, and the language entailed in order to build a metaphor that serves as both description and utopia.

On an epistemological level, the network consists of three dimensions, most often mixed up and conducive to movement from one field to another: a cognitive dimension (the network as concept), a symbolic dimension, and a rational dimension (the network as methodology). Network organization emerges as the organizational model deriving from cybernetics and network computing and it has incorporated a technical "reality" provided by network computing. Here the emphasis is on the symbolic, organizational, and technical topic of interconnection.

Network organization is recognized as a "new" form of organization that raises the question of management along four guidelines: structural consistency, which addresses the heterogeneity of the makeup of these structures; external consistency, which addresses partnership (coordination of activities among partner organizations); internal consistency, which addresses autonomy; and consistency of value systems, which addresses cohesion.

Firms and Networks

The first network dimension faced by corporate management pertains to the very nature of certain economic activities. Several industries consist of network companies. For example, postal, phone, electric, gas, railroad, computer, or water distribution networks are enabled by their own economic models and management constraints. As N. Currien (1992) notes, network companies have an economic intermediation function. One characteristic of network companies is that the density of units and the quality of physical links (e.g., connections between postal hubs, electrical lines between power plants and consumers, etc.) that connect them together determine the firm's economic performance. One managerial issue for network companies is that they are often firms handling workflows that cannot be stored and processed in a regulated fashion. The other issue related to the systemic dimension of network activities is the necessary continuity that compels firms to ensure sustained interconnection of the network's units. Network companies are impacted by the necessary compatibility and interconnectedness of their constituent units. This requires standardized infrastructures.

On a macroeconomic level, the distinctive features of network activities may justify the existence of monopoly positions. Network companies are quintessentially prone to "natural monopoly" as monopolistic situations help optimize economies of scale by leveraging decreasing returns. Network companies thus have specific operation procedures and competitiveness factors that influence the management practices of these intrinsically reticular structures.

In the field of industrial organization, enterprise networks are perceived as a source of competitiveness and competitive advantage to firms that are part of the network, as their competitiveness is equated with the capacity to make an impact within a myriad of values made up by economic partners. The development of strategic networks through alliances, partnerships, or long-term contracts offers them a gateway to information, resources, markets, and technologies. The importance of the reticular structure may spring from the organizational strategies of firms that are refocusing on their core competencies, which may cause them to outsource all their peripheral activities. In this instance, the strategy can no longer be viewed as a rational move of adjustment to the market but as a framework that guides the development and acquisition of resources. The organization is considered as a portfolio of competencies. Its management aims to handle these strategic competencies and bring to fruition the redeployment of necessary competencies to capture new opportunities and rearrange the portfolio of "product-market" activities by anticipating changes in the environment.

By figuring out how similar and complementary the firms of one same network, two types of networks can be identified based on their degree of systemic interconnectedness (Ferrary and Pesqueux 2004):

– Enterprise networks characterized by the low systemic interconnectedness of their members because they consist of similar units with few complementarities and poor operational interaction. The units are autonomous and their performance does not depend on their interaction with other units. In this case, the disappearance of one entity of the network has little impact on the others' performance and the network's overall. One example is bank agency networks or franchise networks (fast food, hair salons, clothing stores, etc.) where the closing of one unit does not hurt others' efficiency. This form optimizes economies of scale to improve the network's "competitiveness-price" ratio rather than economies of quality entailed by interaction between the network's firms.
– Enterprise networks characterized by the high systemic interconnectedness of their members because they consist of firms with different, complementary and interconnected competencies. The disappearance of one member of the network immediately affects the other's efficiency and the entire network's. One example is a network of independent law firms with various specialties (if one of them leaves the network, say the expert on labor law, the quality of supply of the entire network takes a toll instantly because the network can no longer provide this competence to its clients). Similarly, in an industrial cluster, the absence of one competence (e.g., "training" in universities, "research" in laboratories, or "financing" in banks) is detrimental to the efficiency of the other actors of the network (as firms will face recruitment and financing issues) and thus the overall momentum. These networks with high systemic interconnectedness draw their competitive advantage from the optimized complementarities of the network's own firms and the quality of their interaction to improve competitiveness.

Such networks include enterprise networks structured around one central firm in order to optimize learning effects, as in the car industry, formal enterprise networks in order to optimize network effects, as in air companies' alliance networks, and informal enterprise networks, as in industrial districts.

However, it is important to stress the irreducible human dimension of enterprise networks usually underpinned by social networks. These are groups of individuals whose frequent economic interactions and extensive social relations can dispel relational uncertainty by discriminating accurately between dishonest and honest members. The first characteristic of these networks is that the information sought after by members moves very rapidly and reputation effects arise rapidly as well, leading to information asymmetry between members and nonmembers of the network. The second one is that solidarity exists between the members of the network, and this should be taken into account when interacting with any of them because interacting with a member of the network is conducive to interacting indirectly with all members. These characteristics will alter the nature of the exchange. The social appreciation of the risk implies that the commercial exchange should no longer be understood as an in-the-moment relation, strictly professional and individual, but as a sustainable relation mediated by an informal and personal dimension between the contracting parties, requiring at least indirectly, relations with all the members of the social group. While social ties play a major role in information flow and firms' capacity to quickly tap complementary resources, jumpstarting potential social ties enhances the process further and builds new complementarities. A priori belonging to the network guarantees that accessible competencies will build up. The network will interfere as an ex post selection system that accepts or refuses the presence of new members as potential resources. Aspects such as resource complementarity, geographic proximity of members, and duration of the social relation of exchange are critical.

As M. Granovetter suggests, inter-individual interactions translate into macro-social phenomena that symmetrically reflect back on individuals and small groups, in a context where the existence of the community is conditional on strong social ties. Weak ties enable information flow because they are less dense, less emotional, and less frequent. Virtual ties confirm the network's potential since members of a social network benefit from social capital and can trigger off virtual ties when needed. The social mesh is thus shaped by the existence of holes defined by R. Burt (1992) as "structural." A structural hole is defined as the gap between nonredundant contacts and entails the existence of strategic positions in social networks. An individual in between two communities will be better off in the sense that they will be able to communicate information and connect with the members of those communities.

Conclusion and Future Directions

Networks enable social learning (first future direction), generate reputation effects (second future direction), and changes (third future direction) in optimization expectations even if it is limited by the "unsubstitutability" of the possessor of social capital, alters the power relationship between employee and employer, and the authoritarian response it entails from the top management.

Cross-References

► Entrepreneur
► Entrepreneurship
► Social Capital

References

Bourdieu P. Reproduction. Eléments pour une théorie du système d'enseignement. Paris: Editions de Minuit; 1970.
Bourdieu P. La distinction: critique sociale du jugement. Paris: Editions de Minuit; 1979.
Bourdieu P. La Noblesse d'Etat. Grandes écoles et esprit de corps. Paris: Editions de Minuit; 1989.
Burt R. Structural holes: the social structure of competition. Cambridge, MA: Harvard University Press; 1992. 313 p.
Coleman J. Social capital in the creation of human capital. Am J Sociol. 1988;94:95–120.
Curien N. Economie et management des entreprises de réseau. Paris: Economica; 1992. 209 p.
Ferrary M, Pesqueux Y. L'organisation en réseau – mythe ou réalité. Paris: PUF; 2004.
Ferrary M, Pesqueux Y. Management de la connaissance – knowledge management – apprentissage organisationnel – société de la connaissance. 2nd ed. Paris: Economica; 2011.
Granovetter M. Economic action and social structure: the problem of embeddedness. Am J Sociol. 1985;91 (3):481–510.
Granovetter M, Swedberg R. The sociology of economic life. Boulder: Westview Press; 1992. 399 p.
Ponthieux S. Le capital social. Paris: Editions La Découverte; 2006.
Putnam R. Bowling alone: the collapse and revival of American community. New York: Simon & Schuster; 2001.
Putnam R, Leonardi R, Nanetti R. Making democracy work: civic traditions in modern Italy. Princeton: Princeton University Press; 1993.

Network Governance

► Epistemic Governance and Epistemic Innovation Policy

Network-Based Arrangement of Work

► Cross-Employment

Networking Entrepreneurship

Brigitte Gay
University of Toulouse, Toulouse Business School, Toulouse, France

Synonyms

Growth; Interfirm alliance networks

The Multi-Level Dimension of Interfirm Networks

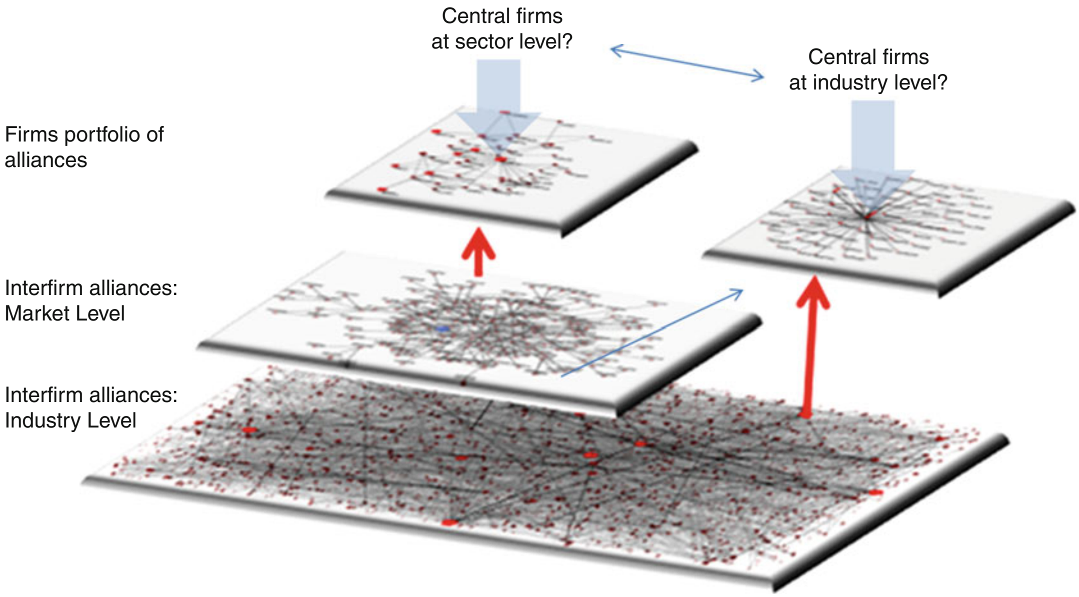
Interfirm alliances are formed today constantly across organizational boundaries. This move of firms toward open and networked systems has culminated in complex webs of international alliances. Terms such as the networked firm or the virtual organization or the open business models are now used to describe an organizational form containing a network of firms. The fact that there is scope for managerial choices has been demonstrated by Patel and Pavitt (1997). They reflect different objectives and designs made by different managers in the face of complexity and uncertainty, differences in the rate, and directions of these exchanges also obviously affecting outcomes. Management thus involves the ability to build temporary alliance portfolios created by global competition and sustained, often radical, innovation and to address the different industry segments the firm wants or needs to compete in. How a firm draws boundaries within global and complex interfirm networks to implement a growth strategy will affect its business performance and at the same time highlight the company rationale to invest in resources. Understanding network structures at firm, specific market, and industry levels and their reciprocally structuring effects should help managers devise strategies for the sustained dynamic building of effective firm alliance portfolios across international and organizational boundaries.

Though the multilevel dimension of networks is intrinsic to their analysis (Lazega et al. 2008), few scholars have addressed the complicated question of the integration of different levels of analysis in which an actor's capital is situated (Breiger 1974; Fararo and Doreian 1984; Hedström et al. 2000; Lazega et al. 2008). Moreover, analyses of structural change in real-world networks are still scarce. Figure 1 visualizes the value added by looking at the multilevel dimension of interlocked interfirm networks.

This contribution aims to seek an understanding of network dynamics at industry and market segment level and of how key entrepreneurial and large incumbent firms cope with or influence the stability or instability of the different network layers they are enmeshed in.

In this chapter, the *k*-core decomposition is used as a network analysis tool particularly adapted to emphasize the hierarchical properties and temporal variations in network structures that are not captured by other topological measures (Alvarez-Hamelin et al. 2008). The *k*-core decomposition (Seidman 1983; Batagelj and Zaversnik 2002) consists in identifying particular subsets of the network, called *k*-cores, each one obtained by a recursive pruning strategy. It therefore provides a probe that allows focusing on the network's regions of increasing centrality and connectedness properties as more central cores are more strongly connected.

The biopharmaceutical industry is an appropriate setting for this analysis as this industry is one of the most alliance-intensive.



Networking Entrepreneurship, Fig. 1 Multilevel network analysis. Nodes in this figure are firms and links between nodes are transactions. The lower network map represents interfirm alliances in a whole industry while the intermediate network, extracted from the lower one, represents the alliance network in one of the industry market segment. Central players, or hubs, and their alliance portfolios can be pulled out from one or the other level (as pointed by arrows; one at each level in the figure as examples) for analysis of their alliance strategy. Analysts can thus rapidly assess and compare firms' alliance portfolios at all levels and determine whether central players at industry – and market – level are the same and the incumbency of their structural position. A dynamic network analysis will reveal the relative stability of the different global structures (Sources: Proprietary database of alliances for the pharmaceutical industry (Gay 2010). VisuGraph software (Gay and Loubier 2009) is used for network visualization)

The innermost *k*-core structure of the industry can be characterized as it evolves, here from 2000 to 2007, and compared with the *k*-core structure obtained in one of its major sector, the antibody sector, for the same time period. This analysis shows that the *k*-core structure is extremely different at industry and sector level and that the *k*-core decomposition tool is able to clearly characterize variations in network structures and hierarchies across time at each level. This study moreover demonstrates that the different network layers evolve differently and have different levels of stability. It also emphasizes the challenges of managing entrepreneurial firms, while large incumbent firms may systematically and somewhat "passively" gain dominant positions.

Alliances and Networks as the Defining Industry Trend

The number of alliances has dramatically increased worldwide over the last decade, shifting the fundamental competitive paradigm in markets from firm-to-firm competition to more alliance-based boundary spanning, competition and strategy (Newman and Chaharbaghi 1996; Hitt et al. 1998; Holmberg and Cummings 2009). Analysts (e.g., Datamonitor) have reported recently that transactions may now account for 16–25% of median company value and more than 40% of market value for almost one-quarter of companies, while Booz-Allen and Hamilton estimate that more than one-third of the revenues of the top 2000 US and European companies come from alliances. Prominent firms such as IBM, Pfizer, and Eli Lilly generally find themselves in hundreds of alliances clearly shifting the attention from issues regarding the management of individual transactions to issues regarding the management of evolving huge portfolios of alliances. Indeed, Pfizer reviewed in 2005 only over 400 licensing or acquisition opportunities. Procter & Gamble claims that the strategy of leveraging on other assets produces more than 35% of the company's innovations and billions of dollars in revenue (Huston and Sakkab 2006).

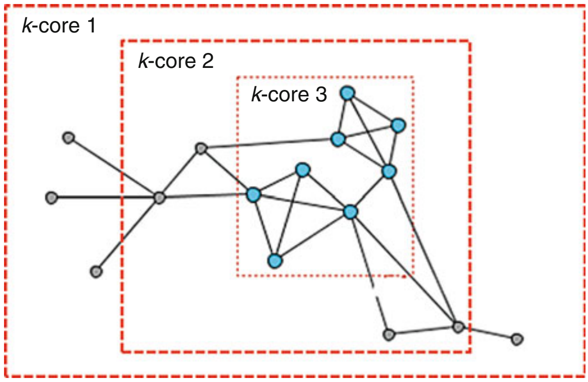
Research on the evolution of interorganizational networks suggests that networks become ever more self-reproducing and centralized, as more and more dense webs of relationships are developed among firms (Chung et al. 2000; Gulati 1995; Gulati and Gargiulo 1999; Powell et al. 1996; Walker et al. 1997). In other studies, locally embedded firms are globally connected by a handful of "shortcuts," the network being then structured as a "small world" (Baum et al. 2003; Watts and Strogatz 1998). Shortcut formation is thought to be another possible route to network change. These studies however do not help address questions of how network structures might change more significantly.

Importantly, many studies have highlighted that interfirm network structure could significantly alter performance outcomes such as growth in diverse industries (Nooteboom 1992; Hagedoorn 1993; Powell et al. 1996; Rowley et al. 2000; Ahuja 2000; Owen-Smith and Powell 2004). Soh and Roberts (2003) also suggested that the evolution of interorganizational networks is interdependent on the technical subfields they were created to control. Orsenigo et al. (2001) demonstrated the importance of technological determinants of the structural evolution of alliance networks in the pharmaceutical industry. They showed that one technological wave led to consecutive others and was induced by technical breakthroughs led by the entry of new firms acting as specialized technology "originators." However, it is not clear in extant research how innovative firms that are less endowed and socially embedded than big incumbent companies can have central positions in new markets as established firms appear to be more socially embedded than entrepreneurial firms (Katila et al. 2008). Khana, Gulati, and Nohria (1998) also introduced the concept of a firm's relative scope or ratio of the scope of the alliance to the total sets of markets in which the firm is active. They highlight that the extent of market overlap in activities between partners and with the alliance should be considered an important determinant of the likely behavior of partners.

If, as Burt (1992) argues, "something about the structure of the player's network and the location of the player's contacts in the social structure of the arena creates a competitive advantage in getting higher rates of return on investment," different categories of actors at different levels may need to call upon different networking strategies. Interestingly, Ozcan and Eisenhardt (2009) have very recently proposed that incumbent firms could possibly essentially rely on the deterministic account of interdependence and embeddedness (Gulati and Gargiulo 1999) and be successful in stable industries, while strategic action was necessary for entrants in nascent or rapidly changing markets.

Network Analysis

Previous studies in the biotech or health sector have concentrated mostly on alliances formed before 1998. This work focuses on more recent underlying topologies which are the result of profound technological and business transformations led by biotechnology in the pharmaceutical industry since 2000, following the sequencing of the human genome. Biotechnology drugs can broadly be grouped into four categories: recombinant protein therapeutics, monoclonal antibodies, nucleic acid therapeutics, and therapeutic vaccines. Recombinant protein therapeutics and monoclonal antibodies form two major market segments set to generate about 95% of total biotech sales from 2004 to 2010 (Datamonitor).



Networking Entrepreneurship, Fig. 2 Sketch of the k-core decomposition for a small graph. Each *closed line* contains the set of nodes belonging to a given k-core. Larger values of k clearly correspond to nodes with larger degree as well as more central position in the network's structure. Each decomposition step thus peels the network leaving connected the inner part of it

Both firms' transactional activities in the pharmaceutical industry and in one of its major subnetworks, the antibody market, are examined here.

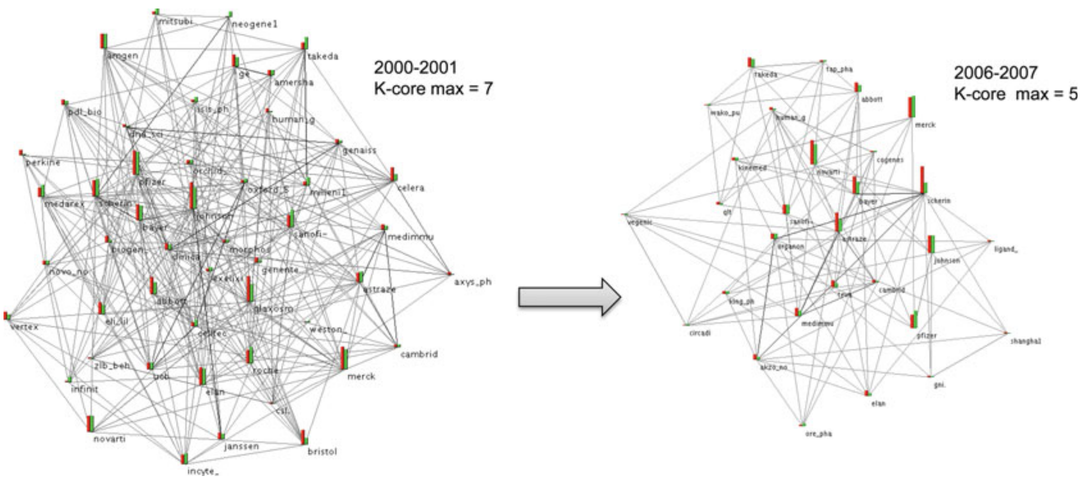
A unique collaborative agreement dataset was used for this purpose (Gay 2010). This dataset was compiled by querying specialized internet sites (leading sources for news releases and regulatory filings from companies throughout the world such as Business Wire and PRNewswire, as well as companies' Internet site) for alliances made in the pharmaceutical industry in the years 2000–2007. The data sample contains 4,755 firms worldwide with 1974, 1740, 1624, and 1,740 firms being involved in the whole industry in 2000–2001, 2002–2003, 2004–2005, and 2006–2007, respectively, and 102, 128, 300, and 370 firms being involved in the antibody sector alone for the same time periods.

VisuGraph network display software was also used for the representation of network evolving structures (Gay and Loubier 2009). Firms in this study are nodes, and the links that connect them are the alliances, or legal binding agreements. Centrality measures the importance of a node in a network. The simplest of centrality measures is degree centrality, also called node degree. The degree k of a node in a network is the number of links connecting it with other nodes. The k-core decomposition consists of a recursive pruning of the least connected organizations that allows disentangling the hierarchical structure of interfirm networks by progressively focusing on their central cores. Different subsets of the network, called k-cores, are obtained by this recursive removal of all organizations of degree, or number of alliances, smaller than k, until the degree of all remaining organizations is larger than or equal to k. Larger values of "coreness" clearly correspond to organizations with larger degree and more central position in the network structure. The core of maximum order is referred to as the main core or the highest k-core of the graph (Fig. 2).

Temporal Variations of Network Structures

The fact that the pharmaceutical industry and the antibody sector have a power law, i.e., hub-dominated, distribution of firms has already been published elsewhere (Powell et al. 2005; Gay and Dousset 2005). A multilevel study allows examining how the pharmaceutical industry is structured by its hubs and how the two types of actors that define this industry, small innovative biotech firms and large pharmaceutical incumbents, influence it or its market segments, taking a major one as an example.

The network maps obtained at various time points between 2000 and 2007 are considered here.



Networking Entrepreneurship, Fig. 3 *k*-core analysis of the pharmaceutical industry from 2000–2001 to 2006–2007. The nodes/histograms are firms, their height being proportional to the number of transactions that the company makes (the *red* and *green bars* account for the transactions made in 2000 and 2001, respectively, for the *left figure* and 2006 and 2007 for the *right figure*). Central players or hubs on the left (2000–2001) are major pharmaceutical companies (Astrazeneca, Pfizer, Schering, Bayer, GlaxoSmithkline, Novartis, Roche, Sanofi-Aventis, Abbott, Merck, Johnson and Johnson, Takeda, GE-Healthcare, Bristol-Myers) followed by biotechs which brought breakthrough technologies to the industry such as Genentech, Amgen, Biogen, Protein Design Labs, Cambridge Antibody Technology, Medimmune, Millennium, Human Genome Sciences, Vertex, Celera, Celltech, Medarex, and Morphosys. Fewer hubs are present in the right figure (2006–2007) and now include essentially major pharmaceutical companies (Astrazeneca consolidating its biologics portfolio in Medimmune and Cambridge Antibody Technology acquired in 2007, Pfizer, Bayer-Schering which purchased Organon International, the drug unit of Netherlands-based Akzo Nobel in 2007, Abbott, Sanofi-Aventis, Merck, Takeda, and Novartis) (Sources: Proprietary database of alliances for the pharmaceutical industry (Gay 2010). VisuGraph software (Gay and Loubier 2009) is used for network visualization)

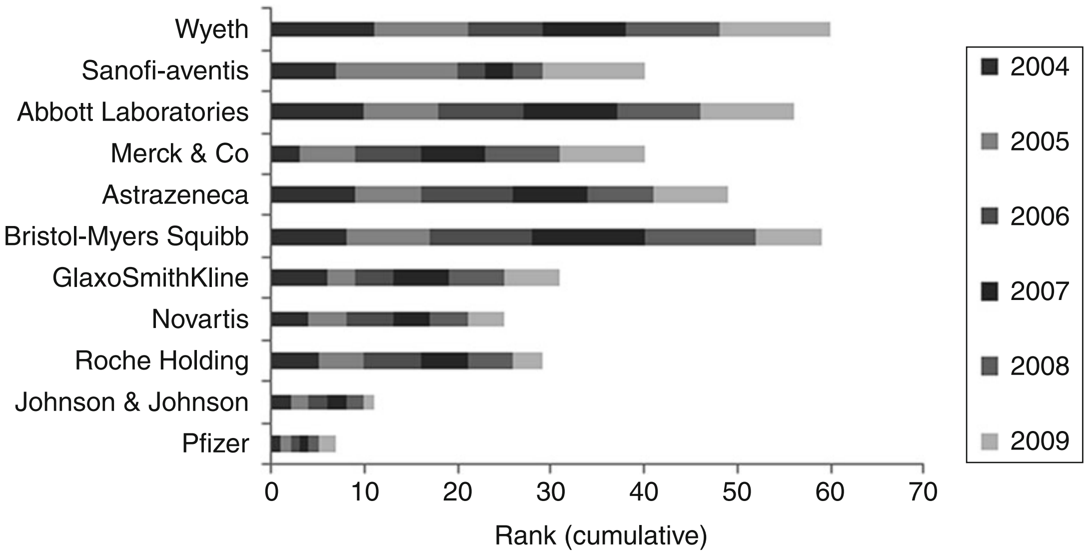
The *k*-core structures of maximum order obtained at industry and sector level are compared, and differences in these structures are discussed. As described below, the *k*-core analysis provides an interesting characterization of these differences and of temporal variations in network structures at each level.

Fingerprints of the structural changes at industry level between one snapshot (first period, 2000–2001) and the other (last period, 2006–2007) are provided in Fig. 3.

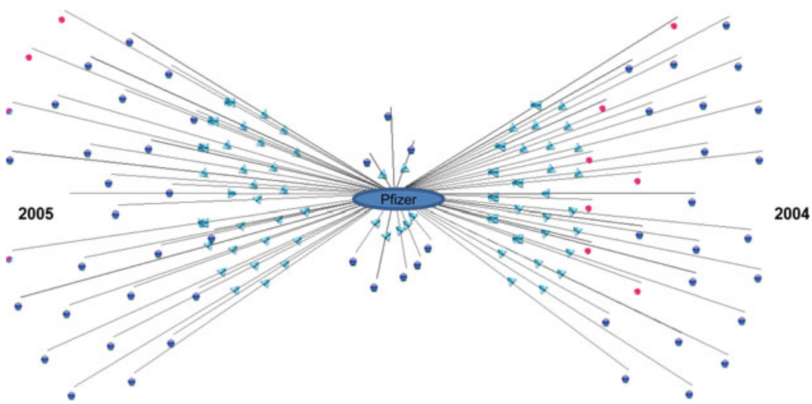
Figures 3 and 4 show the clear and constant domination of major pharmaceutical companies at industry level, in line with their performance. Interestingly, the *k*-core of maximum order is the highest in 2000–2001 (*k*-core max = 7) and contains a mix of pharmaceutical and biotech players. This high cohesiveness decreases afterward until 2006–2007, where the *k*-core structure becomes essentially driven by big pharmaceutical players (Fig. 3).

As the industry seems to be repeatedly dominated by pharmaceutical hubs, looking at their alliance portfolios is essential. As shown in Fig. 5, the turnover of the transactions is extremely high at all times. Pharma hubs make many new alliances each year and mostly with new partners. Stability at node level is therefore offset by instability at link level.

Figure 5 also illustrates that major companies are mostly making in-licensing agreements, thus capturing continuously innovation in terms of technologies and products (information summarized from the data base of transactions). The database highlights that 70% to as much as 90% of the transactions of the 7 first pharmaceutical hubs were in-licensing agreements between 2004 and 2007.



Networking Entrepreneurship, Fig. 4 Top performers in the pharmaceutical industry, period 2004–2009. The ranking is based on a mix of four metrics: sales, profit, assets, and market value (Source: Adapted from Forbes 2000, data available starting in 2004)



Networking Entrepreneurship, Fig. 5 Pfizer (*center*) high turnover of alliances from 2004 (*right*) to 2005 (*left*). Repeat partners are placed by VisuGraph in the center close to Pfizer. Links are directed inward for out-licensing agreements and outward otherwise. Blue dots represent licensors, pink ones licensees (Sources: Proprietary database of alliances for the pharmaceutical industry. VisuGraph software is used for network visualization)

Figure 6 illustrates the dramatic change in network topology the biotech sector undergoes from 2000–2001 to 2006–2007. At sector level, the *k*-core of maximum order is quite low in 2000–2001 (*k*-core = 2 against *k*-core = 7 at industry level for the same period). Three small biotechs (Medarex, Abgenix, Cambridge Antibody Technology) having proprietary key technologies that introduced radical change in the antibody sector then dominate the network. The database reveals that these new biotech entrants become hubs essentially by granting access to their technologies or providing products derived from it. In 2006–2007, however, two of these hubs have been bought by incumbents, and many more actors with different strategies (buying, selling, or both) operate within the then much larger and cohesive network (k-core of maximum order = 6) (Fig. 6).

Alliance dynamics differ from one network layer to another. While pharma hubs such as Pfizer made over 30 deals on a yearly basis at industry level, biotech hubs made yearly 5–50 transactions at sector level, but maximum degree, or number of alliances, occurred early in the life cycle of the sector and then diminished constantly while the number of new entrants increased. Few biotech firms stayed hubs during the whole period studied, and the biotech network was infiltrated increasingly by large pharmaceutical incumbents as it evolved. Additionally, 57% of the biotech firms involved in 2006–2007 had been created recently, between 2000 and 2007, while 43% had been created between 1992 and 1999. More generally, 75% of new entrants did not maintain themselves in the network from 1 year to another. The system is thus completely unstable at sector level in the sense that it is defined by a high turnover of links but also by persistent entry and exit of firms, including hubs.

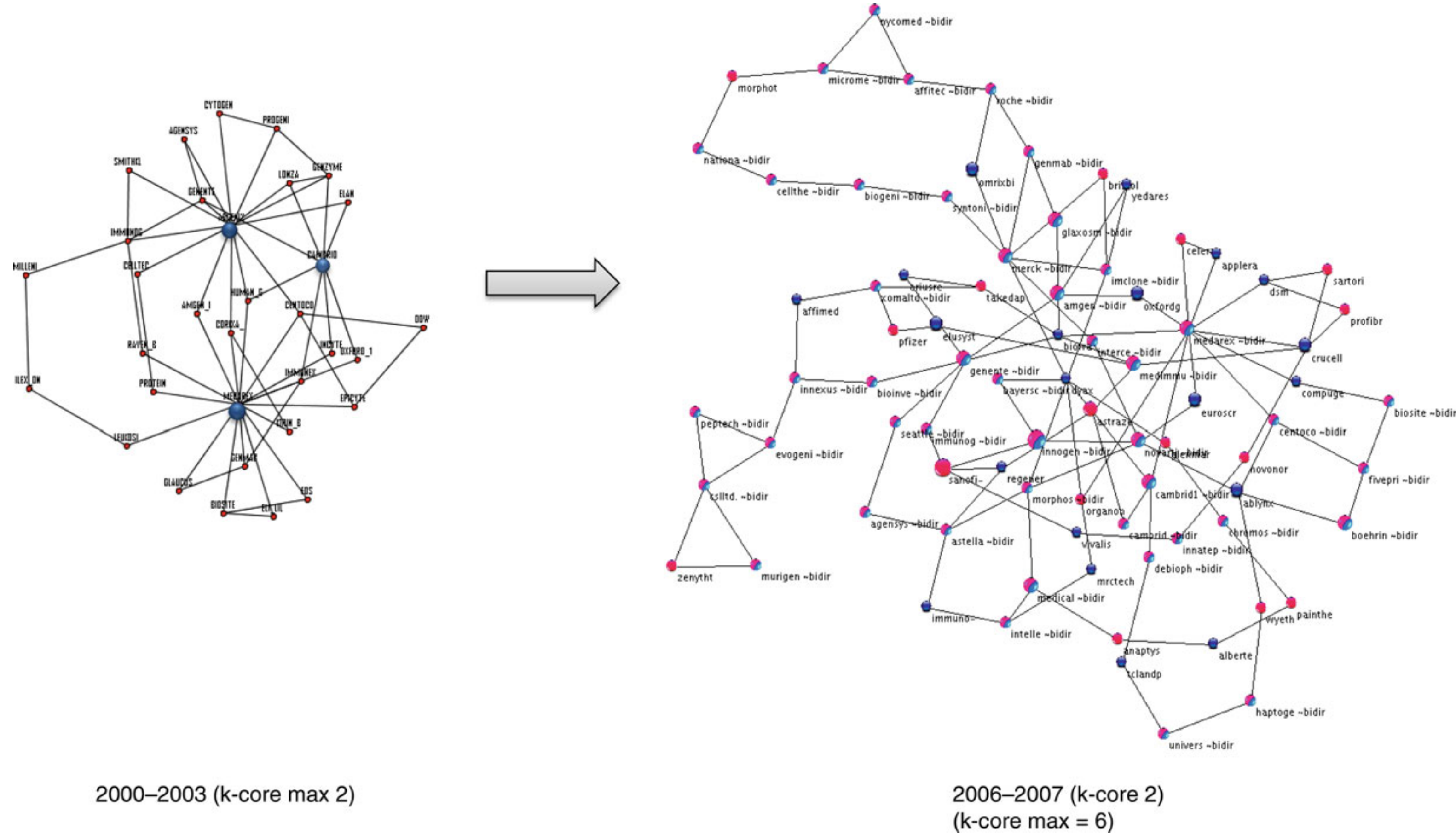
Looking at multilevel networks thus presents interesting results. At sector level, the system is unstable (high turnover of nodes and links) until it finally rests on more actors and more incumbent firms and acquires stability. At industry level, the system is stable for large incumbent firms as they are the main performers at all time (whether measured by alliance numbers or sales, profit, assets, and market value). These “money” hubs can stay high performers owing to the high turnover of alliances they use to divest some assets while constantly acquiring others (Fig. 7).

The Sheer Advantage of Size

A major drawback of research on complex networks is that it is static and, with a few exceptions (e.g., Lazega et al. 2008; Gay 2008, 2011), does not address the complementary nature of individual and organizational resources and the interdependencies of multilevel networks. Research on social capital has first emphasized position in social structure. Position was found to affect the actions and opportunities of the social actor (Burt 1992; Uzzi 1996, 1997) as well as innovation and financial performance (Powell 1998). High centrality is typically taken as a measure of the prestige or prominence of an actor in a network (Wasserman and Faust 1994). Centrality is correlated with firm success in strategic alliance research, and hence centrality has often been used as the dependent variable to determine firm performance (Ahuja 2000; Walker et al. 1997). However, the literature, using resource and social embeddedness theories, offers more a descriptive account of which ties are formed as networks evolve rather than how they are formed by firms (Gulati 1998; Gulati and Gargiulo 1999). Powell et al. (2005) in a study of the biotechnology industry interpret central firms as a form of accumulative advantage obeying a rich get richer process (Barabási and Albert 1999). Multiconnectivity (multiple forms of cooperation such as R&D, finance, marketing, or manufacturing) expands as a group of actors increases. Multiconnectivity logic dominates biotech over money or market power. Correspondingly, Gulati (1999), working on network structure, has proposed a model whereby strategic behavior is influenced by network embeddedness that gives access to informational resources accumulated through time. The social structural context within which a firm is positioned influences its strategic action.

For Bae and Gargiulo (2003), however, new ties are seen as building blocks of emerging network structures. Network structure is built dynamically and therefore destabilized constantly by the permanent formation of new links, affecting firm performance and preventing its ability to completely position itself autonomously in the overall network through alliance portfolios. New entrants entering multiple ties grow faster though increased embeddedness (cohesive structure in their network neighborhood) has a negative influence on network growth. Additionally, Kogut (2000) considers that a strong intellectual property, control of bottleneck resources, as well as rules for cooperation will lead to central players in an industry.

Therefore, opposite theories compete, offering either a deterministic account of network



Networking Entrepreneurship, Fig. 6 *k*-core analysis of the antibody sector from 2000–2001 to 2006–2007. The network hierarchical structure and firms' transactional activities are very different in the two periods. In 2000–2001, three highly innovative biotech hubs, Medarex, Abgenix, and Cambridge Antibody Technology (*blue dots*) are essentially selling their technologies or products derived from these technologies to other firms (*pink dots*). Different types of firms of all sizes are present in 2006–2007. These firms either sell (*blue dots*), buy (*pink dots*), or both buy and sell (*blue-pink dots*) assets (Sources: Proprietary database of alliances for the pharmaceutical industry. VisuGraph software is used for network visualization)

Networking Entrepreneurship, Fig. 7 Network instability at different levels, summary results

Industry level	Sector level
Hubs = « Rich » firms	**Hubs = « Innovative » firms**
Stability of hubs	Instability of hubs (fast change in hubs opportunity structure)
Instability of links	Instability of links
Link asymmetry **(in-licensing)**	Link asymmetry **(out-licensing)**
Relative stability of network structure (hubs; *k*-core)	Complete renewal of network structure (*k*-core)

evolution or that of an unstable construction, and raise three questions: that of the degree to which network structure constrains strategic action, that of how novel innovative entrants can become central players compared to socially embedded incumbents, and that of systems stability. These questions are difficult to address without longitudinal data on the different categories of actors and network levels that characterize industries. This chapter thus investigates a rather new trend in network research, that of multilevel network analysis and dynamics, and the role different categories of central players, entrepreneurial or incumbent firms, may play in shaping and connecting entwined layers.

The analysis of interfirm alliances and networks at industry or market levels demonstrates that, due to intense competition, global systems can be very unstable, the level of instability differing at different levels.

Moreover, different network levels are basically led by only one of two categories of hubs, young highly innovative firms when breakthrough innovations are needed or large incumbents. Incumbents or rich firms operate in the industry quasi-passively in the sense that they rely essentially on a high turnover of links to capture others' innovation, while innovative firms leverage essentially on idiosyncratic value mostly applicable to unique market segments; link asymmetry defines clearly the different roles: giving away or receiving assets. The position and thus survival of innovative organizations is constantly challenged by innovation dynamics within the biotech sector. A high instability at market level (high turnover of firms and alliances) is therefore witnessed as innovation cycles follow one another until increased structural cohesion is observed epitomizing a stable, mature, sector. At industry level, major firms first share the industry with major biotechs in 2000 with the rapid emergence of the biopharmaceutical industry. They then increase their control of the whole industry. In 2006–2007, the inner core of the industry presents a much simpler structure held essentially by big pharmaceutical incumbents.

Taken together, these results support extant research and notably an extreme archetype of industrial evolution that some researchers have called "Schumpeter Mark 1" regime (Dosi et al. 1995; Malerba and Orsenigo 1995) as well as a model of industrial dynamics that builds on this archetype (Winter et al. 2000) whereby only entrants have a positive probability of advancing the current state of technological knowledge, while incumbent knowledge is highly inertial.

At industry level, large incumbent firms are central, and long-term dynamics seem to favor them. Conversely, in the biotech sector or industry subnetwork, centrality for biotech firms is linked to a strong intellectual property, the value of which decreases rapidly due to a highly competitive environment. The sector is built by a dynamic flow of entrants that are carriers of innovation, shifting centrality metrics indicating successive technological phases (Gay and Dousset 2005). System growth depends on technical progress (and on demand since value must be perceived by the market), and the process of competition and collective growth is fed by an unending process of entry and exit.

Conclusion and Future Directions

A network perspective on alliances at firm and market or industry level can be a valuable asset for theories of strategic management and organizational theory, the more so in unstable environments. It can also be used by managers of biotech firms to continuously assess their position in the market segment in which they operate as well as that of their partners and competitors. It can also be used by managers of major pharmaceutical companies to address the complexity of managing in complex, fast-paced, environments by looking globally and separately at the many high-tech segments into which they must invest constantly today. With a few exceptions, researchers have treated network metrics regarding alliances as static. This study adds emphasis on the different layers or levels that make up an industry and their constant restructuring. Distinct categories of central players operate at different levels though durably or temporarily and use fundamentally opposite, asymmetrical, strategies to do so. The *k*-core analysis demonstrates the certain advantage of sheer size in hierarchical systems.

These results on the instability of systems are exploratory and should be replicated in other industries and economies. Further research in this area is needed as systemic instability has high consequences for entrepreneurial firms.

Cross-References

► Entrepreneurial Firms
► Networks

References

Ahuja G. Collaboration networks, structural holes, and innovation: a longitudinal study. Adm Sci Q. 2000;45:425–55.

Alvarez-Hamelin JI, Dall'Asta L, Barrat A, Vespignani A. k-core decomposition of Internet graphs: hierarchies, self-similarity and measurement biases. Netw Heterog Media. 2008;3:371–93.

Bae J, Gargiulo M. Local action and efficient alliance strategies in the telecommunications Industry. Working paper, Insead, France, 2003.

Barabási AL, Albert R. Emergence of scaling in random networks. Science. 1999;286:509–12.

Batagelj V, Zaversnik M. Generalized cores. *cs.DS,* 0202039. 2002.

Baum JAC, Shipilov AV, Rowley TJ. Where do small worlds come from? Ind Corp Change. 2003;12(4): 697–725.

Breiger R. The duality of persons and groups. Soc Forces. 1974;53:181–90.

Burt RS. Structural holes: the social structure of competition. Cambridge: Harvard University Press; 1992.

Chung S, Singh H, Lee K. Complementarity, status similarity and social capital as drivers of alliance formation. Strat Manag J. 2000;21(1):1–22.

Dosi G, Marsili O, Orsenigo L, Salvatore R. Learning, market selection and the evolution of industrial structures. Small Bus Econ. 1995;7(6):411–36.

Fararo TJ, Doreian P. Tripartite structural analysis: generalizing the Breiger-Wilson formalism. Social Netw. 1984;6:141–75.

Gay B. Firm dynamic governance of global innovation by means of flexible networks of connections. J Innov Econ. 2008;2(2):63–83.

Gay B. Innovative network in transition: from the fittest to the richest. July 28, 2010; Available at SSRN: http://ssrn.com/abstract=1649967 or http://dx.doi.org/10.2139/ssrn.1649967.

Gay B. Universal dynamics on complex networks, really? A comparison of two real-world networks that cross structural paths . . ... but ever so differently. In: I-Hsien Ting, Tzung-Pei Hong, Leon Wang SL, editors. Social network mining, analysis and research trends: techniques and applications. Taiwan: National University of Kaohsiung; 2011. In: IGI Global, NY, USA, ISBN 978-1-61350-513-7.

Gay B, Dousset B. Innovation and network structural dynamics: study of the alliance network of a major sector of the biotechnology industry. Res Policy. 2005;34(10):1457–75.

Gay B, Loubier E. Dynamics and evolution patterns of business networks. International Conference on Advances in Social Networks Analysis and Mining, Short Paper. 2009.

Gulati R. Social structure and alliance formation pattern: a longitudinal analysis. Adm Sci Q. 1995;40(4):619–52.

Gulati R. Alliances and networks. Strat Manag J. 1998;19(4):293–317.
Gulati R. Network location and learning: the influence of network resources and firm capabilities on alliance formation. Strat Manag J. 1999;20(5):397–420.
Gulati R, Gargiulo M. Where do interorganizational networks come from? Am J Sociol. 1999;104:473–506.
Hagedoorn J. Understanding the rationale of strategic technology partnering. Strat Manag J. 1993;14(5):371–85.
Hedström P, Sandell R, Stern CH. Mesolevel networks and the diffusion of social movements: the case of the Swedish social democratic party. Am J Sociol. 2000;106:145–72.
Hitt MA, Keats BW, DeMarie SM. Navigating in the new competitive landscape: building strategic flexibility and competitive advantage in the 21st century. Acad Manag Exec. 1998;12(4):22–43.
Holmberg SR, Cummings JL. Building successful strategic alliances: a strategic process and analytical tool for selecting alliance partners. Long Range Plann. 2009;42(2):164–93.
Huston L, Sakkab N. Connect and develop. Harv Bus Rev. 2006;84:58–66.
Katila R, Rosenberger J, Eisenhardt K. Swimming with sharks: technology ventures, defense mechanisms and corporate relationships. Adm Sci Q. 2008;53:295–332.
Khanna T, Gulati R, Nohria N. The dynamics of learning alliances: competition, cooperation and scope. Strat Manag J. 1998;19(3):193–210.
Kogut B. The network as knowledge: generative rules and the emergence of structure. Strat Manag J. 2000;21: 405–25.
Lazega E, Mounier L, Jourda MT, Stofer R. Catching up with big fish in the big pond? Multi-level network analysis through linked design. Social Netw. 2008;30:157–76.
Malerba F, Orsenigo L. Schumpeterian patterns of innovation. Cambridge J Econ. 1995;19(1):47–65. Oxford University Press.
Newman V, Chaharbaghi K. Strategic alliances in fast-moving markets. Long Range Plann. 1996;29(6):850–6.
Nooteboom B. Towards a dynamic theory of transactions. J Evolution Econ. 1992;2:281–99.
Orsenigo L, Pammolli F, Riccabonni M. Technological change and network dynamics: lessons from the pharmaceutical industry. Res Policy. 2001;30:485–508.
Owen-Smith J, Powell WW. Knowledge networks as channels and conduits: the effects of spillovers in the Boston biotechnology community. Organ Sci. 2004; 15:5–21.
Ozcan P, Eisenhardt KM. Origin of alliance portfolios: entrepreneurs, network strategies, and firm performance. Acad Manage J. 2009;52(2):246–79.
Patel P, Pavitt K. The technological competencies of the world's largest firms: complex and path-dependent, but not much variety. Res Policy. 1997;26:141–56.
Powell WW. Learning from collaboration: knowledge and networks in the biotechnology and pharmaceutical industries. Calif Manage Rev. 1998;40(3):228–40.
Powell WW, Koput K, Smith-Doerr L. Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. Adm Sci Q. 1996;41:116–45.
Powell WW, White DR, Koput KW, Owen-Smith J. Network dynamics and field evolution, the growth of interorganizational collaboration in the life sciences. Am J Sociol. 2005;110:1132–205.
Rowley T, Behrens D, Krackhardt D. Redundant governance structures: an analysis of structural and relational embeddedness in the steel and semiconductor industries. Strat Manag J. 2000;21(3):369–86.
Seidman SB. Network structure and minimum degree. Social Netw. 1983;5:269–87.
Soh P, Roberts EB. Networks of innovators: a longitudinal perspective. Res Policy. 2003;32:1569–88.
Uzzi B. The sources and consequences of embeddedness for the economic performance of organizations: the network effect. Am Sociol Rev. 1996;61:674–98.
Uzzi B. Social structure and competition in interfirm networks, the paradox of embeddedness. Adm Sci Q. 1997;42:35–67.
Walker G, Kogut B, Shan W. Social capital, structural holes and the formation of an industry network. Organ Sci. 1997;8:109–25.
Wasserman S, Faust K, editors. Social network analysis: methods and applications. Cambridge: Cambridge University Press; 1994.
Watts DJ, Strogatz SH. Collective dynamics of "small world" networks. Nature. 1998;393:440–2.
Winter SG, Kaniovski YM, Dosi G. Modeling industrial dynamics with innovative entrants. Struct Change Econ Dynam. 2000;11(3):255–93.

Networks

► Academic Firm
► Collaborative Innovation and Open Innovation
► Microfirms
► Open Innovation and Entrepreneurship

Networks and Network Governance

► Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Networks and Scientific Innovation

Thomas Heinze
Lehrstuhl für Organisationssoziologie,
Bergische Universität Wuppertal, Germany

Synonyms

Co-citation; Co-publication; Cumulative advantage; Homophily; Patents; Research productivity; Scientific elite; Trend-following

Introduction

The analysis of social networks in scientific innovation has seen a remarkable boom since the late 1990s: research on networks has developed into an interdisciplinary field comprising numerous mathematicians, physicists, and computer specialists, and no longer solely anthropologists, psychologists, and sociologists. A major reason for this boom is the availability of larger data sets and greater computer capacities for analyzing these data. Today, analyses quite commonly focus on co-publications with tens of thousands of researchers, co-citations between several million papers, or patent applications over periods of several decades. These data sets have improved the possibilities of investigating the mechanisms of network evolution and their role in scientific innovation (Chen and Redner 2010; Jones et al. 2008; Fleming et al. 2007; Wuchty et al. 2007; Newman et al. 2006; Powell et al. 2005).

This entry discusses key questions to approach selected findings from recent literature; a summary follows them: (1) What are networks in science and how are they defined? (2) What structures and characteristics do such networks have? (3) How do such networks arise and develop? (4) What is their role in scientific innovation?

What are Networks in Science?

In the terminology of mathematical graph theory, graphs consist of a finite number of nodes, connected by vertices. If all the vertices point in one direction, one speaks of a directed graph, otherwise, of an undirected graph. The number of vertices ending in a node is called the node degree; with directed networks, an indegree is distinguished from an outdegree. In the terminology of social network analysis, graphs are called networks, nodes are called actors, and vertices are called relationships.

When speaking of networks in science, one refers to collaboration among scientists, for example, in the framework of experiments, projects, or publications. Such cooperative relationships have the production and distribution of new knowledge or new technologies in the foreground. Here, the term *social networks* suggests itself. An indicator for social networks often used in the literature is joint authorship in the form of *co-publications* (*copub*). These are especially visible relationships that usually emerge from diverse formal and informal kinds of collaboration. Copub networks always consist of undirected relationships.

Networks in science also include intellectual connections among scientists arising through reference to the work results of colleagues. In the foreground of such reference relationships is usually the embedding of new arguments and findings within existing knowledge, where this is not based on collaborations. Here, the term *cognitive networks* suggests itself. An indicator for cognitive networks often used in the literature is *citation* (*cit*) *or co-citation* (*cocit*). Here, too, one deals with especially noted relationships to already published knowledge, which are far from being able to comprise all the real intellectual relations of a publication. Cit networks (A cites B, B cites C, etc.) always consist of directed relationships, while cocit networks are composed of undirected relationships (A and B cite C, B and C cite D, etc.).

Social and cognitive relationships can be analyzed not only on the microlevel of scientists. Empirical studies also investigate such relationships on higher levels of aggregation. These include research organizations, disciplinary communities, national research systems, and the global science system. The selection of the level of aggregation is generally determined by the knowledge the respective study is interested in. But analyses on a higher aggregation level also have the advantage of using temporal and disciplinary limitation to counter the long-familiar methodological problem of network analysis, namely, that there are no clearly derivable rules defining where a network begins and where it should end. With the *temporal limitation* to specific years or decades and the *factual limitation* to specific disciplinary communities (Chen and Redner 2010), research organizations (Jones et al. 2008; Heinze and Kuhlmann 2008), or – as in the case of the global science system – to selected databanks (Milojevic 2010; Jones et al. 2008), the boundaries of the networks to be investigated are defined pragmatically.

Structures and Characteristics of Networks in Science

Once the data basis is defined, the first important step of network analysis consists in investigating the fundamental structures and characteristics of the relationships. These include, in particular, the distribution of node degrees, the network's degree of differentiation, and its cohesion.

Distribution of Node Degree. For some years now, there has been intensive discussion about how the distribution of node degrees follows from copub and cit networks (Newman et al. 2006: 335ff). In many networks, the node degrees are not normally distributed around the mean, as they would be with the bell curve. Rather, there are many extreme values, so-called hubs, that is, actors who collaborate extremely often or articles that are extremely frequently cited. Networks with such hubs can be better described with the power law distribution (PLD), the distribution that is also valid for the productivity of scientists (Lotka's Law). But the PLD typically registers only observed values within a certain range of values that does not cover the entire distribution. In the case of a copub network in nanotechnology investigated by Milojevic (2010), for example, this value range lies between 20 and 200 coauthors. Below the threshold of 20 coauthors, there is a lognormal distribution.

The distribution of the node degrees is of great theoretical importance, because it is tied to the question of the mechanisms responsible for the rise and reproduction of network ties. There is a general consensus in the literature that the PLD results from the mechanism of *cumulative advantage* (CA), which was already described by Merton (1973). The hypothesis here is that scientists with higher node degrees are more likely to have new collaboration partners than are scientists with lower node degrees. Small initial differences grow over time into greater inequality. CA thus leads to a higher concentration of relationships in a few nodes. The close connection between PLD and CA means that whenever other distributions can be shown in addition to PLD, as in the case of Milojevic (2010), mechanisms other than CA are obviously at work in the genesis of the network. What mechanisms these are will be discussed below (cf. section "Mechanisms of Network Formation and Network Evolution").

Degree of Differentiation. There is also an intensive discussion about the effective identification of sub-communities and thematic fields within disciplines. In addition to the traditional procedures of social network analysis, for example, the analysis of cliques, clusters, or block models, in recent years a promising algorithm has been developed that identifies densely connected segments of the network without requiring knowledge of the content of the field covered by the network (Newman et al. 2006). Within a value area that is simple to interpret ($0 < Q < 1$), this *modularity* algorithm measures a network's degree of differentiation. For example, for the cit network of the journal family Physical Review, Chen and Redner (2010) calculate $Q = 0.543$, corresponding to 274 delimitable thematic areas. These thematic areas are in turn differentiated to different degrees. While high-temperature superconductivity ($Q = 0{,}198$) and Bose-Einstein condensation ($Q = 0.217$) have only a few subfields, metals/alloys ($Q = 0.481$) and quantum mechanics ($Q = 0.447$) are each markedly more differentiated.

Cohesion is another important concept for characterizing social and cognitive networks.

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It is measured, on the one hand, by the average number of nodes lying between two randomly chosen nodes. As Newman (2001) is able to show for copub networks in various disciplines, the average distance is about six nodes and thus an order of magnitude comparable to that of other social, biological, and technological networks. In the global science system, a researcher thus needs only six intermediate steps to reach another, randomly selected researcher.

Another indicator for cohesion is the *cluster coefficient*, which measures the relative frequency of transitive triads (A publishes with B, B with D, and A with D). For the aforementioned copub networks (excepting in biology), Newman (2001) calculates probabilities between 30% and 70% that relationships A-B and B-D will result in a relationship A-D. These results are very similar to the idea of Granovetter (1973) that whenever strong relationships exist between A-B and B-D, there is social pressure on A-D to enter into a similarly directed relationship and thereby to bring about a *transitive triad* (also: closed triad). In the case that the relationship A-D does not come about, the social cohesion between A, B, and D is endangered. Granovetter (1973) coined the triple constellation that lacks the A-D relationship a *forbidden triad* (also: open triad) and points out that transitive triads arise only where relationships are strong. Where relationships between A-B and B-D are weak, A-D typically do not enter into a relationship; here, B remains a broker who mediates between A and D. Newman's results thereby indicate that, in the copub networks he investigated, between 30% and 70% of the relationships are strong. At the same time, Newman's findings indicate that here there is another mechanism leading to the rise of social relationships that effects the *formation of transitive triads* (FT). The extremely low probability of transitive triads in biology (7%) is an indication that in this discipline the majority of relationships are weak and biologists therefore do not customarily recruit new collaboration partners from the group of their own collaboration partners. Powell et al. (2005) confirm this finding (cf. section "Mechanisms of Network Formation and Network Evolution").

Mechanisms of Network Formation and Network Evolution

In the booming interdisciplinary context of network research on scientific innovation, an intensive discussion is being conducted on what mechanisms are crucial for the formation and evolution of networks. On this, the following discusses randomness, cumulative advantage, homophily, trend-following, and multiple connections.

Random Attachment. In many studies, randomly generated connections between actors play an important role. This is because mathematically oriented network analysis has always studied randomly generated graphs (model networks) and uses the characteristics it finds in them for comparisons with real networks (Newman et al. 2006: 229ff). But by far, not all the characteristics of randomly generated networks can be found in real networks of relationships. One especially striking deviation was found for the aforementioned cluster coefficients, where real networks often display a large multiple of what is measured in randomly generated networks. The reason for this deviation is the aforementioned FT mechanism, which ensures that real networks consist of many small clusters (cf. section "Structures and Characteristics of Networks in Science"). It is interesting that the high degree of cluster formation in real networks leads one to expect a relatively long average path length. This would mean that contacts spanning more than one cluster would be rare and that the actors would need long routes to reach an actor in another cluster. But as Watts (2003: 69ff) shows, the path lengths in real networks are typically quite short and differ only slightly from those in randomly generated networks. Many real networks, and especially copub networks, display high local densities and at the same time good global accessibility (Newman 2001). In the literature, networks with these two opposing characteristics are called "small worlds" (Newman et al. 2006: 9ff, 286ff).

How can relatively short path lengths arise despite the FT mechanism? Watts (2003: 83ff) argues that the short average path lengths could be produced by reconnecting existing relationships randomly. The underlying idea is simple: in networks with high local density, the probability that a random reconnection will produce a very distant relationship is quite high. This means that each reconnection very probably results in a connection with a previously unconnected cluster, which in turn reduces the average path length. The crux of the matter in this consideration is that randomness not only serves as heuristics for modeling the rise of real networks. Watts (2003) explicitly points out that forces of disorder and unforeseeability affect every real network, so that relationships among actors arise partially randomly. Taking this argument seriously, then, in the example of path length, randomness appears as a corrective to the FT mechanism. Thus, in the genesis of relationships between actors and in the dynamic of networks, random connections play a substantial role.

Cumulative Advantage. As already noted, the CA mechanism has the effect that already reputed and networked scientists can win new collaboration partners more frequently than less well-known or peripheral colleagues can. The logic of CA is thereby that small initial differences among researchers can grow over time to become a distribution in which a few researchers have a great many collaborative relationships and many colleagues have only a few (PLD). In the analysis of CA, progress has been made by carrying out a longitudinal study of extensive copub networks. For example, Barabási et al. (2002) analyze mathematics and the neurosciences on the global level in the years 1991–1998. New actors and relationships are added to the network each year, so Barabási et al. (2002) examine two sub-mechanisms. CA-1 means that young scientists co-publish with established researchers. Each increase of new researchers should thus lead to an increase in the average node degree. CA-2 means that the probability of a first-time collaboration between two established researchers within the network increases linearly with the frequency of their prior collaborations. CA-1 and CA-2 are both empirically confirmed.

Trend-Following and Homophily. In the literature, it is non-controversial that CA is an important element in the explanation of network emergence. However, in their study of the dynamics and evolution of inter-organizational networks between biotech companies in the period 1988–1999, Powell et al. (2005) identify additional social mechanisms. Trend-following (TF) means that one chooses the partner whom one's own circle perceives as attractive. Homophily (HP) means that partner selection is shaped by the principle that "birds of a feather flock together." Each of these mechanisms, however, has been only partially empirically confirmed. This means that, when choosing new partners, the biotech companies initially take their orientation from the conventions of their circles. Those partners are selected whom the circle perceives as attractive. But TF is not valid for repeated contacts; here, the biotech companies manage to emancipate themselves from the trend. A similar pattern emerges for HP. New contacts are extremely frequently begun with spatially close partners, but spatial closeness plays no role for repeated contacts.

Multiple Connections. Whether a biotech company repeats its collaboration with a partner depends, rather, on whether the partner brings diversity into the relationship and whether the partnership holds promise of long-term gains. Multiple connections thus mean, first, a preference for heterogeneity in choice of partners (MC-1) and, second, a preference for deepening existing partnerships (MC-2). As Powell et al. (2005) show, in biotechnology or the life sciences, there is a marked preference for competences and contact structures that one does not possess oneself. Collaboration partners with a diverse contact portfolio are thus especially attractive, because they open up access to new knowledge and new technologies. The great preference for heterogeneous knowledge and know-how is reflected in the fact that young beginners are especially coveted, in contrast to established biotech companies (MC-1). However, Powell et al. (2005) also show that, once a high level of diversity is achieved, the search for new partners slackens. In this case, the biotech company deepens its relationships to its partners and bonds them to it for the long term (MC-2). As a social mechanism that steers the formation and continuation of relationships in networks, multiple connections thus entail a tension between the search for new knowledge and know-how, on the one hand, and the search for a stable and fruitful partnership, on the other. Overall, the results of Powell et al. (2005) indicate that MC-1 and MC-2, rather than CA, are the dominant social mechanisms that explain the rise and evolution of inter-organizational partnerships in the biotech sector. The authors thereby confirm Newman's (2001) finding that, in biology and the life sciences, it is less customary than in other disciplines to make contacts within the circle of one's own collaboration partners (cf. section "Structures and Characteristics of Networks in Science").

Networks and Scientific Innovation

Networks are not only important in the biotech sector but also in other scientific fields and disciplines. For example, Fleming et al. (2007) examine the collaborative networks of inventors in the United States, based on 2.8 million patent specifications from the years 1975 to 2002. The starting point for this study is the question whether brokered structures with open triads or cohesive structures with closed triads increase the productive capacity of networks (cf. section "Structures and Characteristics of Networks in Science"). The authors show that collaborative networks with brokers often lead to technical innovations. At the same time, however, technical innovations from brokered networks are less frequently used again than are those from cohesive networks. These results indicate that new knowledge spreads better in socially integrated contexts, while brokered contexts create hurdles for the spread of new ideas. Fleming et al. (2007) point out that there is a paradox here, namely, that the network structures suitable for developing technical innovations are not suitable for their diffusion, while vice versa those network structures that are unsuitable for bringing about technical innovations are especially suitable for spreading them. Fleming et al. (2007) sketch a possible escape from this paradox: recruiting actors in cohesive networks who have a broad spectrum of knowledge, have gathered experience in various organizations, and also initiate contacts outside their own work contexts. In this way, the structural disadvantages of cohesive networks in giving rise to new ideas can be at least partially compensated.

Networks also influence scientific productivity capacity and rankings in research. Jones et al. (2008) show in their analysis of the 662 largest universities in the United States that, based on the Web of Science, in the period 1975–2005 interuniversity copub relationships more than doubled, both among the natural and engineering sciences and among the social sciences. Today, about a third of all papers are published by interuniversity teams. This growth derives essentially from decades of the generally increasing proportion of co-publications in the global science system. Also based on the Web of Science, Wuchty et al. (2007) calculate that, in the period 1955–2000, the number of co-publications in the social sciences rose from 18% to 52% and in the natural and engineering sciences from 50% to 83%. At the same time, the average number of coauthors in the social sciences increased from 1.3 to 2.3 and in the natural and engineering sciences from 1.9 to 3.5.

As Jones et al. (2008) further show, interuniversity publications are cited substantially more often than are publications by authors who all belong to a single university. The greater visibility of interuniversity publications is unequally distributed: the greater the number of citations from a site, the more it profits from interuniversity collaborations. This means that the effect of interuniversity publications on visibility and thus also on scientific prestige is concentrated on elite organizations. Here, the gap in visibility and prestige between elite and periphery increased markedly in the period 1975–2005. The increasing density of interuniversity copub networks thus amplifies the already marked institutional stratification of the university system in the United States. Finally, Jones et al. (2008) show that collaborations between different sites of the university elite (and incidentally also, separately, between peripheral sites) are more frequent than mixed relationships. This indicates that the aforementioned HP mechanism decisively shapes the genesis of interuniversity relationships (cf. section "Mechanisms of Network Formation and Network Evolution").

Conclusion and Future Directions

In sum, it can be noted that many interesting things about network formation, network evolution, network structures, and their influence on innovative science are known. The availability of large longitudinal data sets makes it possible to conceptualize and empirically examine the connection between the statistical distribution of cognitive and social relationships, the mechanisms of their emergence and reproduction, and their role in fostering research productivity and scientific innovation. The wide spectrum of investigated networks has also resulted in a better understanding of the cultural differences between various disciplines and fields of research. Good examples of this are the life sciences, whose networks markedly differ from other disciplines, in particular from physics (Powell et al. 2005; Newman 2001).

With regard to the aggregation levels mentioned at the beginning of this entry, recent research on networks has produced some studies of the global science system (Wuchty et al. 2007; Newman 2001), but the majority of the analyses still focus on disciplines and fields of research (Chen and Redner 2010; Milojevic 2010). In this regard, recent interdisciplinary research on networks follows an established path to the disadvantage of research organizations. There are only a few studies that address the theme of universities or non-university institutes, including industry research, as nodes of social or cognitive networks and their role in scientific innovation (Jones et al. 2008; Powell et al. 2005). There is a clear need to pay more attention to the organizational level with regard to networks and scientific innovation in the future.

Cross-References

- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovation Policy Learning
- ▶ Innovations of and in Organizations
- ▶ Research on Creativity
- ▶ Science of Creativity

References

Barabási A-L, Jeong H, Néda Z, Ravasz E, Schubert A, Vicsek T. Evolution of the social network of scientific collaborations. Physica A. 2002;311:590–614.

Chen P, Redner S. Community structure of the physical review citation network. J Informetr. 2010;4:278–90.

Fleming L, Mingo S, Chen D. Collaborative brokerage, generative creativity, and creative scientists. Adm Sci Q. 2007;52:443–75.

Granovetter M. The strength of weak ties. Am J Sociol. 1973;78:1360–80.

Heinze T, Kuhlmann S. Across institutional boundaries? Research collaboration in German public sector nanoscience. Res Policy. 2008;37:888–99.

Jones BF, Wuchty S, Uzzi B. Multi-university research teams: shifting impact, geography, and stratification in science. Science. 2008;322:1259–62.

Merton RK. The normative structure of science. In: Storer NW, editor. The sociology of science: theoretical and empirical investigations. Chicago: The University of Chicago Press; 1973. p. 267–78.

Milojevic S. Modes of collaboration in modern science. Beyond power laws and preferential attachment. J Am Soc Inf Sci Technol. 2010;61:1410–23.

Newman M. The structure of scientific collaboration networks. Proc Natl Acad Sci. 2001;98:404–9.

Newman M, Barabási A-L, Watts D. The structure and dynamics of networks. Princeton: Princeton University Press; 2006.

Powell WW, Koput KW, White DR, Owen-Smith J. Network dynamics and field evolution. The growth of interorganizational collaboration in the life sciences. Am J Sociol. 2005;110:1132–205.

Watts D. Six degrees. The science of the connected age. New York: Norton & Norton; 2003.

Wuchty S, Jones BF, Uzzi B. The increasing dominance of teams in production of knowledge. Science. 2007;316:1036–9.

Networks Interfirms Cooperation

▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)

New Business Firm, Creation

► Entrepreneurship in Developing Countries

New Companies in Innovative Sectors

► Start-Up and Small Business Life

New Forms of Entrepreneurship in a Sustainable Knowledge-Based Service Economy

Faridah Djellal and Faïz Gallouj
Clersé-CNRS, University Lille 1 and RRI, Villeneuve d'Ascq, France

Synonyms

Business creation; Start-ups in services

Introduction

The question of entrepreneurship and its links with services is not a new one since most new businesses operate within the tertiary sector. Few studies, on the other hand, have addressed the link between entrepreneurship and innovation in services (Gallouj and Djellal 2010). The leading theoretical reference in the field of entrepreneurship and innovation is undoubtedly Schumpeter, who has developed two well-known models of innovation. His first model (Schumpeter Mark 1) describes the characteristics of an entrepreneur: (1) his capacity to detect, from among a stock of accumulated knowledge, an invention suitable for socialization, that is, transformation into an innovation, and (2) his capacity to mobilize an interessement ("know-who") network to bring about this socialization. In the second model (Schumpeter Mark 2), knowledge is more explicit, to the extent that the Schumpeterian spirit of enterprise is endogenized in corporate departments specializing in knowledge creation. Expanding on Schumpeter's theory, we have hypothesized the existence of a Schumpeter Mark 3 model (Gallouj 2002a), based on interaction with knowledge-intensive service firms (engineering and consulting). The Schumpeter Mark 2 model appears to be incompatible with the characteristics of the service economy. In fact, R&D departments (in the traditional sense) are extremely rare in the service sector, and the endogenization of the entrepreneurial function takes the form of multifaceted and transitional project groups, in which customers are also included. To a certain extent, this reduces the risk of the "bureaucratization" and the stifling of the enterprise spirit evoked by Schumpeter.

There are no studies, to our knowledge, devoted specifically to the Schumpeterian entrepreneur in services (i.e., to the "Schumpeter Mark 1 model," the model of the entrepreneur who creates a business in relation to a "new combination"). As regards services, the subordination approach to innovation or to spatial location and regional economic dynamics, regularly highlighted and criticized in the literature, can be applied very naturally to the field of entrepreneurship. While the service sector would appear to be the principal host of "routine entrepreneurship" (the creation of traditional businesses), "innovation entrepreneurship" seems to be based elsewhere. If we underestimate innovation in services, we logically underestimate its stakeholders. However, the service-specific literature appears to imply the existence of four new entrepreneurial figures which are outlined below and merit a more in-depth theoretical, empirical, qualitative, and quantitative analysis: the "cognitive" entrepreneur, the "social" entrepreneur, the "ecological" entrepreneur, and what we have called the "entrepreneurial" entrepreneur (see Table 1).

The "Cognitive" Entrepreneur

The "cognitive" entrepreneurs are experts who root the creation of their business in new

New Forms of Entrepreneurship in a Sustainable Knowledge-Based Service Economy, Table 1 New figures in service entrepreneurship

Types of entrepreneurship	Possible examples or subcategories (non-exhaustive list)
Cognitive entrepreneur	Consultant entrepreneur, doctor entrepreneur (researcher), e-entrepreneur
Social entrepreneur	Gray market entrepreneur, toddler entrepreneur, emergency outreach entrepreneur
Ecological entrepreneur	Ecotourism entrepreneur, "green technologies" entrepreneur
"Entrepreneurial" entrepreneurs	Nurseries, hives, incubators

knowledge (new fields of knowledge) that they have either helped develop or benefited from without contributing to it. This new knowledge may or may not be incorporated into technical systems. It can belong to the natural sciences and engineering or to the human and social sciences.

"Cognitive" entrepreneurship is a heterogeneous category. It is probably possible to distinguish between several types of entrepreneurs within "cognitive" entrepreneurship itself, depending on the main field of knowledge addressed and their contribution to knowledge in this field.

The first interesting example of cognitive entrepreneur is the setting up of a consulting firm based on a new field of knowledge or expertise. The *consultant entrepreneur* is closely related to what we term "new expertise-field" innovation (Gadrey and Gallouj 1998; Gallouj 2002b) to describe the detection of an emerging field of knowledge and the provision of consulting services in this area. This type of cognitive entrepreneur does not create the field of expertise: they detect it, appropriate it, and construct it socially. They can be said to create it in the same sense that it is sometimes said that insurance "creates" risk. The "objective" origin of these fields of expertise is the dynamic of institutional, technological, economic, and other types of change. Although they do not create these fields of knowledge objectively, the consultant entrepreneurs can contribute knowledge, methods, etc., to them. Examples of expertise-field innovation include the entry of lawyers into new legal fields (such as space law, computer law), the expertise in civil partnership contracts, the enlargement of the EU, and the environmental and sustainable development issues Many different fields of knowledge are therefore involved and cover the complete spectrum of business functions (technological, legal, social, etc.).

The second type of cognitive entrepreneur is the *researcher entrepreneur* (or *doctor entrepreneur*). This type of entrepreneurship refers to the creation of businesses by university researchers (young doctors making use of their thesis results and senior researchers drawing on their research). Unlike a consultant entrepreneur, the researcher entrepreneur plays a decisive role in the production of the exploited knowledge. They actually create this knowledge and not just socially. Business creation is based both on expertise in the hard sciences and in the social and human sciences. Social and human sciences play a significant role (which should not be neglected) in defining R&D in services. In other words, social and human sciences, like natural sciences, can provide the foundation for cognitive entrepreneurship. They should not be underestimated. When knowledge is not incorporated into technologies or tangible entities, the line between consultant entrepreneurs and researcher entrepreneurs can be very tenuous. The "researcher entrepreneur" category raises an interesting theoretical issue in that it challenges the validity of the notion of the Schumpeterian entrepreneur, to the extent that, in Schumpeter's theory, invention and innovation are defined as two fundamentally different phenomena, just like their corresponding stakeholders – researchers and entrepreneurs.

The doctor entrepreneur is the subject of a quite numerous literature (Murray 2004). The sector-specific variable (i.e., taking into consideration, if appropriate, the specific nature of the services) is never factored into these studies, which are primarily focused on the link between human capital (the researcher's expertise) and social capital (the capacity of the researchers to mobilize a network and incorporate themselves into it).

The third expression of cognitive entrepreneurship is what we might call *e-entrepreneurship* or *cyber-entrepreneurship*, which includes service entrepreneurship linked to new information and telecommunication technologies (incorporated or otherwise and produced by the entrepreneurs themselves or adopted). e-Entrepreneurship could be a specific example of the two previous definitions of cognitive entrepreneurship (such as an IT researcher who creates a business to apply his or her results or who sets up a consulting firm). However, since this form of entrepreneurship (closely linked to the dominant information paradigm) is so important, we have treated it separately here and consider it as an independent category. Cognitive entrepreneurship's field of intervention is broader still. It covers all service activities developed to take advantage of NICTs (examples include people who set up websites and web designers) along with, if we adopt an even broader understanding of this form of entrepreneurship, all business activities designed to promote and sell goods and services via ICT networks: e-commerce (Internet sales) and e-business (all types of business transactions performed on the Internet).

The "Social" Entrepreneur

The field of action of social entrepreneurs is the social and solidarity economy. Social entrepreneurship consists of creating new organizations to manage, in an original (i.e., innovative) manner, certain disadvantaged or vulnerable sections of the community, such as young children, the elderly, or people with disabilities of all kinds – socioeconomic, physical, and psychological. In other words, the aim of social entrepreneurship is to resolve social problems. The form that concerns us here provides an innovative solution to these problems. Social entrepreneurship, like any form of entrepreneurship, can be performed at a local, national, or international level.

It is not necessarily a nonprofit entity (a nonprofit organization entrepreneur). It can also be a public organization or a private company and increasingly a hybrid form of commercial and noncommercial activities. It is therefore, as with the previous form of entrepreneurship, a heterogeneous category (both on an institutional and a functional level). We have, however, been able to identify three major groups. They are not independent nor do they constitute an exhaustive typology.

The first group includes organizations (firms, public organizations, nonprofit organizations, etc.) created to meet, in an innovative way (in terms of services provided or service provision methods), the needs of the elderly (all types of care services). Taking into account demographic developments, the "gray market" or the "seniors market" (although the entry threshold for this category is not always clearly defined) has a major development potential. *"Gray market" entrepreneurs* may operate in the commercial field or the noncommercial field.

The target of the second group is services for young children. This "toddler" market is at the origin of what we might term *"toddler" entrepreneurship*, which is the mirror image of *gray market entrepreneurship* and which can also operate in both the commercial and noncommercial fields.

The third group consists of what we have termed *"emergency outreach" entrepreneurship*. This refers to the creation of organizations that offer innovative, supportive solutions in the fight against all forms of insecurity and social exclusion at a local, national, and international level. One of the most widely publicized examples of this type of entrepreneurship is the free distribution of food to the homeless by the French organization "Les Restos du Cœur." However, there are many other examples, including microfinance schemes, that is, the granting of microloans, savings or insurance schemes for poor people excluded from the traditional banking system, and inclusive schemes for people in difficult circumstances. Unlike the two previous forms of social entrepreneurship, this particular form exists exclusively in the noncommercial field.

Although a fairly large number of studies have been devoted to the social and solidarity economy and the major role played by local services in this field, very little attention has been paid in economic theory to the entrepreneurial dimension of this economy and even less so from the point of view of services. The same cannot be said for the management sciences, which, for a number of years, have held an obvious interest for the notion of social entrepreneurship and more generally the social dimension of all forms of entrepreneurship (This interest is not only reflected in the large number of studies on this issue. It is also institutionalized within university courses.) (Leadbeater 1997). In any event, the theory – economic, sociological, and management – in this field lags behind social practices. The current debate on the social utility of organizations in this field and, more generally, on new wealth indicators could, we believe, help provide a better understanding, in socioeconomic terms, of the nature and role of social entrepreneurship (associated with innovation in services).

The "Ecological" Entrepreneur

The field of action of *"ecological" entrepreneurs or "ecopreneurs"* is environmental prevention and the quest for sustainable development. Once again, the few studies to have addressed this subject (Issak 1998) lag behind social practices. This form of entrepreneurship is often considered as a specific expression of the former if the social dimension is widened to include the sustainable inclusion of man in his environment among the social problems addressed.

The ecological entrepreneur is also a heterogeneous category. Once again, we are not concerned, at this stage, with providing a typology for it; instead, we will simply identify interesting groups by way of example.

The first interesting group of ecological entrepreneurs is developing its activities in the traditional service sectors to take advantage of ecological and environmental opportunities and the drive toward sustainable development. The tourism sector and the various components of this composite service (hotels, restaurants, leisure, etc.) include numerous examples of this type of entrepreneur who invests in opportunities and niches, particularly by supplying new tourism opportunities related to the local social fabric or new discovery activities, including agricultural tourism, industrial tourism, and cycle tourism. With this type of entrepreneurship, the service derives its innovative status from its ecological characteristics.

Another group has developed around the use of what are sometimes called green technologies – in other words, technologies that protect the environment. This could include technologies in both the tangible and intangible sense of the term, that is, technical systems, methods, or protocols. This group can overlap the cognitive entrepreneurship group when, for example, a researcher develops a "green technology" that he or she exploits by creating a business. Although there are studies devoted to ecological entrepreneurs who develop their activities around "green technologies," they mainly focus on agricultural or industrial entrepreneurship (Andersen 1998). The service eco-entrepreneur is rarely taken into consideration in these studies. One example we could give is "car sharing," which consists of institutionalizing informal car sharing practices and which falls somewhere between private car ownership and car rental, particularly when used as a means of reducing pollution and urban congestion. Unlike the social entrepreneur (in the strict sense), the ecological entrepreneur appears to work, in the main, in a commercial environment (Hockerts 2003).

The "Entrepreneurial" Entrepreneur

The "entrepreneurial" entrepreneur refers to a set of service mechanisms targeted at producing entrepreneurs and which are generally called business incubators. Incubators are mechanisms designed to encourage and support, in different ways, the gestation, birth, and first steps of a company and thereby increase its viability. We use the term incubator in the generic sense to refer to this particular group of (still semantically variable) mechanisms that include nurseries, hives, and incubators. This category involves a different analytical approach to the previous categories since incubators are defined as *"entrepreneurial entrepreneurs."*

The incubator is an organization providing complex services that aims to create entrepreneurs (who may belong to the different categories mentioned previously). In some ways it is a "laboratory of entrepreneurs." In the case of innovative entrepreneurship (which is what interests us here), the innovation incubator is a new form of the endogenization of the entrepreneurial function, which complements the two Schumpeterian models and the model that we have, for our purposes, called Schumpeter 3 or the interactional innovation model. The incubator builds on the Schumpeterian analysis in an interesting way, in that it unexpectedly combines the Schumpeter 1 model and the Schumpeter 2 model. In fact, the incubator can be considered as a machine or a laboratory to "produce" entrepreneurship rather than innovation.

Conclusions

Defining and qualifying the notion of service entrepreneur offers a potentially interesting line of research. If we understand the notion of entrepreneur in its Schumpeterian sense (i.e., closely related to the issue of innovation), it would involve verifying if, like the activities in which they operate, the service entrepreneur is specific in nature.

The categories of entrepreneurs working in services (in sales, retail, etc.) are not all taken into consideration in the four types of entrepreneurs mentioned above. They are, rather, relatively new and particularly dynamic forms of innovation entrepreneurship.

These four forms of entrepreneurship in services are not separate wholes. Entrepreneurship can obviously develop simultaneously in different fields – cognitive, social, and ecological. In fact, an innovation based on scientific research (PhD thesis) can, for example, be applied to environmental protection (e.g., the decontamination of polluted sites and "green" technologies) or the protection of disadvantaged people ("senior technologies"). A new consulting activity in the field of organic farming emerging, for example, from the enactment of new EU regulations, falls into both the cognitive and ecological fields of entrepreneurship. A business devoted to social inclusion through economic activities that specialize in an original form of waste recovery and treatment service relates to both ecological and social entrepreneurship. An open source software developer can be both a social entrepreneur and a cognitive entrepreneur. Lastly, business incubators themselves can specialize in one of the previous forms of entrepreneurship. In the United States, for example, there are incubators that specialize in women's entrepreneurship, ethnic minorities, nonprofit organizations, etc.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Cyber Entrepreneurship
- ▶ Digital Economy and Business Creation
- ▶ Entrepreneur
- ▶ Entrepreneurial Opportunities
- ▶ Entrepreneurship and Social Inclusion
- ▶ Green Business and Entrepreneurship
- ▶ Innovator
- ▶ Schumpeterian Entrepreneur
- ▶ Social Entrepreneurship
- ▶ University Research and Innovation

References

Andersen AR. Cultivating the garden of Eden: environmental entrepreneuring. J Org Change Manag. 1998;11(2):135–44.

Gadrey J, Gallouj F. The provider-customer interface in business and professional services. Serv Ind J. 1998;18(2):1–15.

Gallouj F. Knowledge intensive business services: processors of knowledge and producers of innovation. In: Gadrey J, Gallouj F, editors. Productivity, innovation and knowledge in services: new economics and socio-economics approaches. Cheltenham/Northampton: Edward Elgar; 2002a. p. 256–84.

Gallouj F. Innovation in the service economy: the new wealth of nations. Cheltenham/Northampton: Edward Elgar; 2002b.

Gallouj F, Djellal F, editors. The handbook of innovation and services. Cheltenham/Northampton: Edward Elgar; 2010.

Hockerts KN. Sustainability innovations: ecological and social entrepreneurship and the management of antagonistic assets. Ph.D. thesis, University St Gallen, Switzerland, 2003.

Issak R. Green logic, ecopreneurship, theory and ethics. Sheffield: Greenleaf; 1998.
Leadbeater C. The rise of the social entrepreneur. London: Demos; 1997.
Murray F. The role of academic inventors in entrepreneurial firms: sharing the laboratory life. Res Policy. 2004;33(4):643–59.
Thompson J, Alvy G, Lees A. Social entrepreneurship: a new look at the people and the potential. Manag Decis. 2000;38(5):348–58.

New Molecular Entities

► Translational Medicine and the Transformation of the Drug Development Process

New Public Management

► Epistemic Governance and Epistemic Innovation Policy

New Social Organization

► Entrepreneur in Utopian Thinking

New Venture Creation

► Innovation and Entrepreneurship

Newness

► Product Innovation, Process Innovation

Nexus

► Network and Entrepreneurship

Nine-Dot Puzzle

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Nonlinear Growth Models

► Technology Life Cycles

Nonlinear Innovation

► Academic Firm
► Epistemic Governance and Epistemic Innovation Policy

Nonlinear Innovations

Karl H. Müller
Wiener Institut für Sozialwissenschaftliche Dokumentation und Methodik (WISDOM), Vienna, Austria

Synonyms

Innovation diffusion; Innovation networks; Innovation waves; Power-law distribution for innovations

Introduction

This entry will start, first, with a very short discussion of a set of linear models of innovations which are usually characterized by two important features. On the one hand, these models are specified in sequential stages and linearity, thus, refers to a set of different innovation stages which have to be passed in time consecutively. On the other hand, linearity can be linked to the types of

Nonlinear Innovations, Fig. 1 A research-based linear innovation model (Source: Michael Eigner [WISDOM])

Nonlinear Innovations, Fig. 2 An invention-based linear innovation model (Source: Michael Eigner [WISDOM])

relations between these different stages which can be assumed as linear as well.

As a next step, these linear models will be transformed into nonlinear configurations. Here, the focus shifts to nonlinear aspects of innovation processes as well as to the still predominant Schumpeterian framework for the cyclical diffusion of innovations.

The third part of this entry will advance a general nonlinear innovation framework which is largely based on complex, nonlinear network theory. This general nonlinear framework for innovations can be characterized by a considerable amount of comparative advantages, especially in comparison to the traditional innovation perspective in the Schumpeter tradition.

Linear Innovation Models

Usually, linear models of innovation assume at least three different stages where the third stage comprises either technological innovations or their diffusion processes. Figures 1 and 2 show two different linear innovation models where the first one has its focus on scientific research and the second one on technological inventions. Figure 1 assumes a three-stage sequence in which basic research provides the potential for technological applications which, finally, can be implemented as economic innovations. Figure 2 focuses on the invention process, the transformation of an invention into an economic innovation and its subsequent diffusion. In both cases, time and information flow from the left side to the right side and provide a strict temporal as well as informational order.

The general scheme for linear innovation models may comprise longer innovation chains of more than three stages. Again, the information flows as well as the arrow of time move from one stage to the next in a strict sequential manner.

Additionally, linear innovation models usually operate with linear relations, adhering to the rules of additivity and homogeneity. The additivity rule requires a decomposition of a function $f(x + y) = f(x) + f(y)$, and the homogeneity rule can be specified as $f(\alpha x) = \alpha f(x)$ for all α. In sum, the relations between the different stages exhibit a linear pattern as well where, for example, a higher input into basic science leads to a proportionate increase in basic science outputs and a proportionate advancement for the applied sciences as well as for innovations.

These linear models turn out to be highly problematic because they do not allow for feedback loops within an innovation chain, and they assume that all these different stages have to be passed in a strictly sequential mode with linear effects only. In sum, the sequential and linear nature of relations renders linear innovation models as highly artificial and not very fruitful for the analysis of innovation processes.

Nonlinear Models of Innovations

Linear models can be transformed into nonlinear variants either by abandoning the temporal and

Nonlinear Innovations, Fig. 3 A research-based nonlinear innovation model (Source: Michael Eigner [WISDOM])

informational order of a set of stages or by assuming nonlinearity in the diffusion process of innovations and by allowing for nonlinear features like path dependencies, lock-ins, or sensitivities to initial conditions.

Thus, the first transition from linear to nonlinear forms of innovations is accomplished by admitting feedback loops across the different stages of the innovation processes. These feedback loops imply that information can flow freely between various stages and that innovations and their diffusion processes can take a variety of different trajectories, starting, for example, in the field of applied science, moving to the basic science area, and proceeding from there directly to the innovation stage. Figure 3 presents a nonlinear counterpart to the linear science-based model.

Turning to nonlinear innovation relations, the dominant framework here has been provided by Joseph A. Schumpeter with an elaborated theory of long, medium, and short innovation waves which was published in 1939 in his English version of *Business Cycles*. Here, the central focus of the explanation lies in the capitalist innovation dynamics and in the leading role of entrepreneurs.

It is important to note, first, that Schumpeter saw innovations as a very broad phenomenon which moves well beyond the realm of technologies or technological change. Aside from technological changes in the production of commodities already in use, innovations in the Schumpeterian sense comprise also the opening up of new markets or of new sources of supply, Taylorization of work organization, improved handling of material, and the setting up of new business organizations such as department stores – in short, any "doing things differently" in the realm of economic life. Formally, Schumpeter defines innovations as any change which does not alter the quantities of production factors of a production function but which leads to a variation in the production function itself.

Schumpeter explains this cyclical clustering of large-scale innovations on the basis of a diffusion- and imitation-oriented theory of learning. Imitation is facilitated in successful large-scale innovations by a continuous removal of obstacles and thresholds. The steadily decreasing demands for implementing innovation can be met by an increasing number of entrepreneurs whose propensity for innovations can be assumed to be unequally distributed.

Over the last decades, the theoretical and empirical contributions on nonlinear innovations have been undertaken mostly from the position and perspectives of the giant shoulders of Joseph A. Schumpeter. Five of the more original contributions to the existing analyses are worth mentioning.

In the late 1970s, Gerhard Mensch published "Stalemate in Technology," in which the long cycle of innovation is substantiated with data taken from the history of inventions. Inventions, too, tend to cluster in the downward phases of long waves, creating the conditions for a new upswing.

Furthermore, the S-shaped logistic curve has become the standard nonlinear model for the diffusion of innovations (Everett 2003 or Fagerberg et al. 2007), and long waves have been formalized in the modeling framework of so-called Schumpeter clocks (Weidlich and Haag 1983; Weidlich 2000). Moreover, innovations and their diffusion have been formulated within an evolutionary framework (Nelson and Winter 1982 or Müller 1999) and are being studied in institutional settings of national innovation systems (Lundval 1992; Nelson 1993, 2005 or Leydesdorff 2006).

Thirdly, Christopher Freeman, Luc Soete, and others have provided a large number of summaries and surveys which provide historical, statistical, and theoretical support for the propagation of long waves (Freeman 1983, 1987, Freeman and Soete 1982 or Freeman and Soete 1994, 1997). In a recent anthology that offers a *summa* of contemporary contributions and insights on the subject of long innovation waves, most of the authors are affirmative regarding the more than 200-year reproduction of cycles as a result of surges in technological development or basic product innovations (Devezas 2006).

Fourth, nonlinear innovation models have been advanced further by stressing additional important characteristics. For example, W. Brian Arthur (1994, 2009) has placed special emphasis on increasing returns to scale especially during the take-off phase of long innovation waves. James M. Utterback (1996) and others have stressed the role of path dependencies, lock-ins, the sensitivity to initial conditions, and the divergent technology trajectories despite similar initial levels.

Finally, nonlinear innovations as a cyclical pattern have been used in the structuration of technological-organizational regimes as exemplified by French regulation theory (Boyer and Saillard 2002). Additionally, long waves helped to define long-term societal and even world systems phases of development, namely, for the ups and downs of hegemonic phases in the evolution of a capitalist world system (Friedman 1982; Fröbel et al. 1981 or Hopkins and Wallerstein 1980).

However, a Schumpeterian framework for nonlinear innovations, both as an empirical phenomenon and as an explanatory strategy, exhibits serious deficits, inconsistencies, and interpretation problems.

A particularly strong counterargument to a pattern of long innovation waves is based on the very limited range of these basic industrial revolutions, like the construction of the railroad systems, which only rarely superseded 10% of the annual net investments. Conversely, apparently 90% or more of the annual net investments take place outside of the long wave segment (Hoffmann 1965 or Spree 1977).

Another argument against long innovation waves lies in their periodicity, which can hardly be maintained in a clockwise fashion. These difficulties with respect to the time periods of long waves have led to serious variations in the time scales and in the duration of cyclical ups and downs (Ayres 2006). Strong empirical doubts have again and again been raised regarding the statistical significance of long waves, and only insignificant differences have been noted for the individual periods of upswings and downswings. Interestingly enough, authors in Devezas (2006) who worked with statistical and time-series methods were mainly critical about long waves and classified them largely as artifacts.

A third, notorious problem lies in the relationships between long, medium, and short cycles, leading to the following dilemma. On the one hand, these relations can be specified additively – each long wave consists of a fixed number of medium-term cycles, which in turn consist of a fixed number of even shorter cycles. Along this path, one is confronted with the insurmountable problem of analyzing economic ensembles as majestic or trivial clockworks and not as evolving and complex configurations. On the other hand, one could define these periodicities in a nonadditive way which, however, leads to multiple problems of overlap. Moreover, there is the problem of consistency in explaining long, medium, or short cycles, since the explanatory variables for long waves cannot simultaneously account for upswings and downswings of medium and short duration.

Toward a General Framework for Nonlinear Innovation Models

The third part of this entry will undertake a profound change in the conventional view of innovations, nonlinear or otherwise. In particular, this new framework has its focus on:

- Innovation networks of various types as primary units of analysis
- Power-law distributions as the characteristic nonlinear configuration for small-, medium-, and large-scale innovations
- Preferential attachments as primary generative mechanism for self-generative nonlinear innovation processes

Starting with innovation networks (Hage and Hollingsworth 2000 or Mote et al. 2008) as units of analysis, an expanded typology for innovations in general will be introduced. If one differentiates between innovations according to their output in product and process innovations, as well as between a low, medium, and high diffusion potential of innovations, then one reaches a configuration with a total of six different innovation types, of which only a single group at the interface of product innovation/high diffusion potential corresponds to the long Schumpeter waves. Within the new framework, the other five types play a significant role and are viewed as necessary for the emergence of product innovations with a high diffusion potential.

It would be tempting to introduce Schumpeterian entrepreneurs or enterprises as the basic agents of innovation networks, but such a restriction would prove to be too limited since not just entrepreneurs and their enterprises but also the state sector, the civil realm, as well as the private sphere – households – appear as parts of innovation networks. The fourth industrial revolution with automobiles and road networks does not just require the participation of households as consumers of automobiles. The individualization of mobility also brings about a reversal in the modal split (Gershuny 1983) and a radical change in lifestyles. On an abstract level, thus, network actors can be of various types – entrepreneurs, inventors, companies, households, public organizations, NGOs, etc. (Müller 1999).

Moreover, the network linkages, like the network actors themselves, can also be of different types. Such linkages range from physical connections – lines, cables, pipes, high-frequency signals, etc. – and from the attributes of network actors such as personal acquaintances, trust, or social capital to activities of network actors like the migration of employees between enterprises, the movement of customers between products or product groups, and much more.

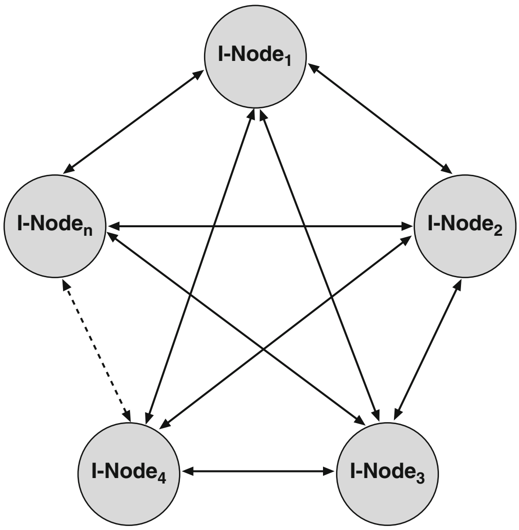
- Flow networks have, as their *differentia specifica*, physical connections between their network nodes and manifest themselves, *inter alia*, as railroad networks, power grids, water networks, road networks, the Internet, high-frequency networks for mobile telephony, etc.
- Relational networks comprise attributes or operations of network actors and do not involve physical connection lines. Relational networks can be based on kinship, on friendship, on acquaintance, on cooperation, etc.

A third network typology must be introduced with respect to the operational domains of networks where a separation is suggested into infrastructural, economic, and societal networks.

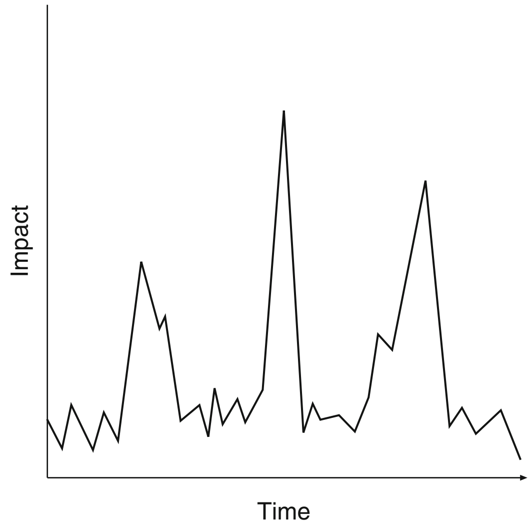
- Infrastructural networks are focused on the domains of energy, information, and transport and are organized as flow networks. They lie at the core of the evolution of long waves because all industrial revolutions so far were concentrated on energy (steam engine, electricity), transport (railroads and automobiles), or information (the current wave of information and communication technologies). Due to their overriding importance for societal evolution, economic innovation networks have been singled out as a special domain.
- All other innovation networks fall under the heading of societal networks and are situated in domains as different as politics, science, culture, households, and the like. These network domains can be combined as well to infrastructural-economic networks or to infrastructural, economic, and societal networks.

Figure 4 offers a general depiction for all three different types of innovation networks, which can be composed of a small, medium, or large number of network actors with flow or relational links, which can be situated in a variety of societal domains and which are focused either on product or on process innovations of marginal, medium, or basic novelty.

As for the network topologies (Barabási 2002, 2010; Buchanan 2002; Hollingsworth and Müller 2008; Newman 2005; Newman et al. 2006; Sornette 2003, 2006; Watts 1999, 2003, 2004), innovation networks of various types can be differentiated into two different architectures or



Nonlinear Innovations, Fig. 4 Nonlinear innovation networks as the reference configuration (Source: Michael Eigner [WISDOM])



Nonlinear Innovations, Fig. 5 Long waves at first sight (Source: Michael Eigner [WISDOM])

forms, namely, into so-called random or egalitarian networks and into complex networks, scale-free or aristocratic networks.

- Random networks evolve in a configuration in which the emergence of new nodes or links is not dependent on the prehistory of the overall topology. A typical random network, like the street connections of a region, links all relevant nodes.
- Scale-free networks emerge where the creation of new connections does not take place randomly. Global air traffic – but also the Internet – exhibits such a complex architecture in which new connections tend to orient themselves to the most connected nodes.

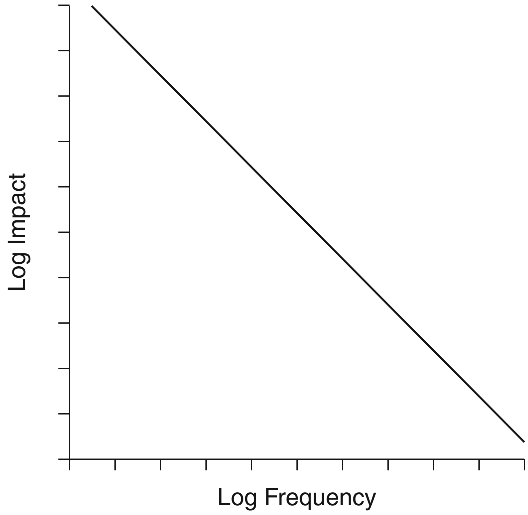
The second element in the new innovation framework, aside from different types of innovation networks, shifts the focus to the overall distribution of innovations. Here, innovations are not primarily arranged as long waves, reserved for a very few infrastructural revolutions, but in a power-law distribution, composed of a very large number of marginal or incremental innovations, of a limited number of medium-sized innovations, and of a very small number of innovations with a very high level of diffusion.

Figure 5 reproduces fluctuations in a typical sequence of small, medium-sized, and large innovations, which, at first glance, appear as three large innovation waves. Figure 6, by contrast, shows that there is a highly structured power distribution behind or underlying the three cycles from 5. Power-law distributions, as shown in Fig. 6, can be either very steep or rather flat, depending on the exponential coefficient in (1). For instance, for $\gamma = 1$, the slope consists of a 45° gradient.

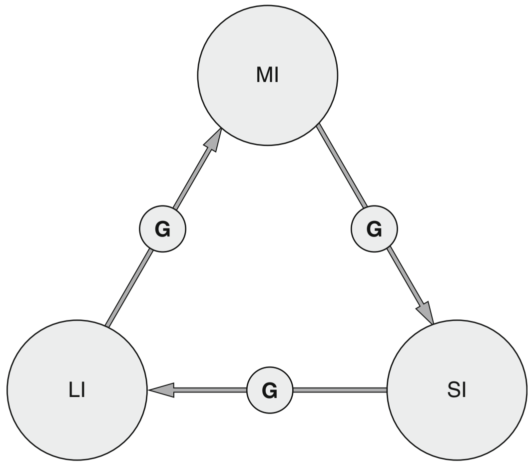
$$P(k) \sim k^{-\gamma} \tag{1}$$

In the context of Fig. 6, seemingly cyclical patterns of big surges in large-scale innovations are transformed into a highly structured configuration with a very small number of innovations with very large-scale effects – the classical long waves – and a very large number of small changes with marginal or small effects.

As a third element for the new nonlinear framework, one needs a general generative mechanism that activates the microdynamics of network actors and keeps them drifting to such a power-law configuration. These innovations of different types and sizes turn out to be generative



Nonlinear Innovations, Fig. 6 A power-law distribution of innovations at second glance (Source: Michael Eigner [WISDOM])



Nonlinear Innovations, Fig. 7 The generative relation between small-, medium-sized, and large-scale innovations across domains. *LI* large innovations, *MI* medium-sized innovations, *SI* small innovations (Source: Michael Eigner [WISDOM])

where two forms of dynamics can be distinguished.

- Pull dynamics: The first dynamic type refers to the diffusion process of innovations and to the emergence of new linkages which are due to the imitation of already available innovations.
- Push dynamics: The second type of network dynamics is focused on the creation of innovations and of the potential new linkages which are opened up by such a new innovation.

The important point here is that these push and pull dynamics generate each other. Many small-scale innovations in economic or societal domains usually lead to bottlenecks and shortages mainly in the infrastructural networks which increase the propensity for a new large-scale innovation in one of the three infrastructural networks. Likewise, a very large-scale product innovation in one of the three infrastructural networks enables a number of medium-sized as well as smaller innovations across other economic or societal domains. Additionally, small- and medium-sized innovations in emerging peripheral fields add to potential shortages in the infrastructural innovation networks. Figure 7 illustrates this generative and productive pattern between the many small, the less frequent medium-sized, and the rare large-scale innovations.

As for the generative mechanisms for the push and pull dynamics, probably the most interesting models come from complex networks (Dorogovtsev 2010; Easley and Kleiberg 2010; Jackson 2008 or Newman 2010). Here, two conditions must be met simultaneously, namely, a growth process which leads to a production of new components or nodes as well as nonrandom linkage formations which have been classified as preferential attachments.

Preferential attachments work in the case of push and pull dynamics in a trivial way (Bak 1996; Barenblatt 2003; Jensen 1996; Laughlin 2005; McComb 2004; Ong and Bhatt 2001 or Sornette 2003, 2006). Modern societies are characterized by a permanent production of new nodes, that is, new enterprises, households, and nonprofit organizations either in already existing segments or in newly emerging domains. These formations do not evolve randomly but exhibit complex systemic components. New companies are established preferably in new and hot technology fields with high profit expectations and expansion opportunities; new civil society formations or public organizations operate in new societal problem areas.

In terms of pull dynamics, network actors establish new links to already available innovations. Large-scale infrastructural innovations for railroads, for electricity, for automobiles, or for information and communication technologies (ICT), due to their comparative advantages, become attractive for a very large segment of economic or societal network actors, including especially the financial markets, as well as for the two other infrastructural networks. Moreover, in the typology of scale-free networks, the velocity of these new network formations is comparatively high.

With respect to the push dynamics, new innovation networks emerge constantly either in new peripheral areas like biotechnology, in already established innovation networks especially in the form of process innovations, or in the three infrastructural innovation networks of energy, transport, and information. These innovations provide either new solutions for bottlenecks or open new frontiers for the expansion of the overall landscape of innovation networks.

Conclusion and Future Directions: Comparative Advantages of the New Nonlinear Framework for Innovation Research

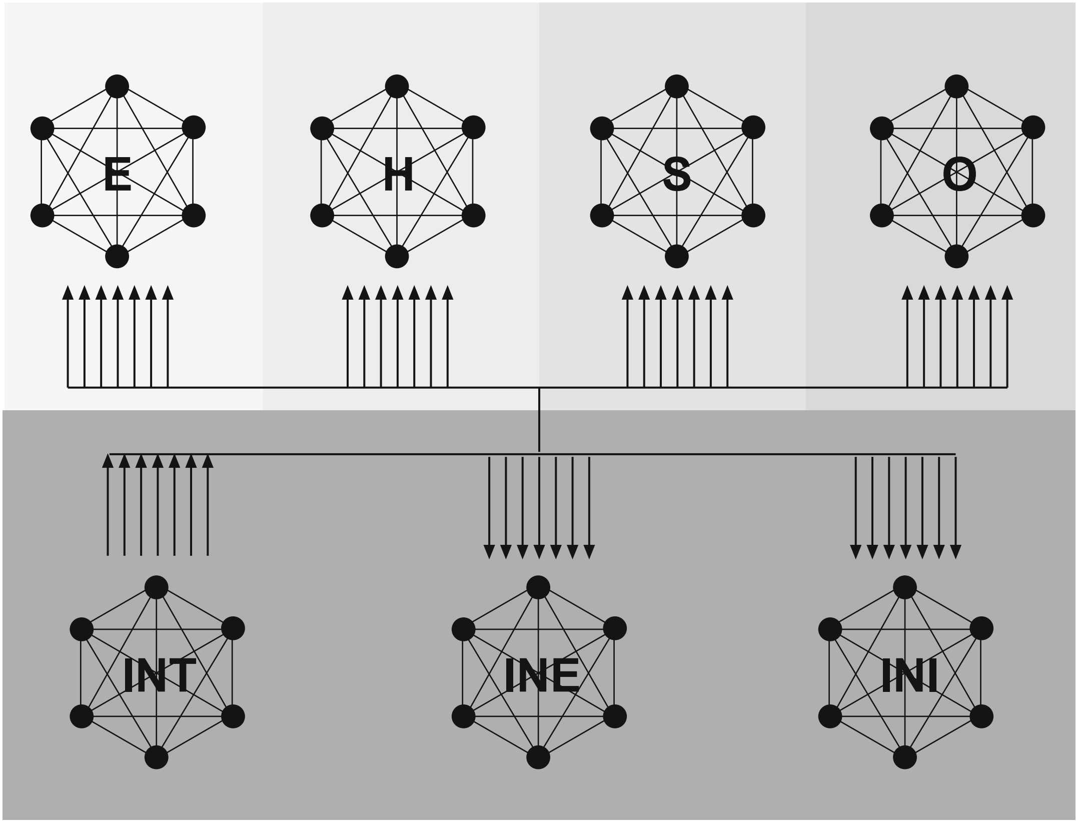
Toward the end of this entry, some of the comparative advantages of this new nonlinear innovation framework can be summarized.

Probably, one of the greatest assets of the new approach is the new distribution of generative functions between small, medium-sized, and large innovations of various types. Within the Schumpeterian paradigm, a manifold of small or medium-sized innovations only offered background noise, which was to distort or disrupt the basic crescendo (Joseph A. Schumpeter) of the long wave symphony. From the new network perspective, small, medium, and large innovation networks both reproduce and recreate each other. As a precondition of the unfolding of a large-scale infrastructural innovation, an endless number of small or marginal innovations become necessary which create the conditions for the new and large-scale innovation within the infrastructural networks in order to remove emerging bottlenecks in the societal capacities in energy, information, or material transport.

Moreover, through the new framework, it becomes clear why the industrial revolutions so far are concentrated in the three infrastructural networks of energy, transport, and information. These infrastructural domains can be described as configurations with a maximum diffusion potential, as shown in Fig. 8 (Müller 2010b). Here, IN_i ($i = T, N, I$) stands for infrastructural networks, EN for the network of economic networks, and SN for societal networks outside the economic sphere. A large-scale infrastructural innovation either in energy, information, or transport is capable of revolutionizing its own domain, other infrastructural ensembles, and the economic or societal networks. Economic or societal innovations, however, leave the available capacities in energy, information, and transport mostly unchanged and cannot, therefore, reach a maximum diffusion level.

The new perspective also exhibits a special sensitivity for processes of creative destruction and of lock-ins, for the disappearance of potentially viable alternatives, as well as for the inevitability of a crowding out of these alternatives once a new infrastructural regime has effectively started to move along its diffusion trajectory. Here, fascinating issues can be raised which, to date, have not been properly analyzed, even on a superficial level.

Another important point lies in the inhomogeneous coevolution of the three infrastructural networks of energy, information, and transport and in the role of a large innovation wave in a single infrastructural network for the development of the two other infrastructure networks. Normally, a large-scale infrastructural innovation leads to shortages and typical bottlenecks in the other two infrastructural networks, thereby creating the conditions for a new large-scale innovation in another infrastructural network with critical shortages. Historically, it becomes highly relevant that one can observe a shift from energy (steam engine) to transportation (railroads) to energy (electricity) to transportation (automobiles) and, finally, to information. Relations (2) and (3) show that a large-scale innovation wave



Nonlinear Innovations, Fig. 8 The maximum diffusion potential of an infrastructural revolution for modern societies (Source: Michael Eigner [WISDOM])

LI in a specific infrastructural network IN_i at time t lowers the probability P for another large-scale innovation in the same domain at t' (t' > t). Rather, a large-scale innovation in one infrastructural network at t increases the probability P for a new and large-scale innovation wave in another infrastructural ensemble $(IN_{j,\,t'})(i \neq j)$ at t'.

$$LI(IN_{i,t}) :< P(IN_{i,t'}) \quad (2)$$

$$LI(IN_{j,t}) :> P(IN_{j,t'}) \quad (3)$$

With respect to a large-scale innovation, it becomes one of the challenging tasks in economic history to reconstruct and recreate the diversity of alternatives and also their viability in the early phase of an infrastructural revolution. One could refer, for example, to the classical study by Robert W. Fogel (1964), who envisioned for the USA a network of channels as a possible alternative to the railroad system in the transport sector and also, albeit to a limited extent, as a viable one. Thus, the infrastructural revolution in transport was contingent and dependent on the relative strengths of the emerging networks of railroads and tracks versus steamships and canals.

Furthermore, one can point out to the centrality of the peripheries in the overall landscape of innovation networks, since the central network actors of a new infrastructural revolution are not present – or if at all, only marginally – at the beginning of the preceding revolution. Most entrepreneurs for the electrification of the world were not born nor were the technological components for the subsequent revolution available when railroads were capturing the imagination of wider circles of economy and society in the 1840s. Thus, a new infrastructural revolution operates, at first, within an empty infrastructural niche in the overall innovation space.

A further interesting point has to do with network architectures and their risk potentials. In light of the new perspective, the emergence over the past 50 years of mostly complex networks – international air traffic or the Internet – becomes a relevant topic for inquiry. Additionally, the new perspective offers a different assessment of risk potentials for historical as well as present-day societies. For example, complex networks are characterized by a higher degree of robustness with respect to the failure of randomly selected nodes. By contrast, in complex networks, the elimination of few central nodes can result in the breakdown of the entire network (Müller 2010a).

In sum, these comparative advantages of the new framework for nonlinear innovations should give rise to a stream of self-similar innovation research across different levels, ranging from the microlevels of single researchers or small innovation networks to the medium or mesolevels of organizations to the macrolevels of national, supranational, or global innovation networks (Hollingsworth and Hollingswort 2011 or Müller 1999, 2011). A general long-term perspective in innovation and technology research should no longer focus on cyclical patterns and on the recurrence of long waves. Instead, it should orient itself toward infrastructural random or complex networks, their fluctuations and accumulations, as well as the generative mechanisms, which produce and perpetuate a few large-scale innovations in the infrastructural domains of energy, information, and transport along with a larger number of medium-sized and a practically endless number of small or marginal innovations; *round and round, round and round* – endlessly and seamlessly.

Cross-References

- ▶ Business Cycles
- ▶ Creative Destruction
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Directed Evolution® Technology
- ▶ Entrepreneurial Opportunities
- ▶ Innovation and Entrepreneurship
- ▶ Multilevel Innovation Systems
- ▶ National Innovation Systems (NIS)
- ▶ Network and Entrepreneurship
- ▶ Schumpeterian Entrepreneur

References

Arthur WB. Increasing returns and path dependence in the economy. Ann Arbor: University of Michigan Press; 1994.

Arthur WB. The nature of technology: what it is and how it evolves. New York: Free Press; 2009.

Ayres RU. Did the fifth K-wave begin in 1990–92? Has it been aborted by globalization? In: Devezas TC, editor. Kondratieff waves, warfare and world security. Amsterdam: IOS Press; 2006. p. 57–71.

Bak P. How nature works. The science of self-organized criticality. New York: Springer; 1996.

Barabási AL. Linked: the new science of networks. Cambridge: Perseus; 2000.

Barabási ASL. Bursts. The hidden pattern behind everything we do. New York: Dutton Books; 2010.

Barenblatt GI. Scaling. Cambridge: Cambridge University Press; 2003.

Boyer R, Saillard Y, editors. Regulation theory: the state of the art. London: Routledge; 2002.

Buchanan M. Nexus: small worlds and the groundbreaking science of networks. New York: W. W. Norton; 2002.

Devezas TC, editor. Kondratieff waves, warfare and world security. Amsterdam: IOS Press; 2006.

Dorogovtsev SN. Lectures on complex networks. Oxford: Oxford University Press; 2010.

Easley D, Kleiberg J. Networks, crowds, and markets. Cambridge: Cambridge University Press; 2010.

Everett R. The diffusion of innovations. 5th ed. New York: Free Press; 2003.

Fagerberg J, Mowery DC, Nelson RR, editors. The oxford handbook of innovation. Oxford: Oxford University Press; 2007.

Fogel RW. Railroads and American economic growth: essays in econometric history. Baltimore: Johns Hopkins University Press; 1964.

Freeman C, editor. Long waves in the world economy. London: Butterworths; 1983.

Freeman C. Technology and economic performance. Lessons from Japan. London: Frances Pinter; 1987.

Freeman C, Soete L. Work for all or mass unemployment: computerised technical change into the 21st century. London: Frances Pinter; 1994.

Freeman C, Soete L. The economics of industrial innovation. 3rd ed. London: Frances Pinter; 1997.
Freeman C, Clark J, Soete L. Unemployment and technical innovation. A study of long waves and economic development. London: Frances Pinter; 1982.
Friedman E, editor. Ascent and decline in the world-system. Beverly Hills: Sage; 1982.
Fröbel F, Heinrichs J, Kreye O, editors. Krisen in der kapitalistischen weltökonomie. Reinbek: Rowohlt; 1981.
Gershuny J. Social innovation and the division of labour. Oxford: Oxford University Press; 1983.
Hage J, Hollingsworth JR. A strategy for the analysis of idea innovation networks and institutions. Organ Stud. 2000;5:971–1004.
Hoffmann WG. Das wachstum der deutschen wirtschaft seit der mitte des 19. Jahrhunderts. Berlin: de Gruyter; 1965.
Hollingsworth JR, Hollingswort EJ. Major Discoveries, Creativity, and the Dynamics of Science. Vienna: edition echoraum; 2011.
Hollingsworth JR, Müller KH. Transforming socio-economics with a new epistemology. Socio-Econ Rev. 2008;3(6):395–426.
Hopkins TK, Wallerstein I, editors. Processes of the world system. Beverly Hills: Sage; 1980.
Jackson MO. Social and economic networks. Princeton: Princeton University Press; 2008.
Jensen HJ. Self-organized criticality. Emergent complex behavior in physical and biological systems. Cambridge: Cambridge University Press; 1996.
Laughlin RB. A *different universe. Reinventing physics from the bottom down*. New York: Basic Books; 2005.
Leydesdorff L. The knowledge-based economy. Modeled, measured, simulated. Boca Raton: Universal Publishers; 2006.
Lundval BA. National systems of innovation: towards a theory of innovation and interactive learning. London: Pinter; 1992.
McComb WD. Renormalization methods. A guide for beginners. Oxford: Oxford University Press; 2004.
Mensch G. Das technologische patt. Innovationen überwinden die depression. Frankfurt: Fischer; 1977.
Mensch G. Stalemate in technology. Innovations overcome the depression. Cambridge: Ballinger; 1978.
Mote JE, Hage JT, Whitestone YK, Jordan GB. Innovation, networks, and the research environment: examining the linkages. Int J Foresight Innov Policy. 2008;3(4):246–64.
Müller KH. Marktentfaltung und Wissensintegration. Doppelbewegungen in der Moderne. Frankfurt/New York: Campus Verlag; 1999.
Müller KH. RISC-processes and societal coevolution: towards a common framework. In: Kajfež-Bogataj L, Müller KH, Svetlik I, Toš N, editors. Modern RISC-societies. Towards a new paradigm for societal evolution. Wien: edition echoraum; 2010a. p. 63–113.
Müller KH. Wissenschaft, Wirtschaft und Gesellschaft in Österreich: Eine dynamische Netzwerkperspektive. In: Biegelbauer P, editor. Steuerung von Wissenschaft? Die Governance des österreichischen Innovationssystems. Innsbruck: StudienVerlag; 2010b. p. 187–222. ISBN 978-3-7065-4834-2.
Müller KH. The new science of cybernetics. The evolution of living research designs, vol. II: theory. Wien: edition echoraum; 2011. ISBN 978-3-901941-16-0.
Nelson RR, editor. National innovation systems: a comparative analysis. Oxford: Oxford University Press; 1993.
Nelson RR. Technology, institutions and economic growth. Cambridge: Harvard University Press; 2005.
Nelson RR, Winter SG. An evolutionary theory of economic change. Cambridge: Harvard University Press; 1982.
Newman M. Power laws, Pareto distributions and Zipf's Law. Contemp Phys. 2005;46:323–51.
Newman MEJ. Networks. An introduction. Oxford: Oxford University Press; 2010.
Newman M, Barabási AL, Watts DJ, editors. The structure and dynamics of networks. Princeton: Princeton University Press; 2006.
Ong NP, Bhatt RN, editors. More is different. Fifty years of condensed matter physics. Princeton: Princeton University Press; 2001.
Schumpeter JA. Theorie der wirtschaftlichen Entwicklung. Eine Untersuchung über Unternehmergewinn, Kapital, Kredit, Zins und den Konkunkturzyklus. 5th ed. Berlin: de Gruyter; 1952.
Schumpeter JA. Konjunkturzyklen. Eine theoretische, historische und statistische Analyse des kapitalistischen Prozesses, vol. 2. Göttingen: Vandenhoeck&Ruprecht; 1961.
Schumpeter JA. Kapitalismus, sozialismus und demokratie. 4th ed. München: UTB; 1975.
Schumpeter JA. Business cycles. A theoretical, historical and statistical analysis of the capitalist process. Philadelphia: McGraw-Hill; 1989.
Sornette D. Why stock markets crash: critical events in complex financial systems. Princeton: Princeton University Press; 2003.
Sornette D. Critical phenomena in natural sciences: chaos, fractals, selforganization and disorder: concepts and tools. 2nd ed. Berlin: Springer; 2006.
Spree R. Die Wachstumszyklen der deutschen Wirtschaft von 1840 bis 1880. Berlin: Duncker & Humblot; 1977.
Utterback JM. Mastering the dynamics of innovation. Harvard: Harvard Business Press; 1996.
Watts DJ. Small worlds: the dynamics of networks between order and randomness. Princeton: Princeton University Press; 1999.
Watts DJ. Six degrees: the science of a connected age. New York: W. W. Norton; 2003.
Watts DJ. The 'New' science of networks. Annu Rev Sociol. 2004;30:243–70.
Weidlich W. Sociodynamics. A systematic approach to mathematical modeling in the social sciences. London: Taylor & Francis; 2000.
Weidlich W, Haag G. Concepts and models of a quantitative sociology. The dynamics of interacting populations. Berlin: Springer; 1983.

Non-Research-Intensive Entrepreneurship

► Low-Tech Entrepreneurship

Norms

► Gender and Innovation

North–South Economic Integration

► From Personal to Impersonal Exchange in Ideas

Novel

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Novelty

► Cognition of Creativity
► Creativity and Emotion

Novelty Creation

► Invention and Innovation as Creative Problem-Solving Activities

Novice

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Novology

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Definition

Novology is the science of newness.

Introduction

The number of research works on creativity and innovation has been growing exponentially. G. Wallace (Wallas 1926) is credited with the first research on creativity and J. Schumpeter, with offering the term "innovation" (Schumpeter 1942, see the Russian article Инноватика in Wikipedia). Researchers, studying creativity (see, e.g., the history of creativity research in Albert and Runco 1999) and innovation, often operate in the realm of intuition because the sciences of creativity and innovation are still in the process of development (See ► Science of Creativity). This statement directly applies to the concept of newness, the meaning of which (*new, novel, innovative*, etc.) is widely used for both creativity and innovation definitions, but has never been categorized. It has become clear that efforts to build sound theories on creativity and innovation may be wasted without understanding the concept of newness as a founding phenomenon. On the other hand, if the founding concept of newness is formalized, this may give a boost to both creativity and innovation research.

Since newness is ontologically present everywhere in nature, it lends itself to research. The challenge for the researcher is to develop concepts and laws that will apply universally. The goals are to discover the general mechanism of newness existence, to formulate the laws of newness production/consumption, to find ways to accelerate the process, and to predict the future directions of research. That is what novology, the science of newness, does. Novology gives one general explanation for various phenomena, thus making the domain of newness easier to comprehend.

History

Novology, the science of newness, was first introduced in 1991 in Russian, then briefly described in English (Aleinikov 1999a, 2001), and finally detailed in a separate article in 2002 in a monograph by presenters for the Dr. E. Paul Torrance Annual Lecture Series 2000, Athens, Georgia, where the author was a keynote speaker (Aleinikov 2002a).

New Science

Traditionally, every new science begins from gathering empirical data. This initial stage of gathering information is not yet a science, but the first step to it. Only after the accumulation of some data, the first patterns are recognized and the first experiments are carried out. When these patterns and experiments are explained, a theory evolves, then another one. When theories are combined and united into one logically acceptable system, when data is measured and calculated, science emerges. This science usually explains numerous features or regularities by one or several laws and makes reality image compacted and, therefore, comprehensible, teachable, and reproducible. That is the economy of force principle acting everywhere, including science. The final step for a science to be proven a science is to have specific results (broadening the vision of the world for humanity) and to foresee the future since a science should save humankind from troubles, problems, and challenges by explaining the past, better organizing the present, and predicting the future.

Novology: The Science of Newness

Creativity has many definitions, and hundreds of them are collected and published (Aleinikov et al. 2000, Treffinger 1995; See ► Creativity Definitions, Approaches). Most of them state that creativity is the generation of novel and useful ideas. The main concept in the traditional vision of creativity is the notion of "new" (*novel, innovative*). Creativity, as it was and is understood by the majority of people, is about generating *new* ideas, producing *new* concepts, inventing *new* objects and processes, etc. Note that the words, which are most frequently used in the definitions of creativity, are used in other fields of research. For example, the words "generation" and "ideas" belong to the field (and the science) of psychology. The words "useful" and "usefulness" belong to the field (and the science) of pragmatics. However, the words "new" and "newness" in the definition of creativity do not have a science to relate to. Accidentally or not, these words are also widely used in another field – the innovation field (see some classics like Rogers 1962; von Hippel 1988; as well as the creativity and innovation bibliography at the International Center for Studies in Creativity, Buffalo State College, the cradle of creative education in the USA). Except for some fragmentary analysis at the dictionary and etymology level, there is no explanation to the concept of new. It means that the words "new" and "newness" have never been categorized, that is, scientifically shaped to be terms. They are still used on the intuitive or prescientific level.

The Encyclopedia of Creativity, an outstanding collection of research (Runco and Pritzker 1999), does not offer any article on newness. On the other hand, every business emphasizes innovation. Books on innovation are in the hundreds and articles in the thousands. Empirical research that employs the concept of newness (see, e.g., "'*Newness*' and the risk of occupational injury" or "Small social groupings and the emergence of *newness*") clearly demonstrates that practical cases require theoretical reflection, thus corroborating the general statement "practice requires a theory (a science)." The Internet and non-Internet organizations promoting innovation and researching innovation are becoming increasingly popular. In the last decades, the topics of creativity and innovation have become so common for business, education, and social life that it is becoming obvious – there is a need for a science. Moreover, the International Creativity Day is now celebrated, and this century is sometimes called "the Century of Creativity and Innovation." It is time to provide a scientific explanation for all of the above-mentioned phenomena.

As all other well-established sciences, a new science includes the following elements:

- Name
- Objective
- Specific subject of study
- Classification
- Units of measurement
- Specific methods and results
- Laws
- Predictions

For novology, these elements have been defined as following:

Name

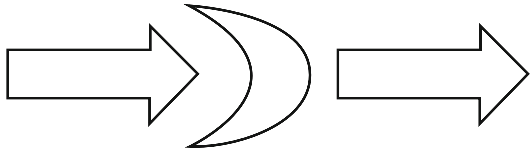
The term "novology" was selected from a list of candidates. The root *nov* comes from Latin *novus* which means *new*. The second part -*logy* comes from Greek *logos – word, study of*. The term novology was selected because it is short (which is important for any scientific name, especially the name of a science) and it follows the model of other, well-established sciences like geology, biology, psychology, mythology, graphology, and morphology.

Objective of Novology

The objective of novology is to make newness (novelty) described, understood, classified, calculated, and consequently increased. For example, chemistry increased the speed of production processes because it helped to describe, understand, and calculate the regularities of combining atoms of certain substances into molecules of other (new) substances. The same happens with all other sciences.

Newness as Subject of Study

Newness is a quantitative or qualitative difference caused by change and causing change. The essence of newness is reflected by the model in Fig. 1.



Novology, Fig. 1 Newness as a result of change and cause of change

If change is depicted as an arrow on Fig. 1, then every instance of newness exists between the change that caused newness (left arrow) and the change this newness causes (right arrow).

However, to make the process more complete, it has to show the previous and the next stages of change, as in Fig. 2:

Newness illustrated on Fig. 2 is the difference between State 2 and State 1, as well as between State 3 and State 2 separated by the arrows of change. Mathematically (quantitatively), newness (N) is the difference (delta) between the states $N_1 = \Delta\ S_2 - S_1$. Also, $N_2 = \Delta\ S_3 - S_2$.

Figure 2 shows the quantitative change: from 1 object to 2 objects and then to 3 objects. Newness could also be a qualitative change like the change of color in Fig. 3:

Figure 3 illustrates the color change of the object from white (left) to gray (middle) and black (right). Arrows illustrate the change.

The change may also be a form change, while the number and the color remain the same as in Fig. 4.

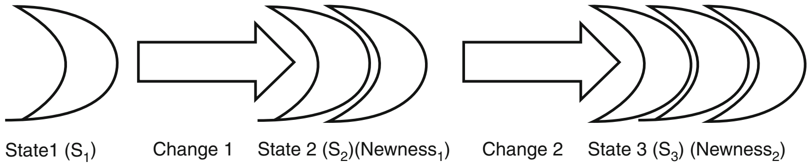
The shape (object shown on the left) on Fig. 4. undergoes change (arrow) and becomes bigger (middle), then it undergoes another change (arrow) and becomes bigger again (right).

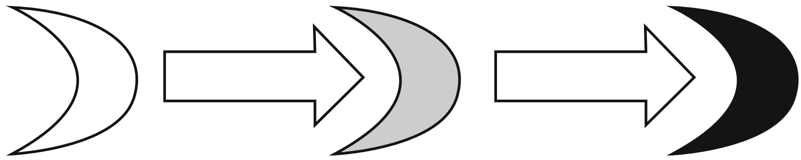
In addition to number, color, and shape, there may be a change in position, as it is shown in Fig. 5.

The same shape (object on the left) under the influence of change (arrow) depicted on Fig. 5 makes a clockwise rotation resulting in a position switch (middle), and then after the second change (arrow) makes another clockwise position switch (right).

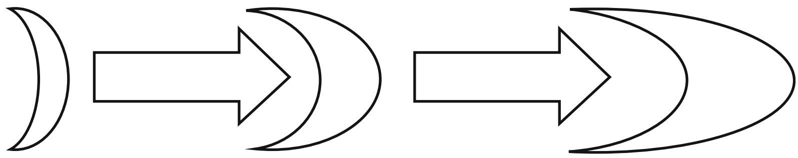
These are the examples of only basic types of newness intuitively known since childhood, but

Novology, Fig. 2 Stages of newness

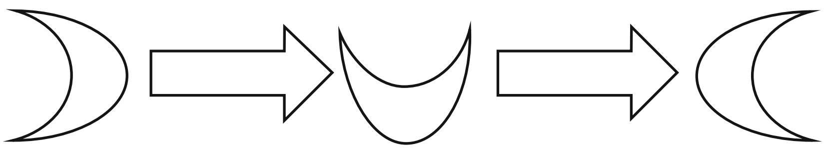




Novology, Fig. 3 Change in color



Novology, Fig. 4 Change in form



Novology, Fig. 5 Change in position

the amount of calculated newness will be different when only one change is applied or 2, or 3, or 4, or 5 at once. Calculations should show the difference in newness of the object depending on the amount of change.

Newness as a concept is based on the word "new." The form of the word "new" goes back to Greek *neos*, that appeared in English as *new* but also exists in the altered forms like *nei* – for example, in *misoneism* meaning "hatred to the new" (from Greek *misein* hatred + *nei* coming from *neos*). The word "novel" goes back to Latin *novus* "new." The derivatives from both the Greek and Latin language stems are numerous: neology, neologism, neocortex, neophil, neologize, neophyte, Neolithic, nova, supernova, novel, novate, innovate, innovation, novelize, renovate, etc. On the other hand, the sema (minimum unit of meaning) of "new" exists in hundreds of other words which seemingly in their form have nothing to do with the above-mentioned Greek and Latin roots. This sema *new* certainly exists in the following words: fresh, unused, inexperienced, original, additional, recent, modern, further, extra, other, raw, immature, untried, untouched, unfamiliar, changed, altered, mutated, different, converted, unskilled, unconventional, etc. All these words describe or denote some kind of newness, or some essence of newness appearing in numerous phenomena. This essence may be explicit (in the root) or implicit (hidden).

Newness as a phenomenon exists everywhere: new photon, new collision of elementary particles, new star, new baby elephant (or any baby), new generation of butterflies, etc. Particles change trajectories and collide. Atoms lose and acquire electrons, get into combinations, and form molecules. Molecules grow and change. Organisms reproduce and mutate. Nature is a huge pool of interacting objects and forces. Nature experiments in its natural labs using natural resources. Successful (productive) newness spreads within the physical, chemical, biological, and social domains. Those new processes, new objects, and new features which are more able (faster, stronger, better camouflaged, or accommodated, more flexible, etc.) survive and disseminate; the others perish.

In the human activity domain, newness may be both suppressed and cultivated, but the production of the new accelerates immensely. It begins to acquire a faster and sometimes even planned character. Language and instruments become the powerful force of change. Individuals, as social beings, come to an understanding that it is newness that allows them to survive. A wheel, a spear, a bow, a fishing rod, a plow, a machine – all these and millions of others are the steps in this survival. Original decisions at work or in the battle, new tools or new weapons, new strategies or new tactics, new technical decisions and new production lines, new educational equipment, new methods, and new policies – all serve for the benefit and survival of certain societies or social groups. Truly, creativity is the process of accelerated generation of newness (on the psychological level), and innovation is the process of consumption of the generated newness (on the social level). The more open the society is for accepting the new, the faster it will grow and develop.

In general, everything in this world is, was, or will be new. Everything, never mind what people are talking or thinking about,

- Comes into existence (appears *anew*)
- Grows (shows *new* features, sizes, colors, etc.)
- Matures (climbs to *new* peaks of development)
- Ages (acquires *new* features, or loses *new* features)
- Disappears or dies (turns into a *new* state).

The Big Bang theory states this universe started one moment some thirteen–fifteen billion years ago as a huge explosion. The religious point of view and creationism state God created the world. The creation myths in different ethnic origins describe the world birth. What remains invariable in all approaches, however, is that this world somehow came into existence – it was born, it started *anew*, it was *new*, and it is *new*.

The *new* as a subject to study was in this world from the beginning. It is interesting that nobody noticed such an obvious subject to study.

Classification of Newness

Classification is conventionally the first step to transforming the gathered data and descriptions into collections, studies, and theories. Sciences generalize the data about reality and divide this data into classes, subclasses, types, subtypes, etc.

Classes: Material or Ideal

The most general category for classification is material versus ideal newness. Any newness occurring in the objective world, environmental change, growth of trees, grass, animals, buildings, and so on – every tangible change – constitutes material newness. Any newness occurring in the subjective world, ideas, images, concepts, etc. – every intangible change – constitutes ideal newness. These classes contain some subclasses and sub-subclasses, but this is beyond the scope of this entry.

Types: Natural or Artificial

Another major differentiation of newness is types of newness. The two basic types are natural newness (produced in nature and naturally) and artificial newness (produced by human beings or human society).

Levels: Function, Substance, and Structure

The next division of newness on the way down from philosophical heights (abstracts) to the ground-level practicality (concreteness) is the so-called general systems theory (L. von Bertalanffy and others after 1930s). This approach has discovered that all objects, processes, and organisms are systems having structures, elements (substance), and functions. Therefore, from the systems point of view, novology must differentiate functional newness, substance newness, and structural newness. Illustrations are numerous. For example, the same object can be used for various functions (functional newness). Also, the same structure can be manifested in various substances, like wood, brick, and metal (substance newness). Finally, changing the structure itself (relations between elements) constitutes structural newness. These differentiation levels may have sublevels within.

Stages of Newness

One more important parameter of classification is the aspect of time. Changes in general include certain stages: appearing, growing, culminating, decreasing, and disappearing – all within a certain time range. Consequently, newness may be of different stages and substages within these stages.

Forms of Newness

According to the way newness is manifested, novology distinguishes forms of newness: latent (hidden) versus open, and within open, it may be emphasized versus non-emphasized. So forms and subforms of newness may be analyzed.

Layers of Newness

Depending on the step in the movement from objective (material) to subjective (ideal), there may be different layers of newness. The layers of reflection that exist in any reflecting system, including the human mind, may be used as an example. These layers can be identified and even divided further into sublayers. The language activity, consisting of multiple layers of understanding and analysis (reflection), is a good example. Newness certainly can exist in any of these layers.

Patterns in Varieties

As a result of classification effort, people must deal with classes and subclasses, types and subtypes, levels and sublevels, layers and sublayers, forms and subforms, and stages and substages of newness. It must be already a six-dimensional matrix to embrace the varieties of newness. What is more important, this is not the final list: it is rather open than not. Therefore, multidimensional matrices are used for newness classification.

Units and Measurements

The fields of research become sciences when they acquire calculations. Calculations make the research results testable (measurable) and repeatable.

Linguistics, a very well-structured field of research, illustrates how it can be done, and novology follows the modus operandi. Just as phoneme (Greek *phone*- "sound" + *eme* "unit") is the basic unit of phonology, morpheme (Greek *morphe*- "form") is the basic unit of morphology, lexeme (Greek *lexis*- "word") is the basic unit of lexicology, and sememe (or seme, Greek *sema*- "sign") is the basic unit of semantics, novology creates its own basic unit called *noveme*.

As phonemes in phonology are divided into vowels and consonants, novemes are divided into:

- Qualitative units (qualitemes)
- Quantitative, or measurement units (quantemes)

  Quantemes are divided into:
- Obnov (*ob*jective *nov*elty) for measuring the quantity of objective newness
- Subnov (*sub*jective *nov*elty) for measuring the quantity of subjective newness

  The qualitative units (qualitemes) include:
- Shifteme (newness within the paradigm)
- Transeme (newness of paradigm switch)
- Leapeme (jump over paradigms)
- Revolueme (revolutionary switch from one set of paradigms to another set of paradigms)

Special Instruments: Methods and Techniques

The history of humanity shows that the most impressive results are often achieved not by pure force, pure power, or harder training, but by genuine bright idea and by new method or technique. For instance, never mind how sharp a human eye sight is and how strong one's desire for star counting is, a telescope invented by Galileo leaves all unarmed eye observations in dust.

So what are these special instruments offered by novology?

- The quantitative and qualitative analysis of newness introduced above is an instrument.
- The new definitions of creativity and innovation (Aleinikov 2000) are tools for new research.
- The new models (like a four-side universal model of sign, language consciousness, speech act, and heuristic act) are instruments (Aleinikov 1994).
- The regularities and laws of newness existence (Aleinikov 2002a) are instruments of understanding and accelerating newness production.

With the help of these scientific instruments (just like with the help of telescopes and microscopes), humankind is now able to disassemble and assemble reality, to manipulate the elements of this reality to make it work faster and thus achieve better results in a shorter period of time. Creativity is ectropy accelerator (see ► Creativity). Moreover, creativity in the field of science, like this particular case of creating a new science for improving the study of creativity and innovation, is a meta-accelerator.

Laws of Novology

Novology offers five laws for the science of newness:

- The 1st law: Newness exists as an objective phenomenon – it exists as the changing nature's aspect.
- The 2nd law: Newness is the result of change and the cause of change; it never appears from nowhere or nothing, and it never disappears without a trace.
- The 3rd law: Newness is instrumental: the faster the production of newness, the higher the probability of surviving and succeeding.
- The 4th law: Newness is functionally oriented: the higher the system in the hierarchy of nature development, the higher the necessity to produce newness.
- The 5th law: The inter-function of newness production is organization: the higher the speed of producing newness, the larger its influence on world organization.

Examples of these laws working in nature are numerous, but the volume of this entry sets restrictions.

Specific Results and Predictions

Novology describes theoretical and practical results achieved due to the introduction of a scientific category of newness. One of them is the development of the creative output measurement (new unit) and, as a consequence, the development of the most powerful methodologies in creative output – BAMMA (Brainstorming Advanced by Morphological Matrix Analysis), allowing a leap to MegaCreativity (Aleinikov 2002b). Another significant result is the design of most accelerated methodologies of changing human behavior in education – Genius Education Methodology (Aleinikov 2002b). Novology also forms a number of predictions. It foresees the formulation of a new vision (worldview), formation of new languages and sublanguages for its description, new methods of reality changing, new types of education, and even new objections to novology as a science. But more importantly, novology paves the way to the creation of the science of creativity, whether it is called sozidonics (Aleinikov 1994) or creatology (Magyari-Beck 1999), as well as innovatics (Rus. инноватика) and/or any other science studying innovation.

Conclusion and Future Directions

Novology, the science of newness, is a further step in understanding creativity and innovation (see ► Creativity and Innovation: What Is the Difference?), united by the underlying category of newness. When newness becomes measurable, both creativity and innovation acquire the fundamentals necessary for being understood deeper, described more precisely, and reflected scientifically. Newness, as a vast subject of study, receives a system of terms and laws to reflect it. Novology, on the other hand – as a system of study that has its specific name, objective, subject of study, instruments of research (methodologies, methods, and techniques), its own classification and units of measurements, specific results (never achieved by other sciences), and its own predictions of the future – has the full right to be called a science.

The new science of novology, in addition to the new vision of newness and new definitions of creativity and innovation, creates the gnosiological foundation necessary to move further in understanding complex psychological and social phenomena. It opens new horizons for future investigators and researchers in science, technology, business, and education, political, economical, and social life. It will be applied to the evaluation of most advanced scientific discoveries and technological inventions (see ▶ Invention Versus Discovery) for committees like Nobel Prize or McArthur Foundation with its "genius" fellowship. Novology must develop tools for selecting the technological trends because a single mistake can be costly not only for the company but also for the country. One of the most important directions is also education where novology has to apply its tools to determining the amount of newness needed for various groups for them to reach the level of genius (see ▶ Genius), to become ideal learners (see ▶ Creative Pedagogy), or to stay at least successful students on all levels of education. This alone can solve numerous educational problems because when some students are ready to move forward, the others cannot still digest the amount of newness in the given material, so they protest, they revolt, they quit, etc. Novology is a must for future evaluations in advertising (now done on the intuitive level) where millions of dollars can be saved or earned by calculating the precise amount of newness needed to influence the viewer/listener most effectively (see ▶ Business Creativity). Finally, novology has a huge potential for political campaigns to determine the newness of the given platform and to help politicians shape a better program to lead to the future with most innovative ideas (see ▶ Creative Leadership).

Cross-References

▶ Business Creativity
▶ Creative Leadership
▶ Creative Pedagogy
▶ Creativity and Innovation: What Is the Difference?
▶ Creativity Definitions, Approaches
▶ Genius
▶ Invention Versus Discovery
▶ Science of Creativity

References

Albert RS, Runco MA. A history of research on creativity. In: Sternberg RJ, editor. Handbook of creativity. Cambridge: Cambridge University Press; 1999.

Aleinikov AG. Sozidolinguistics for creative behavior. J Creative Behav. 1994;28(2):107–23.

Aleinikov AG. Mega-creator: from creativity to mega-, giga-, and infi-creativity. Montgomery: MIMII; 1999a.

Aleinikov AG. Humane creativity. In: Runco MA, Pritzker SA, editors. Encyclopedia of creativity, vol. 1. San Diego/London/Boston: Academic; 1999b. p. 837–44.

Aleinikov AG. Novology: The hunt for newness. In: Coste TG, editor. Creative Odyssey. Mind. Body. Spirit. St. Paul, MN: American Creativity Association; 2001. p. 49–53.

Aleinikov AG. Novology, the science of newness for creativity and innovation research. In: Aleinikov AG, editor. The future of creativity. Bensenville: Scholastic Testing Services; 2002a.

Aleinikov AG. Mega creativity: five steps to thinking like a genius. Cincinnati: Walking Stick; 2002b.

Aleinikov AG, Kackmeister S, Koenig R. Creating creativity: 101 definitions of creativity. Midland: Alden. B Dow Creativity Center Press; 2000.

Magyari-Beck I. Creatology. In: Runco MA, Pritzker SA, editors. Encyclopedia of creativity, vol. 1. San Diego/London/Boston: Academic; 1999. p. 433–41.

Rogers EM. Diffusion of innovations. New York: Free Press; 1962.

Runco MA, Pritzker SA, editors. Encyclopedia of creativity. San Diego/London/Boston/New York/Sydney/Tokyo/Toronto: Academic; 1999.

Schumpeter JA. Capitalism, socialism, and democracy. London/New York: Routledge; 1942.
Treffinger DJ. Creativity, creative thinking, and critical thinking: In search of definitions. Sarasota, FL: Center for Creative Learning; 1995.
Von Hippel E. Sources of innovation. New York/Oxford: Oxford University Press; 1988.
Wallas G. The art of thought. New York: Harcourt Brace; 1926.

N-Tuple of Helices

Loet Leydesdorff
Amsterdam School of Communication Research (ASCoR), University of Amsterdam, Amsterdam, The Netherlands

Synonyms

Complex dynamics

Definition

As a generalization of a biological double helix and an institutional triple helix, the *n*-tuple of helices is based on Luhmann's distinction of symbolically generalized media and codes of communication that can be functionally differentiated as the economy, polity, science, etc.

In response to Carayannis and Campbell's (2009) introduction of a Quadruple Helix and the further extension to a Quintuple Helix by Carayannis and Campbell (2010), Leydesdorff (2012) argued that an *N*-tuple of helices can be expected in a pluriform and differentiated society. The metaphor of a Triple Helix (TH) of university-industry-government relations (Etzkowitz and Leydesdorff 2000) more or less invites proposals to extend the model to more than three helices.

In a discussion which focused on bringing "society" or "the public" back into the model as a fourth helix, Leydesdorff and Etzkowitz (2003) argued that the helices represent specialization and codification in function systems which evolve from and within civil society. A pluriform "society" is no longer coordinated by a central instance, but functions in terms of interactions among variously coded communications. Money, for example, can be considered as a prime example of a symbolically generalized medium of communication (Parsons 1968): It enables us to pay without having to negotiate the price of a commodity. Power, truth, trust, and affection are other "performative" media (Luhmann 1975, 1995).

Following Merton (1957), Luhmann (1995) historicized the possible functionalities in social communication in terms of "performative" media. For example, one can raise the question of whether a new code has emerged at the interface between the sciences and the economy since patents became increasingly organized at the interfaces as a vehicle for the protection of intellectual property rights (Leydesdorff 2008). Simon (1962, p. 478) conjectured that any complex system operates with an alphabet. Thus, there may be 20+ symbolically generalizable media of communication available in interhuman interactions. While this plurality of codes can be expected to resound latently in interhuman interactions, some of the codes of communication can be specifically deselected in institutional settings. A discourse in court, for example, is structured differently from a scholarly discourse.

The differences in meaning provided in the various communications can be translated by reflexive (human or institutional) agency. From this systems perspective, communicative competencies thus are developed in the plural (cf. Habermas 1981; Leydesdorff 2010). University-industry-government relations, for example, can be expected to flourish when all partners in the arrangement are provided with feedback from the interactions meaningfully to their own further development.

In a knowledge-based economy, in other words, one should not only optimize the retention of "wealth from knowledge," but also nourish the generation of further research questions from social and economic demand. Variety is required in the different dimensions of a triple or *n*-tuple helix so that differently coded discourses can select upon each other and interact (Ashby 1958).

One may wish to move beyond the Triple Helix model with three relevant selection environments, but every further dimension requires substantive specification, operationalization in terms of potentially relevant data, and sometimes the further development of relevant indicators (Leydesdorff and Sun 2009).

Cross-References

► Innovation Systems
► Triple Helics

References

Ashby WR. Requisite variety and its implications for the control of complex systems. Cybernetica. 1958;1(2):1–17.

Carayannis EG, Campbell DFJ. 'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem. Int J Technol Manag. 2009;46(3):201–34.

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation, and environment relate to each other? Int J Soc Ecol Sust Dev. 2010;1(1):41–69.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and 'mode 2' to a triple helix of university-industry-government relations. Res Policy. 2000;29(2):109–23.

Habermas, J. Theorie des kommunikativen Handelns. Frankfurt a.M.: Suhrkamp. 1981.

Leydesdorff L. Patent classifications as indicators of intellectual organization. J Am Soc Inform Sci Technol. 2008;59(10):1582–97.

Leydesdorff L. Communicative competencies and the structuration of expectations: the creative tension between Habermas' critical theory and Luhmann's social systems theory. Complicity Int J Complexity Educ. 2010;7(2):66–76. http://ejournals.library.ualberta.ca/index.php/complicity/article/view/8915.

Leydesdorff L. The triple helix, quadruple helix,. . ., and an N-tuple of helices: explanatory models for analyzing the knowledge-based economy? J Knowl Econ. 2012;3(1):25–35. doi:10.1007/s13132-13011-10049-13134.

Leydesdorff L, Etzkowitz H. Can "the public" be considered as a fourth helix in university-industry-government relations? report of the fourth triple helix conference. Sci Public Policy. 2003;30(1):55–61.

Leydesdorff L, Sun Y. National and international dimensions of the triple helix in Japan: university-industry-government versus international co-authorship relations. J Am Soc Inform Sci Technol. 2009;60(4):778–88.

Luhmann N. Einführende Bemerkungen zu einer Theorie symbolisch generalisierter Kommunikationsmedien. In: Soziologische Aufklärung, vol. 2. Opladen: Westdeutscher; 1975. p. 170–92.

Luhmann N. Social systems. Stanford: Stanford University Press; 1995.

Merton RK. Social theory and social structure. Rev. ed. Glencoe: The Free Press; 1957

Parsons T. Interaction: I. Social interaction. In: Sills DL, editor. The international encyclopedia of the social sciences, vol. 7. New York: McGraw-Hill; 1968. p. 429–41.

Simon HA. The architecture of complexity. Proc Am Philos Soc. 1962;106(6):467–82.

O

Observation

▶ Strategic Scanning of SME

Observe

▶ Invention Versus Discovery

Online Role Playing Game

▶ Alternate Reality Games as Inventions

Open Business Model

▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies

Open Business Models

▶ Open Innovation and Entrepreneurship

Open Creativity

▶ Creative Collaboration

Open Innovation

▶ Innovations of and in Organizations
▶ Patents and Entrepreneurship
▶ Technology Push and Market Pull Entrepreneurship

Open Innovation and Entrepreneurship

Brigitte Gay
University of Toulouse, Toulouse Business School, Toulouse, France

Synonyms

Growth; Networks; Open business models

Global Interorganizational Networks and the Embeddedness of Open Business Models

Entrepreneurs have to keep up today with an ever more complex, global, and dynamic environment. The term "global innovation arms race" was used to highlight the competitive pressure that forces firms to accelerate their rates of innovation in products, services, and business models to keep up with others. The sale, licensing, and trading of technology has hence become a

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large-scale activity. Recent data demonstrate that the number of alliances per firm has indeed gone up significantly, and it is common for large firms to manage over 500 alliances simultaneously (Hagedoorn et al. 2005). Firms have also to face the increased pressure for short-term yields coming from private equity funds backed by investment banks, asset management firms, and hedge funds.

Networks are ubiquitous in the real as well as in the financial economy. Entrepreneurs and their firms are therefore tied through legal binding agreements to complex and ever-varying networks of agents, as they operate within interrelated spheres, the real economy and financial capitalism, and therefore between innovation and finance (Gay 2011).

By opening its business model through economic transactions, a company can be more effective in creating as well as capturing value. Firms thus leverage other companies' assets but also let other organizations leverage their assets. They are hence constrained by the continual moves of others, the different networks they are embedded in playing an important role in influencing their performance as shown in a number of studies. A common proposition is also that firms' differential positioning within a network structure has an important impact on resource flows and hence on their performance.

Moreover, there is but one type of firm populating our modern-day changing environment spurred by intense and global competition. Companies are in reality predominantly quite small and short-lived, coming and going on a much smaller time scale than large firms. Interestingly, small firms are much more innovative than their larger counterparts (U.S. Small Business Administration 2006). When firms operate within global enmeshed networks, the question arises as who actually benefits from innovation. Who harvests the value highly innovative firms led by risk-taking entrepreneurs create?

Though the importance of networks and of central positioning for firm performance is generally acknowledged, small companies, and particularly start-ups, depend heavily on deal flows and contracts with dominant market players for performance as well as on venture capital strategic financing.

Consequently, entrepreneurs can only infer the outcomes of their small innovative firms if they understand the different global networks within which they operate as well as the open business models their dominant partners use to capture value/innovation as they interact with, or invest in, smaller entrepreneurial firms. A small set of examples borrowed from the pharmaceutical industry are used in this chapter to represent the dynamics of the open business models of large venture capital firms and major pharmaceutical companies as they maneuver in this industry. Even though the strategies used by venture capital firms and large pharmaceutical companies are quite different, both categories of players use networks of alliances as a "wheel" to rapidly grab value in the form of open innovation as it is produced by smaller firms. Small biotech companies are little more than commodities for both major venture capital firms and dominant pharmaceutical companies. Pharmaceutical, biotech companies, and life science venture capital are intertwined in networks, but their fate is not. Open innovation seems to benefit essentially larger players whether they belong to the financial or to the real sphere.

The Business Logic of Open Innovation: Interdependency and the "Buy Side"

The business model is an important construct in entrepreneurship research. Various perspectives exist regarding the definition, nature, structure, and evolution of business models (see Morris et al. 2005, for a unified viewpoint). This work focuses on the open business perspective epitomized by Chesbrough (2003, 2007) which starts with the statement that open systems are today more successful than closed systems.

The first function of a business model, creating value, as summarized by Chesbrough (2007), requires the definition of a series of activities or value chain (from raw materials through to the final customer) that will lead to a new product or service; value being added as each step of the value chain is processed. The second function which is to capture a portion of that value requires that the firm has one or more unique assets within the value chain allowing the firm to enjoy a competitive advantage (Chesbrough 2007).

A business model is thus in essence a "system that is made up of components, linkages between the components, and dynamics" (Afuah and Tucci 2000). Zott and Amit (2009) conceptualized a firm's business model as a system of interdependent activities that transcends the focal firm and spans its boundaries. Value creation arises from multiple sources and relates to strategic network theory (Jarillo 1995) and cooperative strategies (Dyer and Singh 1998). An open perspective on the business model therefore also implies a system perspective. The further firms open their boundaries, the further they become at the same time interdependent and embedded within complex networks of interactions.

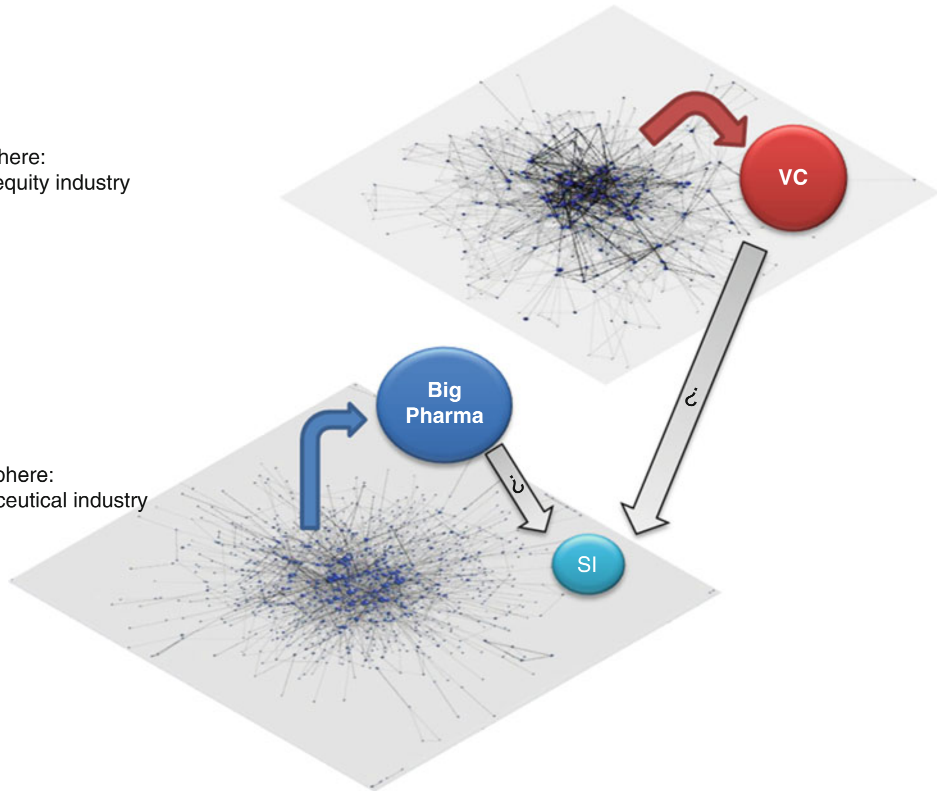
Moreover, as clearly stated by Chesbrough (2003), open business models are in fact about dividing the work of innovation. Business success depends on capturing external resources or creating value that can be used internally and/or placed into other firms' business models. The premise is that powerful advantages will be conferred to any firms willing to open their business models. This is however especially evident for firms profiting from other firms' innovation. Open business models indeed attack the cost side (rising development costs) by leveraging external R&D resources and the revenue side by licensing external technologies or products worldwide. These models are also more efficient to show shareholders a return on R&D investments. Therefore open business models that leverage external research and development resources work best. Indeed, when briefly summarizing the open innovation principles or "new rules of the new realities," as elaborated by Chesbrough (2003), the core of the model resides in that firms should leverage innovation outside ("not all the smart people work for us . . . External R&D can create significant value . . .. We don't have to originate the research to profit from it . . . Building a better a better business model is better than getting to market first . . ."). Openness is then mostly a strategy that allows rapid access to valued innovation worldwide while reducing operating costs and removing supply chain dependencies. The benefits of open systems cannot possibly accrue equally to the other side, that is, that of the sellers or young companies that can base openness only on their new, often unproven, technology. Moreover the business models of their partners affect necessarily young innovative companies.

The Strategy of Open Innovation: How Big Players Operate Within and In-Between Networks

Open business models are not made in isolation. As firms interact with one another, they weave an ever-changing network of interactions into which they embed themselves and which may constitute an asset or a liability. For any company, the interdependency of the many "open" business models at play needs to be understood. A firm immerged in connected worlds can master its own business model only if it realizes that the business models of its partners can have a significant impact on its own performance and survival.

The biopharmaceutical industry is a clear example of an industry where the open innovation paradigm is in place (Chiaroni et al. 2009). However, very few biotech companies have demonstrated the ability to sustain profits in this very difficult industry (Pisano 2006). It is important to understand if the open innovation philosophy per se benefits firms or if indeed only one side of innovation, value capture, outperforms the other side, value creation.

Partnering money is highly important for innovative biotech companies as it constitutes a large percentage of biotech funding, increasing from 42 % in 2007 to 59 % in 2008 (Huggett et al. 2009). Top deals in particular are made with



Open Innovation and Entrepreneurship, Fig. 1 Relations between small innovative companies (SI) and their partners, in particular large players in the industry and in the financial sphere (VC firms and big pharmas in the chosen example) (Sources: Proprietary database of alliances for the pharmaceutical industry, VentureXpert Database for the venture capital industry. Visugraph Software (Gay and Loubier 2009) is used for network visualization. Nodes in the networks represent firms and links represent legal binding agreements between firms)

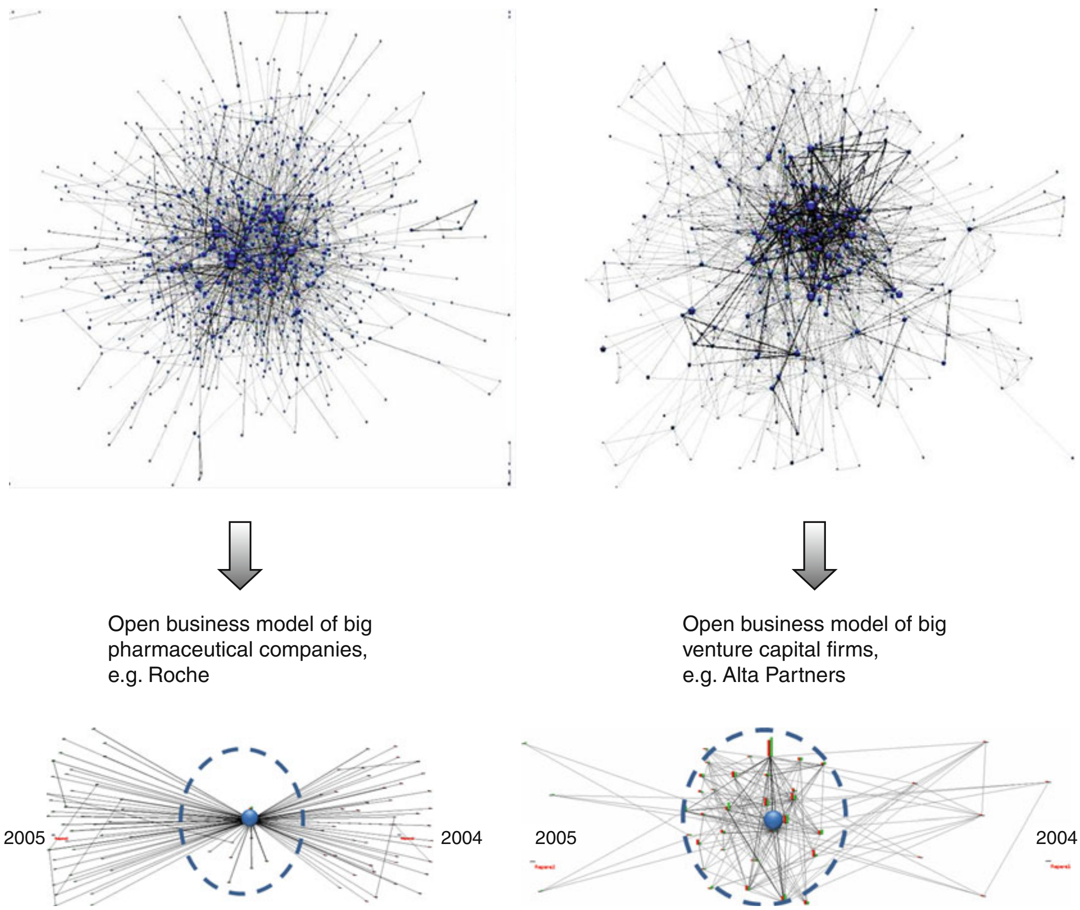
large incumbent companies. For example, Sanofi-Aventis entered in 2010 into a global strategic alliance with Regulus Therapeutics to discover, develop, and commercialize microRNA therapeutics. The alliance is the largest microRNA partnership to date, worth potentially $750 million to Regulus Therapeutics.

Venture capital (VC) is another major source of investment provided by VC firms to high-technology firms to finance their growth and product development. VCs are financial go-betweens between the financial and economic spheres. They first raise funds from institutional investors and then make equity investments in companies.

Understanding the critical link between high-growth, high-technology firms and their main capital providers, large players in the pharmaceutical and in the VC industries require that analysts know how these two categories of actors operate in their respective spheres, economic and financial, and how they explicitly deal with entrepreneurial firms (Fig. 1).

Figure 2 depicts the unique and complex connected environments into which the different agents operate: the network of interfirm transactions in the pharmaceutical industry and the network of syndicated deals VC firms make in order to invest into innovative biotech companies. A syndicate is formed when two or more VC firms take an equity stake in an investment for a joint payoff (Brander et al. 2002; Manigart et al. 2006).

Both big pharmaceutical companies and large VC players are the most active firms in their

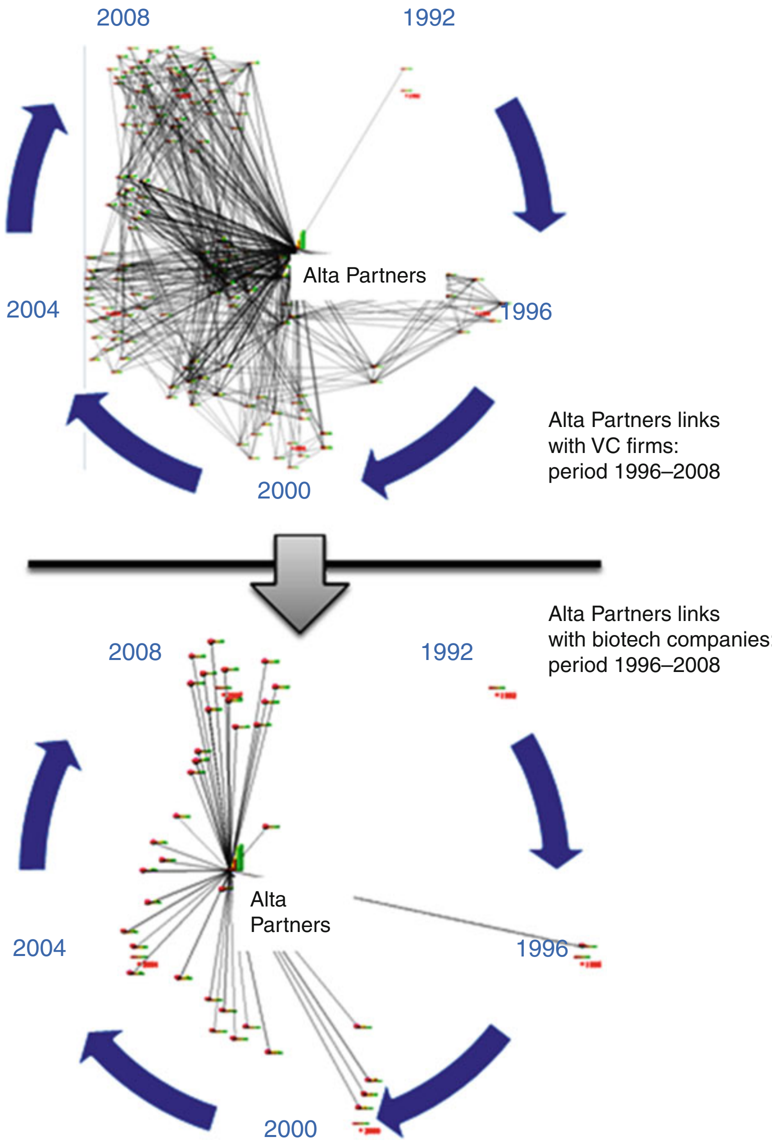


Open Innovation and Entrepreneurship, Fig. 2 Networked industry landscapes and open business models (*Top*) Open business landscapes, here the pharmaceutical and the private equity industries between 2004 and 2005 are in fact meshes of entwined firms. Node size in all maps is scaled to standardized network degree, or number of deals per firm, in the total network. Larger nodes, or firms with the highest transactional activity, are major players in each industry (e.g., Roche in the pharmaceutical industry and Alta Partners in the equity industry). The *lines in bold* between any two institutions indicate the presence of repeated ties between the same firms. The two landscapes have very different structures, the VC network being much more cohesive and its central players interacting repeatedly among themselves, contrarily to the pharmaceutical industry network. (*Bottom*) The open business models of the major players in each business landscape are very different (period 2004–2005). Roche for example (*left graph*; *blue dot* at the center of the graph), one of the world's leading healthcare companies, makes each year many new, dyadic transactions with many different partners. Links represent mainly in-licensing activities. The stable partners with which Roche interacts are few (*inner circle*). Conversely, Alta Partners (*right graph*; *blue dot* at the center of the graph), a leading venture capital firm in life sciences, interacts repeatedly with its partners (*inner circle*). Novel partners are few each year and Alta Partners links them to partners with which it has recurring partnerships (Sources: Proprietary database of alliances, VentureXpert Database. Visugraph Software is used for network visualization)

respective industries. However, their respective strategies are very different (Fig. 2).

Big pharmaceutical companies essentially interact with many new and smaller partners on a yearly basis (Fig. 2). They mostly leverage external assets. Conversely, biotech companies are in effect on the sell side of the open business model. (See other contributions in this book and Gay et Dousset 2005).

Contrarily to big pharmaceutical companies, when they syndicate with other VCs, large VCs interact repeatedly with previous relations as well

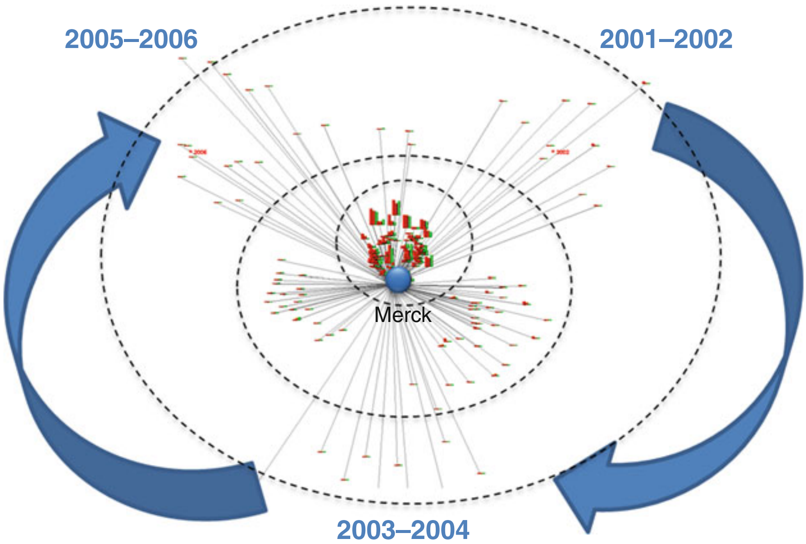


Open Innovation and Entrepreneurship, Fig. 3 Alta Partners' business model, the two levels (*Top*) Alta Partners interactions with other VC firms from 1996 to 2008. VisuGraph software allows seeing the firm's interactions as they happen in a clockwise manner. Interactions are extremely cohesive. Alta Partners, funding over 145 companies in the industry since 1996, increases its interactions with other VCs suddenly after 2000, with the rapid takeoff of the biotech industry following the sequencing of the human genome. (*Bottom*) The many cohesive links Alta Partners has with other VC partners (in particular after 2000 as seen in the *top figure*) allows it to invest in many biotech companies (*pink dots*; *bottom figure*) on a timely basis. Alta Partners is thus able to rapidly expand its portfolio of biotech companies after 2000 (Sources: Proprietary database of alliances, VentureXpert Database. Visugraph Software is used for network visualization)

as conjointly develop new partnerships with other VCs (Fig. 2). However, akin to big pharmaceutical companies, this open business model allows them to also invest rapidly in many biotech companies when deals are considered attractive (see Fig. 3 as an example).

A consequence of the constant search of new partners by dominant pharmaceutical companies is, as illustrated in Fig. 4 (See other contributions in this book), that it becomes extremely difficult for small companies to maintain themselves for an extended time in an industrial network.

Thus, on the "buyers" side, be it equities or assets, business models function as wheels that move forward extremely fast as needed. Open "wheel" practices on the "buyer" side constitute a challenge for small innovative biotechs as they are basically made into commodities that any firm with capital can rapidly trade in the market place.



Open Innovation and Entrepreneurship, Fig. 4 Open business model of Merck (*blue dot* at center of the graph) Merck, a global healthcare leader, makes some alliances with large incumbent players (large histograms) with high transacting activity (*inner circle*) from 2001 to 2006. It interacts otherwise essentially with many companies that are not able to maintain themselves in the pharmaceutical industry more than 4 (*intermediary circle*) or 2 (*outer circle*) out of the 6 years and have low transacting activity (very small histograms) (Sources: Proprietary database of alliances, VentureXpert Database. Visugraph Software is used for network visualization)

Conclusion and Future Directions: The Entrepreneurial Firm Dilemma

A main contribution of the chapter is to outline the interdependency of open business models and, in particular, how business models on the "buy" side affect business models on the "sell" side. In highly competitive markets, open "wheel" practices on the "buy" side allow big players to rapidly invest into innovative companies. Big pharmaceutical companies use in-licensing as a main contractual form. Linkages therefore constitute quasi-market mechanisms that give these large players the opportunity to continually grab valuable resources ceaselessly produced by a plethora of small firms, competition among innovative firms being foremost. Repeat interactions are few and small biotech firms are mainly used as commodities, their value equating that of their technologies or products. Another interesting finding is that open business models can be structured very differently. Unlike that of big pharmaceutical companies, the business model of VC firms is based on repeat, cohesive interactions with many partners. The endpoint is however the same, it allows rapid investment into many biotech companies for maximum profit.

Network analysis software has been used here to highlight that openness in fact leads to (inter)dependencies which need to be investigated. Emphasis has also been brought on the fact that open business models are not static; wheels are turning very fast, and partners come and go. Further research in this area is needed, in particular regarding the different possible structures of open business models and the linkages between firms' distinct assets and possible models and outputs. Researchers need also to solve the entrepreneurial firm dilemma, that of its survival when assets are exchanged very fast and their value limited by both competition, fast obsolescence, and the business models of large partners.

Cross-References

- ▶ Entrepreneurship
- ▶ Informal Venture Capital
- ▶ Innovator
- ▶ Networks
- ▶ Open Business Models
- ▶ Small Business
- ▶ Strategy

References

Afuah A, Tucci CL. Internet business models and strategies: text and cases. 4th ed. New York: Irwin/McGraw-Hill; 2000.

Brander JA, Amit R, Antweiler W. Venture-capital syndication: improved venture selection vs. the value-added hypothesis. J Econ Manage Strategy. 2002;11(3):423–52.

Chesbrough H. Open innovation: how companies actually do it. Harv Bus Rev. 2003;81(7):12–4.

Chesbrough H. Why companies should have open business models. MIT Sloan Manage Rev. 2007;48(2):22–8.

Chiaroni D, Chiesa V, Frattini F. Investigating the adoption of open innovation in the bio-pharmaceutical industry, a framework and an empirical analysis. Eur J Innovat Manage. 2009;12(3):285–305.

Dyer J, Singh H. The relational view: cooperative strategy and sources of interorganizational competitive advantage. Acad Manage Rev. 1998;23(4):660–79.

Gay B. Universal dynamics on complex networks, really? A comparison of two real-world networks that cross structural paths . . ... but ever so differently. In: Ting I-H, Hong T-P, Wang LSL, editors. Social network mining, analysis and research trends: techniques and applications. National University of Kaohsiung, Taiwan, In: IGI Global, 2011, ISBN 978-1-61350-513-7.

Gay B, Dousset B. Innovation and network structural dynamics: study of the alliance network of a major sector of the biotechnology industry. Res Pol. 2005;34:1457–75.

Gay B, Loubier E. Dynamics and evolution patterns of business networks. Paper presented at the international conference on advances in social network analysis and mining (ASONAM), Athens, 2009.

Hagedoorn J, Roijakkers N, Van Kranenburg H. Inter-firm R&D networks: the importance of strategic network capabilities for high-tech partnering formation. Br J Manage. 2005;17(1):39–53.

Huggett B, Hodgson J, Lähteenmäki R. Public biotech 2008-the numbers. Nat Biotechnol. 2009;27(8):710–21.

Jarillo JC. Strategic networks. Oxford: Butterworth-Heinemann; 1995.

Manigart S, Lockett A, Meuleman M, Wright M, Landstrom H, Bruining H, Desbrieres P, Hommel U. Venture capitalists' decision to syndicate. Entrepreneurship Theory Pract. 2006;30(2):131–53.

Morris M, Schindehutte M, Allen J. The entrepreneur's business model: toward a unified perspective. J Bus Res. 2005;58(6):726–35.

Pisano GP. Science business: the promise, the reality, and the future of biotech. Boston: Harvard Business School Press; 2006. ISBN 1-59139-840-1.

Zott C, Amit R. The business model as the engine of network-based strategies. In: Kleindorfer PR, Wind Y, editors. Network-based strategies and competencies. Upper Saddle River: Wharton School Publishing; 2009.

Open Science

▶ Citizen Science in Health Domain

Open Source

▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies

Open Source Biotechnology

▶ Translational Medicine and the Transformation of the Drug Development Process

Open System

▶ State Space Paradox of Computational Research in Creativity

Open-Ended Investigative Practical Work in Science Education

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Opportunities Recognition

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Opportunity

▶ Product Development, Business Concept, and Entrepreneurship

Opportunity Creation

▶ Business Emergence

Opportunity Spin-Off

▶ Extrapreneurship

Optimization

▶ Method for Creating Wisdom from Knowledge

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Organizational Arrangement of Nonlinear Research (Knowledge Production) and Nonlinear Innovation (Knowledge Application)

▶ Cross-Employment

Organizational Behavior

▶ Entrepreneurship and Small Business Agility

Organizational Capability

▶ Entrepreneurial Capability and Leadership

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Organizational Development

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Organizational Linguistic Identity

▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship

Organizational Slack and Innovation

Johannes Leitner[1] and Michael Meyer[2]
[1]University for Applied Sciences bfi Vienna, Vienna, Austria
[2]Nonprofit Management Group, WU – Vienna University of Economics and Business, Vienna, Austria

Synonyms

Resources and innovation; X-inefficiency and innovation

Introduction: Which Factors Influence Innovation

Innovation as a dependent variable has a rich tradition in empirical research (Damanpour 1991). And certainly, organizational slack is neither the only nor the most researched determinant of innovation. Alternative concepts investigate the impact on innovation on different levels of analysis. Accordingly, innovation has been researched at the individual level by examining a range of different characteristics such as personality, motivation, cognitive ability, job characteristics, or mood states. On a group level, team structures, team climate, team member characteristics, processes, and leadership styles have been researched. Finally, on the organizational level, structure, strategy, size, (slack) resources, and culture have been looked at (Anderson et al. 2004). Somewhat as a revival, the entrepreneurship literature has been gaining momentum recently especially in the fields of social entrepreneurship. Finally, organization external factors such as organizational environment are analyzed in the field of innovation research (Meyer and Rowan 1977; DiMaggio and Powell 1983; Zucker 1987; March and Olsen 1989; Powell and DiMaggio 1991; Scott 2003, 2001; Fernandez and Wise 2010).

Since organizational factors have not been researched as prominently as individual factors recently, a focus on organizational slack helps to shed light on this blind spot. Additionally, at the organizational level of analysis, theoretical as well as empirical literature has brought forward promising results concerning the relation between organizational slack and innovation.

Organizational Slack

Since its introduction to organizational literature by Cyert and March (1963), the concept of organizational slack has widely been recited, altered, advanced, and specified. These processes took place in two main areas, with the first concerning definitions and the second concerning measurement. The slack construct was established under the framework of the organizational behavior theory. More concisely, slack was conceptualized as the difference between the total amount of resources and the necessary payments to the members of an organization to protect the coalition from dissolving (Cyert and March 1963: 42).

A broader definition by Bourgeois (1981: 30) refers to organizational slack as "*that cushion of actual or potential resources which allows the organization to adapt successfully to internal pressures for adjustment or to external pressures for change in policy, as well as to initiate changes in strategy with respect to the external environment.*" As opposed to Cyert and March (1963), who focus their definition on payments, Bourgeois (1981) in his frequently cited article "On the Measurement of Organizational Slack" refers to an unspecified set of resources that could contain financial, factual, or human resources.

By summarizing the state of slack research in the beginning 1980s, three roles are attributed to slack in organizations, which are represented in the definition provided above. Firstly, slack functions as a cushion that guarantees an organization the flexibility to quickly adapt to rising demands, i.e., slack as an insurance against an unforeseeable future. Secondly, slack is a tool applied by top management to enable strategic changes where slack provides the extra resources necessary to carry through these change processes to adjust to new environmental demands. Thirdly, organizational slack takes on the role as a means for permitting innovation processes, either product innovations or process innovations. Finally, another important conceptual contribution of Bourgeois is the idea of slack and its association with organizations' success. The argument is that either zero slack or too much slack is connected with considerable disadvantages for the organization because zero slack leaves the organization too inflexible, while too much slack results in inefficiencies accelerating the organizations' termination. Consequently, the proposed relationship between success and slack is inversely U shaped, an idea which has been widely acknowledged in slack research subsequently (cf. Geiger and Cashen 2002; Geiger and Makri 2006; Herold et al. 2006; Kim et al. 2008; Love and Nohria 2005; Nohria and Gulati 1996, 1997; Tan 2003; Tan and Peng 2003).

Out of an almost infinite pool of definitions for organization slack, a more recent concept from Geiger and Cashen (2002: 69) seems to be very suitable and perfectly applicable to understand the concept: "The resources in or available to an organization that are in excess of the minimum necessary to produce a given level of organizational output." This definition is viable as it incorporates different dimensions of slack that are distinguished in the relevant literature (Bourgeois and Singh 1983; Bowman et al. 2005; Geiger and Cashen 2002; Herold et al. 2006; Lant 1985; Love and Nohria 2005; Sharfman et al. 1988; Singh 1986). The idea to frame organizational slack as a multidimensional concept was originally developed by Bourgeois and Singh (1983) in their study "Organizational Slack and Political Behavior among Top Management Teams," where they identified the need to develop a more sophisticated and differentiated concept of slack. Advancing the findings from Bourgeois' 1981 paper, where he developed a measurement tool based on financial indicators, it is now observed that these financial indicators are not homogeneous concerning their availability and transformability from one resource into another. Imagine, for instance, excess liquidity, which is easily accessible and can rather quickly be transformed from monetary into any other form which might be needed in the organization, e.g., computer equipment or a new ambulance car. If the slack resource does not exist in the form of excess liquidity but overhead cost, then both the access and the transfer of slack are not as easily possible any more since reducing overheads often requires restructuring or streamlining processes first. Consequently, before overheads can be transformed into another resource, it has to be made available, turned into liquid funds, and redeployed. This example already clarifies that organizational slack can emerge in very different forms with substantially different effects in organizations.

A more elaborated slack model was constructed that takes into account the different degrees of ease-of-recovery, i.e., their degree of incorporation in the organization's structures, processes, and routines. These three slack dimensions comprise (1) available slack, being the resources that have not yet been absorbed by the organization, e.g., excess liquidity or retained earnings, (2) recoverable slack, being the resources that have already been assimilated into the organization's structures, processes, or routines, typically as excess overhead costs, and finally (3) potential slack, as the organization's capacity to generate additional resources from outside, e.g., debts, loans, and equity capital (Bourgeois and Singh 1983: 43).

Another concept pointing in the same direction is that of absorbed and unabsorbed slack resources (Singh 1986). Similar to available slack, unabsorbed slack denotes resources that are in excess and liquid resources that are not committed to any organizational task or activity. Absorbed slack would therefore equal recoverable slack that signifies some excess costs in an organization, i.e., absorbed slack indicates waste since it does nothing else but increase the cost of production in the respective organization (Singh 1986: 567).

Yet another way to distinguish between the different dimensions of slack is to concentrate on the degree of discretion resources allow. Clearly, uncommitted resources can more flexibly be shifted – thus leaving managers with greater possibilities for following their aims – which can but do not have to align with the organization's goals. In their research on the antecedents of organizational slack, Sharfman et al. (1988) follow the argument of a multidimensional slack concept but add a different perspective by focusing on the degree of managerial discretion that is determined differently by each slack dimension. Accordingly, Sharfman et al. (1988: 602) distinguish between high-discretion slack, which would basically equal available slack, and low-discretion slack, which equals the recoverable slack dimension.

Organizational Slack and Innovation

Following the conceptual and theoretical considerations about organizational slack and innovation as formulated in behavioral theory (Cyert et al. 1959, 1963), which assume that organizational slack might provide the necessary cushion for experimentation, hence innovation, first empirical insights were still pending at that time.

Among the first to test the slack-innovation-proposition empirically were Aiken and Hage (1971) in their study on organizational design and innovation. Slack was measured by (1) the percent increase in the organization's budget and (2) whether or not the resource base changed during a 3-year period and correlated with the rate of innovation during the same period. The findings supported the assumption that innovation requires increased financial resources since the data showed that the innovative organizations had increased resources available (Aiken and Hage 1971: 78). A major shortcoming of this study is that only a correlation analysis was conducted which cannot answer the question of causality.

The positive influence of organizational slack on innovation was also shown by Miller and Friesen (1982), who found in their study of 52 business firms from the Montreal region that resource availability and innovation were positively correlated in the case of conservative firms (Miller and Friesen 1982: 13). Further quantitative studies that confirmed the supposed linear positive association between organizational slack and innovation were conducted by Nystrom et al. (2002); Greve (2003); Barrett and Sexton (2006); Geiger and Makri (2006); Ruiz-Moreno et al. (2008); Franquesa and Brandyberry (2009); Pohl and Elmquist (2010). Finally, the meta-analysis by Damanpour (1991) is outstanding within the research on slack and innovation as it reviews 23 empirical studies. Statistically significant associations are found for slack resources, specializations, functional differentiation, professionalism, centralization, managerial attitude toward change, technical knowledge resources, administrative intensity, as well as internal and external communication.

However, although there seems to be thorough empirical evidence for a positive relationship between slack and innovation, there are also studies that came to contrary conclusions. Not so much building on the organizational behavior theory (Cyert and March 1963) but adhering to propositions from economic approaches and agency theory (Fama 1980; Leibenstein 1966) and conceptual papers reasoning a negative relationship (cf. Child 1972; Jensen 1993), this research found negative associations between organizational slack and innovation.

Katila and Shane (2005), for instance, revealed in their quantitative study among a large sample of 964 US firms' innovation attempts that new firms were more innovative when suffering from a lack of resources (Katila and Shane 2005: 826). Similarly, Zajac et al. (1991) found in their qualitative and quantitative investigation among hospitals that slack exerted a negative influence on innovation. But the results for the slack variables were not significant, which was partly explained by sample characteristics (Zajac et al. 1991: 181). Yet another study by Manns and March (1978), which was rather in the tradition of behavioral theory, unveiled that university departments enjoying high reputation and a convenient resource outfit were less prone to innovate (in terms of introducing new curricula) compared with their less-equipped counterparts. Bolton (1993) also confirmed in his study the negative impact of slack resources on innovation and found that instead substandard performance seemed to stimulate organizational innovation.

Echoing the ambiguous incidences on the relation between slack and innovation ranging from positive to negative, with each of them featuring strong theoretical and empirical evidence for their findings, Herold et al. (2006: 372) still ask the question: "What is the relationship between organizational slack and innovation?"

Most obvious, there is no simple linear relation. One of the most prominent empirical studies investigates the association with a sample of multinational business firms and asks the question "What is the optimum amount of organizational Slack?" (Nohria and Gulati 1997). The authors show empirically that the relationship between slack and innovation is neither purely linearly positive nor entirely linearly negative. Rather, it seems as if the relationship can best be described as inverse U shaped, meaning that up to a certain level of organizational slack in the organization, the impact of slack resources on the innovative behavior is positive, but when this point is exceeded, then additional slack resources imply adverse effects on innovation.

Two major variables are identified that shape the association between slack and innovation. On the one hand, there is the propensity to experiment. Since innovations are always subject to risk and uncertain outcome, a resource cushion can facilitate to master the ups and downs along an innovation project. Additionally, managerial attention is increasingly focused on long-term projects in the presence of slack resources, as compared to low-slack situations, when managerial attention is tight and emphasizes short-term projects (Cyert and March 1963). Consequently, when slack resources rise, also the number of innovation projects can be expected to increase but only to a certain level because then the opportunities for innovations decrease and suggest diminishing returns from experimentation. However, the second variable, which is discipline, influences innovation propensity in a different direction. The presence of slack resources also relaxes control mechanisms exerted by management and leads to a situation where the degree of discipline in selecting, pursuing, and terminating innovation projects shows adverse outcomes (Leibenstein 1969). Nohria and Gulati (1997: 605) name two errors that might occur. The type I error describes situations when innovation projects get funded but should not be funded due to negative net values, and type II errors are decisions that stop projects that should be continued. However, not only can too lax discipline diminish innovation, this is also the case with too stringent discipline. Low levels of slack result in tight controls and therefore impede innovation projects. These findings, particularly the aspect of an inverse U-shaped relation between slack, have been reconfirmed by a number of follow-up studies (cf. Geiger and Cashen 2002; Herold et al. 2006; Kim et al. 2008; Mishina et al. 2004; Nohria and Gulati 1996).

While the two investigations by Nohria and Gulati (1996, 1997) do not distinguish among different forms of organizational slack as proposed by Bourgeois and Singh (1983), the study by Geiger and Cashen (2002) includes available, recoverable, and potential slack measures. Recognizing suggestions that different slack dimensions exert a different impact on the innovation, three different hypotheses were established, with each of them relating to one of the three slack dimensions. Consequently, it was argued that available slack was related inversely U shaped with innovation, recoverable slack was supposed to behave similarly, and potential slack was predicted to be related in a linearly positive way with innovation.

The study was based on a random 250 firm sample over a 10-year period drawn from the Fortune 500 database. Innovation was operationalized as the R&D intensity of the firm, available slack was measured by the quick ratio, recoverable slack was measured by sales expenditure, general and admin expenditure through sales, and potential slack was captured by the debt to equity ratio. Risk, firm size, product diversification, time, and administrative structure were included as control variables. The subsequent linear regression models illustrated that all hypotheses were confirmed. Thus, available and recoverable slack show the inverse U-shaped association with innovation, and potential slack seemed to have the positive linear relationship.

In contrast, Herold et al. (2006) argue that only unabsorbed slack measures are suitable to investigate the influence of slack on innovation. This is because all other slack resources are already incorporated into the organization, the recovery of which might be a difficult and lengthy process probably not supporting the role slack is supposed to play for innovation (Herold et al. 2006: 374). Unabsorbed slack was predicted to have an inverse U-shaped relation with innovation. Therefore, the quick ratio was the independent variable representing available slack, and the dependent variable innovation was operationalized by taking a look at the impact of a firm's innovation based on the number of citations referring to a specific company's patent. The statistical analysis supported the inverse U-shaped theory for available slack. Also, Kim et al. (2008) focused on only a single dimension of slack, which was financial slack as measured by the ratio of quick assets to liabilities. Innovation was captured as R&D investments with the statistical analyses of 253 Korean manufacturing firms resulting in an inverse U-shaped relationship between financial slack and innovation.

After all these empirical endeavors, is there any conclusion about the relationship between organizational slack and innovation? Empirical evidence supports three different assumptions. The first assumption holds a linearly positive relationship between organizational slack and innovation (cf. Aiken and Hage 1971; Barrett and Sexton 2006; Damanpour 1991; Franquesa and Brandyberry 2009; Geiger and Makri 2006; Greve 2003; Miller and Friesen 1982; Nystrom et al. 2002; Pohl and Elmquist 2010; Ruiz-Moreno et al. 2008). These results, however, are doubted by a number of other researchers, who found thorough evidence for their assumption, which supposes a linearly negative relationship between organizational slack and innovation (cf. Bolton 1993; Katila and Shane 2005; Manns and March 1978; Zajac et al. 1991). Thirdly, more recently researchers have commenced to combine both assumptions in a new model which proposes an inverse U-shaped relationship between organizational slack and innovation. The synthesis (inverse U-shaped relation) of the thesis (positive relation) and its antithesis (negative relation) found empirical support repeatedly (Fernandez and Wise 2010; Geiger and Cashen 2002; Herold et al. 2006; Kim et al. 2008; Nohria and Gulati 1996, 1997).

Conclusion and Future Directions

The analysis of organizational slack and its impact on innovation focuses on the organizational level. Therefore, factors situated at the individual level, e.g., the personal characteristics of innovators, their motivation, and cognitive abilities, but also characteristics of specific jobs are neglected. Slack is not even the most important organizational factor, as research has identified a number of further influencing variables such as structure, strategy, size, or culture. Assuming that one single variable explains how innovation emerges would be far too simplistic and myopic. On the other hand, innovation research has not yet come up with a comprehensive model considering all different levels of analysis and variables simultaneously (Damanpour 1991), and organizational slack shows at least some strong relationship with innovation in organizations. What can be learned from these results is that organizations need to be well equipped with resources to stay competitive through being innovative.

This basic interpretation of the literature is consistent with empirical findings according to which organizational slack enables innovation (cf. Fernandez and Wise 2010; Franquesa and Brandyberry 2009; Geiger and Makri 2006; Greve 2003; Herold et al. 2006; Kim et al. 2008; Nohria and Gulati 1997; Pohl and Elmquist 2010;

Ruiz-Moreno et al. 2008). However, discipline seems to be an important variable in funneling slack resources into innovation. With reference to theoretical considerations and empirical results yielded by Nohria and Gulati (1996, 1997), arguing for the considerable effect discipline exerts on the relation between slack and innovation, the disciplining external influence seems to stem from competition.

In view of the empirical results, there is still the question which mechanisms are at work to make slack impact on innovation. Recalling Nohria and Gulati (1997: 609), they suggest the following: “We propose two underlying mechanisms to explain the relationship: (1) the effect of slack on the process of experimentation, and (2) the effect of slack on the discipline exercised over experiments.” They argue that on the one hand, organizational slack enables creativity and experimentation, the probability of which to result in innovation is higher when simultaneously disciplinary forces are present as well. Otherwise, so the suggestion, slack resources would indeed increasingly be used for unproductive behavior. This interplay between slack resources on the one hand and a certain degree of discipline on the other hand is also reflected in the stage-gate model which proposes a sequence of stages enabling creativity and experimentation and gates, where thorough discipline is intended to streamline the innovation process (Cooper 2008: 214 p). A whole bulk of literature advocates distinguishing between available, recoverable, and potential slack. Even empirically, it has been shown that these different slack dimensions impact differently on innovation. Despite the convincing arguments, there is still room to doubt the relevance of this distinction.

The point here is that recoverable slack is a highly underspecified category since it might include financial slack, slack of human resources, slack of tangible assets, etc. Thus, when a lot of relevant variables are per se in the recoverable slack pool, as is the case with all HR-related slack variables, the difference has vanished and has moved to another level. A potential explanation is that the skills and motivation which are brought into the organization by its employees are key resources for organizations. Likewise, Pohl and Elmquist (2010, p. 380) argue that HR slack is responsible for the radical innovation process at VOLVO Cars even in the absence of financial slack. Therefore, employees equipped with both high motivation and a superior qualification and education background may contribute not only to routinized operations but to innovation as well.

To sum up, an in-depth analysis within the category of recoverable slack is essential to identify where differences emerge between the various slack measures and their impact on innovation. Prior research suggests that it is mainly slack in human resources, namely, motivation, skills, and competencies of employees, which foster innovation.

Nevertheless, even after 50 years of slack research, the question of causality between innovation and organizational slack has not been answered definitely. Theoretical slack models provide clear arguments for proposing that organizational slack fosters innovation. However, empirical results cannot doubtlessly confirm these theories. One major problem in empirical research is to solve the hen and egg problem, i.e., to concisely separate whether organizational slack is the consequence of successful innovations or vice versa.

Cross-References

- ▶ Business Creativity
- ▶ Corporate Creativity
- ▶ Creative Management
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Entrepreneur
- ▶ Entrepreneurial Organizations
- ▶ Freedom and Constraints in Creativity
- ▶ Innovation Systems and Entrepreneurship
- ▶ Innovations of and in Organizations
- ▶ Social Entrepreneurship

References

Aiken M, Hage J. The organic organization and innovation. Sociology. 1971;5(1):63–82.

Anderson N, De Dreu CKW, Nijstad BA. The routinization of innovation research: a constructively critical review of the state-of-the-science. J Organ Behav. 2004;25(2):147–73.

Barrett P, Sexton M. Innovation in small, project-based construction firms. Br J Manag. 2006;17(4):331–46.

Bolton MK. Organizational innovation and substandard performance: when is necessity the mother of innovation? Organ Sci. 1993;4(1):57.

Bourgeois LJ. On the measurement of organizational slack. Acad Manag. Acad Manag Rev. 1981;6(1): 29–39.

Bourgeois LJ, Singh JV. Organizational slack and political behavior among top management teams. Acad Manag Proc. 1983;43:43–7.

Bowman WH, Keating EK, Hager M. Organizational Slack in Nonprofits, vol. 30. Harvard University: Hauser Center for Nonprofit Organizations; 2005.

Child J. Organizational structure, environment and performance: the role of strategic choice. Sociology. 1972;6(1):1–22.

Cooper RG. Perspective: the stage-gate® idea-to-launch process – update, what's new, and NexGen systems. J Prod Innov Manag. 2008;25(3):213.

Cyert RM, Feigenbaum EA, March JG. Models in a behavioral theory of the firm. Behav Sci. 1959;4(2):81–95.

Cyert RM, March JG. A behavioral theory of the firm. Englewood Cliffs: Prentice Hall; 1963.

Damanpour F. Organizational innovation: a meta-analysis of effect of determinants and moderators. Acad Manag J. 1991;34(3):555–90.

DiMaggio PJ, Powell WW. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am Sociol Rev. 1983;48: 147–60.

Fama EF. Agency problems and the theory of the firm. J Polit Econ. 1980;88(2):288.

Fernandez S, Wise LR. An exploration of why public organizations 'Ingest' innovations. Public Adm Rev. 2010;88(4):979–98.

Franquesa J, Brandyberry A. Organizational slack and information technology innovation adoption in SMEs. Int J E-Bus Res. 2009;5(1).

Geiger SW, Cashen LH. A multidimensional examination of slack and its impact on innovation. J of Manag Issues. 2002;XIV(I):68–84.

Geiger SW, Makri M. Exploration and exploitation innovation processes: the role of organizational slack in R & D intensive firms. J High Technol Manag Res. 2006;17:97–108.

Greve HR. A behavioral theory of R&D expenditures and innovations: evidence from shipbuilding. Acad Manag J. 2003;46(6):685.

Herold DM, Jayaraman N, Narayanaswamy CR. What is the relationship between organizational slack and innovation. J Manag Issues. 2006;18(3):372–92.

Jensen MC. The modern industrial revolution, exit, and the failure of internal control systems. J Finance. 1993;48(3):831–80.

Katila R, Shane S. When does the lack of resources make new firms innovative? Acad Manag J. 2005;48(5): 814–29.

Kim H, Kim H, Lee PM. Ownership structure and the relationship between financial slack and R&D investments: evidence from Korean firms. Organ Sci. 2008;19(3):404.

Lant TK. Modeling organizational slack: an empirical investigation, vol. 20. Stanford: Stanford University; 1985.

Leibenstein H. Allocative efficiency vs. "x-efficiency". Am Econ Rev. 1966;56(3):392–416.

Leibenstein H. Organizational or frictional equilibria, x-efficiency, and the rate of innovation. Q J Econ. 1969;83(4):600.

Love GE, Nohria N. Reducing slack: the performance consequences of downsizing by large industrial firms, 1977–93. Strateg Manag J. 2005;26(12): 1087–108.

Manns CL, March JG. Financial adversity, internal competition, and curriculum change in a university. Adm Sci Q. 1978;23(4):541.

March JG, Olsen JP. Rediscovering institutions. New York: The Free Press; 1989.

Meyer JW, Rowan B. Institutionalized organizations: formal structure as myth and ceremony. Am J Sociol. 1977;83:340–63.

Miller D, Friesen PH. Innovation in conservative and entrepreneurial firms: two models of strategic momentum. Strateg Manag J (pre-1986). 1982;3(1):1.

Mishina Y, Pollock TG, Porac JF. Are more resources always better for growth? Resource stickiness in market and product expansion. Strateg Manag J. 2004;25(12):1179.

Nohria N, Gulati R. Is slack good or bad for innovation? Acad Manag J. 1996;39(5):1245–64.

Nohria N, Gulati R. What is the optimum amount of organizational slack? A study of the relationship between slack and innovation in multinational firms. Eur Manag J. 1997;15(6):603–11.

Nystrom PC, Ramamurthy K, Wilson AL. Organizational context, climate and innovativeness: adoption of imaging technology. J Eng Technol Manag. 2002;19 (3/4):221–47.

Pohl H, Elmquist M. Radical innovation in a small firm: a hybrid electric vehicle development project at VOLVO Cars. R&D Manag. 2010;40(4).

Powell WW, DiMaggio PJ, editors. The new institutionalism in organizational analysis. Chicago: University of Chicago Press; 1991.

Ruiz-Moreno A, García-Morales VJ, Llorens-Montes FJ. The moderating effect of organizational slack on the

relation between perceptions of support for innovation and organizational climate. Pers Rev. 2008;37(5):509.
Scott WR. Institutions and organizations. 2nd ed. Thousand Oaks: Sage; 2001.
Scott WR. Organizations: rational, natural, and open systems. 5th ed. Upper Saddle River: Prentice Hall; 2003.
Sharfman MP, Wolf G, Chase RB, Tansik DA. Antecedents of organizational slack. Acad Manag Rev. 1988;13(4):601–14.
Singh JV. Performance, slack, and risk taking in organizational decision making. Acad Manag J. 1986;29(3):562–5.
Tan J. Curvilinear relationship between organizational slack and firm performance: evidence from Chinese state enterprises. Eur Manag J. 2003;21(6):740–9.
Tan J, Peng MW. Organizational slack and firm performance during economic transitions: two studies from an emerging economy. Strateg Manag J. 2003;24(13):1249–63.
Zajac EJ, Golden BR, Shortell SM. New organizational forms for enhancing innovation: the case of internal corporate joint ventures. Manag Sci. 1991;37(2):170–84.
Zucker LG. Institutional theories of organizations. Annu Rev Sociol. 1987;13:443–64.

Originality

▶ Cognition of Creativity
▶ Conflict and Creativity
▶ Creativity and Systems Thinking
▶ Creativity in Invention, Theories
▶ Creativity: Cultural Capital in Mathematics
▶ Divergent Thinking
▶ Ideas and Ideation
▶ Nature of Creativity

Ownership Succession

▶ Small Businesses - Value, Transmission, and Recovery

P

Palliative Care

► Palliative Care and Hospice - Innovation at End of Life

Palliative Care and Hospice - Innovation at End of Life

Andreas Heller and Claudia Wenzel
University of Klagenfurt | Vienna Graz, Faculty of Interdisciplinary Studies (IFF Vienna) Department of Palliative Care and Organisational Ethics, Vienna, Austria

Synonyms

End-of-Life Care; Hospice; Palliative Care; Terminal Care

Hospice and Palliative Care: Reactions in Modern Society

Until a few decades ago, people in Europe knew how to deal with the fateful destiny of death. Dying, death, and grief were all incorporated within the cycle of familial life. The social place for the beginning and the end of life was, in the broadest sense, the home (from the Greek *oikos*), the economy of the house, and the life – relationships within families and neighborhoods. Dealing with these crises of life was facilitated through natural, social, and traditional rituals and customs. People lived in a closely woven network of normative and ritualized customs and certainties. The menacing threats unleashed throughout life needed fencing in, taming, and domesticating: For centuries the ancestors had prayed, "From hunger, disease and war, plague, keep us, O Lord." As it was a relatively enclosed living environment, this construction of social reality was socially reinforced and confirmed. The religious concept of *heaven* (Gronemeyer 2012), arching almost self-evidently over individual and collective life, gave meaning and hope, as well as guidance in both good times and in bad, while the European Christian tradition provided the assurance that life does not end with the end of earthly existence. On the contrary, death and dying could be put in perspective with a glance at the sky – a view into the afterlife. Death, the care for the dead, and the survival of the mourners were in certain ways socially and ritually manageable.

Nowadays in Europe, this horizon of heavenly confidence is only observable in a religious minority. These religious certainties have lost much of their plausibility. Life has been radically secularized. How then should the modern, secular man handle his final frontier, and deal with his individual death? Should he just resign himself to fate? Or fight – planning and controlling his life, and taking his death in his own hands?

Today, the differentiation of society has given people radical freedom, releasing them from

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socialties, and designing their own paths for life and death. Within society's market of opportunities, in the juggle between powers and ideologies, people will be forced to choose how to lead their own individual lives. It only stands to reason that you will have to tailor the last coat (*pallium*) for yourself. Modern society has developed a new branch of care which offers possible options for "end of life" as part of its healthcare management. With advance directives by the patient, an individual picture will be built around one's death, along the question of what is desirable (or undesirable) for them at the end of life. A growing network of professionalized and highly specialized hospice and palliative care staff ensures that the end of life will correspond to that picture. What people do not want is to be alienated, lonely, in pain, suffering needlessly, attached to machines and deprived of freedom – just a part of a large, anonymous medical system. An individual death, which is peaceful, gentle, with a suitable preparedness "to go," has emerged as the normative leading model. This is a question of "leading a good death" – something that does not seem possible without outside assistance. It is about quality of life in death, which can apparently only be delivered by professionals. The idea is to have a choice between euthanasia, and hospice and palliative care, a reality already possible in some European countries (Netherlands, Belgium, Luxembourg, and partially in Switzerland).

Palliative Care is at the Root of the Hospice Movement

Palliative care originates from the International Hospice Movement, whose implementation in German-speaking countries began with a slight delay – arriving behind their English and American counterparts in the 1980s. Within the framework of international euthanasia societies (right-to-die-movement, DGHS = German Society for Humane Death) calling for dignified death, for the purposes of criminal law and legalizing active euthanasia, and in the rapid development of highly specialized and technology-dominated medicine, it seemed impossible to have a dignified death in a hospital: The image of a "cold lonely death in a broom closet" was overwhelming. This compelled a focus for the hospice movement, with the objective of being able to die in dignity and character by the people concerned.

The thanatology research, substantiated by the Swiss physician Elizabeth Kuebler-Ross living in America, has made it clear: Even patients who have exhausted all therapeutic options have needs for contact and relationships, want to be respected and not abased, and will experience different dimensions of affective-cognitive altercation to their impending death. They will require empathic communication and extensive attention as a basic human right. This ground-breaking work has spread throughout the world, though it had long been misunderstood in the sense of a linear step system.

The British doctor, carer, and social worker Cicely Saunders, who saw herself as a committed Christian, is regarded as a pioneer of modern hospice work and Palliative Care. She helped open St. Christopher's Hospice in London in 1967 – after a 20-year "pregnancy" with this idea of establishing a home for the dying. The terms *hospice (work)* and *palliative care* were always used interchangeably in their mother country of England.

The hospice concept continues to live on under the idea of European and ancient oriental hospitality. Human life, conceived as a pilgrimage, is reliant on hospitality to find its path and the destination. Hospices offer hospitality without ulterior motive – they provide unconditional interest in others and for the sake of others in their own right. These hospices are not just buildings, but rather they represent an approach and attitude to people and culture in society. In times of increasing commercialization and managerialism of health care (*It counts only if you can count it!*), the hospice currently provides a critically different option in offering care and attention to people in need via assistance and support for end-of-life requirements. First and foremost, the hospice movement is simply a citizens' movement, supported by volunteers – dedicated people committed to the right and the opportunity for a good, dignified, and individualized death at the end of life, regardless of religion, race, gender, and financial status. In the German-speaking countries, palliative care (in Germany translated as *palliative medicine*) had eventually become marked by a profound process of professionalization, dominated by medicalization and institutionalization, and is still so influential today.

The term "palliative" is derived from the Latin *pallium* – meaning *coat*, and for a German-speaker, this would be described firstly as *enveloping*, or *wrapping*, in the sense of "caring protection." Etymologically, this Latin has roots in Indo-European: "Palliative" originates from "*pel*," meaning something akin to "fur" or "animal skin," and thus creating the meaning of "*pelte*," that is, defensive shield weapons for military use (cf. Morris 1997, cited by Clark and Seymour 1999). This dual aspect of "palliative" provides the affected persons to consider a more active role, and also highlights a "radical orientation for the affected persons" (Heller and Knipping 2007) by this approach in the modern health care system. The situation is always about an appropriate balance between too much and too little (invasive and therapeutic measures); it is about balancing the deceleration and acceleration of death, as described by the accepted WHO definition.

Conceptual Perspectives of Palliative Care

According to the globally accepted definition of the World Health Organization (WHO), palliative care is "*. . . an approach by which the quality of life of patients and their families will be improved if they are faced with a life-threatening illness and its associated problems. This shall be achieved through the prevention and relief of suffering by means of early identification, faultless assessment and treatment of pain and other physical, psychosocial and spiritual problems.*" (*WHO* 2002).

This definition includes the focused involvement of relatives and carers – that is, of persons affected by the suffering and of those connected to them – and of sharing in their concerns and care. Particular attention is given to the grief which sets in not only after death, but often also over the lengthy period of the diagnosis of a chronic disease, the multiple treatments until the death, and beyond. Although discussions concerning active euthanasia are currently in constant debate in many countries, the WHO definition is clearly limited in scope (Steffen-Bürgi 2007), though it is in the meanwhile seen as a normative guideline in the palliative care community.

In the revised version of the original definition dating back to 1990, there is a clear emphasis that the palliative care approach should come in very early on within the disease process – indeed, in parallel with other curative measures (WHO 2002). It remains open as to how these conceptual building blocks are to be implemented within different healthcare systems: thus, a variety of structures and forms have developed in Germany, Austria, and Switzerland over the past 20 years.

Specialist proposals resulted in an idea implemented through the development of primary care, and were mainly carried out by differentiated educational training and further education – from introductory training of volunteers to Master's courses in palliative care. (The first German-language training programs in palliative care were and are being offered by the IFF Faculty since 1999 as an interdisciplinary study in Vienna; other universities and colleges have followed suit according to this model, for example, Dresden, Freiburg, Salzburg, and St. Gallen). Another starting point is to look at the teething and interweaving of the development of individuals with the development of organizations; this is based on the view that a culture respecting death is always an *organizational* culture respecting death (Heller 2000a). Hospice work and palliative care are viewed as healthcare concepts focused on different emphases, especially in German-speaking countries.

Based on this understanding, palliative care will often be translated as "*Palliativversorgung*" in German, literally meaning *palliative provision or supply*. This simple translation does not imply the rich diversity of the English term *care*. The term *care* is not without problems, since it insinuates a division of labor in which it treats one party as the subject of care and the other as an object of care. Therefore, it seems appropriate linguistically to use the Scandinavian-origin concept of *Umsorge*, literally meaning *nurture* or *care*, when speaking of hospice and palliative care-culture.

Palliative Care – A Matter of Age?

In the development of the hospice concept, the applicability of these conceptual elements for the chronically ill and elderly was never strictly excluded – indeed they were even decidedly highlighted by Cicely Saunders: *Terminal care should not be a facet of oncology, but of geriatric medicine, neurology, general practice and throughout medicine* (Saunders and Baines 1983: 2).

Nevertheless, the concept was based on and developed for terminally ill individuals with cancer. Academic palliative medicine has been largely rooted within the context of university-oncology. There are, however, many other groups of affected persons (only about 25 % of people in Central Europe die from a tumor-based disease – 75 % die from something else altogether). The focus of attention in the last few years has been, in particular, on the deaths of older men and women. There have been pilot projects trying to establish a hospice and palliative culture in nursing homes (Heller and Kittelberger 2010).

For several years now, there has been a systematic dedication in palliative care discourse at the international level, focusing on other target groups, including older persons.

Creating a close link between Gerontology and Palliative Care, Seymour and Hanson (2001: 102) write, *"Both attend to the pursuit of symptom control, while advising the judicious use of investigations and rejecting highly invasive and aggressive treatment modalities; both make the person and their family the unit of care, and have led the way in developing multidisciplinary and community-based models of care. In so doing they have developed parallel discourses of 'patient-centered' care, 'quality of life,' 'dignity,' and 'autonomy.' Further, both disciplines focus on areas – aging and cancer – that tend to provoke strong, even 'phobic' reactions from the public at large."*

Showing the way is a WHO publication entitled "Better Palliative Care for Older People" (Davies and Higginson 2004). It calls for public health strategies at the national level, with the objective of improving palliative care for older people. The term *palliative geriatrics* has been experimented with in German-speaking countries, and it certainly insinuates a "medicalizing tendency" (Clark 2002). It does not accommodate appropriately for either the practice or the daily lives of the elderly, or the interdisciplinary theoretical reflection of the concerns and care of the elderly.

The revolutionary notion in this approach of a new care-culture at the end of life views the individual person, as a woman, man, child, or adolescent within the context of their life-relationships. The "care unit" is, therefore, the social system, not just the individual.

According to the concepts and "discovery" of Cicely Saunders, people suffer *comprehensively* (her concept of "total pain") – that is, biopsychosocially and spiritually. This multidimensionality in the anthropology of "Caring" is indeed a revolution which is not only represented by conventional medicine. It makes interdisciplinary theory and practice essential – a logical consequence designed to complement interprofessionalism, especially for the so-called voluntary workers, the citizens (in a civic concept of civil society) who maintain the continuity of care.

The WHO definition of palliative care also stresses the spiritual needs of dying people. In recent years, this information has raised the awareness with regard to other non-medical dimensions of end-of-life care: Different approaches were discussed either via an interreligious approach (Heller 2000b), or based on the reinterpretation of the role of pastoral care and medicine. Similarly, the area of gender-sensitive hospice and palliative culture is becoming increasingly important (Reitinger and Sigrid 2010), as is the realization that gender is also a significant dimension in the experience of suffering and pain (Lehner 2010).

Conclusion and Future Directions

Palliative care can be understood as an innovation within the healthcare system, both as an organizational and social innovation: interdisciplinary theory and practice are essential in the palliative care concept, while the "unit of care" is not just the individual, but the whole social system. The multidimensionality in the anthropology of "Caring" (on biopsychosocial and spiritual levels) can be seen as a revolutionary notion in this new care-culture, where the so-called voluntary workers and the "civil society" maintain the continuity of care.

Insofar the palliative care concept is also relevant for the knowledge society, because knowledge is not derived by the experts or professionals, but by the laymen. It is an anti-elitist approach, in which professionals act as supporters and facilitators, focusing on the needs of the persons concerned.

It must be noted that palliative care, within this multidimensional concept, has proven resistant to any form of machine-like image of man; it respects and recognizes people as subjects of their own lives, and strives for the required balance of autonomy and care needs in order to assist their social caregivers. It makes it necessary to reflect on the comprehensive work of the entire team, in both the outpatient and inpatient sectors, as well as being a part of a comprehensive care-culture within society.

Insofar that hospice work and palliative care have been forming a profound innovation within the healthcare system – and because this gap has been discovered and revealed as the "place for action" – the movement, as such, is guided by interdisciplinary, inter-professional, inter-organizational, interreligious, and intercultural principles.

Interestingly, hospice work is also an area where a new image of a "healthy death" (Wenzel 2012) can be created. Death is understood and attended to not as a result of disease or organ failure, but as part of a (spiritual) developmental process of a person, wherein pain may also be considered as an approach to a central dimension of life. "Healing" may then be possible, even if "curing" no longer is (Rakel and Weil 2003).

In this sense, hospice work and palliative care serve as a thorn within the medically and curatively oriented healthcare system, demanding a challenging discussion about death despite all the achievements of modern medicine not only for the dying individual, but equally for the relatives, carers, and professionals. Hospice work and palliative care do not only remind but also allow to trace (a society) back to the power of civil society, who is concerned to form and participate in new "cultures of care."

Cross-References

▶ Citizen Science in Health Domain
▶ Creativity and Age
▶ Healthcare and Innovation
▶ Interdisciplinary Research (Interdisciplinarity)
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Transdisciplinary Research (Transdisciplinarity)

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References

Clark D. Between hope and acceptance: the medicalisation of dying. BMJ. 2002;324:904–7.
Clark D, Seymour J. Reflections on palliative care. Buckingham: Open University Press; 1999.
Davies E, Higginson I. Better palliative care for older people? Copenhagen, Denmark: WHO Regional Office for Europe; 2004.
Gronemeyer R. Himmel, der. Sehnsucht nach einem verlorenen Ort. München: Pattloch; 2012.
Heller A. Die Einmaligkeit von Menschen verstehen und bis zuletzt bedienen. In: Heller A, Heimerl K, Husebø S, editors. Wenn nichts mehr zu machen ist, ist noch viel zu tun. Wie alte Menschen würdig sterben können. Freiburg im Breisgau: Lambertus; 2000a. p. 9–24.
Heller A, Kittelberger F. Hospizkompetenz und palliative care im Alter. Lambertus: Eine Einfer. Ei. Freiburg im Breisgau; 2010.
Heller A, Knipping C. Palliative care – Haltungen und Orientierungen. In: Knipping C, editor. Lehrbuch palliative care. Bern: Hans Huber; 2007. p. 39–48.

Heller B. Kulturen des Sterbens. Interreligiosität als Herausforderung für Palliative Care. In: Heller A, Heimerl K, Metz C, editors. Kultur des Sterbens. Bedingungen für das Lebensende gestalten. Freiburg im Breisgau: Lambertus; 2000b. p. 177–92.
Lehner E. Schmerz und Depression – die Bedeutung von Gender im Erleben von Leid. In: Reitinger E, Beyer S, editors. Geschlechtersensible Hospiz- und Palliativkultur in der Altenhilfe. Frankfurt am Main: Mabuse; 2010. p. 231–44.
Rakel D, Weil A. Philosophy of integrative medicine. In: Rakel D, editor. Integrative medicine. Philadelphia: Saunders; 2003. p. 3–10.
Reitinger E, Sigrid B. Gender-Care: verschiedene Sichtweisen für eine gelingende Integration. In: Reitinger E, Beyer S, editors. Geschlechtersensible Hospiz- und Palliativkultur in der Altenhilfe. Frankfurt am Main: Mabuse; 2010. p. 9–20.
Saunders C, Baines M. Living with dying: the management of terminal disease. Oxford: Oxford University Press; 1983.
Seymour JE, Hanson E. Palliative care and older people. In: Nolan M, Davies S, Grant G, editors. Working with older people and their families. Maidenhead/Philadelphia: Open University Press; 2001. p. 99–119.
Steffen-Bürgi B. Reflexionen zu ausgewählten Definitionen der Palliative Care. In: Knipping C, editor. Lehrbuch palliative care (2. durchg. u. korr Aufl.). Bern: Hans Huber; 2007. p. 30–8.
Wenzel, C. Heil Sterben. Zur Bedeutung alternativer Ansätze für eine ganzheitliche Begleitung Sterbender in Hospizarbeit und Palliative Care. Unveröffentlichte Dissertation zur Erlangung des akademischen Grades Doktorin der Philosophie an der Alpen-Adria Universität Klagenfurt I Wien I Graz, Fakultät für Interdisziplinäre Forschung und Fortbildung, Abteilung Palliative Care und Organisationsethik, Wien; 2012.
World Health Organization (WHO). National cancer control programmes. Policies and managerial guidelines. Geneva: World Health Organization; 2002.

Paradigm Shift

► Innovation and Entrepreneurship

Paradox of Agency

► Institutional Entrepreneurship

Park

► Clusters, Networks, and Entrepreneurship

Partial Retirement

► Cross-Retirement (Cross-Employed Cross-Retired) and Innovation

Partnerships and Entrepreneurship (Vol Entrepreneurship)

Delphine Gallaud
INRA CESAER (UMR 1041), Unité Mixte de Recherche INRA-Agrosup, Dijon Cedex, France

Synonyms

Networks interfirms cooperation; Strategic alliance

Introduction

Scholars have considered entrepreneurship only as a creation by an independent entrepreneur for a long time. However public policies reconsidered this view in the 1980s and encouraged the development of two new kinds of entrepreneurships: first, academic entrepreneurship during the 1990s, and second, corporate entrepreneurship (CE) in the following decade (Phan et al. 2009). At the end of the 1990s, public policies tried to improve the system of innovation and to speed up the conversion of fundamental research into commercial innovation. So, it encouraged the development of academic entrepreneurship (Nicolaou and Birley 2003). Academic entrepreneurship is a real breakdown with the traditional culture of university that focuses on the production of knowledge, and not on commercial purposes. Corporate entrepreneurship includes various kinds of organizational practices that allow the firm to develop new innovations in internal such as in external ways (Narayanan et al. 2009). Internally, the parent company creates a structure that remains linked to her by property rights. Scholars call such situation as a "quasi-firm." Externally, the means that are used to develop CE are more varied. The parent firm can purchase license, buy other firms, create joint venture, or use any kind of strategic alliances between organizations.

Scholars have discussed for a long time about the definition of partnership. Partnership can take two main definitions. In the first and larger definition, partnership can be assimilated to interfirms cooperation. Economists use more the term of cooperation whereas managers use the notion of strategic alliance, but the meaning is quite similar. Interfirms cooperation is defined by the fact that two or more organizations, that remain legally independent, will coordinate their objectives and can share various means of production (human, financial know-how, etc.) to attain a common goal. But the organizations are still competitors in the end-product market (Imai and Itami 1984). Such situation is often qualified as "co-opetition" because firms use both competition and cooperation. Interfirms cooperation can take various concrete forms: subcontracting is the more frequent form, R&D contracts, agreement of joint R&D, joint venture, etc.

In the narrower second sense, partnership is defined only as the evolution in the interfirms relationships from subcontracting to more equal relationships. In fact, subcontracting is in general linked with unequal relationships between firms. With this evolution to more equality the subcontractor becomes co-owner of the product and it is encouraged to innovate to regularly improve the product. The narrower definition is less used because it is too restrictive. Afterward we will use the first definition.

These two definitions appeared following the rapid increase of partnerships in the 1980s, especially between competitors. This point challenged scholars about this kind of organization of interfirms relationships. Scholars developed two main theoretical approaches to explain this growth of partnerships. The two approaches are the neo-institutional economics (Williamson 1975, 1985) and the resource-based theory of the firm and the evolutionist approach (Wenerfelt 1984; Teece and Winter 1990).

The emergence of partnerships will be different in the three kinds of entrepreneurships. Entrepreneurs in start-ups can mobilize partnerships to develop their firm only when it has been created (after the registration of the status). Before the setup of the firm, we will qualify the interaction with other organization as a social network. But before this moment the firm cannot use an interorganizational link by definition.

CE is not systematically linked with partnerships. In the case of internal creation, in most of the cases, the parent company grants self-determination to the spin-out to allow it to explore any risky innovation projects, reducing the financial risk for the rest of the organization. The parent company keeps stakes in the capital of the spin-out but it can sell them if the project fails. The amount of the stakes will determine the degree of autonomy of the spin-out and its ability to conclude partnerships by itself. We can talk of partnerships only when they are concluded with another organization than the parent company. As far as external means are concerned, purchasing license and buying another firm are generally not considered as partnerships, however joint venture and strategic alliance can be qualified of partnerships.

Academic entrepreneurship is characterized by its origin. Academic entrepreneurs come from the research sector and they keep their relationships with their former colleague. So, the entrepreneur uses former networks that come from links into the academic world to be informed about new opportunities and to set up a new organization.

What are the relationships between partnerships and entrepreneurship? First, we will begin by the influence of partnership on the development of entrepreneurship, and in the second part, we will treat the opposite relationship.

The Influence of Partnership on Entrepreneurship

Setup of a new organization needs different stages: detection of opportunities, pre-setup, setup, and then very often a reorientation of the project to assure the sustainability of the project development. In fact, the difficulty for setup is to pass from one stage to another. The new firm manages to pass the different stages by recombining resources networks and partnerships or by creating new resources. Doing so, the firm recombines and makes evolves it links with other organizations. The entrepreneur mobilizes first its social network before building a professional inter-organizational network. So, time is important to understand the relationships between entrepreneurship and partnership.

Evolution of the Nature of the Links Between Organization and Its Environment

A new entrepreneur, in order to set up his firm has to mobilize a network that must be more dense and must include as many diversified resources as possible to favor the setup of the firm.

The pre-setup stage is associated with social network (including family members, friends, and neighborhood) (Schutjens and Stam 2003). Such network cannot be defined as partnership because partnership is only an inter-organizational linkage. And at the stage of pre-setup, the organization does not exist. But when the start-up is set up on the market it begins to establish such inter-organizational links. Then, the social network of the entrepreneur evolves toward partnership. New entrepreneurs can mobilize partnerships with customers and suppliers of the firm where they were employed before the setup of their own firm, or they can create totally new partnerships with new actors.

Public Policy Toward Start-Up: The Rise of Public-Private Partnerships (PPP) and Their Influence on Entrepreneurship

States used PPP since the nineteenth century to provide collective services when the budget necessary to fund them was too important for the state's budget. They were used especially to build large infrastructures or collective equipment (as hospital or schools). But PPP were used extensively only in the 1980s because public debts became too important in most of the European countries. PPP in the field of innovation obey the same logic as the one described above. For the traditional economic theory of innovation, knowledge produced during innovation activities is a public good characterized by non-rivality and non-excludability. These characteristics justify public intervention. So states must fund public research to sustain innovative activity (Arrow 1962). PPP includes devices to encourage entrepreneurship but they are not really efficient.

During the 1980s, countries that have used the model of furniture of knowledge by the state, via public organism of research, encountered many technological failures. In France, for example, the "plan calcul" failed. So the European Union, especially France, tried to correct their innovation policies. France had to face the lack of private R&D funded by firms. So, it tried to increase the investment in fundamental research, and PPP device was a means to increase private spending. France impulsed this device quite recently, during the 2000s. Many kinds of PPP relative to innovation are used such as RRIT, CNRT, CRITT or devices for human resources such as ERT, CIFRE, and corthechs. More recently, the device of pole of competitivité and the increase of the part played by the organism in charge of the transfer of technology was encouraged. PPP should also increase entrepreneurship especially the academic one. RRIT gathers all the actors of a technological field: public organism of research, firms, universities, school of engineers, professional organization of a field, and club of entrepreneurs. But in practice, in France, very few PPP include entrepreneurs. The evaluation of RRIT demonstrated that it was incumbent firms that have proposed projects of innovation and not start-up. But in fact, if PPP are not an efficient device to promote entrepreneurship it is because public policy dissociates innovative projects in partnerships and measure to sustain entrepreneurship (MESR 2009). And the point is validated even if the definition of the device of PPP allows gathering all the actors in the field, including the entrepreneurs. The experience of other European countries gives the same mitigated result. For example, in Portugal, on 100 PPP studied, if almost all of them included associations of entrepreneurs of national regional or sectoral level, only eight PPP traduced on the development of innovative projects new entrepreneurs.

Influence of Entrepreneurship on the Kind of Partnerships Established

Difficulties for Start-up to Establish New Relationships

To introduce the point, we can remember that almost new entrepreneurs have a lot of difficulties to establish relationships with external organization and to create partnerships. Only 30% of new firms have two partnership relationships at the end of their first year of existence in addition to their standard relationships with suppliers and customers (Schutjens and Stam 2003). Besides, firms have many difficulties to stabilize these relationships during their first 3 years of ongoing business. Firms modify their networks during these years, diminishing their number to focus on the most important.

New technology based firms (NTBF) do not face such difficulties to establish new partnerships (Colombo et al. 2006). Seventy percent of the NTBF have at least one relationship during the first years. However the authors underline one difficulty; it seems that these firms face threshold effects, because of their lack of credibility in the marketplace. These firms are created around the innovative project and the competence relative to R&D and sometimes around the competence of development of products. They develop the competences of commercialization later. Throughout the first stage of development, they are too small to develop internally functions of commercialization and marketing. So they use partnerships with incumbent firms to access these competencies and the networks of distribution. NTBF are skilled in R&D and do not search in priority technological partnerships, but they can use partnerships in technology as complementary activities. For example, they can work as subcontractor on R&D contracts. In many cases, NTBF remain specialized on subcontracting of R&D and never develop capacities of production (Perez and Martinez Sanchez 2003). So commercial partnerships are dominant and represent 70% of the total of partnerships for NTBF versus 30% for technical partnerships. This kind of partnership remains important during the first 5 years of the firms and then they decline.

New firms have to establish partnerships, but in practice, many of them are reluctant to do so because they understand very well that such behavior is risky. NTBF that are highly skilled in scientific research are especially conscious of the risk to be expropriated from their knowledge by large incumbent firms. And their knowledge is a strategic asset for this kind of firm (Colombo et al. 2006). So, this behavior of large firm slows down the formation of NTBF's new partnerships till firms are able to protect their know-how, by patenting for example.

So, the most important difficulty for new firms will be to pass from the social to the professional network and to do so being able to protect their strategic asset.

Influence of the Entrepreneurs' Characteristics on the Kind of Partnerships: Difficulties to Diversify the Partnerships

Partnerships of New Independent Firms

Networks of new entrepreneurs evolve, after the start-up creation, from a social to a professional network (Schutjens and Stam 2003). The traits of the entrepreneurs influence the characteristics of partnerships they create. The question of the existence of a difference in the network of male and female entrepreneurs is still debated. Schutjens and Stam (2003) do not confirm the hypothesis, but Hoang and Antoncic (2003) found no difference between the two kinds of networks. Besides, characteristics of the firms influence its ability to establish partnerships. The intensity of R&D has an influence on partnerships. Firms that spend more in R&D establish more relationships than others. This relationship was regularly validated by econometrical studies since the 1980s. To own patents is a factor that influences positively the probability to establish relationships. Patents act as a signal of technological ability and help firms to create credibility to attract partners.

Small firms create fewer partnerships than bigger firms (Schutjens and Stam 2003). Firms in industry would create more partnerships than in services. But this result is validated only for technical partnerships (Colombo et al. 2006). Firms in service sector develop more commercial partnerships. At last, urban firms would have more partnerships than rural firms (Schutjens and Stam 2003).

Specificities of CE on the Kind of Partnerships Established

When a parent firm creates a spin-out, in fact the parent will serve as incubator for the spin-out. In function of the degree of autonomy that the parent let to the spin-out, the spin-out will have different possibilities to create partnerships (Parkhangras and Arenius 2003). These authors analyzed the creation of spin-out and identified three types of new firms. In the first group, the parent dissociates a subset of the company to explore risky technological project. It provides resources, such as financial or human or equipment, and then it only takes some stakes in the capital of the start-up. During all the exploration stages of the project, there are very few relationships between the parent company and the spin-out. This kind of spin-out never becomes an independent firm because if the project succeeds, the parent company buys all the stakes of the start-up and re integer it into the parent company. In this group, the spin-out has never enough time to establish partnerships with external organization.

In the second group, the parent company and the spin-out have the same technical basis. In most cases, the parent created the spin-out to provide it some special component that was difficult to purchase in the marketplace. R&D cooperation is strong in this group but with the parent company. As the time goes by, the marketplace can provide the components and purchasing on the market becomes less difficult. The parent firm can give autonomy to the spin-out and let him develop by himself. But then, the spin-out has to survive in the marketplace. As it is now an independent firm it can create the same partnerships as the one described in the first point. Spin-out of the third group is old and dissociated from the parent a long time ago. It is the case in more traditional sector, for example. At the beginning, the parent company plays the same part of incubator as described before; it shares resources with all the spin-outs. Then, the parent company generally refocuses on its core activity that is in most cases different from the core activity of the spin-outs. And at last, the spin-out becomes more and more a process developer. Links with the parent company loosen. Then the situation becomes the same as that described just before.

Academic Entrepreneurship and Partnership

Public policy tried to encourage academic entrepreneurship since the 1980s. Public policy maker's goal was to speed up the conversion of technological opportunities into commercial innovation. Literature on academic entrepreneurship takes up the literature about entrepreneurship and then brings to the fore the specificities of academic entrepreneurship. The literature underlines above all the lack of entrepreneurial culture in universities (Nicolaou and Birley 2003). Public policy tried to sustain the creation of start-up by academics, but in France, academic entrepreneurships are in fact in three fourth of cases scientific advisors in firms (MESR 2009). So scientific researchers do not often create their own start-up but let another person do it in most cases, such as an entrepreneur or an experienced manager.

Academic entrepreneurship can be associated to various degrees of implication of the scientific in the new firm. Scientific that give up their academic position are more implicated in the new firm and generally, this kind of firm grows faster. But, the academic diminishes his links with his prior university and at the same time takes the risk to slow down the speed of innovation in his start-up. Academic start-up generally maintains dense links with research and the scientific field. These traits are specific to the academic entrepreneurship, but contrary to more commercial start-up, academic entrepreneurs have often many difficulties to create market links with customers and suppliers (Perez and Martinez Sanchez 2003). But factors that slow down the establishment of networks can be the problem of trust in relationships with large incumbent firms (Colombo et al. 2006). In fact, many academic start-ups, at the end of any years of ongoing business, do not still commercialize any products at all, but remain specialized as subcontractor of R&D contracts. That choice of specialization reduces their need to establish partnerships.

Besides, these firms have difficulties to diversify their partners. Spin-outs located in scientific parks, for example, have relationships with the university of the academic but not very dense and very few relationships with other external partners.

Conclusion and Future Directions

Partnerships have grown very quickly since the 1980s. But theoretical approach of partnerships is not still taking into account all the implications of that growth, as Chesbrough (2003) indicates with the debate around the model of open innovation. Scholars have conceptualized innovation activity as an internal activity of the firm for a long time. All the innovative activities from research to development of the products should be developed internally. From Chesbrough's point of view, this model is coherent when scholars think innovative knowledge as a strategic asset of the firm. The main drawback of this way of thinking is the risk of the "Not invented here" syndrome for the firm. In fact, many large firms do not detect very profitable innovative project because they lose their perception of the competitors' projects and the evolution of clients' needs, thinking all their projects internally. The model of open innovation is a way of thinking project development by screening all the competitors' projects and clients' need and by using all the external sources possible to innovate. It implies that if a firm cannot develop a part of a project internally it can buy the technology developed outside or establish partnerships to develop it. This model encourages firms to create a dense set of partnerships for each firm. But on the other hand, the model does not question the risk of partnerships especially for small SMEs. Open innovation could have a positive impact on the corporate entrepreneurship, because this model encourages firms to stay innovative by screening their environment to pick up future profitable projects. The best way to achieve this goal is to be able to create spin-out regularly.

As far as public policy is concerned, various points are at stake, which are as follows.

Firstly, public policy has difficulties to sustain entrepreneurship in efficient ways. This point was underlined analyzing the PPP's device, where entrepreneurship was dissociated from innovative projects. More generally, in France, public policy about entrepreneurship follows two main goals: on the one hand, to encourage the creation of start-up, especially in the more high-tech sector of the economy, but on the other hand, to encourage the creation of their own job by the entrepreneurs during the time of economic crisis. This second way often leads to the creation of small firms in the service sector that are less innovative than the first kind of firms. Public policy puts in place various devices for each kind of new firms, but these devices are often not linked to each other that increase the difficulty for new entrepreneurs to identify the measure.

Secondly, as far as academic entrepreneurship is concerned, the main problem is the link of the new firm to the marketplace. This kind of new firm is well connected to the scientific research but often lacks the production and commercial skills needed to allow the growth of the start-up. It can also be the case when these academic entrepreneurs try to sell their knowledge. One of the possible measures of public policy should be to incite more systematically the academic entrepreneur to create their firm with another entrepreneur specialized in management or commercialization.

At last, public policy often underestimates the risks associated with partnerships especially for SMEs; besides, for these kinds of firms, knowledge constitutes very often their unique strategic asset (Colombo et al. 2006). The problem is the protection of intellectual property for small firms and for start-ups that are generally small. In general, SMEs do not perceive the importance of the protection of their intellectual assets and actual means of protection that fit for the large firms but not for SMEs. It is are case for patents, for example. Besides, European public policy develops at this time a pro-patent trend and does not create specific tools designed for SMEs.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Corporate Entrepreneurship
- ▶ Network and Entrepreneurship

References

Chesbrough H. Open innovation the new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003. 231.

Colombo M, Grilli L, Piva E. In search of complementary assets: the determinants of alliance formation of high tech start-ups. Res Policy. 2006;35:1166–99.

Hoang H, Antoncic B. Network-based research in entrepreneurship: a critical review. J Bus Ventur. 2003; 18:165–87.

Imai H, Itami K. Interpenetration of organization and markets: Japan firms and markets in comparison with the US. Int J Ind Org. 1984;2:285–310.

MESR. Recherche et développement, innovation et partenariats. 2009. 90 p. http:www.media.enseignementsup-recherche.gouv.fr/.../SETTAR_2009_159899.pdf. Accessed June 2011.

Narayanan VK, Yang Y, Zahra X. Corporate venturing and value creation: a review and proposed framework. Res Policy. 2009;38(1):58–76.

Nicolaou N, Birley S. Academic networks in a trichotomous categorization of university spin-outs. J Bus Ventur. 2003;18:333–59.

Parkhangras A, Arenius P. From a corporate venture to an independent company a base for a taxonomy for corporate spin offs firms. Res Policy. 2003;32(3):463–81.

Perez M, Martinez Sanchez A. The development of university spin offs: early dynamics of technology transfer and networking. Technovation. 2003;23:823–31.

Phan P, Wright M, Ucbazarn D, Tan WL. Corporate entrepreneurship: current research and further direction. J Bus Ventur. 2009;24(3):197–205.

Schutjens V, Stam E. The evolution and nature of young firm's networks: a longitudinal perspective. Small Bus Econ. 2003;21:115–34.

Patent

▶ Patent System

Patent Exchange

▶ From Personal to Impersonal Exchange in Ideas

Patent Markets

▶ From Personal to Impersonal Exchange in Ideas

Patent System

Eskil Ullberg
Interdisciplinary Center for Experimental Science, George Mason University, Fairfax County, VA, USA

Synonyms

Intellectual property rights; IP system; Patent

Definition

The patent system grants and enforces temporal exclusive, transferrable, and licensable private rights on inventions – that provide solutions to (mostly) technical problems in the area of products and processes – in exchange for disclosure of the invention to the public at a level that can be understood by a person skilled in the art.

In order for an inventor to receive such a right, the invention typically has to meet three criteria: (1) The invention has to be new, i.e., after search there is no prior art found, (2) There is an inventive step or non-obviousness to the idea, i.e., new prior art is created that required a flash of genius or long toil thus advancing technical knowledge that others can build on (not so simple anyone could discover it), and (3) The idea has to be industrially applicable or useful – which excludes schemas as natural laws, mathematical formulas, and some military strategic inventions – i.e., has a focus on industrial (economic) productivity. The ideas have to be technical in nature, except in the USA where nontechnical ideas also can be granted patents since the 1990s.

The patent system can be seen as operating under the principle of exchange between the inventor (or firm, university, research institution) and the state: An exclusive and tradable right is given for a limited time in exchange for disclosing to the public – teaching the world – about the invention, opening up for everyone to build on this previously private knowledge and invent further, thus creating *competition* in technical inventions. The system also establishes private and *tradable* property rights on new technology, creating the fundaments for a market in technical ideas. Such markets aught to allow, like all competitive markets, for specialization and specialization for increased productivity, wealth creation, and economic growth.

From an institutional perspective, the patent system is divided into two parts: the *patent office* and *patent enforcement* which sometimes is organized in specialized courts or specialized appeals courts. When granted, the patent is *presumed* valid and when enforced can be declared valid or be annulled. If patents are infringed by a third party, injunctions and stiff penalties can be deemed to the infringer based on the loss for the patent holder. However, an estimated 95 % of court cases are dropped prior to enforcement, resulting in a licensing agreement instead. The mechanism thus serves to give incentives for negotiation. It is important, for the well functioning of the patent systems, that procedures do give this incentive and not to rent seeking behavior.

The patent system was first established in Venice in 1474 and then spread via the Italian city states to first most European countries and in the nineteenth and twentieth centuries the industrialized countries of the world. Today, many emerging market countries are developing patent systems. See WTO/TRIPS agreement. The patent systems are national systems since about 150 years but remain essentially the same as the first system when it comes to the private, transferrable, and licensable right in exchange for disclosure.

Cross-References

▶ From Personal to Impersonal Exchange in Ideas

Patents

▶ Networks and Scientific Innovation

Patents and Entrepreneurship

Julien Pénin
University of Strasbourg – BETA (UMR 7522 CNRS-UdS), Strasbourg Cedex, France

Synonyms

Innovation policy; Intellectual property rights; Markets for technology; Open innovation; R&D collaboration

A patent gives to its owner an exclusive right on a product or process which is new, inventive, and has an industrial application (in the USA, this third criterion is broader in the sense that the invention needs not to have an industrial application but must merely be useful). From a legal point of view, a patent is a negative right. It gives the right to exclude but not necessarily to use an invention, if this use leads to infringe a right held by someone else. The maximum duration of the patent protection is 20 years after the first application (but a majority of patents does not last this long). Also, in most countries, patent applicants must provide a description of their invention which, 18 months after the first application, is made public (made available to everybody). The description must be sufficiently clear and exhaustive in order to allow a person knowing the state of the art to reproduce the invention simply by reading the patent.

Originally, the patent system has been designed to provide entrepreneurs with incentives to invest in research and development (R&D) while, in the same time, ensuring a minimal level of knowledge diffusion (they are intended to solve the Arrow dilemma also called the incentives-diffusion dilemma, Arrow 1962). On the one hand, patents improve the level of appropriability over inventions (since they enable inventors to exclude imitators), which should increase incentives to invest in inventive activity. On the other hand, they participate to disseminate new knowledge since they are published. With respect to this double mission (provide entrepreneurs with incentives to both invent and disclose their invention), standard economic studies have thus been able to analyze the optimal length, width, and depth of the patent system (Scotchmer 2004).

Yet, in the last three decades, most economic studies (both theoretical and empirical) have questioned this traditional and simplistic view of the patent system (Levin et al. 1987; Mazzoleni and Nelson 1998; Jaffe 2000; Cohen et al. 2000). First, they show that patents are often not an efficient tool to prevent imitation because they are easily turned around and because they are often difficult to enforce in court (judicial trials are uncertain, long, and costly). Second, those studies also show that, for entrepreneurs, appropriation failure is usually not as important as considered by the classical view. Often, entrepreneurs can easily appropriate the value of their inventions without relying on patents (because, for instance, secrecy can be preserved, or the knowledge base is tacit, or technology is complex, i.e., not easy to reproduce). Third, recent economic studies stress that the production of innovation also faces a strong *coordination failure* and not only an *appropriation failure*. Innovation being a collective and interactive process, actors involved in this process need to interact, to collaborate, and to exchange knowledge. Yet, this collective process of knowledge production is often impeded by information imperfection and by the tacit dimension of the knowledge base. In sum, in a knowledge-based economy, the economic role of the patent system is likely to be more complex than what is presented by the traditional view (which considers only the role of patent as an instrument to exclude).

The following of this entry is divided in two parts. First, it describes the role of the patent system for entrepreneurs in a knowledge-based economy. In particular, it stresses that there is not one single role but a multiplicity of uses, according to the context. Second, it introduces the costs of patents for entrepreneurial activities and shows how patents may sometimes impede innovation.

The primary role of the patent system is not merely to restore appropriation but also to ensure the coordination of the innovation process. Patents are, in a sense, structuring elements of open innovation (Chesbrough 2003), because they cumulate two important properties: They both secure and disclose new knowledge. Those two properties imply that patents can improve both market and nonmarket coordination of the innovation process:

– *Market coordination*. Patents sustain the raise of markets for technology (Arora et al. 2001). Thanks to the patent system, innovative firms can directly specialize in knowledge production and sell their technologies to manufacturing firms via licensing agreements. They can also cross-license their patents, as it is typically observed in industries with complex technologies (in this second case, they barter their patents on markets for technologies) (Grindley and Teece 1997).
– *Nonmarket coordination*. Patents can also promote directly collaboration and knowledge exchange. First, because they signal relevant knowledge, which makes it easier for firms to find partners and to coordinate around a focal point, and second because, by securing technologies, they facilitate interfirm agreements. At the extreme, patents can also promote open-source type of knowledge production by preserving the openness of the knowledge base (Pénin and Wack 2008).

The role of the patent system for entrepreneurs is therefore very different from the image found in most economic textbooks. In a sense, patents may enable entrepreneurs to “include” other actors in the innovation process more than they “exclude.” This is all the more relevant that the invention is emerging, i.e., knowledge is tacit, and opportunities (market and technological) are uncertain. In those emerging situations, it is indeed likely that needs of coordination overcome needs of exclusion, which may induce entrepreneurs to use the patent system essentially in order to smooth coordination problems and to foster open innovation.

This evolution of the utilization of the patent system also leads to rethink the rationales to patent for entrepreneurs. In most cases, firms apply for a patent not in order to effectively prevent imitation and to exclude competitors but, more subtly, in order to obtain access to technologies held by rival, to signal competencies, to trade technologies on a market, to prevent other firms to patent, etc. Entrepreneurs must therefore acknowledge and exploit this multiple and strategic role of the patent system.

In particular, patents play a critical role to sustain the emergence of entrepreneurial firms (start-up, spin-offs, etc.) (Arora and Merges 2004). Those “fabless” firms (they do not have tangible fabrication) produce only knowledge, which is intangible and, in the absence of patents, can be appropriated only to a limited extent. Hence, it is straightforward to understand why patents are often critical to the survival of these firms: They contribute to solve the Arrow paradox (1962). Without patents it is likely that they would find it difficult to make money out of their knowledge and hence could hardly raise venture capital funds. In sum, patents may sustain the emergence of a new industrial organization, with a vertical division of labor between fabless firms, which produce knowledge upstream, and then sell their technologies to manufacturing firms located downstream on the value chain. The cases of the pharmaceutical and of the electronic sectors are two famous examples of such a new industrial organization, which sees the emergence of fabless, entrepreneurial firms.

However, the role of the patent system is not homogeneous across sectors. It depends critically upon the characteristics of the firm and of the industry it belongs to, in particular the competitive intensity and the technological regime. The technological regime of a sector defines all the features of the basic technology which underlies a given industrial production and which affects the strategy of the actors. Its main dimensions are the degree of appropriability of the technology, its more or less modular nature, its degree of complexity, the existence of network effects, etc. Different technological regimes lead to largely different patenting strategies, and this explains the major differences observed in the use of patents in sectors such as pharmaceuticals, electronics, software, chemistry, etc. Due to heterogeneous technological regimes, actors of the innovation process in those sectors must rely on different patenting strategies.

For instance, the simple nature of the technology in pharmaceuticals, coupled with the specificity of the regime of appropriation in this sector (natural appropriation is weak but legal appropriation via patent is strong), explains why, in line with the traditional view of the patent system, pharmaceutical firms use patents primarily to exclude. Conversely, the complex, multicomponent nature of the technology in electronics explain why in this sector patents are used primarily in a defensive way, i.e., not to exclude imitators but to prevent being excluded, hence preserving firms’ freedom to operate (Kingston 2001).

To sum up, in many industries patents are critical strategic instruments for entrepreneurs, which explain the burst of patent applications in fields such as life sciences and information technologies. Furthermore, the use of patents by entrepreneurs is not uniform and is not based solely on strategies of exclusion. It varies according to the context. The second part of this note aims now at exploring the problems that this new role of patents may raise.

Indeed, if the evolution in the utilization of the patent system can hardly be denied, a strategic use of patents can also entail serious costs and largely contribute to harm entrepreneurial activities. Standard economic theory mostly stresses the monopoly deadweight loss generated by the patent system. Since patents give monopoly power to their owner, during their period of validity they inevitably contribute to raise prices above marginal cost, which generates a loss of surplus for society. This static loss is believed to be the price to pay in order to foster dynamic efficiency (to increase entrepreneurs' incentives to innovate). Within this view, patents have only positive effects in the long run. They can never damage the innovation process and undermine the dynamic evolution of the system.

Yet, when patents are used strategically, costs that stem from the patent system may be very different and, above all, may affect the innovation dynamics, i.e., may have negative consequences on the long run. First, patents can impede the dynamics of innovation by preventing entrepreneurs from accessing existing knowledge. Innovation proceeds indeed cumulatively, and today's inventions feed tomorrow's inventions (knowledge is both an input and an output of the innovation process). It is hence primarily important for entrepreneurs to have access to existing knowledge. Yet, patents give an element of control on this knowledge, thus potentially raising the cost to access it. In other words, the exclusive right conferred to inventors must not be too strong in order to preserve incentives to develop future innovations. This is all the more the case with respect to sequential innovations, in which a delicate balance must be found in order to preserve incentives to invest both in first- and second-generation innovations (Scotchmer 2004; Pénin and Wack 2008).

Second, the multiplication of overlapping patents in some sectors (this is especially true in sectors such as electronics where the technology is complex) may generate what authors have referred to as a "tragedy and the anticommons" (Heller and Eisenberg 1998) or a "patent thicket" (Shapiro 2000). The idea is that the proliferation of fragmented patents on a given technology makes it prohibitively costly for entrepreneurs to develop this technology (it is the well-known problem of multiple marginalization). Each patent owner having a right of veto over the overall technology, potential developers must bargain with all the stakeholders, which, at the end, may undermine the development of this technology. Patent thickets may hence deeply influence the choice of research programs and affect technology trajectories. They may lead to closing some technological fields which, from a pure research point of view, would be worthwhile pursuing, thus generating huge dynamic inefficiencies.

Third, the development and institutionalization of the patent system may give birth to perverse behaviors which, in the long run, could harm innovation (Jaffe and Lerner 2004). For instance, opportunistic strategies of "patent trolls" or "patent sharks" on markets for technology may radically decrease incentives of entrepreneurs and manufacturing companies to invest in R&D. Trolls indeed use the patent system for the sole purpose of litigation, without any intention to use the technology protected by the patent. The business model of those firms is therefore literally to be infringed (in order to earn money via litigation fees), thus hijacking radically the primarily role of the patent system (to prevent infringement). While perfectly legal, this strategic use of the patent system is likely to harm innovative activities by decreasing the incentives of genuine entrepreneurs to invest those activities.

Conclusion and Future Directions

In the knowledge-based economy, patents are important strategic tools for entrepreneurs who, in many innovative sectors, could hardly develop their activity without them. But in the same time, patents are also susceptible to seriously damage the pace of innovation, mainly by increasing the cost of accessing existing knowledge and technologies, which entrepreneurs need in order to develop tomorrow's technologies. The net benefit of the patent system for society is the outcome of those two counterbalancing forces.

This discussion on the role of the patent system is essential because it contributes to introducing new dimensions to comprehend the present debate on intellectual protection.

Yet, future research will have to complete it at least with respect to three issues:

First of all, future research will have to develop a framework to understand the determinants of firms' optimal patenting strategies. This note has suggested that the technological regime may be a central determinant of firms' choices. Yet, future work will have to go further and build a theoretical framework which, ideally, should be detailed and precise enough so that it can help with decision making for practitioners and policy makers.

A second important research track deals with the normative implications of the strategic use of patents. As soon as patents are also considered as tools of coordination or even of collaboration in a framework of open innovation, conducting a welfare analysis becomes very difficult. New threats may appear in the long run (anticommons, patent thickets), but also new benefits (markets for technology, open innovation). Hence, improving the normative understanding of patents is essential since proper public decisions can only be taken provided that we understand the likely consequences of each possible change.

A third "hot spot" with respect to the strategic use of patents deals with their financial value. In a knowledge-based economy, in which firms' main assets are their knowledge and technologies, it is highly important to be able to properly evaluate the financial potential of those technologies. Putting a value on a technology (patented or not) is critical, just to give a few examples, any time firms are trading technologies on a market (licensing in and out), are looking for capital, are buying other firms, are funding a joint venture, etc. It might therefore become primarily important to develop financial tools in order to assess the value of technologies and of patents.

Again, if, as assumed by the traditional framework, the role of a patent is just to secure a monopoly position, it is feasible (but not easy) to evaluate its financial value. Methods exist in order to forecast the size of the market and to compute the current value of future expected profits with more or less precision. But those methods neglect completely the strategic dimension of patents. And with respect to this issue, very little is known. For instance, how to evaluate with accuracy the financial value of a signal? A collaboration? Freedom to operate? Precise results and methods are still lacking.

Cross-References

▶ Academic Entrepreneurship
▶ Business Start-Up: From Emergence to Development
▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies
▶ Open Innovation and Entrepreneurship
▶ Start-Up

References

Arora A, Fosfuri A, Gambardella A. Markets for technology: the economics of innovation and corporate strategy. Cambridge: MIT press; Mass 2001.

Arora A, Merges R. Specialized supply firms, property rights and firm boundaries. Ind Corp Change. 2004;13:451–75.

Arrow KJ. Economic welfare and the allocation of resources for invention. In: The rate and direction of inventive activity: economic and social factors. Princeton: Princeton University Press; 1962. p. 609–25.

Chesbrough H. Open innovation: the new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003.

Cohen WM, Nelson RR, Walsh J. Protecting their intellectual assets: appropriability conditions and why US manufacturing firms patent (or not). NBER working paper 7552, 2000.

Grindley P, Teece D. Managing intellectual capital: licensing and cross-licensing in semi-conductors and electronics. Calif Manage Rev. 1997;39:8–41.

Heller MA, Eisenberg RS. Can patents deter innovation? The anticommons in biomedical research. Science. 1998;280:698–701.

Jaffe A. The US patent system in transition: policy innovation and the innovation process. Res Policy. 2000;29:531–57.

Jaffe A, Lerner J. Innovation and its discontents: how our broken patent system is endangering innovation and progress, and what to do about it. Princeton: Princeton University Press; 2004.

Kingston W. Innovation needs patent reform. Res Policy. 2001;30:403–23.

Levin RC, Klevorick K, Nelson RR, Winter S. Appropriating the returns from industrial research and development. Brooking Pap Econ Activity. 1987;3:783–820.

Mazzoleni R, Nelson RR. The benefits and costs of strong patent protection: a contribution to the current debate. Res Policy. 1998;27:273–84.
Pénin J, Wack J-P. Research tool patents and free-libre biotechnology: a unified perspective. Res Policy. 2008;37(10):1909–21.
Scotchmer S. Innovation and incentives. Cambridge: MIT Press; 2004.
Shapiro C. Navigating the patent thicket: cross licenses, patent pools, and standard setting. Innov Policy Econ. 2000;1:119–50.

Pattern

► Models for Creative Inventions

Patterns of Technological Evolution

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Synonyms

Engineering (engineered) systems; Laws; Tendencies; Trends

Introduction

One of the most valuable outcomes of G. Altshuller' s endeavor with the *Theory of Inventive Problem Solving* (TRIZ) was the discovery that technological systems evolved not randomly but rather following objective *Patterns of Technological Evolution*. These patterns could be identified based on the analysis of historical development of various technological systems; once having been documented, they could be purposefully used for further system development of systems avoiding numerous blind trials. Eventually, patterns of technological evolution provided a means for *TRIZ Forecasting* and *Directed Evolution*® (registered Trademark of Ideation International Inc.) – controlling the evolution of technological systems rather than merely solving ongoing problems.

The relatively wide practical application of the first *TRIZ knowledge base tool – 40 Inventive Principles* during the 1970s revealed the dramatic range of efficacy of the principles: while certain principles prompted fairly conventional solutions (such as principle 3, *local quality*), others yielded strong solutions with narrow application (32, *changing the color*) and some offered robust and widely applicable solutions that could be further refined and strengthened. In time it became clear that the most powerful Inventive Principles represented strong, recurrent Patterns of Technological Evolution (such as 15, *dynamicity*) or supported them (25, *self-service* as a way to increase *the ideality of a system*).

The first set of Patterns of Technological Evolution was distributed by Altshuller among TRIZ schools in the spring of 1975. This seven-page manuscript became the most valuable component of TRIZ and established the foundation for TRIZ as a science (Altshuller 1984).

The set of patterns included three groups named after the laws of theoretical mechanics as follows:

Group 1 – Statics – determines the beginning of a system's life cycle, including:

1. Completeness of an engineered system
2. Energy flow in an engineered system
3. Harmonization of the synchronization rhythms or parts in an engineered system

Group 2 – Kinematics – determines the general evolution of a system, including:

4. Increasing ideality of an engineered system
5. Nonuniform evolution of subsystems comprising an engineered system
6. Transition to the overall system

Group 3 – Dynamics – reflects evolution in contemporary conditions involving certain physical and technical factors, including:

7. Transition from macro- to micro-level in an engineered system
8. Increasing substance-field involvement

While continuing his work on the Patterns, Altshuller established several critical requirements a pattern of evolution should comply with: be ***informative*** (describing how systems evolve), ***prognostic***, making it possible to predict the directions in which a given system would evolve; and ***instrumental***, helping to realize these directions and ultimately control the system's evolution.

In the fall of 1975, Boris Zlotin began teaching the first course on the Patterns of Technological Evolution to second-year students at the St. Petersburg People's University for Technical Innovation (SPUTI). During this and subsequent courses, Altshuller's patterns were presented in detail and illustrated with many examples, including military weaponry and even tactics and strategy. The active participation of many of the students (among whom were a number of talented engineers) prompted new ideas on the subject, encouraging attempts to further develop structure of the patterns via introducing *subpatterns* that were later called *Lines of Evolution* (sequences of actual steps within a particular Pattern). Although this structure was later criticized for its redundant complexity, the most important output of this attempt was the recognition that much room existed for enhancing and further developing the Patterns. Research efforts of various TRIZ theoreticians included studies in biological evolution (Vladimir Petrov and Boris Zlotin) as well as the evolution of science, art, language, social systems, etc.

In 1982, at the TRIZ conference in Petrozavodsk, Russia, Vladimir Petrov presented the forecasting of the evolution of electrical welding equipment (the first large-scale forecasting based on the Patterns of Technological Evolution). The second full-scale TRIZ forecasting was conducted by Boris Zlotin and Svetlana Visnepolschi for water pumps. The project also included a comparison of traditional forecasting and TRIZ forecasting methods.

Until 1985, the majority of studies on the Patterns were in technology, although examples of nontechnical applications were known and utilized in educational courses. Later, TRIZ forecasting projects included banks, mercantile and stock exchanges, educational systems, certain social systems, etc.

At the TRIZ conference in Novosibirsk, Russia, in 1984, several interesting works on the Patterns of Technological Evolution were presented, including:

- The "pulsing" model of evolution, by Yury Salamatov and Igor Kondrakov
- The increasing complexity and simplification of technological systems in the process of evolution, by Igor Vertkin
- Evolutionary patterns of methods and devices for curing broken extremities, by Nikolai Predein
- Two ways of increasing ideality of technological systems, by Boris Zlotin and Alla Zusman

By 1985, further development of the patterns of evolution became the primary focus of the Kishinev TRIZ School. The founders of this school changed the approach from working primarily with the patent library to studying the history of technology. The first results were published the same year (Altshuller et al. 1985), including:

- Upgrading the pattern of *coordination of rhythms* to *matching-mismatching of all technological system parameters*
- Introducing two new patterns: *reduction in human involvement* and *increasing dynamism and controllability*
- A new structure for the patterns, including multiple Lines of Evolution

In addition, several of Altshuller's patterns were omitted from the new system, in particular:

- Two patterns from the group Statics (*completeness* and *energy flow* in technological systems), as they represented the conditions for a system's emergence rather than its evolution. Moreover, certain cases were found that contradicted these patterns.
- The pattern *increasing substance-field involvement* related more to system models than to the evolution of real technological systems. However, the essence of the pattern related to the actual utilized field evolution, which was included as a line of evolution within the pattern *transition to the micro-level*.

Eventually, the following system of patterns was suggested (Zlotin and Zusman 1989):

- Stages of evolution (infancy, growth, maturity, and decline)
- Evolution toward increased ideality

- Nonuniform development of system elements
- Evolution toward increased dynamism and controllability
- Evolution toward increased complexity followed by simplification
- Evolution with matching and mismatching elements
- Evolution toward micro/multi-levels and the increased use of fields
- Evolution toward decreased human involvement
- TRIZ and elements of creative education

Given the above, it can be said that over the last 65 years TRIZ has grown from a problem-solving methodology to a ***science of technological evolution***, with the Patterns of Evolution at its core. At the same time, all known patterns are empirical in nature and therefore can describe the main direction ("what") of a system and its actual evolution ("how") but lack the "why" – that is, an explanation of the origin and driving forces of technological evolution. Obviously, finding answers to these questions is critical for revealing and structuring the patterns and for TRIZ becoming widely recognized as a science.

Another important aspect of converting knowledge about evolutionary patterns into a real science is consensus with regard to the main definitions and assumptions. To date, TRIZ literature refers to laws of evolution, patterns of evolution, trends of evolution, and lines of evolution. Different translations from Russian into English and other languages also contribute to the confusion.

Definitions and Assumptions

Definitions

The first attempt to clarify definitions for English terms for the main TRIZ elements related to technological evolution was made as follows (TRIZ in Progress 1999):

An *evolutionary trend* is a sequence of events directly and/or indirectly connected through cause-effect relationships. Each event in the chain (alone or together with the others) leads to the next one and thus increases the probability of its emergence. A trend may represent a limited (specific) model of an evolutionary process that describes its specific feature(s). Examples of trends in social life, technology, science, fashion, art, etc. are well known.

Examples.
- *Growth of "high-tech" technologies*
- *Increasing attention to the environment*
- *Increasing utilization of synthetic materials*

A *Pattern of Evolution* represents a strong, historically recurring tendency in the development of technological systems.

Examples.
- *Evolution toward decreased human involvement*
- *Evolution toward increased dynamism and controllability*
- *Evolution toward micro-levels and the increased use of fields*

A *Line of Evolution* reflects the historical sequence of changes that a technological system undergoes during its evolution.

Example. *A multistep transition that includes the following steps:*
1. *Use of a permanent field*
2. *Transition to a pulsed field*
3. *Utilizing a pulsed field with matched frequency*

While a trend might be a short-lived event (e.g., certain styles in consumer products) patterns and lines represent the strongest long-term (often permanent) trends. In other words, a pattern of evolution addresses *what* exactly will happen as a result of evolution (e.g., increasing dynamism); a line of evolution shows *how* this goal will be accomplished (step-by-step).

Selected Assumptions

Evolution at the Expense of Resources

A system's evolution proceeds via the consumption of various *resources* existing in the system itself, its neighboring systems, and/or the system environment. Each evolutionary step generates new resources that can be used to further develop the given system as well as other systems. However, negative resources that can cause undesirable effects might also result from the evolutionary process (Zlotin and Zusman 2001).

Short-Versus Long-Term Forecasting

A system's short-term evolution (improvement) depends primarily on the resources inherent in the system. Long-term development, including next-generation systems, breakthroughs, etc., depends on the evolution of the overall technology and/or market rather than on the particulars and resources of the given system.

Limited Number of Ways to Perform a Function

A function can be realized in a limited number of distinguishable ways based on the utilization of available resources. New types of resources might arrive as a result of a discovery.

Formation of Specialized Lines of Evolution

For a specific system or for systems of a certain type (e.g., measurement and control systems, milling systems, software, etc.) a set of specialized lines of evolution can be developed that will reflect and take into consideration the main particulars of that system or system type.

Driving Forces of Technological Evolution

Any TRIZ specialist practicing TRIZ forecasting or Directed Evolution for products and/or technologies would eventually realize that to make a reliable forecast for a particular subsystem (such as a car door or cleaning products) one must first understand where the higher-level system is headed (the automobile for the car door, the home for the cleaning products). Furthermore, the design of the car or home might be governed by certain environmental and/or social regulations. At the same time, requirements imposed by a higher-level system are always dominant and "force" the subordinate system (or subsystem) to evolve accordingly (with the "permission" from technology, of course). Indeed, technological evolution is not an isolated process but rather is an aspect of the more general evolution of society; moreover, the evolving world resembles a Russian nested doll (*matreshka*) with multiple evolution processes of different scale taking place both independently and interdependently.

Given the above, it can be suggested that the evolutionary trends/patterns of the higher level serve as evolutionary driving forces of the lower levels. This suggestion can explain why the Patterns of Technological Evolution are so strong and reliable. For example, the pattern *increasing dynamism* is strong because increased dynamism means more flexibility – an important performance feature that in turn provides more convenience for the user. This pattern also could be considered long-term (or even permanent or "eternal") because convenience is an "eternal" user's benefit.

Orientation according to the main user benefits can help create a certain structure for evolutionary patterns. These main user benefits could be listed as follows (in no particular order):

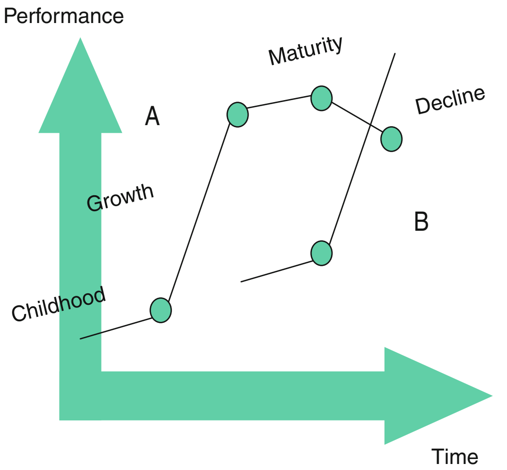
- System performance (i.e., providing a certain positive function)
- Cost
- Quality (reliability, absence or limited number of drawbacks and side effects)
- Safety/security
- Fun associated with the owning and/or utilization of the given system

It seems reasonable to suggest that these main requirements serve as a natural selection mechanism for all man-made systems.

General Patterns of Technological Evolution

Stages of Evolution

In the process of evolution, technological systems evolve along S-curve with specific definite stages as shown below (Fig. 1).



Patterns of Technological Evolution, Fig. 1 Stages of evolution (Altshuller 1984)

Stage 1 (Childhood) – A new system A appears due to a high-level invention and begins slow development.
Stage 2 (Growth) – Begins when society recognizes the value of the new system.
Stage 3 (Maturity) – Begins when the resources of the system's original concept is mostly exhausted.
Stage 4 (Decline) – Begins when a new system B or next system generation emerges to replace the existing one.

Depending on the stage, different recommendations on further development of the given system are recommended (Altshuller 1984, Zlotin and Zusman 2001).

Later, an extended and more detail S-curve was introduced (Fig. 2):

Under this approach, two additional stages have been indicated:
Stage 0 – A system does not yet exists but important conditions for its emergence are developing.
Stage 5 – Begins if the new system does not completely replace the existing system, which still has limited application.

In addition, stages 1–4 have been divided into three substages (beginning, middle, and end) as the system behavior could be very different during different parts of a stage.

Selected lines for this pattern include for each stage:
- Typical objectives
- Typical mistakes
- Typical features

Evolution Toward Increased Ideality

Technological systems evolve in the direction of increasing *ideality*. Ideality for a given system can be defined as the ratio of the sum of its useful features (benefits) to the sum of harmful (or undesired) factors. Therefore, system's ideality can be increased by increasing its useful features, reducing the harmful ones, or both.

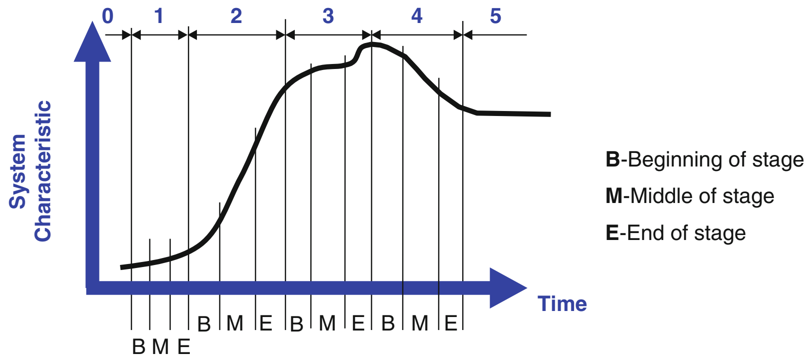
Typical lines for this pattern include:
- Increasing system benefits
- Reducing harmful factors
- Increased involvement of *resources*

Given the above, there are several possible general ways to gradually increase Ideality:
1. Increase the number of useful functions/features, including:
   - Absorbing the useful functions of other systems nearby the given system, or of the environment
   - Inventing new useful functions
2. Improve the quality (and other parameters) of the useful functions
3. Reduce the number of harmful factors, including:
   - Eliminating/preventing harmful factors
   - Diverting harmful factors to other systems or parts where the harmful influence is less critical
   - Finding useful applications for harmful factors
4. Reduce the magnitude of harmful parameters
5. Combine the above actions to ensure a higher ratio

Non-uniform Development of System Elements

In the process of evolution, different components of a technological system usually evolve according to their own schedule. As a result, they might reach their inherent limits at different times, causing *contradictions* preventing further evolution of the given direction.

Patterns of Technological Evolution, Fig. 2 Extended S-curve (Zlotin and Zusman 2001)



A component that reaches its limit first is usually "holding back" the overall system development. To ensure further system development, the component(s) holding the system back have to be identified and contradictions limiting further evolution have to be removed (resolved).

Evolution Toward Increased Dynamism and Controllability

In the process of evolution, technological systems become more dynamic and allow better handling (higher controllability), that is, become more adaptive to contradictory requirements and to the environment.

Increased dynamism and controllability allows the system to conserve high ideality in changing conditions. An airplane wing, a car seat, a bed, and many other things became changeable, flexible, and thus much more comfortable.

Typical lines for this pattern include:

- Transition to multifunctional performance
- Increasing degree of freedom

System's dynamism could be increased via:

- Decreasing the degree of stability
- Transition from a stationary to a mobile condition
- Dividing into mobile parts
- Introducing a mobile object
- Applying different physical and chemical effects

System's controllability could be increased via introducing:

- Control field
- Controllable additive
- Controllable antiprocess
- Self-control of the system
- Negative or positive feedback

Evolution Toward Increased Complexity Followed by Simplification (Reduction)

In the process of evolution, technological systems tend to develop first toward increased quantity and quality of system functions (function deployment) resulting in increased system complexity. After improved functionality is achieved, the system developers try to simplify the system (reduction) maintaining the achieved functionality.

In a particular system evolution, the stages of deployment and simplification take place in turn forming cycles (each cycle includes one deployment and one simplification). They also can partially overlap. For example, while the overall system is in the simplification process, its subsystems can still be in deployment, and vice versa.

Typical lines for these patterns include:

- Transition to mono-bi-poly-system
- Idealization

There are several scenarios for system deployment:

- Introducing new subsystems extending functional capabilities
- Segmentation (dividing the system into parts with different functions assigned)
- Integration, including duplication, multiplication, or Integration "up" (the given system is included into a higher-level system as a part together with some others)

- Hybridization (combining systems with similar functions implementing different principle of operation)

For simplification step, one can use the following selected recommendations (other techniques known as *trimming* and *idealization* could be also utilized):

- Excluding duplicate elements
- Using more highly integrated subsystems
- Excluding auxiliary functions
- Introducing self-service
- Simplification through total replacement (changing principle of operation of subsystems)

Evolution with Matching and Mismatching Elements

In the process of evolution, systems' elements and parameters are undergoing a number of steps involving matching and/or mismatching to improve performance or to compensate for undesired effects.

The process of matching starts from the beginning of the system's existence when necessary system elements are selected and combined in one system. Besides providing minimal performance, these elements have to be compatible. Compatibility is very important for the overall performance; that is why sometimes the elements with the best individual performance might not be the best from the overall system performance point of view.

Matching/mismatching could be applied to the following elements:

- System structure
- Materials
- Functioning
- Parameters

One of the typical lines for this pattern is shown below. These steps constitute a cycle that can be repeated as the system evolves.

Step 1: From unmatched elements to matched ones

In the beginning of a system evolution, the system could be assembled from subsystems and parts that are available and have never worked together before. Next, various adjustments are made to improve their compatibility.

Example. *The first automobile was assembled from a horse carriage, an engine, and other elements. Later, these elements were modified to work in a new environment.*

Step 2: Intentionally mismatched systems

In many situations, the system elements can be intentionally mismatched to obtain new useful features or avoid negative effects.

Example. *Automobile front wheels are made slightly nonparallel to ensure that after making a turn a steering wheel automatically returns to the straight position.*

Step 3: Dynamic matching-mismatching

Often a system should work in changing (dynamic) conditions. In this case, the system would alternate its state to match those conditions.

Example. *An airplane wings change its shape to match higher speed and goes back when the speed drops.*

Evolution Toward Micro/Multi-levels and Increased Use of Fields

In the process of evolution, systems tend to utilize multiple systemic (structural) levels available in the given system, capitalize on their properties and increase use of *fields* and various physical states.

Typical lines for this pattern are shown below:

1. Utilization of deeper structural levels or combinations of these levels, using:
   - System made of elements with specific shapes
   - Poly-system made of elements with simple shapes
   - Poly-system of small elements (powder, microspheres, granules, drops, etc.)
   - Effects associated with substance structure (super-molecular or crystal level)
   - Molecular phenomena
   - Atomic phenomena
   - Field actions instead of substances

Patterns of Technological Evolution, Table 1 Utilization of fields and/or combinations of fields (Table 1, Zlotin 2001)

Basic field	Specific fields	Special corresponding substance(s)
Mechanical	Gravity	
	Pressure	
	Shocks, vibration	
	Explosion	Explosives
	Acoustic waves	
Thermal	Heating/cooling Aggregate state transformation	Water-ice-vapor
		Bimetals
		Shape-memory effect materials
Chemical		Catalysts, inhibitors
Electrical	Electrical charges	Dielectric materials
	Electrical current	Conductive materials
Magnetic	Electrical current	Conductive materials
	Permanent magnetic field	Magnetic materials, magnets, ferromagnetic particles

2. Utilization of the following fields and/or combinations of fields (Table 1, Zlotin 2001):

Evolution Toward Decreased Human Involvement

In the process of evolution of various systems, gradual reduction of human involvement has been taking place, increasing the level of systems automation until the system becomes completely manless.

Typical lines for this pattern include reducing human involvement in:

1. Operation (execution), using:
   - Simple mechanical tools instead of hands, teeth, etc.
   - Mechanical energy transformers and accumulators for human power, such as levers, gears, jacks, bow, springs, sling, etc.
   - Nonhuman energy sources (animals, wind, water, steam, chemical power, electrical power, nuclear power, etc.)
2. Process control (management), using:
   - Tools to control system functioning, such as rudders, steering wheels, airfoils, guides, etc.
   - Special devices to transform control commands, such as amplifiers, reducers, filters, rectifiers, stabilizers, modulators/demodulators, etc.
   - Devices to produce control commands, such as cams, gyroscopes, punched cards, etc.
3. Decision making, using:
   - Various sensors (mechanical, thermal, chemical, electrical, magnet, etc.) instead of human senses as information tools
   - Devices for processing information – that is, analyzing, summarizing, measuring, verifying, etc.
   - Devices to make decisions based on information analysis

Conclusion and Further Directions

1. Over the last 65 years, TRIZ has grown from a problem-solving methodology into the ***science of technological evolution***, with the Patterns of Evolution as its core. At the same time, we know that all known Patterns are empirical in nature and therefore can describe the main direction ("what") of a system and its actual evolution ("how") but lack the "why" – that is, an explanation of the origin and driving forces of technological evolution.
2. Technological evolution is not an isolated process but rather is an aspect of the more general evolution of society; higher-level evolutionary trends/patterns serve as the driving force for evolution at the lower level. Because higher-level super-systems include human needs and social requirements, Patterns of Technological Evolution are enforced by the general demand and expectation of customers.
3. Using knowledge of the Patterns of Technological Evolution in conjunction with analytical methods and other instruments provides the following benefits:
   - Ensuring a substantial advantage over competition

- Avoiding costly and often irreparable strategic mistakes in product development and marketing.

4. In spite of over 30 years of history, Patterns of Technological Evolution is a rather new area of research. Further directions could be:
   - Finding an optimal structure of exiting patterns
   - Development of additional lines of evolution, including specialized lines
   - Obtaining actual statistical data on known patterns of evolution
   - Extending the concept of patterns of evolution into other areas, including nontechnical areas, like evolution of arts, social evolution, etc.

Cross-References

▶ Creativity and Innovation: What Is the Difference?
▶ Directed Evolution® Technology
▶ Intellectual Property, Creative Industries, and Entrepreneurial Strategies
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Inventive Problem Solving (TRIZ), Theory
▶ Inventive Resources

References

Altshuller G. Creativity as an exact science. Moscow: Sovetskoe Radio Publishing House; 1979 (In Russian; English edition from Gordon and Breach, Science Publishers, Inc., 1984).

Altshuller G, Zlotin B, Philatov V. The profession of searching for new ideas. Kishinev: Kartya Moldovenyaska Publishing House; 1985.

Altshuller G, Zlotin B, Zusman A, Philatov V. Searching for new ideas: from insight to methodology; the theory and practice of inventive problem solving. Kishinev: Kartya Moldovenyaska Publishing House; 1989.

Mann DL. Hands-on systematic innovation. Ieper: Creax Press; 2002.

TRIZ in progress. Transactions of the Ideation research Group. Southfield: Ideation International Inc.; 1999.

Zlotin B, Zusman A. Patterns of technological evolution. Kishinev: STC Progress in association with Kartya Moldovenyaska Publishing House; 1989.

Zlotin B, Zusman A. Directed evolution: philosophy, theory and practice. Southfield: Ideation International Inc.; 2001.

Zlotin B, Zusman A. Patterns of evolution: recent findings on structure and origin. Altshuller's TRIZ Institute Conference TRIZCON 2006, Milwaukee, April 29 to May 2, 2006.

Perceptron-Imagitron Pairs

▶ Creativity Machine® Paradigm

Performance Creativity

▶ Creativity in Music Teaching and Learning

Periodic Table of Elements

▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Personality

▶ Four Ps of Creativity and Recent Updates

Personality/Traits Explanations

▶ Individual Determinants of Entrepreneurship

Personalized Medicine

▶ Translational Medicine and the Transformation of the Drug Development Process

Persuasion

▶ Four Ps of Creativity and Recent Updates

Petri Nets

▶ State Space Paradox of Computational Research in Creativity

Pharmaceutical Innovation

▶ Translational Medicine and the Transformation of the Drug Development Process

Pharmaceutical Products

▶ Translational Medicine and the Transformation of the Drug Development Process

Phased Retirement

▶ Cross-Retirement (Cross-Employed Cross-Retired) and Innovation

Philosophy of Governance

▶ Epistemic Governance and Epistemic Innovation Policy

Pictures

▶ Speaking Pictures: Innovation in Fine Arts

Picturing

▶ Imagination

Pioneer

▶ Self-made Man

Planned Economy and Entrepreneurial Function

Jesus Huerta de Soto
Catedrático de Economía Política, Universidad Rey Juan Carlos, Madrid, Spain

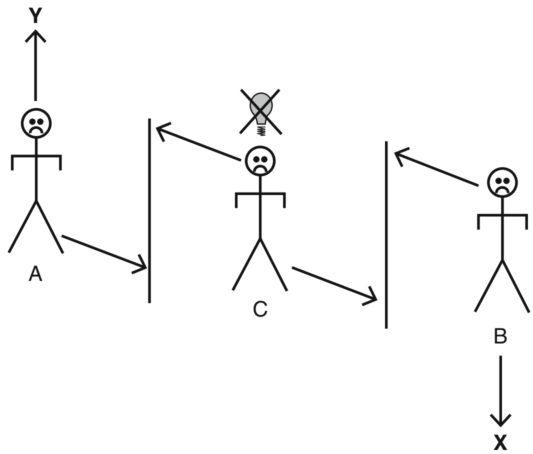
Synonyms

Entrepreneurial creativity; Entrepreneurial knowledge; Government commands; Institutional coercion

Entrepreneurship is a key concept for any definition of the planned economy. In fact, the planned economy or "socialism" could be defined as any *system of institutionalized aggression against the free practice of entrepreneurship* (Huerta de Soto 2010, p. 49). *Aggression* or *coercion* must be understood to mean any physical violence or threat of physical violence which is originated toward and performed on an individual by another human being or group of human beings. As a consequence of this coercion, the individual, who would have otherwise freely carried out his or her entrepreneurship, is, in order to avoid a greater evil, forced to act differently to the way he/she would have acted under other circumstances, thus modifying his or her behavior and adapting it to meet the ends of the person or persons who are coercing him or her. Aggression, thus defined, is considered to be the antihuman action par excellence. This is so because coercion prevents a person from freely carrying out his or her entrepreneurship, that is, from seeking the objectives he/she has set using the means which, according to his or her information and to the best of his or her knowledge, he/she believes or considers to be accessible to him or her for reaching these objectives. Aggression is, therefore, an evil because it prevents the human being from carrying out the activity which is most characteristic of him or her and which essentially and most intimately corresponds to him or her (Hayek 1959, pp. 20–21; Rothbard 1970, pp. 9–10).

There are two types of aggression: systematic or institutionalized and nonsystematic or noninstitutionalized. The latter type of coercion, which is, by nature, dispersed, arbitrary, and more unpredictable, affects the execution of entrepreneurship to the extent that the individual considers there to be a greater or lesser probability that, in the context of a specific action, force will be used upon him or her by a third party, who may even appropriate the results of his or her entrepreneurial creativity. Although nonsystematic outbreaks of aggression are more or less serious, depending on the circumstances, institutionalized or systematic aggression is far more serious as regards coordinated human interaction. This type of aggression constitutes the essence of the given definition of socialism (Hoppe 1989, p. 2). In fact, institutionalized coercion is characterized by being highly predictable, repetitive, methodical, and organized. The main consequence of this systematic aggression against entrepreneurship is to make largely impossible and perversely divert the execution of entrepreneurship in all the areas of society where the said aggression is effective. Figure 1 presents the typical situation resulting from the systematic practice of coercion.

In Fig. 1, it may be assumed that, in an organized and systematic way, the free human action of C in relation to A and B in a specific area of life in society is prevented by coercion. This is represented by the lines which separate C from A and B. As a consequence, it is not possible, as systematic coercion prevents it by the threat of serious evils, for C to discover and take advantage of the profit opportunity which he would have if he could interact freely with B and



Planned Economy and Entrepreneurial Function, Fig. 1 Human action and coercion (Source: Author)

with A. It is very important to clearly understand that the aggression does not only prevent him from taking advantage of the profit opportunity, but also prevents the discovery of this opportunity. The possibility of obtaining gains or profits acts as an incentive to the discovery of these opportunities. Therefore, if a determined area of life in society is restricted by systematic coercion, the actors tend to adapt to the said situation, they take it for granted, and therefore, do not even create, discover, or become aware of the opportunities which are latent. This situation is presented in the figure by crossing out the light bulb which indicates the creative act of pure entrepreneurial discovery.

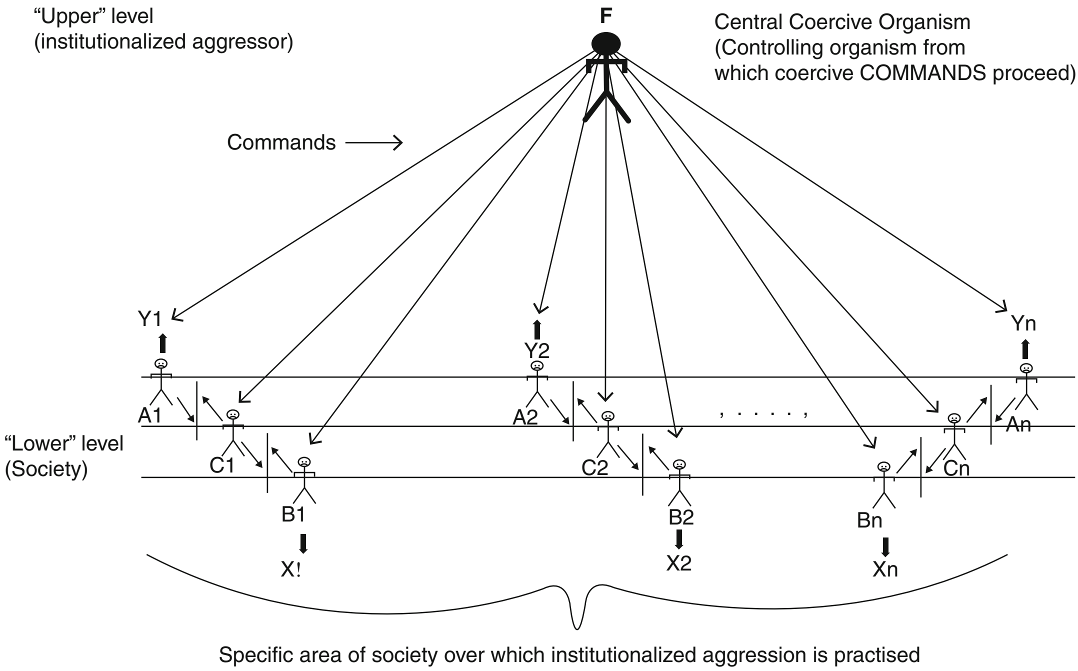
If the aggression falls systematically upon one social area and, as a consequence, entrepreneurship cannot be carried out in that area, none of the other typical effects of the pure entrepreneurial act will take place. In fact, in the first place, new information will not be created, nor will it be transmitted from actor to actor. Second, which is a cause for even more concern, the adjustment necessary in cases of a lack of social coordination will not occur. As the discovery of opportunities for profit is not permitted, there will be no incentive for the actors to become aware of situations of lack of adjustment or coordination which arise. In short, information will not be created, it will not be transmitted from one agent to another, and the different human beings will not learn to discipline their behavior in accordance with that of their peers.

Thus, as C cannot carry out entrepreneurship, the system is maintained continuously uncoordinated (Fig. 1): A cannot pursue end Y due to lack of a resource which B has in abundance and does not know what to do with. He, therefore, squanders and misuses it, unaware that A exists and needs it urgently. As a conclusion, the main effect of the planned economy, as it is defined in this text, is to prevent the action of the coordinating forces which make life in society possible. Does this mean that the proposers of the planned economy are advocating a chaotic or uncoordinated society? On the contrary, apart from a few exceptions, the proposers of the socialist ideal defend it because, tacitly or explicitly, they believe or suppose that the system of social coordination not only will be undisturbed by the existence of the institutionalized and systematic violence which they favor, but will be made much more effective by the fact that the systematic coercion is performed by a controlling organism which is supposed to possess knowledge (regarding both the ends and the means) and valuations which are better, both quantitatively and qualitatively, than those which the coerced actors may possess at a lower level. From this perspective, the definition of the planned economy given at the beginning of this section is now completed, stating that *it is all systematic and institutionalized aggression which restricts the free performance of entrepreneurship in a determined social area and which is carried out by a controlling organism which is in charge of the tasks of social coordination necessary in the said area*. Under the following heading, the analysis will discuss the point to which socialism, as defined above, is or is not an intellectual error.

Socialism as an Intellectual Error

Life in society is possible thanks to the fact that individuals, spontaneously and without realizing it, learn to modify their behavior, adapting it to the needs of other people. This unconscious learning process is the natural result of the practice of entrepreneurship by human beings (Kirzner 1973, 1979, 1985, 1989). This means that, upon interaction with his peers, each person spontaneously initiates a process of adjustment or coordination in which new information – tacit, practical, and dispersed – is continually being created, discovered, and transmitted from one mind to others. The problem posed by the planned economy is whether it is possible, by the coercive mechanism, to verify the processes of adjustment and coordination of the conduct of different human beings, which depend upon each other and which are indispensable if life in society is to function – all the foregoing taking place within a framework of constant discovery and new creation of practical information which makes it possible for civilization to advance and develop. The ideal put forward by socialism is, therefore, highly daring and ambitious (Mises 1981, p. 40) as it implies the belief that not only may the mechanism of coordination and social adjustment be made effective by the controlling organism which performs the institutionalized coercion in the social area in question but that, in addition, this adjustment may even be improved by the coercive procedure.

Figure 2 is a schematic representation of the planned economy as it is defined in this text. On the "lower level" are human beings, endowed with knowledge or practical information, who, for this reason, try to interact freely among themselves, although such interaction is not possible in some areas due to institutionalized coercion. This coercion is represented by the vertical lines which separate the figures forming each group. On the "upper level," there is the controlling organism which, as an institution, practices coercion in determined areas of life in society. The vertical arrows in opposite directions, which come from the figures on the left and right of each group, represent the existence of unadjusted personal plans which are typical of a situation where there is a lack of social coordination. Cases of lack of coordination cannot be discovered and eliminated by entrepreneurship because of the barriers imposed by the effect of institutionalized coercion



Planned Economy and Entrepreneurial Function, Fig. 2 Schematic representation of the planned economy (Source: Author)

on entrepreneurship. The arrows which go from the head of the controlling figure toward each human being on the lower level represent the coercive commands which comprise the aggression typical of the planned economy, aimed at compelling the citizens to act in a coordinated way and to pursue end F which is considered "right" by the controlling organism.

The command may be defined as any specific instruction or stipulation, the contents of which are clearly defined, which, regardless of the legal form it takes, prohibits, or compels determined actions to be taken under specific circumstances. The command is characterized by the fact that it does not allow the human being to freely carry out his or her entrepreneurship in the social area it refers to.

Commands are, moreover, deliberate decisions of the controlling organism practicing institutionalized aggression and are aimed to force all the actors to fulfill or pursue, not their personal ends, but the ends of those who govern or control.

In view of the foregoing, planned practices or "socialism" is an intellectual error because it is not theoretically possible that the organism in charge of practicing institutionalized aggression possesses sufficient information to endow its commands with the contents of a coordinating nature. The next section will examine this simple argument with more detail from the overall perspective of the human beings who constitute society and who are coerced.

The Impossibility of Socialism from the Perspective of Society

The Static Argument

First, from the point of view of human beings who interact among themselves and constitute society (the so-called lower level as in Fig. 2), it must be remembered that each of them possesses exclusive practical and dispersed information, the majority of which is tacit and, therefore, cannot be articulated. This means that it is logically impossible to conceive of its possible transmission to the controlling organism (the so-called upper level in Fig. 2). In fact, it is not only that the total volume of practical information sensed and handled by all human beings at an individual level is so enormous that its conscious acquisition by the controlling organism is inconceivable, but, above all, that this volume of information is disseminated among the minds of all men in the form of tacit information which cannot be articulated and, therefore, cannot be formally expressed or explicitly transmitted to any controlling center.

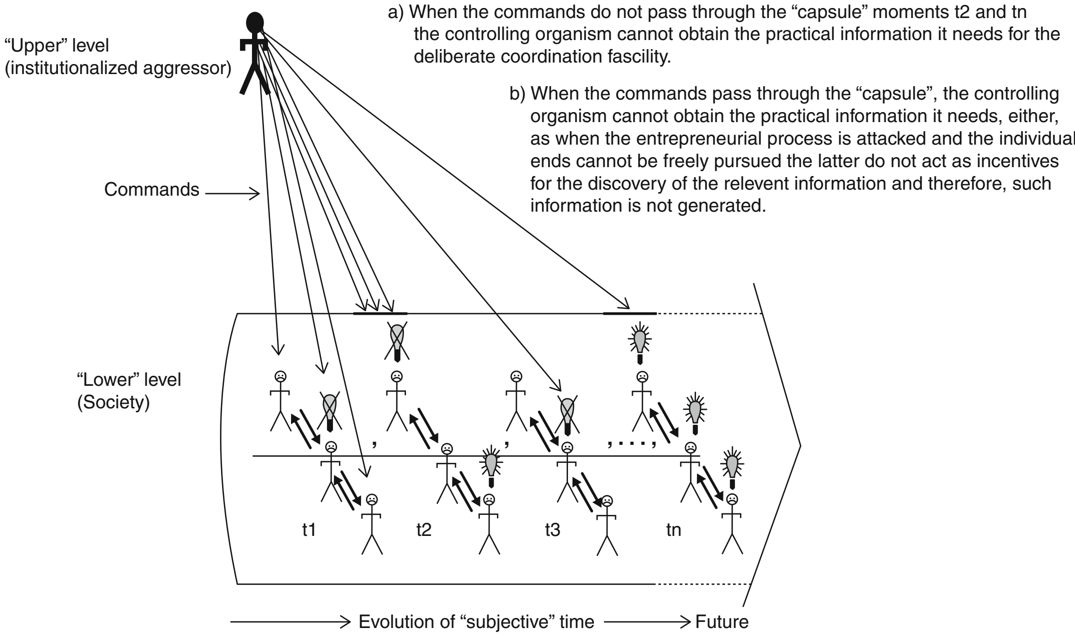
Information relevant to life in society is created and transmitted implicitly in a disseminated way, that is, neither consciously nor deliberately. In this way, the different social agents learn to discipline their behavior in relation to that of other people but are not aware that they are the protagonists of this learning process or that, therefore, they are adapting their behavior to that of other human beings: they are simply conscious that they are acting, that is, trying to obtain their personal ends using the means they believe to be within their reach. Therefore, the knowledge discussed here is a knowledge which is only possessed by human beings acting in a society which, in view of its intrinsic nature, cannot be explicitly transmitted to any central controlling organism. As this knowledge is indispensable if different individual behaviors are to be coordinated socially, thus making society possible, and cannot be transmitted to the controlling organism given the fact that it cannot be articulated, it is logically absurd to think that a planned economic system can work.

The Dynamic Argument

Socialism is impossible not only because the information possessed by the actors is intrinsically unable to be transmitted explicitly, but because, moreover, from a dynamic point of view, human beings, on carrying out entrepreneurship, that is, on acting, constantly create and discover new information. It would be very difficult to transmit to the controlling organism information or knowledge which has not yet been created, but which is continually arising as a result of the social process itself to the extent that the latter is not attacked.

Figure 3 represents the actors who are continually creating and discovering new information throughout the social process. As time, in its subjective sense, elapses, those who perform their entrepreneurship in interaction with their peers are constantly becoming aware of new profit opportunities, of which they try to take advantage. Consequently, the information possessed by each of them is constantly undergoing modification. This is represented in the figure by the different bulbs which light up as time passes. It is clear not only that it will be impossible for the controlling organism to have all the information necessary to coordinate society by commands at its disposal, given that this information is dispersed, exclusive, and impossible to articulate, but also that, moreover, this information will be continually modified and will arise ex nihilo as time passes. It is highly unlikely that it is possible to transmit to the controlling organism information which is at each moment indispensable for the coordination of society but which has not yet even been created by the entrepreneurial process itself.

Thus, for example, when it looks rainy at dawn or there is any other series of meteorological circumstances, the farmer realizes that, as a result of the change in the situation, he/she will have to modify his or her decision on the different tasks that should be done on the farm on that day, without being able to articulate formally the reasons why he/she is taking such a decision. It is not possible, therefore, to transfer this information, which is the result of many years of experience and work on the farm, to a hypothetical controlling organism (e.g., a Ministry of Agriculture in the capital) and await instructions. The same may be said of any other person who carries out his or her entrepreneurship in a determined environment, be it a decision as to whether he/she should invest or otherwise in a certain company or sector, or whether he/she should buy or sell certain stocks or shares, or contract certain persons to collaborate in his or her work, etc. One may, therefore, consider that the practical information not only is, as it were, in a capsule, in the sense that it is not accessible to the controlling organism which practices institutionalized aggression, but, in addition to being in a capsule, is continually



Planned Economy and Entrepreneurial Function, Fig. 3 Dynamic argument against socialism (source: Author)

being modified and regenerated in a new form, as the future is created and made step-by-step by the actors-entrepreneurs.

Lastly, to the same extent as the state coercion is practiced on a more continual and effective basis, the free pursuit of individual ends will be made increasingly impossible and, therefore, the latter will not act as an incentive and it will not be possible to discover or generate the practical information necessary to coordinate society through entrepreneurship. The controlling organism is, therefore, faced with a dilemma impossible to eradicate, as it has an absolute need of the information generated in the social process, which it cannot obtain under any circumstance, because if it intervenes coercively in such process it will destroy the capacity to create information and if it does not intervene, it will not obtain the information either.

As a conclusion, from the perspective of the social process, socialism may be considered as an intellectual error, as, for the following reasons, it is not possible to conceive that the controlling organism in charge of intervening with commands can obtain the information necessary to coordinate society: first, because of the volume (it is impossible for the intervening organism to consciously assimilate the enormous volume of practical information which is spread over the minds of human beings); second, given the fact that the necessary information is essentially impossible to transfer to the central organism (as it is tacit and impossible to articulate); third, because, in addition, it is not possible to transfer information which has not yet been discovered or created by the actors and which only arises as a result of the free process of the practice of entrepreneurship; and fourth, because the practice of coercion prevents the entrepreneurial process from discovering and creating the information necessary to coordinate society.

The Impossibility of Socialism from the Perspective of the Controlling Organism

Second, now from the perspective of what has been called the "upper" level in the figures, that is, from the standpoint of the person or group of persons, organized to a greater or lesser extent, who, systematically and institutionally, carry out aggression against the free practice of entrepreneurship, a series of considerations can be made which confirm, even more, if that is possible, the conclusion that socialism is simply an intellectual error.

For dialectic purposes, one may accept, as did Mises, that the controlling organism (regardless of whether it is a dictator or leader, an elite, a group of scientists or intellectuals, a ministerial department, a group of representatives elected democratically by "the people" or, in short, any combination, of a greater or lesser complexity, of all or some of these elements) is endowed with the maximum technical and intellectual capacity, experience and wisdom, together with the best intentions, which is humanly conceivable (These hypotheses are not true in reality for the reasons presented below). However, what cannot be accepted is that the controlling organism is endowed with superhuman capacities or, specifically, that it has the gift of omniscience (Mises 1996, p. 92), that is, that it is capable of assimilating, knowing, and interpreting simultaneously all the scattered and exclusive information which is dispersed over the minds of all the beings who act in society and which is continually being generated and created ex novo by these beings. The reality is that the greater part of the controlling organism, sometimes also called the planning organism or organism of central or partial intervention, does not know or only has a very vague idea as to the knowledge which is available dispersed among the minds of all the actors who may be submitted to its orders. There is, therefore, a small or nonexistent possibility that the planner may come to know, or discover where to look for and find, the elements of dispersed information which are being generated in the social process and of which it has such a great need in order to control and coordinate such process.

Moreover, the controlling organism will unavoidably have to be composed of human beings, with all their virtues and defects, who, like any other actor, will have their own personal ends which will act as incentives and lead them to discover the information relevant to their personal interests. Most probably, therefore, the men who constitute the controlling organism, if they use their entrepreneurial intuition correctly from the point of view of their own ends or interests, will generate the information and experience necessary to keep themselves in power indefinitely and justify and rationalize their acts to themselves and to third parties, practice coercion in an increasingly sophisticated and effective way, present their aggression to the citizens as something inevitable and attractive, etc. Contradicting the "well-intentioned" hypothesis set out at the beginning of the preceding paragraph, these will generally be the most common incentives and will prevail over others, particularly over interest in discovering the practical, specific, and relevant information which exists at each moment dispersed over society and which is necessary to make the coordinated functioning of the latter possible through commands. This lack of motivation will determine, moreover, that the controlling organism does not even realize, that is, become conscious, of the degree of its own ineradicable ignorance, sinking into a process which distances it more and more from the social realities which it is trying to control.

In addition, the controlling organism will become incapable of making any kind of economic calculation, inasmuch as, regardless of its ends (and one may again imagine that they are the most "humane" and "morally elevated" ones), it cannot know whether the costs incurred in pursuing such ends have, for itself, a value even greater than the value which it attributes subjectively to the ends pursued. The cost is merely the subjective value which the actor attributes to what he/she must renounce in pursuit of a determined end. It is obvious that the controlling organism cannot obtain the knowledge or information necessary to become aware of the true cost incurred in accordance with its own scale of values, as the information necessary to estimate costs is spread over the minds of all the human beings or actors who make up the social process and who are coerced by the controlling organism (democratically elected or otherwise) in charge of systematically practicing aggression against the body of society.

Conclusion and Future Directions

If the concept of responsibility is defined as the quality of the action which is executed once the actor has come to know the cost thereof and takes such cost into account by the corresponding estimated economic calculation, it may be concluded that the controlling organism, regardless of its composition, system of choice, and value judgments, as it is unable to see and appreciate the costs incurred, will always tend to act irresponsibly. There exists, therefore, the unresolvable paradox that the more the controlling organism tries to plan or control a determined area of life in society, the fewer possibilities it will have of reaching its objectives, as it cannot obtain the information necessary to organize society, creating, moreover, new, serious imbalances and distortions to the precise degree that its coercion is carried out more effectively and limits the entrepreneurship of human beings. One must, therefore, draw the conclusion that it is a serious error to think that the controlling organism can make economic calculations in the same way as the individual entrepreneur. On the contrary, the more developed the planned organization, the more practical first-hand information which is indispensable for economic calculation will be lost, making economic calculation completely impossible to the precise degree to which obstacles to free human action are placed by the organism practicing institutionalized coercion.

Cross-References

▶ Entrepreneurial Creativity
▶ Entrepreneurship
▶ Institutional Coercion
▶ Knowledge

References

Hayek FA. The constitution of liberty. London: Routledge; 1959.
Hoppe HH. A theory of socialism and capitalism. Amsterdam: Kluwer; 1989.
Huerta de Soto J. Socialism, economic calculation and entrepreneurship. Cheltenham/Northampton: Edward Elgar; 2010.
Kirzner IM. Competition and entrepreneurship. Chicago: University of Chicago Press; 1973.
Kirzner IM. Perception, opportunity, and profit. Chicago: University of Chicago Press; 1979.
Kirzner IM. Discovery and the capitalist process. Chicago: University of Chicago Press; 1985.
Kirzner IM. Discovery, capitalism, and distributive justice. Oxford: Basil Blackwell; 1989.
Rothbard MN. Power and market: government and the economy. Menlo Park: Institute for Humane Studies; 1970.
von Mises L. In: Greaves BB, editor. Human action: a treatise on economics. 4th ed. New York: Foundation for Economic Education; 1996.
von Mises L. Socialism: an economic and sociological analysis (trans. Kahane J). 3rd ed. Indianapolis: Liberty Press; 1981.

Planning

▶ Small Businesses - Value, Transmission, and Recovery
▶ Strategic Scanning of SME

Planning Lessons

▶ Teaching as Invention

Policy – Line, Program

▶ Institutional Entrepreneurship, Innovation Systems, and Innovation Policy

Political Change

▶ Innovation and Democracy

Political Creativity

► Political Leadership and Innovation

Political Entrepreneurship

► Political Leadership and Innovation

Political Leadership and Innovation

David M. Wineroither
Department of Political Science, University of Innsbruck, Innsbruck, Austria

Synonyms

Human inequality; Political creativity; Political entrepreneurship

Political leadership, in a parsimonious definition, refers to the impact on decision-making and political outcomes that results from action by the holder of political office. Thus, it is connected with leadership style and may be rooted in certain character traits of the leader's personality.

As such, however, it is at odds with core principles of democracy, most evidently equality coupled with the doctrine of popular sovereignty and guarded by the constitutional division of powers. Democracy ultimately rests on the premise of the rule of many embedded in rule of law. Hence, in terms of liberal and democratic theory, political leadership and democracy are contradictory.

Speaking empirically, the relationship between the two is slightly more ambiguous. The practice of liberal democracy is based on – the ensurance and endurance of – representatives' accountability and responsivity. Voters are principals, who direct as their agents politicians. Consequently, the relationship between innovation and political leadership is asymmetric, predominantly established by innovations *in* economy, society, and media and their effect *on* political leadership.

The Modus Operandi of Political Leadership and Democracy

Where to Find Potential Leaders: Bringing States Back In

Although liberal democracies by definition and in practice seek to level out hierarchies and disperse power, political leadership in the world of democratic politics is not entirely absent. After all, change describes the essential trigger of leadership. For the sake of simplicity, this entry will not differentiate (a) between various decision-making arenas and (b) over the course of decision preparation, decision-making, and policy implementation/supervision.

In the reality of political change taking place in liberal democracies, the term innovation denotes medium-scale impact. It hereby markedly differs from the large-scale leadership possible under dictatorship on one hand, and the mere office holding typical for some democracies characterized by extensive power sharing on the other hand. Blondel, in his two-dimensional typology of potential leadership impact (Blondel 1987: 97), defines "innovators" as those bringing about large change limited by specialized scope (thereby exceeding the routinized maintenance-oriented role of the managerial type). At this scope, typically policy areas are addressed and "innovators" as implementers of new policies get identified, e.g., land reform.

However, it is difficult to find clear examples of political leaders in democracy fulfilling these criteria. Adaptive reaction and response to changes and challenges characterize the relationship between change and political leadership, whereas leaders rarely implement large-scale changes, alter procedural rules of the game, or redirect public response in problem-solving tasks. An entrepreneurial style initiative of politicians culminates mostly in adaptive response, and even pioneering leadership seldom unfolds any revolutionary appeal.

Having said this, macro-level political and economic developments in the course of the twentieth century raised doubts as to whether politics does matter at all. Globalization hand-in-hand with the emergence of civil society has imposed challenges to prerogatives of national politics to govern authoritatively and effectively. Nation states and hence national governments have witnessed considerable pressures from:

– Outside (economic globalization and transnational companies)
– Above (supranational political and economic bodies)
– Below (NGO's, public dissatisfaction with representatives/parties)

This has lead to "hollowing out" in the sense of reduced steering capacity. Against this background, critics have described conventional political competition as virtual and political decision as either overthrown or dominated by (organized) business interests (coined "post democracy"). Why then not focus on political leaders in civil society? In the end, negotiations of state actors and policy networks (the paradigm of governance) still take place in the shadow of hierarchy. In turn, if individual politicians matter at all, leadership potential would be obviously limited to those few ranked on the top. The "empty box" character of executive politics, however, has put severe limitations on attempts to probe into empirics of executive leadership. Tellingly, social scientific study of leadership in its beginnings was characterized by the absence of state-centeredness but instead was preoccupied with the wealth of phenomena related to leadership in "voluntary organizations," most notably churches and trade unions.

Somewhat seconding and affirming this notion, cross-country analysis shows substantial variation in the formal powers of presidents and prime ministers. The (d)evolution of powers offers much insight: when chief executives indeed played a key role in institutional redesign, it had almost never been an attempt to expand their power base. Quite the opposite, it mostly had the intended effect of shifting power away, as was the case with devolution under Tony Blair in Great Britain and reforms in a number of semi-presidential countries.

The Interplay of Office, Personality, Leadership Style, and the Role of Creativity

Constitutional democracy consists, among others, of rule of law and has established separation of powers. Beyond that, however, it stipulates the approximation of popular will by government realized through fair and, in this sense, competitive elections (resulting in many countries in "responsible party government"). The notions of moral hazard and rent-seeking, figuring prominently in applications of rational choice theory, signal the threat of undermining responsivity and accountability in principal agent relations. Inevitably, therefore, neither a certain formal position nor character trait, or leadership style on its own, guarantees political leadership, whether pioneering, innovative, or merely adaptive in nature. This holds true even for the combination of great political powers in the hands of a charismatic holder of office. Looking at "idolized heroes" (e.g., John F. Kennedy), Burns denied they could act as transformative leaders because "no true relationships exists between them and the spectators – no relationship characterized by deeply held motives, shared goals, rational conflict, and lasting influence in the form of change" (Burns 1978: 248).

To provide an interim summary, political leadership in democracy is highly contingent and requires a careful analysis of institutional and cultural parameters as well as situational factors. For instance, in some countries, institutional pluralism has led to the notion of "semi-sovereignty," most notably Germany, where effective leadership rather depends on means of coordination than authoritative decision-making. In many countries, extraordinary leaders (often those privileged as first holders of the office following its creation and those acting in times of crisis) established themselves as widely accepted role models (Washington, FDR, Germany's Adenauer). In the USA, ambiguities of the constitution allowed single presidents in the early age of the presidency acting as innovators. Typically, across Western democracies, innovative leaders would be succeeded by inheritors, and strong leaders would be followed by mediocre ones.

Focusing on leaders' personality, even if top-level politicians were willing to take on entrepreneurial routes of leadership, basically risk taking and initiative, they usually lack the creativity required to make a difference. Here one deals with collective inability stemming from politics as career (resembling "politics of survival"), in contrast to politics as vocation. In addition, political leaders today lack the time to familiarize with political theory and develop original political thoughts. Eventually, this appears also to be a product of biographical standardization that inspired observers to conceptualize politicians (elected and/or appointed) as members of a political class, constituted by similar social and educational background as well as shared political interest. As Tucker writes on political creativity, "[A]t bottom it is a gift bestowed on some individuals by nature and life circumstances in combination" (Tucker 1977: 386).

This image of political class provides stark contrast to the agency of political competition in democracy for allowing innovation in the spheres of science, business, and media. As Carayannis and Campbell emphasize for the genuine feature of political competition in democracy, "Political pluralism in democracy cross-refers to creativity-encouraging heterogeneity and diversity of different forms, modes and paradigms of knowledge and innovation" (Carayannis and Campbell 2011: 342).

One step further, in distinguishing seven different forms of bad leadership, Kellerman links lack of creativity with innovative malfunctioning: "Although they may be competent, they are unable or unwilling to adapt to new ideas, new information, or changing times" (Kellerman 2004: 419). The alternative selection modus based on policy expertise (mostly occupational, often managerial, sometimes genuinely scientific) has not proved to overcome such shortcoming. Experts given political mandates plausibly scored even lower compared to professional politicians in terms of political creativity. Similarly, policy expertise and involvement of leaders as professional politicians "may make powerful prime ministers in parliamentary democracies but at the same time it stands out as a central feature of some only moderately successful US presidents" (Helms 2012).

Overall, boundaries between leader and follower roles have been blurred in Western democratic societies. Especially for a public that is both more politically involved and dissatisfied, authoritative top-down decision-making has become costly for its exponents. There is some evidence that effective leaders in current democratic societies act as agents of followers and that performance of allegiance roles to publics lies at the heart of executive leadership. To some observers, leaders are not only bound to popular will but as leaders they appear to be "created by the led" (Kellerman 2004). Consequently, in this perspective, follower action in many instances determines the success and failure of leaders. At the very bottom of the relationship between leaders and followers, as in foreign politics, one of the prime leadership tasks is to generate "soft power" and to combine its means creatively with "hard power."

Political Competition and Innovative Forms of Leadership

Schumpeter's Entrepreneurial Style Leaders

Various theorists of democracy have employed market metaphors in describing the logic of the political process. Among them, Joseph A. Schumpeter stands out for assuming an imperfect market in politics (Schumpeter 1950). Already in his theory of development he had firmly emphasized the incompatibility of perfect competition and economic progress. According to him, "Practically every innovation (. . .) at first creates that kind of situation which is designated by the term Monopolistic Competition" (Schumpeter 1989: 167). The political process in representative democracy exhibits oligopolistic as well as monopolistic features because it is geared toward majority building and interest aggregation, which is ultimately required to secure governability. Furthermore, as elections take place rather infrequently in a world of information (dis-) advantage and passive roles of some constituents, this results in rather low competence levels compared to the sphere of economics.

The Schumpeterian assumption of imperfect markets contrasts, e.g., the economic theory of democracy elaborated by Anthony Downs, which rests on the neoclassical equilibrium model of economy. It is exactly this difference that allows for leadership to be regarded as a potential driver of the political process and the sole originator of endogenous qualitative change. Equating the influence of entrepreneurship in business, leadership in politics in Schumpeter's view has the effect of creating new demand on the side of customers, who are of course the voters in the political realm. Unlike in the equilibrium model of Downs, leaders are not forced to perpetually trail behind shifting voter preferences but quite the contrary are able to shape those. For Schumpeter, again in contrast to Downs, the political process is multidimensional and voters' preferences are multi-peaked, producing cyclical majorities.

Thus, innovative entrepreneurial style leadership for Schumpeter displays a permanent association to politics and can be exercised by leaders as political entrepreneurs again and again. But what can be understood as "political innovation" in the Schumpeterian sense? In any case, innovation is the crucial element in creating qualitative change, consisting of something untried and irreversible, and perhaps even difficult to be repeated, at least by mere imitation. Though Körösényi lists a number of ways to affect public policy, he ultimately regards all of them as being rooted in the ability to "overcome resistance" (2011: 10). Similarly, as noted above, the overall character of political competition is oligopolistic because of the need to create political majorities.

Riker's Heresthetics

Schumpeterian accounts of entrepreneurial leadership share a commonality in their rootedness in political competition. If political leaders are perceived as innovators themselves, they would act as agents of ideas and policies with the ultimate goal to create political majorities at different levels and places in the political process (e.g., the public, in cabinet, in nonmajoritarian institutions, at the decision-making stage, in the phase of implementation, throughout a process of supervision and reevaluation). Following Schumpeter, William H. Riker has shown in his seminal work on *heresthetics* how political actors motivated to win politically may successfully combine agenda setting abilities with rhetorical skills and manipulation of issue dimensions to create new majority coalitions (Riker 1986).

Innovative leadership for Riker means manipulation in order to win. Based on positive political theory, he identified three crucial ways that may make a politician succeed, in addition to the evergreen influence of rhetorics in persuading others. The heresthetic leader skillfully employs three categories or strategies: agenda control, strategic voting, and manipulation of dimensions. As social choice theory has emphasized, voting outcomes are closely related to voting procedures (e.g., Condorcet paradoxon: A wins over B, B wins over C, C wins over A). Moreover, those called upon to vote show a plurality of preferences characterized by different salience and distance to ideal points. From this perception, it follows that redefinition of the situation and/or moderate strategic shifts of the political measures envisaged create plenty of opportunity to rally alternative, stronger coalitions of support.

According to Riker and empirical investigations of a number of scholars, political change as an outcome of *heresthetics* is a rare event when looking at really important issues (motions). The leadership-based "invention of a new viewpoint" alone, not to speak of environmental resistance and the (counter-)strategic moves of many other actors involved, requires literally "artistic creativity" as Riker resumed himself (Riker 1986: 1, 34).

The Impact of Knowledge Revolution on Political Leadership

Knowledge Society and Programmatic Competition

The concept of "knowledge society" was developed at the eve of postindustrial society. Knowledge society, embedded in welfare states of varying size, has led to massive job creation in the educational and health sector. This development has facilitated the emergence of two-dimensional political space. Parties and candidates, once solely competing in the redistributive left–right dimension, now also are judged on sociopolitical and sociocultural grounds. The opening-up of political space limits the ability of both parties and leaders to rally heterogeneous voting coalitions behind them (Kitschelt and Rehm 2011); this, in the sphere of party choice, goes at the expense primarily of centrist catch all parties, while it opens up leverage for entrepreneurial style populist leaders that combine charisma with broking skills (to overcome programmatic inconsistency) as long as they do not enter government, e.g., Bossi in Italy, Haider in Austria, and Wilders in the Netherlands. Often, innovation in political leadership in this respect takes the form of reshaping and redrawing group boundaries. The above-mentioned prime exponents of entrepreneurial style leaders in politics profit from the rise of cultural and identity politics relative to redistributive politics, a process resulting in political realignment of the working class.

Knowledge Democracy and Entrepreneurial Leadership

At times political leaders become subject to innovation attached to central goals of the political process. This is most prominently the case for the trend of personalization transmitted by the multimedia age. The innovation of candidate debates on screen revealed substantially different performances across countries and in some cases probably decided the race for office, e.g., in the 1960 campaign for American presidency.

Technical innovation has affected governing in the media age quite profoundly. Yet, it has not made political leadership more likely, far-reaching, rooted in personality, or innovative. Leaders have increasingly become the center of public attention, and electoral campaigns (making them more vulnerable to public failures and dependent on high approval rates) are "sold" as brands and often engage in unmediated communication with public (the hypothesis of presidentialization of prime ministers).

The emerging concept of knowledge democracy by definition assumes from the presence of network society and media politics great demand for a new mode of governance as legitimacy of traditional representative democracy unpreventably vanishes. It therefore puts a premium on institutional and functional reform. Consequently, advocates of the concept of knowledge democracy have largely bypassed aspects of leadership by individuals (e.g., In 't Veld 2010). Governance appears to be a substitute for government. It should be noted, however, that at a closer look governance and government do not constitute polar extremes but are able to coexist and supplement each other (Helms 2012). While proponents knowledge democracy tend to largely ignore the intact linkages between citizens and parties/politicians (and the above mentioned realignment in favor of populist radical right parties), it also has identified a connectedness of media revolution and populist leadership. More specifically, this kind of leadership proved successful when exerted by political entrepreneurs.

Linkages between political entrepreneurship and leadership might be created in two ways. First, business leaders may enter (sub-)national politics; second, politicians may exercise leadership tasks by conscious or unconscious orientation toward entrepreneurial activities. Most importantly, and by far most prominently, political leaders as entrepreneurs "sell" themselves (*branding*). In some notorious cases, they do so supported by the mass media that they themselves own. In Italy, media tsar Berlusconi aspired a formal leadership position and was elected prime minister a number of times. His success rested on widespread distance to more conventional political parties in many Western democracies and his image as self-made billionaire.

Again, the case of Berlusconi demonstrates the contextuality and crisis boundness of political leadership – Berlusconi initially profited from the breakdown of the established party system in Italy in the early 1990s. The kind of innovation that emanated from his entrepreneurial style leadership, however, hardly could be described as generating a surplus to quality of democracy (equating Schumpeter's "creative destruction"). New public demand was created due to appeals of politainment, met by the prime minister in the guise of anti-politics. In other words, he was offering a combination of somewhat effective leadership and bad governance. Accordingly, the founded political vehicles, avoiding traditional party image, are presented in the fashion of political movements. Whether this self-description accurately depicts the actual operative mode is much debated in current comparative party political research.

Conclusion and Future Directions

Constitutional democracy in interaction with knowledge society leaves virtually no ground for old style political leadership. This applies, for instance, to leadership as a reflection of a politician's personality and forms of top-down individual leadership. When political leadership is tangible, structural features and contextual factors clearly outnumber effects of personality and leadership style.

While innovative political leadership in general is hard to be established, entrepreneurial style leadership in politics has flourished as a consequence of transformation and innovation in

– Economy (e.g., postindustrial job creation)
– Society (e.g., individualism, pluralization of lifestyles, political aspiration of NGOs)
– Media (e.g., Internet access, televized candidate debates)

This populist entrepreneurial version of political leadership, at best, possesses a mixed record in terms of quality of democracy. At the same time, societal demand for innovative leadership prevails and should be accommodated. Political leadership has to be rescued as an effective mode of governance through conceptual and practical innovation. Most importantly, potentially effective leaders would have to accept the logic of network society and dispersed democratic leadership. Furthermore, they have to gain awareness that reshaping of group identity as this is one vital and perhaps dominating cleavage in the future, and they are needed to develop an inclusionary vision of, e.g., citizenship.

It seems justified to discover to lie at the heart of both innovative political leadership and innovation *in* political leadership securing trust in politicians. For that purpose, leaders (a) collectively are demanded to pursue institutional reform of the selection process of politicians at all levels, envisaging greater biographical variation (the import of self-made billionaires, economic entrepreneurs, and policy experts does not sufficiently compensate for that). (b) With reference to political communication, the collective of leaders is required to practice a mix of blame avoidance, credit claiming and technocratic policies both in order to foster political legitimacy, realize good governance conduct, and satisfy output criteria. Likewise, looking upward, it makes rescaling of people's expectations in political leaders necessary.

These are prerequisites in search for acceptance of a mixture of representative and direct democracy in a shrinking world of "hollowing out" of core executive politics. Still in the future, political leaders will play a pivotal role in finding balance of, in the words of Abraham Lincoln, government of, for, and by the people – a matter far too big to be dealt with by political leaders as individuals.

Cross-References

▶ Creative Leadership
▶ Entrepreneurial Capability and Leadership
▶ Innovation and Democracy
▶ Innovations of Direct Democracy
▶ Joseph A. Schumpeter and Innovation
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ Quality of Democracy and Innovation
▶ Schumpeterian Entrepreneur

References

Blondel J. Political leadership: towards a general analysis. London: Sage; 1987.
Burns JM. Leadership. New York: Harper & Row; 1978.

Carayannis EG, Campbell DFJ. Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the quadruple and quintuple helix innovation concepts and the "Mode 3" knowledge production system. J Knowl Econ. 2011;2(3):327–72.
Helms L. Poor leadership and bad governance: conceptual perspectives and questions for comparative inquiry. In: Helms L, editor. Poor leadership and bad governance: revisiting presidents and prime ministers in North America, Europe and Japan. Cheltenham: Edward Elgar; 2012; 1–15.
In 't Veld RJ, editor. Knowledge democracy: consequences for science, politics, and media. Berlin/New York: Springer; 2010.
Kellerman B. Bad leadership: what it is, how it happens, why it matters. Boston: Harvard Business School Press; 2004.
Kitschelt H, Rehm P. Party alignments. Change and continuity. Paper delivered at the conference on the future of democratic capitalism. University of Zurich, 16–18 June 2011, Zurich.
Körösényi A. Innovative leadership and the politics of disequilibrium. A Schumpeterian account of the role of leadership. Working papers in political science 2011/5, Institute for Political Science, Hungarian Academy of Sciences. http://www.mtapti.hu/pdf/wp_korosenyi.pdf (2011). Accessed 25 June 2012.
Riker HW. The art of political manipulation. New Haven/London: Yale University Press; 1986.
Schumpeter JA. Capitalism, socialism and democracy. 3rd ed. New York/London: Harper; 1950.
Schumpeter JA. In: Clemence RV, editor. Essays: on entrepreneurs, innovations, business cycles, and the evolution of capitalism. New Brunswick/London: Transaction Publishers; 1989.
Tucker RC. Personality and political leadership. Polit Sci Q. 1977;92(3):383–93.

Polynomiography and Innovation

Bahman Kalantari
Department of Computer Science, Rutgers, The State University of New Jersey, New Brunswick, New Jersey, NJ, USA

Synonyms

Art-Math; Fractal; Visualization

Introduction to Polynomiography and Its Applications

Throughout the history of science, reaching back to the Sumerians in the third millennium B.C., the task of finding the *zeros* of *pol*ynomials has been one of the most influential in the development of mathematics. The problem has been studied by the most famous of mathematicians and even today, it remains to be a useful problem in every branch of math and science.

Finding a zero of a polynomial is solving for the unknown. Solving for the unknown is a necessity in life and human survival. The task has played a significant role in the development of human intellect, leading to advancements in math, science, and art. A layman may need to figure out what is 17 % of 85. This amounts to solving a linear equation. A carpenter may need to estimate the length of the diagonal of a square having sides of a particular size. This is already the beginning of something deep: computing square-roots, a very special case of solving a quadratic equation taught in middle and high schools across the entire world. These are examples of polynomial equations.

Even though a very small percentage of the world population may actually know the quadratic formula, solving a quadratic equation is a need in everyday life. Of those who know the quadratic formula, an even a lesser percentage knows how to estimate a mundane number such as the square-root of two. They would need the use of a calculator. How does a calculator compute the approximation of the square-root of a number? How can the twentieth or even one-millionth digit in the decimal expansion of the square-root of two be computed?

The famous American artist Jasper John has an axiom describing how one may create art: "Take an object. Do something to it. Do something else to it." What he is perhaps suggesting is *iteration*. Before him, Isaac Newton suggested a method for finding the square-root of two, or the square-root of any other number: Take an initial guess. Then iterate by a certain recipe that would become known as *Newton's method* to get a new estimate that would hopefully come closer to the actual value of the square-root, i.e., having more accuracy. Then iterate again with the new estimate and repeat this process.

Formally, a polynomial, written as *p(x)*, is defined as a linear combination of integral powers of a variable, say x. Thus, a polynomial is sum of terms such as 16, $7x$, $-24x{\bullet}x$, 5 $x{\bullet}x{\bullet}x$, etc. Here "•" *means multiply*. When x is multiplied by itself so many times, it is convenient to write this with an exponent having integral powers. Thus, the integral powers in the examples are 0, 1, 2, and 3. The highest integral exponent of x is called the *degree* of the polynomial and the constant multipliers are called *coefficients*. The degree of a linear equation is one and that of a quadratic is two, and so on. A *zero* or a *solution* to a polynomial equation is a value such that when substituted for x and simplified, the equation yields a value of zero. To formally compute 17 % of 85 is equivalent to solving the linear equation, $17\,x-85 = 0$. To find the square-root of two is equivalent to solving the quadratic equation $x{\bullet}x - 2 = 0$.

A celebrated theorem about polynomials is the *Fundamental Theorem of Algebra (FTA)*, first proved by one of the greatest mathematicians of all times, Carl Friedrich Gauss. The theorem guarantees that a polynomial has as many zeros as its degree. The solution to a polynomial equation is not always a real number, but the FTA guarantees that a *complex number* will always exist as a zero of the polynomial. A complex number is an object of the form a + **i**b where a and b are ordinary numbers corresponding to *real* and *imaginary* parts, respectively, but **i** is a symbol that obeys the rule, **i**•**i** $= -1$. With this convention, the point in the Euclidean plane having coordinate (a, b) becomes a number, a complex number. Then, like the ordinary numbers, two complex numbers can be added, subtracted, multiplied, and divided by each other. This turns the points in the plane into objects that can be algebraically manipulated. Two teenagers can play a game with locations: One could tell the other to meet him at a location x such that when multiplied by the location of the cafe A becomes the location of the theater B. In summary, the roots of a polynomial equation are or correspond to locations in the Euclidean plane.

It is not always possible to find the exact value of zeros of a polynomial. The square-root of two is an example. The exact value of zeros of a quadratic polynomial cannot always be computed, even though an exact formula is available, namely, the high school quadratic formula. Even worse, a deep but negative result about polynomials asserts that for polynomials of degree five or higher, there is no general formula for their zeros. Thus, at best, the roots of a general polynomial can only be approximated. However, this can algorithmically be achieved to any desirable accuracy. Given a polynomial *p(x)*, Newton's method can be viewed as an iterative process that takes a point in the plane and moves it somewhere else, then somewhere else, repeating the process in the hope of getting closer and closer to a root.

Polynomiography can be considered as a visualization of the root-finding process, driven by the FTA. However, the goal of Polynomiography is not the mere approximation of the location of the roots of a polynomial equation, but the entire process of finding the roots and the way this process influences all other points within a particular rectangular region that may or may not include any of the roots. This results in capturing 2D images called the *Polynomiograph*. The process of root-finding is not limited to the use of Newton's method. Polynomiography software offers much more. Like a camera that offers many lenses, settings, and parameters to capture photographs of a single object, Polynomiography software offers many processes (*iteration function*) that are encoded as algorithms for solving polynomial equations, as well as many coloring schemes. These essentially make it possible to capture an infinite number of Polynomiographs from a single equation.

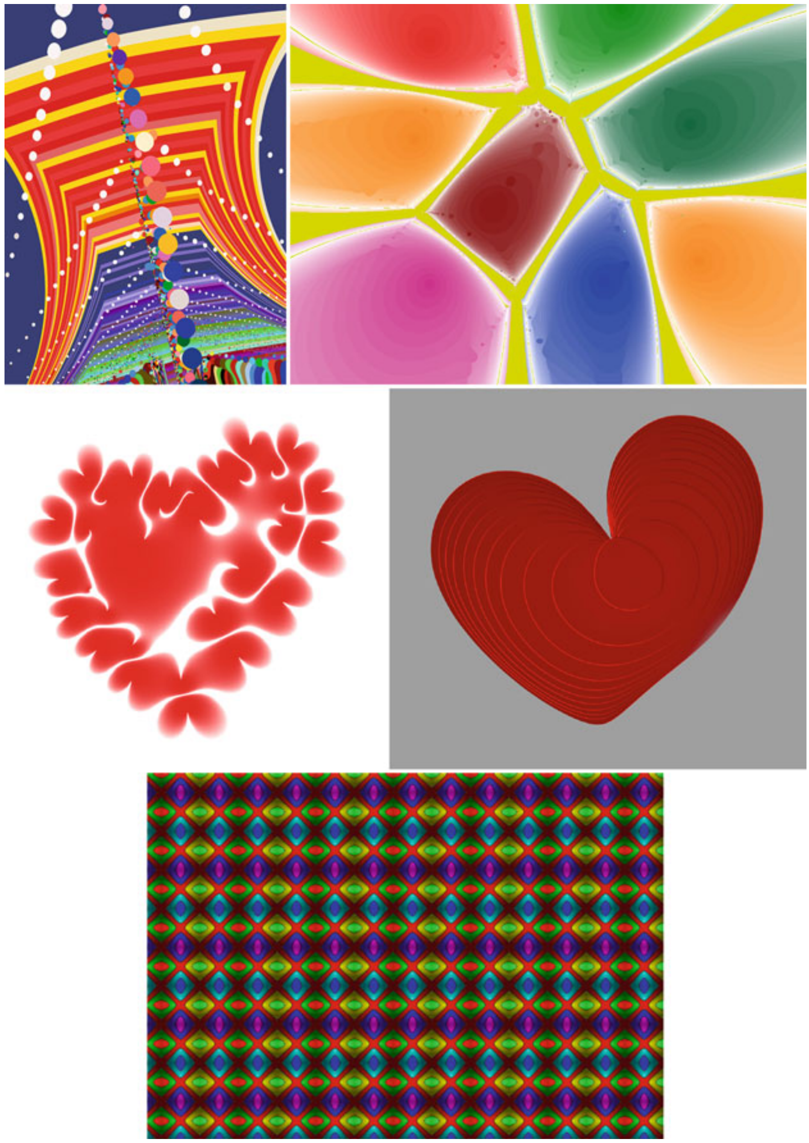
Polynomiography software makes use of the many encoded processes to create artwork. In particular, in the context of visualization and art, one can reverse the role of the ancient root-finding problem and select the location of roots so as to create desirable designs or effects.

Polynomiography and Innovation, Fig. 1 Example Polynomiographs from single polynomials (Bahman Kalantari)

Polynomiography thus turns the root-finding problem upside down and into a visualization tool of art and design, and a serious medium for creating artwork of great variety and diversity through a combination of human creativity and computer power. The following metaphoric description is from the book (Kalantari 2008):

> Solving a polynomial equation could be considered as a game of hide-and-seek with a bunch of tiny dots on a painting canvas. We hide the dots behind a polynomial equation, we then seek them using a formula or an algorithm. Polynomiography is the algorithmic visualization of the process of searching for the dots, and painting the canvas along the way.

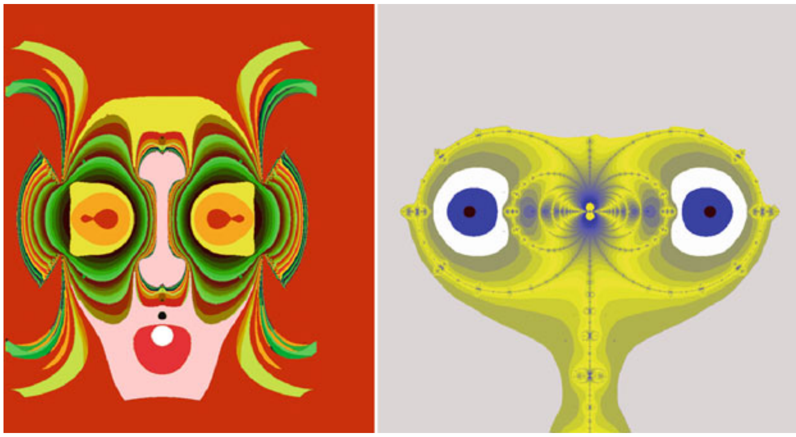
On the one hand, Polynomiography can be considered a digital form of painting, using only a finite set of points, the roots of a polynomial as the generating set. As such it is an art form capable of creating a vast variety of images by manipulating this finite set of points, whether given implicitly through the coefficients of a polynomial equation, or selected explicitly as the roots by the clicks of a mouse. In a sense, Polynomiography is a minimalist and abstract art form, albeit one of enormous power and diversity. What is magical in Polynomiography is that this finite set of points, when combined with one or many iteration functions that are made transparent to the Polynomiography software user, results in a coloring scheme, giving a 2D Polynomiograph. Thus, the initial set of points offer much more than the shape it defines. The input set is very small while the output set is a full 2D image. The Polynomiographer's personal creativity and choice, and the great variety of methods to view a polynomial equation amount to a powerful tool for artistic creation. Even with polynomials of small degree, artists, teachers, or students can learn to produce interesting images on a laptop computer in a reasonable amount of time. Some examples are given in Figs. 1–3, using Polynomiography software.



Polynomiography and Innovation, Fig. 2 Sample artwork, the *bottom* image is from tiling of a single Polynomiograph (Bahman Kalantari)

Innovative Possibilities of Polynomiography in Education

Polynomiography is based on sophisticated algorithmic visualization in solving polynomial equations. Using inventive programming, it creates a medium where an individual, independent of his/her mathematical background, age, and artistic background, is rewarded with satisfying images, while being playful, experimental, artistic, expressive, or scientifically curious. Very significantly in the cases of younger individuals, Polynomiography helps them learn about concepts in mathematics that they would otherwise be much less motivated to study or would find too dry. Polynomiography can be used as the basis of a technology that would lend itself to the encouragement of creativity and innovation in multidisciplinary teaching and learning experiences. It can lead to development of curricula for a wide range of educational courses in K-12 and higher education.



Polynomiography and Innovation, Fig. 3 Polynomiography could even result in characters, artistic (*left*) and cartoon-like (*right*) (Bahman Kalantari)

Prototype Polynomiography software in several settings has already been tested, and proven to be an enthusiastically popular medium for students in middle and high schools, and teachers who are interested in introducing it in their curricula. Survey of students (some as young as 11–13) who have been introduced to Polynomiography shows that these students have become, as a result, interested in learning about polynomials which are central to mathematics and science. Thus, young students get closer early on to these critical building blocks of sciences and mathematics and related complex notions that are otherwise too distant to them.

On the one hand, polynomials are one of the most important building blocks of mathematics, science, and engineering, having numerous applications. Polynomials help approximate functions which in turn approximate science and modeling. In education, polynomials are indispensable abstract objects as well. Through them, students are introduced to more general functions, graphs, equation-solving, calculus, and much more. On the other hand, mathematics education needs to popularize the subject because mathematics is often considered to be dry and not visual enough. Polynomiography can help young students who are always in the need for visual stimulation to connect to mathematics through playful learning and creativity. This in turn will help them learn complex math. Polynomiography is a medium that helps students play, express themselves, enjoy themselves, while picking up easy mathematics, medium mathematics, and even sophisticated mathematics to reach new frontiers in math and science. This in turn has profound consequence in science and culture.

Polynomiography is a by-product of the author's theoretical research into the ancient but historically significant problem of solving polynomial equations. It has received enthusiastic support from artists, engineers, mathematicians, scientists, and the general public, many of whom await a more robust and complete version of the software. This interest stems from the fact that they all foresee new applications to their particular fields. Polynomiography is also related to *fractals* through the process of iteration and as a result, some of its images are in fact fractal, more precisely, *fractal Polynomiographs*. However, it is not a subset of fractals. The word *fractal*, invented by Mandelbrot, see (Mandelbrot 1983) and (Mandelbrot 1993) is associated with many processes resulting in self-similarity. In addition to fractal Polynomiographs, Polynomiography also result in images that are not fractal in any sense. It is a much more focused subject than fractals based on general iterations. This feature of Polynomiography together with the fact that it has a well-defined foundation, namely, root-finding, makes it a more easily appreciated subject than general fractals. It is this basic foundation and the fact that polynomials are so widely present in science and math that turns Polynomiography software into a meaningful tool. This can be contrasted with playing with any software that merely renders images based on an iteration which may not enjoy any meaning, or not be designed to do a particular task. Indeed Polynomiography can be used to teach about fractals and turn the concept into a more tangible subject. In the context of fractals, Polynomiography allows *control* and this feature is very significant. In terms of imagery, Polynomiography also enhances and strengthens fractals because it makes use of more sophisticated iterative methods. Aside from the fractal images in Polynomiography, some of its techniques give rise to very rich class of non-fractal images. This can be seen in some examples images given in the Figs. 1–3. For more details on Polynomiography and its foundation, see (Kalantari 2004a, b, 2005, 2008) and the other references.

Innovative Possibilities of Polynomiography in Art

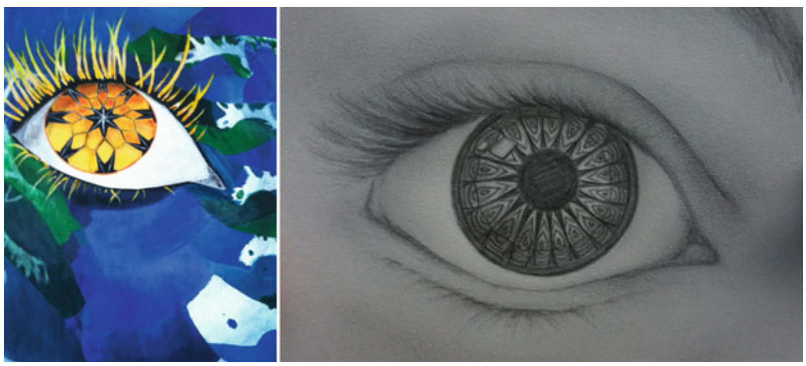
Artistically speaking, Polynomiography can be described as a minimalistic art form capable of creating interesting variety of artwork. The collective shape of the points, their relative gravity with respect to each other, as dictated by the iteration functions which are analogous to the lenses of a camera, and the window through which a polynomial is viewed, together with the Polynomiographer's personal creativity and choice of coloring could all result in a tool of infinite artistic capabilities. Not only can Polynomiography bring art and design into mathematics' and sciences' curricula and education, it can bring mathematics and computer technology to artists who may normally not use mathematics. An artist can learn techniques without the need to have learned the underlying math or algorithms. Thus, Polynomiography offers new creative and innovative possibilities for artists. Polynomials, these fundamental objects of sciences and math, will suddenly find wider and deeper appreciation by the population at large. Just as a camera could help turn a photographer into an artist, Polynomiography software can turn a person not considered an artist to think differently of art and conceive of possibilities that would not have been imagined otherwise. Like photography and painting, many techniques can be developed in Polynomiography and Polynomiographers can discover new techniques of their own, possibly even combining two or more different artforms. Some examples of such work are given in Figs. 5–9. These are produced by the author's students or collaborators.

The author has developed and taught different courses on Polynomiography at Rutgers University to undergraduate students and to high school students at summer, see (Fig. 4) programs. In an interdisciplinary course taken by students from different majors, students must complete a project based on their interest area while using Polynomiography software. The student projects have ranged from such diverse applications of Polynomiography as: art, dance, linguistics, psychology, math, education, computer graphics, computer science, symbology, music, architecture, ecology, neuroscience, special education, chemistry, and religion.

Entrepreneurial and Commercial Possibilities of Polynomiography

Polynomiography is a US patented technology that can lead to a variety of commercial products such as software and other induced products. As a software tool in K-12 education, it has tremendous potentials as evidenced by teachers and students themselves, ranging from 6th to 8th graders to high school students and higher education. It has the potential to be introduced to K-12 education not only in the USA but other countries. In fact, some high school students in USA, Austria, Japan, and South Korea have already gained favorable experiences with the software. This by itself is a promising area of entrepreneurship and could lead to an industry

Polynomiography and Innovation, Fig. 4 A summer Polynomiography workshop for New Jersey high school students at Rutgers (Governor's Summer School of Engineering and Technology, 2011)

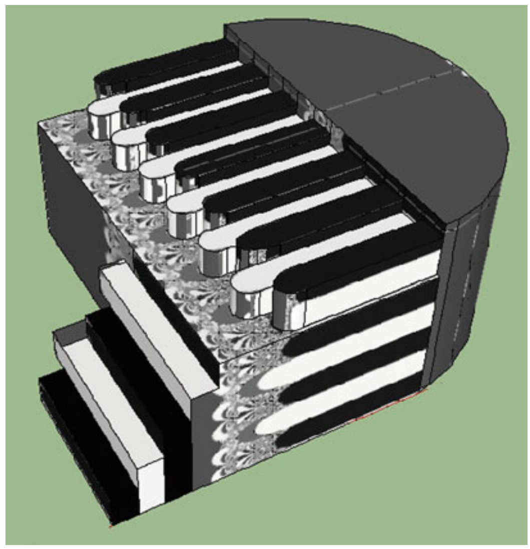


Polynomiography and Innovation, Fig. 5 Polynomiography-inspired drawings by students (Mary K. Battles, *left*), Gina Collins, *right*)

Polynomiography and Innovation, Fig. 6 Polinomio-Calligraphy artwork, combines calligraphy by Ryuji Takaki (http://www.kobe-du.ac.jp/gsdr/takaki/) and corresponding Polynomiography by Bahman Kalantari, 2011

Polynomiography and Innovation, Fig. 7 Virtual sculptor from Polynomiography, jointly with Adrian Sinclair (student)

Polynomiography and Innovation, Fig. 8 Photo of a Polynomiograph of the author that is turned into henna design by Maggie Townsend (student)



Polynomiography and Innovation, Fig. 9 A Polynomiography-inspired sculptor, "Polynomial Piano Playground," created by William Commons (student)

on educational material that could be built around the software technology. Not only could such software be used in several different math classes in K-16 education but in science and art classes as well.

Aside from the above-mentioned educational applications which have actually been studied by a group of MBA student at Rutgers university with profitable forecasts, Polynomiography can be integrated into social media and Smartphone technology for variety of applications. Polynomiography is a true fusion of math and art, which through its software renders artistic visuals made from polynomials, and words or numbers turned into polynomials. As an entrant into the applications industry, it can be of interest to users on social networking websites such as facebook, as well as users of Smartphones such as the iPhone or other popular technologies. The word "Applications" has been a buzzword in the consumer economy for the last few years. Whether it is the growing population of facebook or the growth in Smartphone users, applications are becoming more and more popular among consumers today. Polynomiography as an application aspires to spread virally on facebook through the youth who have a high need for affiliation and self-expression as well as an interest in new and unique applications. Allowing users to express themselves and their identity in a unique manner, Polynomiography can change any word, message, name, etc., into art that will appear on an individual's profile and be commented upon by all their friends on facebook. This could actually have an appeal across all age groups as it allows the user to quickly generate a unique image that can be shared with their friends. This appeals to the user in that it allows them to convert words and sentences into unique images. Viral buzz also tends to be strong among the young population as those between the 13 and 17 year age group as they are more likely to copy their friends' actions as a "trend" and thus spread an application version of Polynomiography.

The Need for Funding and Support

In order to develop Polynomiography as a successful commercial technology, there is the inevitable need to receive seed funding as well as gaining opportunities that would help develop it and to move forward. Two distinct types of support are necessary: (1) financial support, and (2) developmental support to help bring it to a deserving level of appreciation and utilization in education, art, and more. These include funding to help bring in the needed expertise to develop and maintain a successful software, and to help develop its business aspect. The second level of support includes opportunities to carry out interdisciplinary activities, such as designing lesson plans for teachers, holding training teacher and student workshops, holding exhibitions that would help bring Polynomiography to a wide range of audiences, including children, youth, and the general public.

Fortunately, based on much evidence, including business studies by MBA students in more than one study, Polynomiography can succeed without the need for a large amount of investment. However, the seed money needs to be brought in through national or private agencies. Also, through national science and educational agencies, there is a need to gain grant funding that would allow working with experts to develop interdisciplinary curricula for art, math, and science courses, to hold teacher/student workshops, and to design of new creative educational activities.

Conclusions and Future Directions

There is an inevitable need for a wider appreciation of science and math in the USA. In order to make this happen, there is a need to promote creativity and innovation. This entry has introduced a technology that has the potential to turn polynomials into a very popular, if not a household, word. The technology, called Polynomiography, can lead to new forms of art, and advancements in science, math, and education, and help introduce the public to the deep and ancient subject, rooted in the most significant drive in mankind: solving for the unknown.

With the increasing role of visual tools and technologies, through computer-generated algorithmic visualizations, Polynomiography leverages information technology for the teaching, learning, and promoting of mathematics as a means for inducing striking appreciation of the connections between creativity in art and the intrinsic beauty of mathematics. Polynomiography has the potential to become a powerful medium for extending the capability of human creative thinking. This capacity needs to be examined in the context of funded pilot projects to lay groundwork for future development and highly collaborative, interdisciplinary research.

The inspirational power of Polynomiography is multifaceted and extends to many domains, including mathematics, the sciences, education, fine arts, and performance arts. Already there are seeds for cultivating interdisciplinary collaborations of different kinds, and the impact of such pilot projects will be to fuel further developments that stimulate creativity and innovative approaches to education that reward creative thinking and problem solving.

However, in order for such a technology to grow as an educational medium, an artistic tool, or a commercial product, there needs to be support of various kinds. These include institutional support, and seed funding to expand its software, to design interdisciplinary activities, to organize exhibitions and workshops in order to bring it to a wide range of audiences, including children, youth, and the general public. These would help bring about a wider appreciation of science and math and inspire new activities.

National government or private agencies that fund science or art projects need to pay more attention to the growth of science and math through interdisciplinary innovations that help combine art, science, and math. In doing so, these agencies need to think outside of the box and to support new and nontraditional avenues of creativity and innovation. At present, these foundations are not spending sufficient funding to promote creative thinking. The USA has one of the strongest programs in higher education in the world, attracting international students from the best universities in numerous countries. However, its expenditure in K-12 education falls short of many countries. This needs to change since according to studies, K-12 students generally do not score as high in science and mathematics as their international counterparts. Risks must be taken and new topics and inventions must make their way into classrooms.

Likewise, institutions such as universities themselves need to promote and support interdisciplinary research that combines art, science, and math and help these subjects grow. It is often believed that there is not enough time to introduce new curricula into old courses, as if curricula are to permanently remain unchanged. There are many reasons to believe that Polynomiography has the potential to enter math, science, and art curricula at many levels, from elementary school classes, all the way up to college level courses.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Angel Investors
- ▶ Antitechnology Movements: Technological Versus Social Innovation
- ▶ Artistic Research
- ▶ Business Start-Up: From Emergence to Development
- ▶ Creative Pedagogy
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity, Intelligence, and Culture
- ▶ Entrepreneurship Education
- ▶ Experiential Learning and Creativity in Entrepreneurship
- ▶ Freedom and Constraints in Creativity
- ▶ Higher Education and Innovation
- ▶ Imagery and Creativity
- ▶ Innovation by Applied Mathematics
- ▶ Innovations in Geometry
- ▶ Interdisciplinarity and Innovation
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Invention and Innovation as Creative Problem-Solving Activities
- ▶ Invention Versus Discovery
- ▶ Mathematical Discovery
- ▶ Networks and Scientific Innovation
- ▶ Preparing Students for Learning Through Invention Activities

▶ Promoting Student Creativity and Inventiveness in Science and Engineering
▶ Science of Creativity
▶ Speaking Pictures: Innovation in Fine Arts
▶ Start-up
▶ Thinking Skills, Development

References

Kalantari B. A new visual art medium: polynomiography. ACM SIGGRAPH Comput Graph Quart. 2004a;38:21–3.
Kalantari B. Polynomiography and applications in art, education, and science. Comput Graph. 2004b;28:417–30.
Kalantari B. Polynomiography: from the fundamental theorem algebra to art. Leonardo. 2005;38(3):233–8.
Kalantari B. Polynomial root-finding and polynomiography. Hackensack: World Scientific; 2008.
Mandelbrot BB. The fractal geometry of nature. New York: W.F. Freeman; 1983.
Mandelbrot BB. Fractals and art for the sake of science. In: Emmer M, editor. The visual mind: art and mathematics. Cambridge: MIT Press; 1993. p. 11–4.

Websites

http://www.cs.rutgers.edu/~kalantar/
www.polynomiography.com

Post-Normal Science

▶ Transdisciplinary Research (Transdisciplinarity)

Power-Law Distribution for Innovations

▶ Nonlinear Innovations

Preference for Complexity

▶ Conflict and Creativity

Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy

Gerald Bast
University of Applied Arts Vienna,
Vienna, Austria

Synonyms

Aesthetic innovation; Aesthetic research; Re-culturalization of societies; Social design; Societal transformation

Creative Industries or Creative Societies

While in the 1930s, Theodor W. Adorno still was able to say "art is magic – relieved from the lie to be truth," works of the arts more and more are transformed to mere objects of trade. But is not this politically and historically only consistent in an economy-driven society when pieces of art rather have the status of shares at some kind of stock market than artistic statements. Is it really surprising that art dealers change to brokers and art collectors to speculators?

It would be wrong to claim that art would uncouple itself from the social and political relevance. It is rather the *society*, which virtually strategically is going to be depoliticized by increasingly dominant economic structures. Apparently unbiased economic mechanisms take the place of political, cultural, and educational impact parameters in our societies. And this development has not passed by art. How should it? This paradoxically is exactly the evidence of the convexity still existing between art and society. In times when the social and political systems of values are replaced by the shareholder value, when educational contents get degenerated to statistically quantifiable measurements and educational institutions to knowledge-providing factories for the purpose of producing employability to increase economic growth – in such times it would be more than surprising, if this tendency toward the economization of our society would stop in front of the arts?

Since the late 1980s of the twentieth century, the "invisible hand" of the market increasingly has taken over the steering wheel in the stormy system of the arts and the artists are the rowers – although autonomous rowers. The artists, once depending on religious or secular rulers, became producers for the Creative Industry: galleries, fashion and music labels, training companies, theaters or publishing houses, etc. The artists transform to suppliers for the Creative Industries – and only a few of them succeed in actively influencing the market system by taking over the roles of art producer and bidder at art auctions at the same time – like Damian Hirst did.

Promoting the term "Creative Industries" as a political trademark is a real masterpiece of political strategy, initiated by the Blair government in the UK and then perfectly continued by the institutions of the European Union. In 1997, the UK Creative Industries Task Force was established by the Blair administration.

In 1998, the UK Department for Culture, Media and Sport defined the creative industries as "those industries, that have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property." (Creative Industries Mapping Document 1998).

In the same year, the UK Department for Trade and Industries continued in a White Paper: "In the increasingly global economy of today, we cannot compete in the old way. Capital is mobile, technology can migrate quickly and goods can be made in low cost countries and shipped to developed markets. British business must compete by exploiting capabilities, which its competitors cannot easily match or imitate. These distinctive capabilities are not raw materials, land or access to cheap labor. They must be knowledge, skills and creativity, which help create high productivity business processes and high value goods and services. That is why we will only compete successfully in future if we create an economy that is genuinely knowledge driven" (White Paper 1998, http://webarchive.nationalarchives.gov.uk/20000517080533/http://www.dti.gov.uk/comp/competitive/wh_int1.htm). In 2000, the European Council adopted the so-called Lisbon Strategy. Its aim was to make the EU "the most dynamic and competitive knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010." In 2003, the European Commission demanded: "Europe needs excellence in its universities, to optimize the processes which underpin the knowledge-society and meet the target, set out by the European Council in Lisbon, of becoming *the most competitive and dynamic knowledge-based economy in the world*." (Communication from the Commission – The role of the universities in the Europe of knowledge/* COM/2003/0058final)(http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52003DC0058:EN:HTML).

In 2005, the European Cultural Foundation declared the Creative Sector as an "Engine for Diversity, Growth and Jobs in Europe. The important role of the arts and heritage for the economic development of cities and regions, based on direct and indirect revenues and their employment effects, is of particular importance for regions suffering industrial decline in a post-Fordist age." (The Creative Sector 2005).

And the 2010 document about the EU-flagship Initiative Innovation Union points out clearly again: "Businesses should also be more involved in curricula development and doctoral training so that skills better match industry needs building for instance on the University Business Forum. There are good examples of inter-disciplinary approaches in universities bringing together skills ranging from research to financial and business skills and from creativity and design to intercultural skills. Design is of particular importance and is recognised as a key discipline and activity to bring ideas to the market, transforming them into user-friendly and appealing products." (Brussels 2010).

The strategy was quite sophisticated and multilayered:

1. Tell the cultural sector that it is necessary to stress its effects on economic growth and jobs

to gain a better position in the political decision-making processes.
2. Transform the semantics from Cultural Sector to Creative Industries – thus indicating, that culture now is a part of the industrial sector.
3. Make the members of the former Cultural Sector proud and give them a new feeling of social importance by telling them they would be the new heroes of the society by replacing the weakening old economy.
4. Transform the leading management guidelines of the former cultural sector toward the rationalities of entrepreneurial business administration by implementing a system of mainly quantitative performance indicators for measuring success or failure and for indicating the direction of future development.
5. Express that the mission of the whole Creative Industries Sector is to strengthen the economy and the labor market by providing creativity for innovation.
6. Deplore that cultural activities, which do not have enough short-term quantitative measurable economic effects, cannot have political priority in these hard times.
7. And then declare that Creative Industries is about to become the leading term in cultural policies.

Yes. Cultural industries *are* on the way to become the most important economic sector – especially in urban areas and especially when the leading economic sectors are in trouble. The creative industry does not give a complete image of the system of the arts, not even of the cultural sector, but signs and symbols in communication are important factors – structures and semantics effect habits and minds. So: What does it mean for a musician, a video artist, a poet, and an actor, if he or she is told to be part of the creative industries, because he or she is generating or exploiting intellectual property to earn revenues?

What does it mean for orchestras, dance companies, theaters, art galleries, design-studios, and architects to tell them that their activities are socially justified primarily because they contribute to economic growth and to the stability of the labor market.

What does it mean to art schools if they are told that their existence is socially and economically justified because they contribute to the aim of making Europe the most competitive and dynamic knowledge-based economy in the world?

The mission of art schools is not just to produce human resources for the creative industries, but there would be no art schools if there were no possibilities for graduates to earn money with their artistic skills within the cultural sector. Architects do not plan buildings because they want to support the construction industry – but finally they want to physically realize their plans. Painters do not create their works because they want to increase the economic impact of galleries and museums – but what would happen to all the painters, if there were no galleries, museums, and art fairs? Poets do not write books, because they want to strengthen the printing industry – but what would happen to poets if there were no editors, no printing industry, no theaters, and no broadcasting industry? What would happen to the graphic designers if there was no advertising market? What would happen to the filmmakers if there were no film-industry, no producers, no distributors, and no cinemas?

Creative Industries are not a threat for the arts but the advancement of this term semantically represents the recent social and political developments toward a commercialization of the society quite clearly. The subsectors which are summarized under the term "Creative Industries" of course are important elements of any society. The problem is the hierarchy. Universities are not important, if and because they improve the economy. Culture is not "the heart of knowledge based economy," as the European Cultural Parliament stated (ECP, Lisbon Agenda Research Group 2006). Culture, art, and even science should not primarily be seen as the engine for the vehicle called *economy*, which is moving the society. No, *culture* has to be recognized as the vehicle, which moves the society. And in fact, it *is* like that. To paraphrase Bill Clinton: It is the *culture* stupid! At least in the long run, it is the broad range of culture that matters and that remains in history. Just look at cultural history: Music, theater, literature, architecture, visual arts, visual communication; changing techniques, and changing media from stone carving to digital media, from affecting human thinking and behavior to recently even manipulating genetic and microbiological material – for centuries, these were and still are some of the most significant factors of human development. Factors caused and influenced by the arts.

The main directions of action, interaction, and mutual influence between societal subsystems in general and between the sociopolitical paradigms of economy and culture are of crucial meaning for the direction of societal development.

Two centuries after the Industrial Revolution and in the middle of the Information Revolution, again standing on societal and economic crossroads, the crucial question now is: Is it possible to make the development as well as the realization of creative ideas and visions the very trademark of our societies? If ever human societies can succeed in turning themselves into creative innovation societies – and for the sake of the future generations, this option undoubtedly must be undertaken! –the next societal and economic revolution will have to be a "creative revolution." Thus, the valences of societal paradigms must be shifted – from a mere commercialization toward a re-culturalization of the society – which in particular demands consequences for the educational and economic systems. Instead of the fabrication of products, the creation of new ideas will have to be the focus point for the shape of educational and economic systems. Therefore, providing creativity will have to be the leading mission of educational systems and creativity must not be a separate sector of the economy (creative industries vs. noncreative industries). Following these principles, the arts in general and art education in particular need to be integrated parts of education and economy as the economy will have to become a creative economy in *total*. Of course, this is a revolution indeed and naturally, the usual arguments can be heard: Regarding the recent nature of industrial companies, the employment structures, and the needs of our population, it is not possible to change the types of the existing economic structures! But similar concerns were raised on the threshold of the beginning industrial age when most of the population was working in and living from agricultural production.

The education system in so-called western societies is still characterized by the spirit of the industrial revolution, whose engines were fragmentation, specialization, and rationalization. Art education and art schools have to be counter-models to this development. Not isolated specialized knowledge is the basis for later success, but creativity, flexibility, the ability to think and act in interdisciplinary and intercultural contexts, questioning existing intellectual as well as behavioral habits arriving at with new scenarios and producing amazement with its own work. Thus, the arts and art schools are indispensable elements of societal infrastructure – at least as important for the development of societies as streets and financial services. The political positioning of the arts and art schools has to be changed from a servant of economic growth toward a leading factor of societal progress, at least in a role of an equal partner to the economy in steering the society!

With industrial-production increasingly moving away from the developed world, creative education will be one major stronghold on the way to securing the economic as well as intellectual and social future. Transformations of the workplace as well as throughout our societies require art-institutes to rethink their societal role and emancipate themselves as crucial players on the way to a creativity-based and innovation-driven future society. On the way toward the highest and competitive aims, not only the so-called western societies will be moving away from industrial, agriculture, and service-based economic structures and increasingly focus on the development of an economy coined by visions, ideas, and a permanent drive for innovation. This new creativity-driven economic model must help to erase the economic structures in place since the Industrial Revolution. Creativity, intellectual flexibility, and innovation must become the very basis of all economic efforts. To meet this aim, significant changes in the educational and economic systems as well as in the interrelations between education and economy are to be implemented: Creativity and creative skills will have to penetrate the education sector as well as the economic sector in general.

It was at the end of the twentieth century when politics exclaimed the end of utopias. Economic and political pragmatism should dominate and secure the future; feasibility and quantifiability increasingly became the rulers in education and science. Was it really by chance that a few years after proclaiming the end of utopias, after having stopped searching for totally new ideas and paradigms for the future of our social and economic systems, the waves of economic crisis overwhelmed most societies in rapid sequence. With the crisis of the existing market-oriented economic and social system "the chance may arise for a repositioning of the arts as well as art schools within society – not in terms of a re-politicization of art according to historical examples, but rather in the sense of a 're-socialization' of the arts focussing communication and identification." (Bast 2010) Maybe this could be the first step towards a creative revolution.

Of course, it is correct to say that the arts have become massive economic factors and that art education at the universities must refer to practicality and requires contacts, projects, and cooperation with the economic sector – namely the creative economy sector as well. But, at the same time, practicality is not the primary task of universities. Undoubtedly, it seems that the universities and the people connected to them are steadily submitting to economic pragmatism, when in fact, they should be generating the courage to experiment with regard to thought, design, and action: A courage, which – paradox enough – in the final analysis, is also in the interests of economic prosperity. Art schools must be associated more than ever with the development of the arts and the emergence of new artistic approaches, and not be perceived only as places where artistic traditions are passed on, or where students merely prepare for other places outside the art schools where artistic innovation actually happens. In the twenty-first century, the potential for the renewal of art and art education lies in the synergistic coupling and integration of artistic research and art production, aesthetic innovation, and scientific research, preparing artists for the traditional art market as well as for the various means of societal communication.

Conclusion and Future Directions

Art universities and academies will have to decide quickly whether they will continue in the future to be merely a supplier of human capital for the art, architecture, design, music, and theater market, or if they themselves want to claim the organizational rights to the art system and attain effective power: power in terms of fostering, creating and – yes – even defining aesthetic innovation. Of course, such a goal will require not only a change of consciousness, but also a change of contents and structures.

If art universities, in their function as aesthetic research laboratories, are to develop into an effective force beyond the university walls with an impact on the system of arts and on society, if they are to have even more of a social presence when it comes to contemporary art, architecture, and design as well as music, dance, and theater, then the existing institutions must be prepared to expand their traditional roles and spheres of activity. The universities of the arts must seek closer ties with museums and exhibition houses, with activities in the field of urban and social innovation, with theaters and the music industry, as well as connections to current forms and platforms of alternative and popular culture. And art universities must focus on artistic research – much more than they have done so far.

In current social perception, which is colored by the media and politicians, the term "innovation" is more than ever associated with technological and economic progress.

Therefore, the universities of the arts must take care that they do not stumble into an identity trap. The *Zeitgeist*, which dictates that universities – like factories – must also be as efficient and practically oriented as possible, is placing increasing pressure.

Cheaper and quicker output, necessity, need, and economic utility are the dominating arguments in discussions about universities and art universities in particular. The principal ideas of what is university seem to get paler and paler in present times. Universities do not produce products; they had and still have to generate ideas, attitudes, and perspectives in the hearts and in the brains of people who are enthusiastic enough to meet the challenge of leaving the trodden paths of thinking and acting.

In other words: The output of universities in general and especially of universities of the arts is shaping the future. Therefore, universities of the arts should adopt an offensive and self-confident attitude in the societal competition relating to the definition of progress and, thus, generate courage.

Cross-References

► Business Creativity
► Creativity from Design and Innovation Perspectives
► Entrepreneur in Utopian Thinking
► Higher Education and Innovation
► Interdisciplinarity and Innovation

References

Adorno TW. Minima Moralia. Frankfurt a. M.: Suhrkamp, 22. Auflage; 1994, ISBN 3-518-01236-3, S. 298.

Bast G. Designing the future. Against the pragmatism of the useful. An appeal for the resocialization of arts. In: Bast G, Felderer B, editors. Art and now. Wien/New York: Springer; 2010.

Brussels, 6.10.2010 COM(2010) 546 final, Communication from The Commission to the European Parliament, The Council, the European Economic and Social Committee and the Committee of the Regions, Europe 2020. Flagship Initiative Innovation Union, SEC(2010) 1161.

Creative Industries Mapping Document, UK Department for Culture, Media and Sport; 1998.

European Cultural Parliament, Lisbon Agenda Research Group; July 2006.

"The creative sector" – an engine for diversity, growth and jobs in Europe, An overview of research findings and debates prepared for the European Cultural Foundation. By Andreas Wiesand in co-operation with Michael Sondermann, Sep 2005.

The role of the universities in the Europe of knowledge, European Commission, COM/2003/0058final. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52003. DC0058:EN:HTML.

White Paper "Our competitive future: building the knowledge driven economy". Department for Trade and Industry, UK; 1998.

Preparing Students for Learning Through Invention Activities

James Day
Department of Physics and Astronomy, University of British Columbia, Vancouver, Canada

Introduction

Different forms of instruction are better suited to different learning outcomes. For example, repetition is commonly used for developing motor skills and reinforcement is commonly used for fostering desired attitudes or behaviors. Regardless of the specific pedagogy used, humans generate knowledge and meaning from an interaction between their experiences and their ideas. Many educational settings make it difficult for students to make this connection. For example, some disciplines focus mostly on problem-solving routines, but instruction in problem-solving routines is unlikely to prepare students for many other situations they are likely to encounter. Instead of focusing exclusively on problem-solving techniques, instruction should also focus on students' abilities to learn from new situations and resources. Preparing students for future learning, arguably the greatest educational outcome an instructor could hope to achieve, requires the development of new instructional methods as well as the development of assessments that can reliably evaluate whether or not students have been prepared to learn. One such recent and evolving instructional method is the use of so-called invention activities in the classroom. To quantify the effectiveness of such techniques and subsequently optimize them, an increased emphasis must be placed on the development of assessments that can reliably measure this very preparedness of a student to learn.

Key Concepts and Definition of Terms

Key Concepts

1. Experts and novices differ in meaningful ways. The study of these differences has revealed important distinctions in how experts learn new ideas and how they organize and apply their existing knowledge. This is important because it provides insight into the nature of thinking and problem solving – specifically, it provides insight into the nature of learning.
2. The transfer of knowledge is a highly desirable and worthy educational outcome. This is an outcome distinct from simply learning new ideas or from applying existing knowledge to the context in which it was taught.
3. Simply providing students with the expert knowledge – whether it be facts, formulas, or other – can be an efficient method of teaching. Often, this efficiency is a shortcut to some final piece of information, the price of which is that students do not develop integrated knowledge structures. It has been demonstrated (Schwartz and Martin 2004) that telling students the expert knowledge is much more effective after the students have investigated the structure of the phenomenon or idea.

Definitions

Expert: Someone with comprehensive knowledge and/or substantial ability in a specific, well-distinguished domain. Being an expert usually translates to being widely recognized as a reliable, authoritative, and credible source of information, technique, or skill.

Transfer: The application by an individual of the skills, abilities, or knowledge acquired in one setting to a second, unfamiliar setting. Neither a clear nor objective demarcation exists between near and far transfer, but attempts have been made to outline a spectrum along which transfer tasks may be placed (Barnett and Ceci 2002).

Invention Activity: An exercise in which students receive a set of carefully selected cases and their task is to invent a compact description of the data that generalizes across the cases. Students do not need to discover the correct answer. Instead, the invention activity helps students to notice important structure in the cases and to form an organizational framework that prepares them to understand conventional descriptions. After the invention activity, students are ready to be told the expert knowledge.

Metacognitive Scaffolding: The provision of support (e.g., in the form of templates, guides, or reflective questions) to promote awareness of learning when concepts and skills are first introduced to students. Such supports can be gradually removed as the student develops autonomous learning strategies.

Theoretical Background and Open-Ended Issue

The study of differences between experts and novices has revealed important distinctions in how they organize and apply their existing knowledge and how they learn new ideas (Ericsson 2006).

People who have developed expertise in particular areas are, by definition, able to think about problems or perform in situations with efficacy in those areas. It is not simply general abilities (such as memory or intelligence, strength or dexterity) that differentiate the expert from the novice nor is it just the application of general strategies. Rather, experts have acquired vast knowledge and experience that affects not only what they notice in their environments but also how they in turn coordinate, constitute, and construe that information. These are the processes that, consequently, affect abilities to recall, reason, and resolve problems or perform tasks. Understanding expertise is important: not because we want to develop our students into experts of any particular discipline, but rather because it provides meaningful insight into the nature of thinking and problem solving.

Numerous examples of how experts differ from novices are outlined in the second chapter of Ref. (Bransford 2000) and include: that experts have well-developed abilities to notice relevant features, structure, or patterns of information in evidence or situations; that experts possess a mental framework for organizing their knowledge that novices lack; that experts' knowledge cannot be reduced to sets of isolated facts or propositions but instead reflects context of applicability; that experts are able to flexibly retrieve important aspects of their knowledge with little attentional effort; and that experts have varying levels of flexibility in their approach to new situations.

The primary goal for educators should be to equip their students with the skills and attitudes that will be of value to them no matter what may be their later path in life. All the same, it is only natural for an instructor to teach under the assumption that their students will continue studying the current discipline being taught (e.g., a physics teacher assumes they are teaching future physicists). So, how does one position novices onto a path to expertise? Verbally communicating the expert knowledge to the students gives the impression of being an efficient way to teach, but it seems so because it is a shortcut. The cost of this shortcut is that students do not develop integrated knowledge structures. This does nothing to progress students towards the expert characteristics listed above. However, the act of telling becomes much more effective if the students have already engaged in investigating the structure of a phenomenon or idea. Instructors must remember that what is an obvious structure for them may not exist for the student. Students will need to investigate this structure on their own. Investigating the structure does not mean solving a series of discrete or step-by-step problems, because students are likely to treat each step as a separate exercise. Instead, instructors can use invention activities as a proven way to get students to explore structure: students receive a set of carefully selected cases, and their task is to invent a compact description that generalizes across the cases. Students do not need to discover the correct answer. Rather, the invention activity helps students notice important structure in the cases and to form an organizational framework that prepares them to understand conventional descriptions. After this invention activity, students can be told the expert knowledge which they will experience as an elegant solution to an authentic problem.

While this approach may help students to learn content, it does not necessarily guarantee that they become more expert-like in their behaviors. A particular question in this regard is: How do we teach better for transfer? The notion of transfer is at the root of our educational system. Teachers want more from learning activities than simply being successful with the lesson at hand, confined geographically and temporally to their classroom. Educators want learning activities that transcend their classroom and benefit their students in the real world. They are hopeful that students will show evidence of transfer in a variety of situations: from one problem to another within a course; from one course to another within the school year; from one school year to the next; and from problems encountered in school to problems encountered in the real world. Even when certain expertise is present, it does not follow that the transfer of particular skills to new situations (termed "adaptive expertise") will result (Bransford 2000). The question of teaching better for transfer remains mostly unanswered. This is in large part because, after decades of intense research activity on the topic of transfer, scholars remain as divided on the issue as they were at its inception. There are some who claim that transfer is exceptionally rare, there are some who state that transfer is increasingly prevalent, and there are some who opine that the situation is plainly unresolvable and that consensus might never be reached. The corpus of scientific knowledge reasonably makes the case that transfer is indeed a salvageable concept (Barnett and Ceci 2002), and some recent evidence suggests that one of the more promising avenues for the improved teaching of transfer is the proper use of invention activities.

Rather than stumbling through the dark in search of other pedagogical techniques for the teaching of transfer, it is worthwhile to focus our attention to methods that we have already identified as fruitful. In looking under the light, researchers and educators have considered how invention activities could be better delivered. There is good evidence to suggest that transfer is greatly aided by invention (Schwartz and Martin 2004). There also exists evidence that demonstrates how scaffolding these discovery learning activities can boost learning outcomes. Activity scaffolding can occur in a variety of different ways (Lajoie 2005). As some of the loftiest learning goals for introductory university courses involve some form of metacognition (e.g., to have students learn to become better learners), it seems reasonable to complement invention activities with metacognitive scaffolding. Such metacognitive scaffolding might include reflective questioning (does your quantitative final answer run counter to your gut feeling?), structuring the order of operations in a problem (before constructing your analytic solution, first list the properties it should possess), and peer evaluation (have another student critique your solution). Beyond seeming reasonable, this complement of techniques has the benefit of being testable. Researchers can actually measure whether or not students learn content or concepts better and, in principle, whether or not students transfer better when metacognitive scaffolding is built into an invention activity.

The difference between what is possible in principle versus in practice is paramount. How do we measure whether students have improved their transfer skills from invention activities? This question is likely to remain a difficult one for researchers and educators alike. What is needed is that reliable and valid methods of assessment are created to properly measure a students' ability to transfer.

Implications for Theory, Policy, and Practice

The delivery of a learning activity is at least as important as the learning activity itself. Invention activities are no magic bullet and specific care must be taken to ensure that the invention activity is properly delivered. Without proper execution of the activity, students can become frustrated with the activity and both their motivation and their willingness to learn will decrease. In principle, a good invention activity has some rather specific characteristics.

First and foremost, a good invention activity should present a clear and challenging goal to the student – an authentic problem. The goal is often to develop a compact and consistent description or representation of the important features across the given cases. Typically, the description entails integrating multiple features into a single representation, such as a ratio in the simplest case. Examples of these goals could be to find an index for pieces of wood that will allow one to predict whether they will float or sink, or to create a graphical representation that displays the important patterns of an experiment, or to design a cell membrane that allows certain substances to pass through but not others. An appropriate goal is consistent with what an expert does when trying to describe or present novel findings.

The use of contrasting cases in an invention activity is also exceptionally important. Contrasting cases can help novices to notice the distinctive features of each case which they might not otherwise notice (like glasses of wine tasted side by side). An invention activity should comprise multiple cases concurrently, so that students notice both the structure itself and the structural variations across cases that transcend their superficial differences. Ideally, these contrasting cases are made to vary systematically on key parameters, so that students can see how the variations relate at a deeper, structural level. When variables are presented in a confounded way, the contributions of their effects to the parameter under study become significantly more difficult to extract (imagine determining the quality of two wines made from different grapes, served at different temperatures, and paired with different meals). Two to four contrasting cases will provide a reasonable level of difficulty, but a single case can be made to work as well, provided that students will spontaneously generate contrasting cases. If the contrasting cases are structured so that a reasonable but wrong description can be created by the students (e.g., based on just one or two of the given cases and failing to work for the others), then assurance can be taken in having selected suitable cases.

It is also necessary to be mindful of the context and wording of the invention activity, as well as its level of difficulty. The invention activity should involve material that is relatively familiar and meaningful to the students. When such context is lacking, students might not be able to recognize when a description or representation fails for a given case. (Specific demographics have been observed to stall in the earliest stages of certain activities because of an unfamiliarity with things like pitching machines or pumpkin pies.) The task and cases must make sense to the students. Beyond context but still related to making sense, the invention activity should be worded in a manner which avoids jargon. Use of specialized language can trigger the very common student response of equation-hunting ("What was that formula we learned?"), rather than the desired preparing-to-learn response ("This is a new task!"). For instance, in the example above with the pieces of wood sinking or floating, one should avoid the term density. If students attempt to force some previously learned process or concept upon the task or, worse, if they immediately try to look up the solution, then it should be taken as an indication that language has short-circuited and sabotaged their thinking. That is not to say that recalling familiar concepts should be discouraged, only that the blind use of tangentially related concepts is undesirable. Ironically, this camouflaging of the concept in an authentic problem seeks to prevent (initial) transfer of such tangential concepts and allows students to observe the underlying deep structures. Concerning level of difficulty, students should have partial success and not be expected to come up with the solution that covers all cases and took experts centuries to discover. If one is interested in teaching complex ideas, multiple activities should be used that are each limited in scope. To this end, each activity should be used to introduce one or two new structural parameters. If the students are able to get started but seldom find the perfect/complete answer, then the invention activity probably has an appropriate level of difficulty.

Invention activities work best when attempted by pairs (or small groups) of students and so should be completed collaboratively. By explaining to their partners how they have reached a conclusion requires of the student an analysis of their own thought processes; conveying these ideas to others helps deepen their understanding because the student has to explain it in a manner that their peers can also understand. In this way, small group work fosters deep learning. Furthermore, establishing meaning and understanding through presentation to others aids in memory encoding, storage retention, and retrieval.

The structure of the invention activity should not allow for students to be able to divide up the task and work independently; rather, the classroom should be filled with exchanges similar to "But would that method work for this case?" or "Does this solution make qualitative sense?"

Finally, authors of invention activities should anticipate a design cycle. Ideally, one should field-test the activity with a few representative students first and modify as needed before using it with a class. Realistically, modifications are typically made to the following year's class based on what was learned in the previous year. If, when completing the invention activity, students slowly begin to notice and try to represent the key structures that an expert can see easily in the cases, then the invention activity is probably in suitably functional form.

An example of a simple invention activity is shown in Fig. 1. The premise of this invention activity is that students will be better prepared to understand the formula for standard deviation when first afforded an opportunity to differentiate the elements of variability for which the formula must account. Working in small groups, the students try to generate a formula that accounts for all the given quantitative properties (e.g., dispersion or sample size). At the end of the exercises, students should be shown the variability formula used by experts. Other explicit examples of effective invention activities which precede direct

Preparing Students for Learning Through Invention Activities, Fig. 1 A sample invention activity, in the domain of statistics (Modified from data published in Bransford and Schwartz (1999))

Pat, Alex, Chris, and Lee are all members of the Little City Basketball Team. After five games of the regular season, the four begin contemplating their offensive contributions to the team.The table below shows how many points have been scored by each player per game.

Player	Game 1	Game 2	Game 3	Game 4	Game 5
Pat	6	4	8	10	2
Alex	6	5	7	8	4
Chris	10	2	10	10	2
Lee	14	-	8	12	-

Goal: Create one or more mathematical formulas that summarize how each player tends to score in a game.

instruction can be found, for example, for the case of teaching variability in data and the difference between accuracy and precision (Schwartz and Martin 2004) and for the case of creating histograms and calculating standard deviation (Day et al. 2010).

The main purpose of an invention activity is to prime students for learning; therefore, direct instruction must follow the invention activity. Upon detecting the important structure in the cases, students are better able to build an organizational framework that prepares them to understand the conventional description then presented by the instructor – the "elegant solution" to an authentic problem.

The potential benefits of an invention activity are nearly completely lost if this final step is not taken. Conversely, great outcomes can result from proper execution. For example, in a sequence of design experiments on the teaching of descriptive statistics, Schwartz and Martin (2004) demonstrated the effectiveness of invention activities when they preceded direct instruction, even though these students failed to produce canonical conceptions and solutions during the invention phase. In this study, it was observed that invention activities, when coupled with subsequent learning resources like lectures, led to strong gains in procedural skills, insight into formulas, and abilities to evaluate data from an argument. Most importantly, invention activities were found to significantly boost students' future learning, when compared against direct instruction (simple "tell-and-practice") alone.

Conclusion and Future Directions

There is a growing body of literature demonstrating the existence of benefits derived from invention activities on present and future learning. An apparent relationship between failure and mental frameworks forms a common thread through many of the diverse research programs investigating how students learn. The central findings of these research programs can collectively be interpreted as an argument for the delay of structure in learning and problem-solving situations, be it in the form of feedback and explanations, coherence in texts, or direct instruction. The convergence of evidence is pointing to the efficacy of learner-generated processing, conceptions, and understandings, even though such conceptions and understandings may, in the shorter term, not be correct and the process of arriving at them not as expeditious.

One future direction is to deliver these activities with computer-based intelligent tutoring systems. These are used to coach students while they are problem-solving. While intelligent tutoring systems offer sufficient support with proven learning gains, the tasks they facilitate (e.g., basic descriptive statistics or simple graphical representations) are relatively constrained and do not require students to practice their inquiry and scientific reasoning and learning skills. One recent step in this direction has been termed the Invention Lab (Roll et al. 2010), which is an environment that complements the benefits of constructivist tasks (e.g., quantifying the spread of data about the mean of its set) with adaptive support (e.g., an algorithm that generates contrasting cases on the fly). The Invention Lab facilitates invention activities that are structured, more or less, as outlined above by an ex tempore analysis of students' inventions and subsequent creation of new problems to match the perceived gaps in their understanding. In so doing, the Invention Lab offers support without reducing critical elements of the constructivist activity. More recently, these ideas have been extended even further. There exists a computer-based interactive learning environment, called the Invention Support Environment (Holmes 2011), that was built to both improve the in-class use of invention activities and act as a research tool for studying the effects of these activities (for the case of scaffolding relatively complex learning (Reiser 2004), what role does domain-general scaffolding of invention activities play in supporting the acquisition of domain knowledge and of scientific reasoning skills?). The system was designed to support various levels of domain-general scaffolding, as well as invention and reasoning skills. The system also features a platform for which new invention activities may be created and requires minimal programming experience (if any).

A salient characteristic of many research studies usually involves the use of a final transfer task in a "sequestered problem-solving" (SPS) way. In other words, the subjects are isolated while working on the transfer task so that they do not have opportunities to invoke support from other resources (e.g., texts or peers) nor may attempt various solutions, receive feedback, or revise their work. Along with the SPS paradigm is the conception that effectively defines transfer as the ability to directly apply (DA) one's previous learning to a new setting or problem. Of course, there exist alternatives to the union of SPS methodology and DA theory. One such alternative is the approach that appreciates the validity of the SPS/DA position but also extends the concept of transfer by introducing an emphasis on the student's "preparation for future learning" (PFL). In the PFL model, the focus shifts from sequestered tasks to assessments of the student's abilities to learn in knowledge-rich environments and from single-shot task performance to extended learning. The better prepared a student is for future learning, the greater will be the transfer (in terms of speed and/or quality of new learning). So, what does this mean for how research on transfer might look in the future? From the PFL perspective (Bransford and Schwartz 1999), it means that assessments of people's abilities can be improved by moving from static (single-shot, summative testing) to dynamic assessments (environments that provide opportunities for new learning). What one currently knows is clearly important for future learning – this new perspective further proposes the hypothesis that a dynamic assessment of a student's ability to learn over an extended period might better predict that student's success "in the end" than a single-shot SPS test at the beginning. This is a major challenge for future research.

Cross-References

- ▶ Adaptive Creativity and Innovative Creativity
- ▶ Analogies and Analogical Reasoning in Invention
- ▶ Creative Problem Solving
- ▶ Invention Versus Discovery
- ▶ Scientific Inventive Thinking Skills in Children
- ▶ Strategic Thinking and Creative Invention
- ▶ Teaching as Invention
- ▶ Teaching Creativity
- ▶ Thinking Skills, Development

References

Barnett SM, Ceci SJ. When and where do we apply what we learn? A taxonomy for far transfer. Psychol Bull. 2002;128:612–37.

Bransford JD. How people learn: brain, mind, experience, and school. Washington, DC: National Academy Press; 2000.

Bransford JD, Schwartz DL. Rethinking transfer: a simple proposal with multiple implications. Rev Res Educ. 1999;24:61–100.

Day J, Nakahara H, Bonn D. Teaching standard deviation by building from student invention. Phys Teach. 2010;48(8):546–8.

Ericsson KA. The Cambridge handbook of expertise and expert performance. Cambridge: Cambridge University Press; 2006.
Holmes NG. The invention support environment: using metacognitive scaffolding and interactive learning environments to improve learning from invention (thesis). Vancouver (BC): University of British Columbia; 2011.
Lajoie SP. Extending the scaffolding metaphor. Instr Sci. 2005;33:541–57.
Reiser BJ. Scaffolding complex learning: the mechanisms of structuring and problematizing student work. J Learn Sci. 2004;13(3):273–304.
Roll I, Aleven V, Koedinger KR, et al. The invention lab: using a hybrid of model tracing and constraint-based modeling to offer intelligent support in inquiry environments. In: Aleven V, Kay J, Mostow J, editors. Proceedings of the international conference on intelligent tutoring systems. Berlin: Springer; 2010. p. 115–24.
Schwartz DL, Martin T. Inventing to prepare for future learning: the hidden efficiency of encouraging original student production in statistics instruction. Cogn Instr. 2004;22(2):129–84.

Pretend Play

► Imagination

Pretense

► Imagination

Principal–Agent Model in Universities, Problems and Solutions

Andreas Panagopoulos
University of Crete, Rethymnon, Greece

Synonyms

Agency dilemma; Lack of disclosure

Introduction

The modern day university acts as a powerhouse of indirect economic activity that stems from the scientific discoveries, inventions, and innovations that university scientists develop. Bearing in mind that it is hard to assess the potential of novel discoveries, the university is facing the so-called principal–agent problem in the way it incentivizes the research of faculty members.

Definition of the Principal–Agent Problem

The principal–agent problem (henceforth PA problem), which is also known as the agency dilemma, concerns the difficulties in motivating one party (the agent), to act on behalf of another (the principal). In universities, the PA problem is manifested in (1) the way the university motivates faculty research and (2) in the way the university motivates disclosure of faculty inventions to the university Technology Transfer Office (TTO), which is also known as Technology Licensing Office (TLO). The role of the TTO is to act as a technology-transferring mechanism that allows the university to profit by assigning the rights of faculty-made scientific discoveries to a third party.

The Principal–Agent Problem in Motivating Faculty Research

In terms of motivating faculty research, universities rely on the so-called peer-review system, where peer review is a process of evaluation involving qualified individuals within the relevant field. Accordingly, faculty members are rewarded (in terms of tenure or promotion) depending on how many journal publications they amass in journals that follow the peer-review system. Furthermore, reward depends on the quality of the peer-reviewed journal per se, as well as on how many citations such publications stockpile. In effect, the university outsources the solution of its PA problem to independent scientific journals. Thus, it is up to these journals (which usually lack formal ties with the university) to determine what is published and where, and it is up to the readers of such journals to cite the published work or not.

Consequently, with little effort, the university has at hand a cardinal measure of faculty quality on which to base its decisions.

The Principal–Agent Problem in Motivating Disclosure of Faculty Inventions

The facts of university technology transfer are, in theory, surprisingly simple. Upon invention the faculty scientist is obliged to disclose her invention to the TTO, and the TTO must then try to assign the rights of the said inventions to a third party. In this manner the university can derive pecuniary benefits that are then shared with the faculty scientist. Unfortunately, in practice, university technology transfer is not as simple, and only a subset of all faculty inventions are disclosed to the TTO. In fact, as Markman et al. (2007) show, high-valued inventions are never disclosed, leading to a considerable loss of profits for the university. This is not surprising as the benefits accruing to faculty scientists upon disclosure are commonly in the range of 30 % of licensing proceeds, with the university keeping the rest.

It has been argued that the solution to such unwillingness to disclose is a simple reallocation of proceeds. As Thursby and Thursby (2004) note, disclosure is linked to the pecuniary rewards that faculty attains from licensing. Therefore, as suggested by Lach and Schankerman (2004), disclosure can be achieved by shifting the distribution of licensing proceeds in favor of faculty members. This seems easier said than done. In fact, as Markman et al. (2012) display, high-valued inventions will only be disclosed to the TTO if the scientists effectively free-ride, attaining 100 % of the licensing proceeds, in which case the university is left with naught.

Notwithstanding the above, as TTOs have been accused of failing to attract quality licensees (further worsening the lack of disclosure), the distribution of proceeds is but one of the problems plaguing faculty disclosure. In illustrating this point, Markman et al. (2005a) find that TTOs are extremely risk-averse and follow suboptimal licensing strategies focusing on short-term cash maximization. Along these lines, Siegel et al. (2004) present evidence indicating that TTOs appear to do a better job in serving the needs of large established firms, instead of small entrepreneurial firms; even though it is the latter who usually have a greater capacity for adding value to the invention.

In addition, Siegel et al. (2003a) find that informational/cultural barriers exist between TTOs and small firms. This argument is in line with Markman et al. (2005b) who focus on the bureaucratic nature of TTOs. As they argue the bureaucratic nature of TTOs creates barriers for disclosure. This observation is in agreement with Siegel et al. (2003a), and Siegel et al. (2003, 2004) who suggest that the key obstacles to effective university technology transfer seem organizational in nature. As they note, university technology transfer is obstructed by differences in organizational cultures between universities and firms (especially smaller firms), incentive structures, and staffing/compensation practices followed by TTOs.

Solving Principal–Agent Problem in Motivating Disclosure of Faculty Inventions

The main solution used so far is monitoring, which as Markman et al. (2012) display has thus far provided limited results because it is difficult to prosecute academic personnel failing to abide with the TTO's objectives. It stands to reason that the optimal solution to the PA problem would be one that allows faculty scientists a free hand in dealing with their inventions, while fully informing the TTO of their actions, allowing the university to appropriate part of the proceeds. Panagopoulos and Carayannis (forthcoming) formulate such a solution.

As Panagopoulos and Carayannis (forthcoming) display, by altering the TTO's role, from a monitoring office that licenses/transfers university technology to an office that offers faculty scientists some form of "insurance" that guarantees them a positive return if/when they have failed to license their technology (on their own), full disclosure can be achieved. Furthermore, this "insurance" does not have to be pecuniary. In fact, it can take the form of extra brownie points (or any other form of social currency) in appreciation for the faculty scientist's (important yet unlicensed) research. Such a focus on nonpecuniary incentives is in line with Hayter (2011) who suggests that faculty scientists do not solemnly define success in terms of monetary gains and can be also motivated by peer recognition or the choice of public service.

The rationale behind this proposal rests on the following principle. Consider an agent who is bargaining with another party on how to split some value. If this agent is left destitute upon failing to negotiate an agreement, she is obliged to bargain with her back against the wall, accepting even suboptimal arrangements. By contrast, the same agent should expect a better bargaining outcome when she bargains having something to rely on (i.e., a positive outside option) just in case bargaining fails.

The above example suggests that in licensing negotiations by pumping up an agent's outside option, she can expect a better bargaining outcome. The implication of this reasoning is that a faculty scientist (who aims to negotiate her own licensing deal with a perspective licensee) should be willing to disclose her invention to the TTO in order to be granted the aforementioned outside option. All that is needed for achieving disclosure is for the TTO to charge a price (i.e., the licensing proceeds that the university keeps) that does not exceed the additional benefits accruing to the scientist because of this outside option.

Taking a Closer Look at This Policy

Following Binmore (1992, pp. 189–191), cooperative game theory suggests that bargaining can be modeled, via a technique known as Nash bargaining, by using the so-called Nash product. This product accounts for how two parties split up a certain value they are bargaining on depending (1) on how much each party gets if bargaining is fruitful and (2) on one's outside option if bargaining fails. In terms of point (2), maximizing the Nash product (in order to find the optimal bargaining share of each party) immediately lays the argument bare.

Specifically, the bargaining share that accrues to the faculty scientist must always be a positive function of her outside option. In brief, by increasing this outside option the faculty scientist stands to gain a greater share from splitting the value of the technology she is trying to license. The intuition behind this point is almost elementary as it suggests that agents who do not have much to lose can barter a better deal compared to agents who face a negative outcome upon failure and are thus inclined to accept even suboptimal bargaining shares.

As a result, since her share of the licensing fees increases, the faculty scientist should be willing to pay for such an outside option (the abovementioned "insurance") by disclosing her technology to the TTO, allowing the TTO to charge a fee for its services. Consequently, all that is needed to achieve full disclosure is for the TTO to offer some "insurance" that does not exceed the pecuniary benefits accruing to the faculty scientist because of this additional outside option that she enjoys. In determining the value of this "insurance," as well as the TTO's share of the proceeds, one must compare the faculty scientist's payoff from licensing in the absence of such a scheme with the payoff she derives by disclosing her technology to the TTO in exchange for the said "insurance."

For this scheme to work, two are the important parameters that if calibrated correctly can lead to full disclosure for all types of inventions, (1) the value of the "insurance" and (2) the share of licensing fees that accrue to the TTO upon disclosure. Nevertheless, a few interesting points can be immediately differed from the above discussion. Specifically, as Panagopoulos and Carayannis (forthcoming) note, since an increase in the university's "insurance" policy increases the bargaining share of the faculty scientist, in principle the university could charge a greater fee for such a service by appropriating a greater share of the scientist's licensing fees.

In a nutshell, the TTOs share of the proceeds must be positively related to this "insurance."

Conclusion and Future Directions

This policy is effectively a forward looking policy that aims to solve the problem before it emerges. Furthermore, by solving the problem of disclosure this policy further promotes technology transfer, speeding up the innovation process. In this respect, this method adds to a well-established arsenal of incentives that promote innovation, an arsenal that includes patents and prizes as incentive mechanisms. However, prizes and patents do not address the PA problem. In this fashion, the incentive mechanism described here shares some common aspects with the Phoenix Awards, pioneered by the Economic Development Board (EDB) of Singapore. Specifically, since 2000 the Phoenix Award "*seeks to acknowledge technology-related entrepreneurs who have weathered the storm prior to success*." For this award, which seems to be largely dormant at the moment, nominees are evaluated on the way they managed to overcome past business failures prior to finding success using technology. Since the Phoenix Award is backward looking, taking place after the inventor has failed to implement her technology, it is not directly comparable to the "insurance" described here. Nevertheless, the way the award has been structured (and the process used in deciding who gets the award) could offer some important insights on how to accurately come to a decision on the magnitude of the "insurance" that each individual faculty member may require.

Cross-References

▶ Academic Entrepreneur, Academic Entrepreneurship
▶ Academic Entrepreneurship
▶ Game Theory and Innovation Analysis
▶ Higher Education and Innovation
▶ Patents and Entrepreneurship
▶ University Research and Innovation

References

Binmore K. Fun and games. Toronto: D.C. Heath and Company; 1992.
Hayter C. In search of the profit-maximizing actor: motivations and definitions of success from nascent academic entrepreneurs. J Technol Transf. 2011;36: 340–52.
Lach S, Schankerman M. Royalty sharing and technology transfer in universities. J Eur Econ Assoc. 2004;2:252–64.
Markman G, Balkin D, Phan P, Gianiodis P. Entrepreneurship and university-based technology transfer. J Bus Ventur. 2005a;20:241–63.
Markman G, Gianiodis P, Phan P, Balkin D. Innovation speed: transferring university technology to market. Res Policy. 2005b;34:1058–75.
Markman G, Panagopoulos A, Gianiodis P. Scientists or entrepreneurs: rent (mis)appropriation from discoveries made in university labs. Best Paper Proceedings of the American Academy of Management, 2007.
Markman G, Gianodis P, Panagopoulos A. Opportunistic behavior in research organizations. Best paper proceedings of the American academy of management (2012)
Panagopoulos A, Carayannis E. A policy for enhancing the disclosure of university faculty invention. J Technol Transf. (forthcoming).
Siegel D, Waldman D, Link A. Assessing the impact of organizational practices on the productivity of university technology transfer offices: an exploratory study. Res Policy. 2003a;32:27–48.
Siegel D, Waldman D, Atwater L, Link A. Commercial knowledge transfer from universities to firms: improving the effectiveness of university-industry collaboration. J High Technol Manage Res. 2003b;14:111–33.
Siegel D, Waldman D, Atwater L, Link A. Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. J Eng Technol Manag. 2004;21:115–42.
Thursby J, Thursby M. Are faculty critical? Their role in university licensing. Contemp Econ Policy. 2004;22:162–78.

Private Equity

▶ Venture Capital and Small Business

Problem Finding

▶ Four Ps of Creativity and Recent Updates

Problem Solving

▶ Creativity: Cultural Capital in Mathematics
▶ Four Ps of Creativity and Recent Updates

Problem Solving by Wisdom

▶ Method for Creating Wisdom from Knowledge

Problem-Solving

▶ Creativity in Invention, Theories

Procedural Modeling

▶ Imagination

Process Excellence

▶ Six Sigma

Product Development

▶ Product Development, Business Concept, and Entrepreneurship

Product Development, Business Concept, and Entrepreneurship

Laure Morel[1], Mauricio Camargo[1] and Vincent Boly[2]
[1]ERPI, University of Lorraine, Nancy, France
[2]Equipe de recherche sur les processus innovatifs (ERPI), Université de Lorraine, Nancy, France

Synonyms

Business model; Idea generation; Opportunity; Product development

Nowadays, fierce competition and industry relocation toward developing countries, entrepreneurship, and innovation are widely recognized as key factors in competitiveness. The shortening of the product life cycle (products and services), the need to differentiate from competitors and reduce manufacturing costs, and effective logistics and marketing are all reasons to create and develop innovations to meet these challenges. For many countries, the private sector and entrepreneurship have been a powerful engine of economic growth and wealth creation. The formation of new businesses leads to job creation and has a multiplying effect on the economy. Socially, entrepreneurship empowers citizens, generates innovation, and changes mindsets. To that effect, studying the processes that lead an entrepreneur to look for new business concepts and then new product development processes is central to the innovation dynamics.

Entrepreneur Abilities

The most well-known definition of an *entrepreneur* is that of Schumpeter (1934). Indeed, since the 1930s, he has argued that the role of the entrepreneur is essential for economic dynamics and that the individual entrepreneur is the real source of innovation. He said that an entrepreneur is not considered as an inventor, but seems to have a particular momentum, a sense of authority and challenge enabling him to achieve a *new combination* of factors. However, it should be noted that the concept of producing a *new combination* has been somewhat questioned by Perroux (1951) who emphasizes the vagueness of the role of the entrepreneur in the Schumpeterian definition. "A comprehensive analysis of this concept leads ineluctably to the recognition that it denotes a series of separate operations. To achieve the full meaning of the term *new combination*, it must incorporate not only the principle design, assess its implementation plan, decide on the execution, overcome resistance, or raise capital and skills but also agree to take on the production risks permanently. The latter agreement, the latter act, is decisive. Until it is done, all the others remain futile." In other words, the entrepreneur's role is to transform the idea into reality, allowing us to consider innovation as "creativity in action" or the opening up of new areas of design. Indeed, innovation allows the exploration of new areas of knowledge, unsuspected at first, which results in opening up realms of possibilities and the introduction of a high degree of variability into the innovation process (Smith 1996).

The result is, in fact, a higher level of risk to be managed by taking into account a global, systemic approach incorporating information from the environment that has an impact on the process of creating a new business.

Consequently, new methods and skills are needed to enable entrepreneurs to identify opportunities at any time, leading to the integration of a "constructivist" process of thinking (Smith 1996).

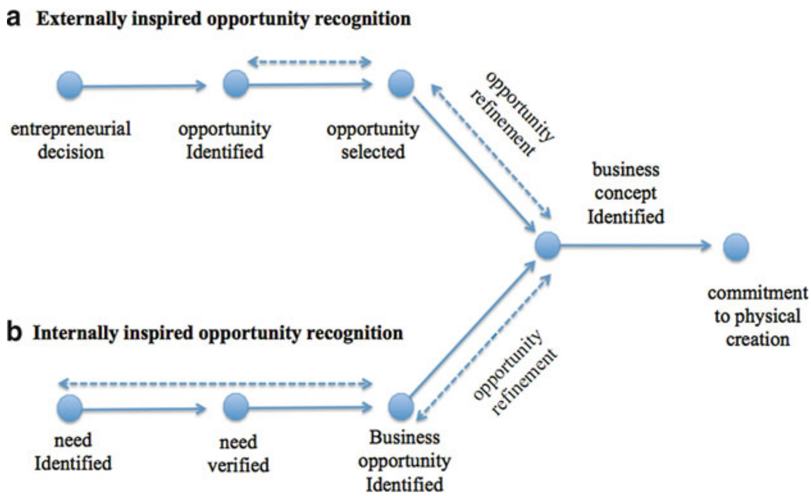
Business Concept and Entrepreneurship

Based on the fact that every business concept has its origin in the ability of the entrepreneur to generate an idea, Bhave (1994) has formalized the existence of opposition in the mind of the entrepreneur at the time of the creative spark, recalling the well-known paradox of the chicken and the egg. Is it the idea or the desire to create a new business which comes first? The author demonstrates that if entrepreneurial desire precedes the identification of an idea, the business process is generated by identifying, selecting, and adjusting an opportunity that becomes a business concept (A). A second case occurs when the creative spark is the identification of a particular need. In this case, the need has to be verified before the business opportunity is identified (B). In both cases, adjustments to the opportunity are formalized in a business concept.

So, the creation of a new business with development potential must satisfy a specific need to claim to become a success. The business concept includes the clear identification and formalization of the unsatisfied need that the new product will provide. For example, how this "product" is new or better than existing ones or what is the unserved market to which it will respond. For Minniti and Bygrave (2001), an entrepreneur's decisions are the result of two types of knowledge: the first from information about market conditions, business opportunities, technologies, or new ideas and the second related to his/her personal experiences, capabilities, and skills as entrepreneur.

The origin of the information used to make decisions is twofold: the entrepreneur's previous experience and beliefs and new information resulting from the formalization phase of the project. The research study by Parker (2006) has shown that on average, these individuals adjust their expectations of unobserved productivity in the light of new information by only 16%. This suggests that while entrepreneurs do exploit new information, they give much greater weight to their prior beliefs when forming their expectations. So the "business concept" appears to be largely predetermined. He also found that, among other things, the age of the entrepreneur and cultural factors significantly alter the influence new information has on decisions (the young entrepreneur seems more receptive to external information because of his reduced feedback or expertise).

Furthermore, it appears that the process of ideation is the result of exchange and confrontation between two spaces of exploration and exploitation. While the first is based on the



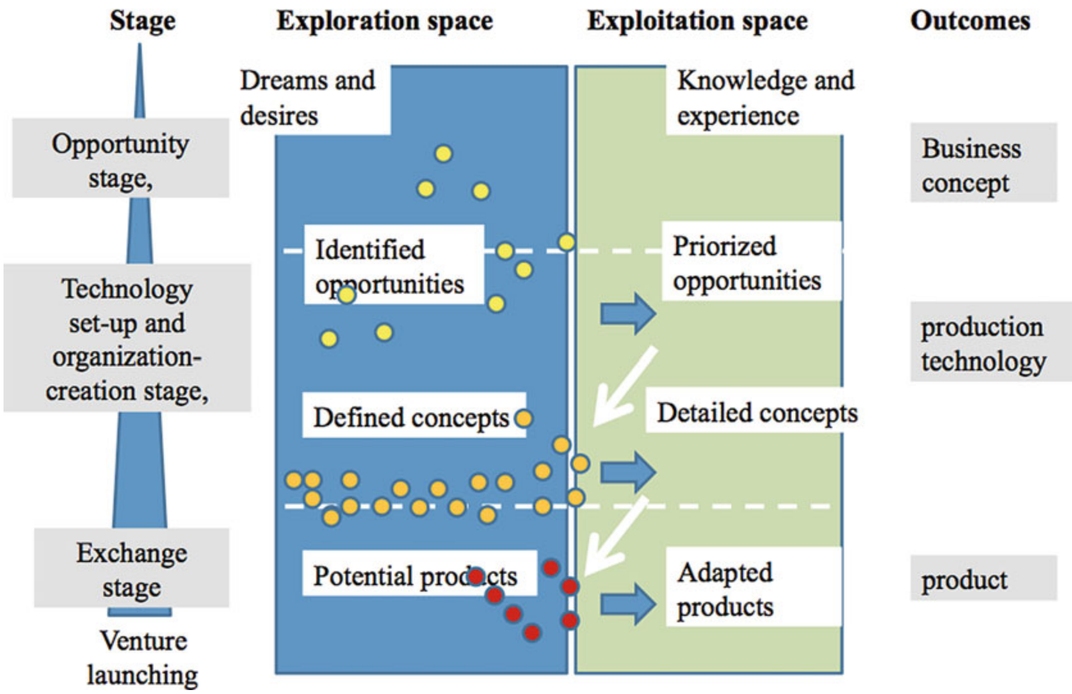
Product Development, Business Concept, and Entrepreneurship, Fig. 1 Opportunity recognition stage in the venture creation process (Source: Adapted from Bhave 1994)

entrepreneur's ability to dream and move forward from his current knowledge and skills leading to innovation, the second reflects a desire to work more in his comfort zone that is based primarily on concepts and processes which are well known and mastered.

Figure 2 shows an overview of the exchange process between the two areas described above. Originally, the model included seven stages (internally and externally stimulated opportunity recognition, commitment to physical creation, production technology setup, organization creation, product creation, connecting to markets, and customer feedback), but for analytical convenience, the author divided the process into three stages: the opportunity stage, the technology setup and organization creation stage, and the exchange stage. Note that the business concept, production technology, and product are the core variables representing the three stages respectively:

– *Opportunity recognition*: This stage includes the process described in Fig. 1, starting from the preparation (internally or externally inspired opportunity recognition) and incubation of the idea through an intuitive non-intentional thinking process allowing the consideration of possibilities or options to solve a problem. This stage ends with the insight (eureka, aha!) and occurs when the entrepreneur consciously realizes that the idea may represent an entrepreneurial opportunity and how it could create value. The main outcome of this stage is the business concept.
– *Technology setup and organization creation*: This involves the tangible actions needed to create an organization, a production technology, a product or service, as well as the first customer contacts. Also, the original idea is further refined toward a more detailed business concept, a practical commitment to actually realizing the idea, and implementing this realization. At the end of this stage, the organization and production technologies are not only defined but the emerging product concept is also evaluated with other people in the entrepreneur's networks.
– *Exchange*: This involves connecting to markets and customer feedback. At this stage, even if the venture has been launched, the product concept and the organization structure must be continually evaluated and adapted from customer feedback until final product definition. There is a growing trend of incorporating latent customer needs as soon as possible in order to reduce the risks inherent to introducing innovation onto the market. A comprehensive analysis of these approaches is made in Ben Rejeb et al. (2011).

In summary, the process of venture creation is a recursive process. Indeed, as pointed out by



Product Development, Business Concept, and Entrepreneurship, Fig. 2 Dynamics of the entrepreneurship process (Source: Our research)

Lumpkin et al. (2004), although the components of the process have been called "stages" here, it is important to note that they are not necessarily linear and may not follow any predetermined sequence.

Business Model and Entrepreneurship

Two schools of thought coexist in entrepreneurship: researchers who argue that a systematic plan and clear business model need to be produced upstream, leading to better performance of the future business, and others who advocate that the entrepreneur's learning ability, flexibility, and strategic management resources are the factors most critical to success, especially in uncertain environments. Furthermore, in a comprehensive literature study using meta-analysis, Brinckmann et al. (2010) reviewed 50 studies in order to explore the effects of a priori planning of the business model on the performance of small businesses already created and entrepreneurial projects. There were two major conclusions:

– First, the positive impact of a priori planning is greater among businesses already established, thanks to their prior knowledge of the industrial sector and information collected about the innovation project to be launched.
– Then, in the case of an entrepreneurial project, basic non-exhaustive planning is enough to start the project. Success will be conditioned by the reliability, quality, and quantity of information gathered and by events requiring the entrepreneur's learning ability and flexibility.

Based on the observation of many several innovation and entrepreneurship projects, a conclusion could be certainly made: the earliest materialization of the idea in product development and the iterative nature of its fine-tuning have a decisive role in defining the business concept to be validated. As previously mentioned, the business concept will be translated paying particular attention to customer definition, the value proposition and compelling story, the product/service proposal, and the identification of the distribution and commercialization process resulting in the development of the most suitable business model. Nevertheless, the choice of business to be undertaken remains complicated. Indeed, the entrepreneur will change back and forth along a path of possibilities from the development of an activity by incremental innovation, which is thus less risky, or focusing his choice on disruptive innovation that, even while it may have more associated risk, can bring the greatest benefits. But this is part of that could be called the "entrepreneur dilemma."

Conclusions and Future Directions

The increasing need to minimize risk and validate the relevance of a concept has led the research into new ways to integrate the customer into the development process as early as possible in order to reduce the uncertainty of the business model definition. In recent years, emerging approaches have appeared based on the open-innovation paradigm, for example, the living labs.

Living labs are innovation environments where stakeholders form a partnership of entrepreneurs, users, public agencies, and research organizations. Cooperation is established for creating, prototyping, and using new products and services in real-life environments. Users are not seen as subjects for innovation and customers, but as early stage contributors and innovators (Følstad 2008). The living labs can therefore be seen as user-driven open-innovation environments with the following features:

Users' integration: In a LL approach, users are considered as cocreators and not simply as observed subjects. In practice, the goal is to increase the degree of user involvement during the product development process. The difficult aspect in this approach is to make users express their preferences consciously.

Interdisciplinary (between partners and users): According to the open-innovation principle, the interdisciplinary approach helps to increase creativity. The interdisciplinary approach allows specifications to be formulated so as to create and develop a product better suited to users' needs.

Experimentation in a real-life context: Taking into account the context for use can have a significant influence on the product's use. The experimentation step is essential for evaluating the potential acceptance/adoption of the product (good, service, application, etc.).

Almirall et al. (2009) defined the implications of involving users as codevelopers under the living lab model for entrepreneurship and more precisely for business concept definition as:

- A reduction in personal entrepreneurial risk
- Support for entrepreneurship through selecting, coordinating, and funding assistance for the innovation network
- The creation of an innovation arena where experimentation can take place
- Fostering an initial demand allowing further development

Indeed, innovation is gradually being perceived, from a systemic viewpoint, as the result of increasingly large groups that were represented first as teams and, later, as networks and communities, leading to an understanding of innovation as an emerging open process based on collaboration and discussion.

Cross-References

▶ Creative Management
▶ Entrepreneur
▶ Entrepreneurial Opportunities
▶ Environmental Determinants of Entrepreneurship
▶ Ideas and Ideation
▶ Risk, Uncertainty, and Business Creation

References

Almirall E, Wareham J. The entrepreneurial role of living labs in closing the gap between research and innovation. eChallenges 2009, October 21–23, 2009. Istanbul, Turkey; 2009.

Ben RH, Boly V, Morel-Guimaraes L. Attractive quality for requirement assessment during the front-end of innovation. TQM J. 2011;23(2):216–34.

Bhave MP. A process model of entrepreneurial venture creation. J Business Venturing. 1994;9:223–42.
Brinckmann J, Grichnik D, Kapsa D. Should entrepreneurs plan or just storm the castle? A meta-analysis on contextual factors impacting the business planning–performance relationship in small firms. J Business Venturing. 2010;25:24–40.
Følstad A. Living labs for innovation and development of information and communication technology: a literature review. eJOV-Vol.10. Electronic J Virtual Org Networks. 2008;10:99–131. ISSN: 1442–9331, www.ejov.org.
Lumpkin G, Hills G, Shrader R. Opportunity recognition. In: Welsch HP, editor. Entrepreneurship the way ahead. New York: Routledge; 2004. p. 73–90.
Minniti M, Bygrave W. A dynamic model of entrepreneurial learning. Entrepreneurship Theory Practice. 2001;25:5–16.
Parker S. Learning about the unknown: how fast do entrepreneurs adjust their beliefs? J Business Venturing. 2006;21:1–26.
Perroux F. Les trois analyses de l'évolution et la recherche d'une dynamique totale chez Joseph Schumpeter. Editions Economie Appliquée; 1951.
Schumpeter J. The theory of economic development. Cambridge: Harvard University Press; 1934.
Smith H. Your product development process demands on going improvement, Research Technology Management, IRI Press, March–April: 1996. p. 37–44.

Product Innovation, Process Innovation

John E. Spillan
School of Business, University of North Carolina At Pembroke, Pembroke, NC, USA

Synonyms

Addition; Alteration; Departure; Modification; Newness; Variation

Definition

General innovation – It is a process that takes an idea or invention and converts it into a product or service that the general public purchase or possess. Innovation(s) are replicable, have economic costs, and satisfy a need. As related to business, innovation is the application of an idea, which reduces the gap between needs of customer and the performance of the company.

(Source: Business dictionary.com http://www.businessdictionary.com/definition/innovation.html).

Specific Definition of Innovative Organization – It relates to new approaches to work and how work is organized, how workflows operate to enhance customers and employee performance, employee retention, and increase in employee knowledge (Kustoff 2008). Organizational innovation requires a culture that supports new ideas, processes, and new ways of doing business. Organizational innovation values knowledge acquisition and learning. As such, continuous learning is necessary for organizational innovation to succeed. Organizational knowledge should focus on change, better processes, better business outcomes, higher customer satisfaction, and increased sales revenue (Kustoff 2008).

Organizational Innovation

As goes innovation so goes a company's competitiveness, sustainability, and a society's economic growth. Growth and sustainability are dependent on continuous innovation. Change and globalization have forced companies to innovate, change, or go out of business. While some believe this state of affairs is disastrous for a company, for people, and for the survival of society as a whole, it is also thought that this process of change and innovation catalyzed by globalization is crucial to our long-term wellbeing and sustainability. As difficult economic times continue to challenge every manager in every part of the world, innovation becomes the one element of hope for the future sustainability of economic development. Unfortunately, many executives indicate that they have not had the extra cash to invest in business innovation and development. Additionally, the pace of change and globalization has been so fast and intense that executives have not had time to really think through how innovation would allow them to compete more efficiently and effectively. So businesses are in a squeeze. They must innovate, but it is necessary to have the correct financial situation and competitive situation to innovate properly. So what direction do companies pursue? Well, Joseph Schumpeter would tell them to continue thinking, continue to find ways to innovate because in the long run, the concept of "creative destruction" will eventually take care of their business and their competitiveness. Everything will change and new products and processes will emerge whether one company likes it or not. Creative destruction is the driving force for innovation and it is and will continue to affect all people and all organizations whether they like it or not (Reisman 2004; Diamond 2007; Beaugrand 2004).

Industry context, strategy preferences, and technological capacities many times determine the innovative direction of an organization. In some cases, organizational structures can hinder the innovative process by relying on history, strategy, and operational design (Bishop, 2008). Since it is almost impossible to achieve any level of innovation without the proper organization, it is imperative that managers find ways of constructing organizational structures that bypass these obstacles in order to promote innovation of products and processes. Using innovative resources to produce these products and services is absolutely essential (Lam 2004). This means that to achieve organizational innovation among employees and structures, it is essential that there be a culture that promotes learning and knowledge creation (Singh 2011).

So, for organizations to remain competitive, they must think about organizational innovation. This means that organizations need to consider not just innovating new products and services but also about organizational innovation. Organizational innovation refers to creating business models, management techniques, strategies, and organizational structures that will form the foundation for meeting these competitive challenges of the time. Without organizational innovation, as stated in the above definition, product and service innovation cannot evolve or take place. At the core of business innovation are three organizational constructs:

First, *business model innovation* – this is required in order to focus on different markets for selling goods and services. It may move from a low cost producing company to a value-added company. Thus, it will change the dynamics of the production supply chain and sales management (American Management Association 2006).

Second, *business structure innovation* – to meet strategic goal(s) or focus on new innovations, companies need to change structure(s) to meet these needs. Such innovation can be achieved through merger, acquisition, reorganization, or developing different structures that did not exist in the past (American Management Association 2006). This is an innovative approach where entrepreneurs thrive by exploiting new opportunities.

Finally, *business process innovation* – this is a very popular and common practice among business entities. As new demands occur, new ways of developing and producing products can and do emerge. It focuses on how to produce the product and service versus what is produced or delivered in services. Many times the company can increase productivity and quality through business process innovation (American Management Association 2006).

With this in mind, organizational innovation is a concept that managers and executives have to deal with every day in order to meet the global business competitive demands. So, all organizations, to be successful, must learn how to be a versatile, innovative company that is able to sustain its competitiveness. By developing new processes, creating an innovative culture, and recognizing and rewarding employees who are innovative, managers can achieve a constant and continuous creative system that removes many of the obstacles inhibiting innovation (Singh 2011). As David Neeleman, founder and CEO of Jet Blue, has stated: "Innovation is trying to figure out a way to do something better than its ever been done before" (Singh 2011, p.714).

A central tenet of organizational innovation rests upon the notion of organizational learning. That is the belief that no organization can achieve any innovation of any form unless it promotes organizational learning among its employees. The learning that occurs in the organization offers new knowledge that can be used to develop new business models, new organizational processes, and new business structures. The knowledge sharing provides the key to creating and catalyzing the development of new ideas that lead to different types of innovation (Singh 2011). As the interface of the organizational structure, organizational culture, and organizational learning take place, it can be seen that the development of more elaborate organizational innovation leads to more competitive products and services offered to the global markets (Singh 2011).

Within the context of all innovation, four approaches exist that catalyze any thinking and acting managers or scientists have about moving forward in this area. Innovators must decide whether they will be involved with radical or incremental innovation and whether they will approach the innovative process from a linear or a nonlinear perspective. The two most popular types of innovation can be described as follows:

(a) Radical product, service, or process innovation consists of extraordinary breakthroughs that produce a new or fundamentally altered product, process, or service. Organizations or businesses that achieve success with radical innovation can increase their profits, their prestige, and growth of their organization(s). Specific examples include online shopping, iPad, and cell phones.
(b) Contrarily, incremental innovation improves the existing products, service, or process in such a way that the value of the product, service, or process is significantly enhanced for a period of time. Examples of this include quality management or TQM activities, Six Sigma (Center for Business Innovation 2012).

From another perspective, there are two ways to proceed in initiating and pursuing innovative activity. One way is the traditional linear method of innovation. According to this method, innovation begins with basic research that continues on by adding applied research and development to the results of the first step and then concludes with production and diffusion of the innovative outcomes (Godin 2005). The other way is the nonlinear approach, which means that innovators can take different paths in the innovative process. Generally, this method deviates from the lock-step linear approach. The innovators can pursue different iterations, testing, observations, discovery, and retest. Serendipity is a common element of this approach with a moment of eureka being fantastic for the innovator. The nonlinear path does not require a lock-step method to reach the ultimate conclusion of the process (Creativityland 2011).

The approach taken in the innovative process depends on the philosophy or orientation of the people involved. Moreover, the organization sponsoring the innovation may dictate which method should be used. Either way, the final goal is to produce a better product, a better service, or a better process.

In the final analysis, to innovate is a critical business decision. A company's innovation potential resides in the human resources (talent) it recruits, the organizational culture it creates, and the desire to remain competitive. As such, organizations need to have a clear understanding of what their innovative ambitions really are and what innovation goals they want to accomplish. They also need the funding to pursue its ambitions and a pipeline management approach where not only products are services continuously thought about but acted upon (Nagji and Tuff 2012). Some companies will fail, some will succeed but not having a belief in a desire for or an organizational structure to accommodate innovation will be problematic to any organization, which desires future sustainability. Joseph Schumpeter's "creative destruction" concept is like time and tide; it will wait for no one. Either a company innovates or its existence is in jeopardy and their future will not exist.

Implementation

Thinking about innovation is a relatively simple activity when compared to the execution of the decisions to make innovation happen. The hard work relates to implementing the organizational mechanisms both structurally and culturally that will get results. To effectively employ the innovation process or any innovation project, managers must focus on several important elements:

(a) *Attention to policies and practices* that exist or need to exist companywide to insure that proper training transpires, technology is available, and mechanisms are in place for professionals and staff to access the necessary resources to achieve the innovation goals. If there are too many obstacles in terms of rules and procedures, innovation will be difficult to achieve.

(b) *Attention to the importance* of the innovation and its implementation. If there is an attitude that it is just another ole project with limited importance, then proper implementation will be stifled.

(c) *Participation by managers* – in the implementation process is critical. For managers to stand back and just watch the process will not be appropriate or effective. Managers must take an active role in the innovation process and work associated with implementation of innovation.

(d) *Attention to the financial resources*. Without proper allocation of resources, nothing can be completed and no innovation can really take place. The correct amount of financial resources is also an important consideration in this process.

(e) *Having an organization that is oriented to learning* is absolutely critical. Employees who are enthusiastic about the innovation project and excited about learning will go a long way in helping the implementation process.

(f) *Finally, having patience* – this is one element that seems to be fleeting in many organization's projects. Good things take time to emerge and develop. While time is always of the essence in the innovation business, patience is a critical factor in making sure the innovation project is implemented efficiently and effectively (Klein and Knight 2005).

Conclusions and Future Direction

The way an organization innovates depends on how it is structured. Some are formed to accept incremental change while others are structured to move forward with disruptive change. Being flexible and dynamic in its approaches to innovation is the hallmark of a successful organization. Innovative organizations have to have flexible workflows, adaptable administration, and a dynamic culture. The organization needs to develop different approaches to meet the needs of the context within which it operates (Junarsin 2009). All managers in the contemporary business environment must understand that the pathway to organizational growth and development resides in being innovative. Learning how to manage innovation is critical to a company's success in just about any environment. Mastering this task will pay big dividends in both returns on investment and future competiveness of the organization (Nagji and Tuff 2012). The critical focus of managers should be on making sure that time is spent on efficiently and effectively developing the organization's internal environment and innovative capacities of the entire firm. This investment has large return on investment (ROI) in the future. Being innovative is a growing imperative so now, not tomorrow, is the time for action focused making sure the organization is innovative.

What does the future hold regarding innovation and organizations? Understanding and the preconditions for any innovation to take place is an organization that accepts it as an imperative activity and designs the structure that allows innovation to happen. The following outlines areas of management that will have to be considered for organizational innovation to occur:

(a) New business models that create and capture value within the value chain.

(b) Inexpensive innovation needs to occur where managers have to look for venues for developing innovation in low-income markets that can be transferred to more developed markets (Eagar et al. 2011).
(c) Increasing the speed of innovation in order to reduce the time to market phenomena (Eagar et al. 2011).
(d) Developing appropriate leadership styles that recognize and provide the capabilities to move innovative resources to the right pathways in order to meet complex global market demands.
(e) Development of interorganizational relationships that will create networks for joint ventures that focus on innovative product and service development (Annual Review of Sociology 1999).

Innovation is a timeless exercise, but without it, all organizations lose. There is no time better than the present to begin developing resources and management infrastructures designed to create organizations that are capable of promoting continuous and sustainable innovation(s).

Cross-References

- ▶ Art of Innovation: A Model for Organizational Creativity
- ▶ Business Model
- ▶ Convergent Versus Divergent Thinking
- ▶ Corporate Creativity
- ▶ Corporate Entrepreneurship
- ▶ Creative Collaboration
- ▶ Creative Management
- ▶ Creative Thinking Training
- ▶ Creativity Across Cultures
- ▶ Creativity and Age
- ▶ Creativity and Systems Thinking
- ▶ Digital Economy and Business Creation
- ▶ Entrepreneurial Opportunity
- ▶ Entrepreneurial Organizations
- ▶ Entrepreneur's "Resource Potential," Innovation and Networks
- ▶ Entrepreneurship and Business Growth
- ▶ Entrepreneurship Education
- ▶ Entrepreneurship in Developing Countries
- ▶ Entrepreneurship Policies
- ▶ Imagination
- ▶ Innovation Opportunities and Business Start-Up
- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovations of Direct Democracy
- ▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship
- ▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)
- ▶ Interdisciplinarity and Innovation
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Method for Creating Wisdom from Knowledge
- ▶ Open Innovation and Entrepreneurship
- ▶ Organizational Slack and Innovation
- ▶ Political Leadership and Innovation
- ▶ Schumpeterian Entrepreneur
- ▶ Small Businesses and Sustainable Development
- ▶ Strategic Thinking and Creative Invention
- ▶ University Research and Innovation

References

A. Lam Organizational innovation, BRESE, School of Business and Management Brunel University E-mail: alice.lam@brunel.ac.uk, working paper, No. 1; 2004.

A.M. Diamond Schumpeterian labor economics: The Labor Pains (and Labor Gains) from Creative Destruction Department of Economics University of Nebraska at Omaha Omaha, NE 68182–0048 http://cba.unomaha.edu/faculty/adiamond/web/diahompg.htm. 2007. p. 1–69.

American Management Association. The quest for innovation, a global study of innovation management; 2006–2016. pp. 1–86.

Annual Review of Sociology. Organizational innovation and organizational change.Vol. 25.J. T. Hage Center for Innovation. Palo Alto, California: University of Maryland; 1999. p. 597–622.

Beaugrand P. And Schumpeter said, "This Is How Thou Shalt Grow": The further quest for economic growth in poor countries-IMF Working Paper; 2004. p. 1–22.

Bishop K., Creativity Myths, http://allforcreativity.blogspot.com/2008/06/creativity-myths-by-kal-bishop.html, accessed 10 Sep 2012.

Business dictionary.com http://www.businessdictionary.com/definition/innovation.html, accessed 10 Sep 2012.

Center for Business Innovation, Innovation Defined. http://www.conferenceboard.ca/cbi/innovation.aspx (2012). Accessed, 31 Oct 2012.

Creativityland. http://www.creativityland.ca/2011/non-linear-innovation-map-for-those-who-like-discovery/. 2011. Accessed on 31 Oct 2012.
Godin B. The linear model of innovation: the historical construction of an analytical framework, project on the history and sociology of S&T statistics, Working Paper No. 30; 2005. p. 1–36.
Junarsin E. Managing discontinuous innovation. Int Manage Rev. 2009;5(1):10–8.
Klein KJ, Knight AP. Innovation implementation. Curr Dir Psychol Sci. 2005;14(5):243–6.
Kustoff R. "What is Organizational Innovation?" http://www.selfgrowth.com/articles/What_is_Organizational_Innovation.html. 2008. Accessed 10 Sep 2012.
Nagji B, Tuff G. Managing your innovation portfolio. Harv Bus Rev. 2012;90(5):66–74.
Reisman D. Schumpeter's market enterprise and evolution. Edward Elgar Publishing Limited Cheltenham, UK • Northampton MA, US; 2004. 283 p.
Rick Frederik van Oene E, Boulton C, Roos D and Dekeyser C. The future of innovation management: the next 10 years, Prism. 2011. p. 1–37.
Singh SK. Organizational innovation as competitive advantage during global recession. Indian J Ind Relat. 2011;46(4):714–25.
Van de Ven A, Polley D, Garud S, Venkataraman S. The innovation journey. New York: Oxford University Press; 1999. p. 440.

Productive Local System

▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)

Productive Thinking

▶ Creative Mind: Myths and Facts

Productivity

▶ Four Ps of Creativity and Recent Updates

Productivity and Age

▶ Creativity and Age

Productivity Curve

▶ Creativity and Age

Project Management

▶ Method for Creating Wisdom from Knowledge

Promoting Student Creativity and Inventiveness in Science and Engineering

Robert L. DeHaan
Division of Educational Studies, Emory University, Atlanta, GA, USA

Synonyms

Creative problem solving; Education; Innovation; Teaching creativity

Introduction

In his 2011 State of the Union Address, President Obama captured the essence of recent national blue ribbon panels and the conclusions of many economists: "We need to out-innovate, out-educate, and out-build the rest of the world" he said. But to create a workforce with enhanced critical and creative thinking skills, we need to train experts in science and engineering who can find innovative solutions to problems. Scientists and engineers in the laboratory or field frequently encounter ill-structured problems that can have many solutions and multiple solution paths. To approach such problems, "higher order" mental operations are crucial. These include analysis, synthesis, and abstraction but in addition, creative thinking, which according to Bloom's taxonomy of learning skills is the most complex and abstract of the higher order cognitive skills (Krathwohl 2002). It is creative thinking that allows restructuring of problem parameters and often produces solutions through unexpected insights (DeHaan 2009, 2011).

It is unfortunate that, in the science or engineering classroom, we often teach as if creativity is not important and as if our fields deal only with well-structured problems with known answers and a single way to find the "correct" solution. Not only is no attention paid to creativity, but – with some exceptions such as Eric Mazur's "Peer Instruction," Jo Handelsman's "Scientific Teaching," or Wendy Newstetter's "Problem-driven Learning Labs" – there is little teaching of any of the higher order cognitive skills in most classrooms. For example, Diane Ebert-May and her colleagues found in a national sample of 77 life science courses taught by 50 different instructors that fewer than 1 % of the items on tests and quizzes were judged to require students to use any of these higher level skills. Could this be one reason that Mark Cracolice at University of Montana and his colleagues report that only about one fourth of US college students have the reasoning skills necessary to solve conceptual problems?

The primary question to be addressed here is how undergraduate students can be taught to enhance their higher order thinking skills and especially how to improve the most abstract and complex of these, that is, to think more creatively. There exists an extensive literature promoting instructional strategies to help students be more creative (For reference citations see DeHaan (2009, 2011). But creativity is a complex construct with many components and therefore not easy to define or assess, especially in the context of science. Nonetheless, evidence reviewed by Michael Mumford and colleagues (Scott et al. 2004) demonstrates that the mental operations required for creativity can be taught and that the instructional strategies that work best are relatively simple modifications of those most effective for teaching abstraction and problem solving.

What Is Creativity?

Theoretical Frameworks that Underlie Creativity

Inventiveness or creativity is often seen as a special talent associated with a Mozart, Michelangelo, or Einstein. This is what Kaufman and Beghetto (2008) call big-C creativity, the ability of individuals to generate new ideas that alter an entire intellectual domain. Howard Gardner defined such a creative person as one who "regularly solves problems, fashions products, or defines new questions in a domain in a way that is initially considered novel but that ultimately comes to be accepted in a particular cultural setting" (Gardner 1993, p. 35). Creativity has been defined within two different theoretical frameworks. In one, a novel idea or solution to a problem occurs in the mind of a single individual as a sudden, seemingly unanticipated creative insight or an "aha" experience. In the other, creativity is a social phenomenon that occurs during interactions among knowledgeable individuals. Kevin Dunbar at McGill University has performed ethnographic analysis of interactions of exceptionally productive scientists during their weekly laboratory meetings. These studies reveal that new hypotheses or models are most often generated through discussions among knowledgeable peers. Dunbar reports that when faced with a series of unexpected results, scientists suggest alternative hypotheses or models to test during their lab discussions through "distributed reasoning." This is most effective when the lab group has scientists from diverse backgrounds that have worked with different organisms and a range of different techniques.

But there is another kind of creativity termed mini-C creativity. Mini-C creativity is widespread among all populations and is represented by the "aha" moment when a student first sees two previously disparate concepts or facts in a new relationship, or a worker suddenly has the insight to visualize a new, improved way to accomplish a task. These are both examples of a kind of creative insight; what Arthur Koestler, in the mid-1960s, identified as *bisociation*, "perceiving a situation or event in two habitually incompatible associative contexts." A classic example in science, among numerous personal accounts, is that of Francois Jacob, co-discoverer of the operon. In a recent essay in *Science*, Jacob describes a creative insight that led to the discovery. Referring to the laboratory of Jacob and Monod at one end of a hall in the Institute Pasteur and that of Boris Ephrussi's group at the other, Jacob says: "Much later came a day in 1958 when, my mind wandering on a lazy July evening, I sensed in a flash that there were important analogies between the systems studied at the two ends of our corridor."

More is known about the mental operations required to produce a creative insight or "aha" experience in an individual mind than the distributed reasoning mechanisms that underlie social creativity. Mark Runco reviewed the evidence in 2004 that two kinds of thinking are required to produce an aha experience in an individual: associative (divergent) thinking, in which thoughts are defocused, intuitive, and receptive to a broad range of associations to a given stimulus, and analytical (convergent) thinking, which provides the capacity to analyze, synthesize, and focus. Efforts to systematically define divergent thinking, which was initially thought to be the main creative element, go back to the 1950s when J. P. Guilford and E. P. Torrance recognized that underlying the construct of creativity were other cognitive variables. According to these pioneers of the field, component mental constructs included ideational fluency (i.e., number of ideas); novelty or originality of ideas; flexibility of thinking (or the ability to produce different types of ideas), as well as sensitivity to problems or missing elements in a situation; and knowing how to search for multiple solutions by making guesses or establishing hypotheses.

Paul Thagard and T. C. Stewart of the University of Waterloo recently introduced the idea of "neural convolution" as a mechanism for integrating disparate concepts or facts in a new relationship in an associative insight. They note that such creative insights often follow conceptual reorganization or a new, nonobvious restructuring of a problem situation. Neuroscience experiments employing magnetic resonance imaging show that different regions of the brain are activated during associative thinking than during analytical problem solving. This is shown when subjects are given remote association problems to solve by associative thinking while lying in a functional magnetic resonance imaging scanner (e.g., find a word that forms a compound word or phrase with each of the following three words: sauce, crab, pine; solution: apple). In this circumstance, brain regions such as the right superior temporal gyrus are more strongly activated than in similar subjects who are given problems to solve by analytical reasoning (Subramaniam et al. 2009). According to Pamela Ansburg and Katherine Hill of Metropolitan State College in Denver, Colorado, associative thinking increases the probability of accessing ideas that are weakly associated with a stimulus, whereas analytical thinking increases the probability that only strongly associated ideas will be accessed from memory.

M. H. Kim and colleagues at Sungkyunkwan University in Korea published a 2007 review of cognitive studies of architects and industrial designers. Their study summarizes the evidence that experts in these fields use strategies for prolonging associative thinking as a means to increase the creativity of design solutions. When design experts encounter an ill-structured problem, they decompose and rearrange components in different contexts, striving to increase the range of associations they apply. Associative thinking is seen as an essential component of creative insight, underlying the argument that science and engineering students, no less than design students, need assistance in enhancing and prolonging associative thinking when dealing with ill-structured scientific problems.

There are numerous strategies meant to achieve this goal. One might be a modification of brainstorming, a technique invented by the advertising executive Alex F. Osborn, that has been shown in modified form to be hugely successful in stimulating inventiveness. In a convincing 2008 *New Yorker* essay, Malcolm Gladwell describes such work by Nathan Myhrvold, the creator of Microsoft's Research Division. Myhrvold has routinely gathered groups of engineers and scientists around a table for daylong sessions to brainstorm about a prearranged topic, say self-assembly or medical imaging. In the previous weeks, participants will have reviewed the relevant scientific literature and recent patent filings in order to be abreast of the latest information on the topic in their area of expertise. The meetings begin as simple conversations, with few ground rules, but at the end, the group will have produced many patentable ideas. Does the method work? Since it was founded in 2000, Myrhvold's firm, Intellectual Ventures, has filed hundreds of patent applications in more than 30 technology areas, applying the "invention session" strategy. Currently, the company ranks among the top 50 worldwide in number of patent applications filed annually.

The main point from all of these works is that creativity is not a mysterious hard-to-measure property or act. While the relationship between creativity in social groups and individuals remains to be explicated, there is ample evidence that a creative insight requires both divergent and convergent thinking and that it can be explained by reference to other well-understood mental skills such as pattern recognition, model building, ideational fluency, analogical thinking, and exploration and testing of alternatives.

Relationship Between Creativity and Expertise

Creative abilities increase in children up to the age of about 8 years and then steadily decrease with further schooling. Most youngsters become increasingly sensitive to the opinions of their peers and adults after age eight, care more about "fitting in," and become conscious of using objects for their intended use rather than for more whimsical purposes. The result is a decline of creativity that usually continues through college. This situation raises a number of interesting questions:

- Are expertise and creativity mutually exclusive?
- Does the very education that gives a prospective scientist or engineer the expertise required to solve difficult problems decrease the likelihood that he or she will be able to invent creative solutions to those problems?
- Are there instructional strategies for teaching complex, content-laden subjects such as science and mathematics that can enhance inventiveness and creativity instead of dampening these abilities?

An extensive literature suggests answers to those questions. It is clear that experts can be creative. Although traditional teaching methods that rely heavily on lectures and rote memorization may dampen creativity, instructional methods that enhance inventive problem solving have been tested successfully. Teaching students to be innovative demands instruction that promotes creativity but does more than that. A large body of research on the differences between novice and expert cognition indicates that creative thinking arises from a certain level of expertise and fluency within a knowledge domain. Ill-structured problems that arise in the real world can be solved best by individuals who know enough about a field to grasp meaningful patterns of information, who can readily retrieve relevant knowledge from memory, and who can apply such knowledge effectively to novel problems. These individuals exhibit what is referred to as *adaptive expertise*. Adaptive experts are able to learn through problem solving as opposed to simply applying knowledge and familiar heuristics to problems. Instead of applying already mastered procedures, adaptive experts are able to draw on their knowledge to build new models and invent new strategies for solving unique or novel problems within a knowledge domain (Nersessian 2010). They are also able, ideally, to transfer conceptual frameworks and schemata from one domain to another. Such flexible, innovative application of knowledge is what results in inventive or creative solutions.

What Is Known About How to Teach Creativity

Promoting Creativity in the Science and Engineering Classroom

Following the Myrhvold model, imagine a classroom in which the instructor takes the role of facilitator in a monthly "invention session."

For this meeting, the topic might be biofuels from algae or nanoparticles as semiconductors. Members of each team of four to five students will have primed themselves on the topic by reading selected articles from accessible sources such as *Science*, *Nature*, and *Scientific American* and searching the worldwide web, triangulating for up-to-date, accurate background information. Each team knows that their first goal is to define a set of problems or limitations to overcome within the topic and to begin to think of possible solutions. The instructor might spark the discussion by asking one of the teams to describe a problem within this topic in need of solution. Although a classroom invention session may seem fanciful as a means of teaching students to think about science as something other than a body of facts and terms to memorize, engaging learners in the excitement of problem solving, helping them discover the value of evidence-based reasoning and critical thinking skills, and teaching them to become innovative as problem solvers have long been the goals of science and engineering education reformers (Handelsman et al. 2007; Felder and Brent 2009). But the means to achieve these goals, especially methods to promote creative thinking or scientific problem solving, have not become widely known or used.

An important part of solving the problem of how to teach creativity is devising conditions to foster such a mental state. On the website of the Center for Development and Learning, Robert Sternberg and Wendy M. Williams offer 24 "tips" for teachers wishing to promote creativity in their students (www.cdl.org/resource-library/articles/teaching_creativity.php). Among them are the following admonitions:

- Model creativity – students develop creativity when teachers model creative thinking and inventiveness.
- Build self-efficacy – all students have the capacity to create and to experience the joy of having new ideas, but they must be helped to believe in their own capacity to be creative.
- Sprinkle question throughout every lecture – make questioning a part of the daily classroom exchange. It is more important for students to learn what questions to ask and how to ask them than to learn the answers.
- Encourage idea generation – students need to generate their own ideas and solutions in an environment free of criticism.
- Cross-fertilize ideas – avoid teaching in subject-area boxes, a math box, a science box, etc.; students' creative ideas and insights often result from learning to integrate material across subject areas.
- Imagine other viewpoints – students broaden their perspectives by learning to reflect upon ideas and concepts from different points of view.

Strategies like these have been grouped under the term "scientific teaching," a highly successful pedagogical approach designed to reduce rote memorization and to promote active learning on the part of the student (Handelsman et al. 2007; Ruiz-Primo et al. 2011). But even in those courses where active learning instruction has been employed, the emphasis has generally been limited to analysis, synthesis, and critical reasoning, the higher order cognitive skills that are less abstract than creative thinking on Bloom's scale (Krathwohl 2002). We expect science and engineering students to solve problems, but we rarely ask them to search for novel problem solutions through the extended exercise of associative thought. Students need to be reminded that there may be other ways to view a problem than the way it is presented; to list the problem features and then try to rearrange or restructure them, or look at them from different angles; and to generate many ideas about possible solutions before beginning to evaluate which of them may be best.

Do these strategies work to enhance creative thinking? A meta-analysis of 70 creativity training studies revealed that the number and diversity of associations could be increased by teaching students techniques to increase associative thinking (Scott et al. 2004). Below are some specific strategies from a prior publication (DeHaan 2011) that are thought to increase students' access to creative insights. With practice, each strategy should take no more than 4 min when inserted into a standard 50-min lecture.

- *Think-Pair-Share-Create*: This variation of the classic think-pair-share strategy is especially useful for fostering associative thinking in ill-structured problem solving. Part way into a lecture, the instructor poses an open-ended question or problem, gives students 1 min to think individually about an answer, asks them to pair up with a neighbor to briefly discuss and reconcile their responses, and finally, reminds students to list the features of the problem, try to restructure or reframe their ideas, and to think of as many solutions as they can. The instructor then calls on several individuals or pairs (not volunteers) to share their responses. This exercise can also serve as preparation for a design-based project to be carried out later in a laboratory setting.

- *Peer Instruction*: As modified from the work of Eric Mazur, the instructor poses a question and asks students first to find as many answers as possible on their own, again by feature listing and reframing. They then attempt to justify their best answer to one or more of their peers, and finally they record a consensus response.
- *Think-Aloud-Pair-Problem Solving*: Retrieving information from memory (self-testing) is known to be a better learning strategy for students than restudying the same information. In this maneuver, modified to promote associative thinking, the instructor poses a problem from previous readings for the class and has the students form pairs with one member serving as the *explainer* and the other as the *questioner*. The explainers are given 2 min to recombine from memory components of the original problem into a new configuration with a different solution, while the questioner asks for clarifications or gives hints when necessary. The instructor repeats this with a different problem at another point in the lecture with the students in reversed roles. The process is stopped after the allotted time, and several explainers are asked to report their new solutions.

Conclusion and Future Directions

If this entry achieves its goal, it will stimulate new research on both the role associative thinking plays in science and engineering, as well as in creativity in these fields. Studies are needed especially to test the hypothesis that teaching students to increase their associative thinking will increase the originality and novelty of the solutions they pose to ill-structured problems. A small but growing number of science and engineering instructors are already engaged in active learning pedagogies aimed at improving students' scientific concept formation (Nersessian 2010) and reasoning skills (Felder and Brent 2009; Ruiz-Primo et al. 2011). They and their more reluctant colleagues deserve encouragement to try some of the strategies described above. If the result is that more of our students learn to think like creative scientists and engineers, it will be well worth the effort.

Cross-References

► Brainstorming and Invention
► Cognition of Creativity
► Convergent Versus Divergent Thinking
► Creative Collaboration
► Creative Pedagogy
► Creative Thinking Training
► Creativity Definitions, Approaches
► Creativity from Design and Innovation Perspectives
► Creativity Tests
► Creativity Training in Design Education
► Creativity, Experiential Theories
► Divergent Thinking
► Fostering Creativity Through Science Education
► Higher Education and Innovation
► Psychology of Creativity
► Scientific Creativity as Combinatorial Process

References

DeHaan RL. Teaching creativity and inventive problem solving in science. CBE Life Sci Educ. 2009;8(3): 172–81 (http://www.lifescied.org/cgi/reprint/8/3/172).

DeHaan RL. Teaching creative science thinking. Science. 2011;234:1499–500.

Felder RM, Brent R. Active learning: an introduction. ASQ High Educ Brief. 2009;2(4):1–5.
Gardner H. Creating minds: an anatomy of creativity seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Ghandi. New York: Harper Collins; 1993.
Handelsman J, Miller S, Pfund C. Scientific teaching. New York: Freeman; 2007.
Kaufman JC, Beghetto RA. Exploring mini-C: creativity across cultures. In: DeHaan RL, Narayan KMV, editors. Education for innovation: implications for India, China and America. Rotterdam: Sense; 2008. p. 165–80.
Krathwohl DR. A revision of Bloom's taxonomy: an overview. Theory Pract. 2002;41(4):212–8.
Nersessian NJ. Creating scientific concepts. Cambridge, MA: Bradford Books; 2010.
Ruiz-Primo MA, Briggs D, Iverson H, Talbot R, Shepard LA. Impact of undergraduate science course innovations on learning. Science. 2011;331:1269–70 (11 Mar 2011).
Scott G, Leritz LE, Mumford MD. The effectiveness of creativity training: a quantitative review. Creativity Res J. 2004;16:361–88.
Subramaniam K, Kounios J, Parrish TB, Jung-Beeman M. A brain mechanism for facilitation of insight by positive affect. J Cogn Neurosci. 2009;21(3):415–32.

Prospection

▶ Imagination

Protest Movements

▶ Antitechnology Movements: Technological Versus Social Innovation

Proximity

▶ Microfirms

Proximity Relations

▶ Innovation Systems and Entrepreneurship

Proximity Relationships and Entrepreneurship

André Torre
AgroParistech, UMR SAD-APT, Paris, France

Introduction

Proximity Relations at the Heart of Firms' Strategies

In the present days of clusters, localized production systems, districts, or technopoles, it is not surprising that the question of proximities is raised with force in the analysis of firms' strategies and the relations they form with their partners, competitors, and more generally with the economic and social environments in which they conduct their everyday activities. Moreover, this aspect has not escaped the makers of economic, industrial, or innovation policies, who unceasingly plead in favor of structures in which economic activities are concentrated, whether they be competitive clusters in France, industrial districts in Italy, technopoles and science parks in Britain and Japan, or the different types of clusters that exist all over the world (OECD 2001).

The studies devoted to the analysis of proximity relations are based on research situated at the

André Torre is research director at INRA (National Institute of Agronomical Researches) and AgroParisTech in Paris. He is past President of the French-speaking section of ERSA, director of the PSDR (For and About Regional development) research programs, and head of the "Proximity team" in Paris. André Torre has published more than 100 articles and 11 books, mostly on issues related to space and coordination between people or groups of people, on the topics of proximity, innovation, and regional development. Its research was for a long time at the crossroads of spatial and industrial economics; it has in recent years become more multidisciplinary and focused increasingly on questions related to land use planning and sustainable development processes. It currently focuses on the analysis of proximity relations and on their importance in processes of coordination between people, and centers on two main areas: local interactions between innovative firms and, more particularly, the role played by geographical proximity in the transfer of knowledge, land use, and neighborhood conflicts.

intersection of industrial and spatial economics (Torre and Gilly 1999), which found, in the 1990s, that one could not study enterprises and their strategies without taking into account the spatial and geographic dimensions of their activities (see entry "▶ Territory and Entrepreneurship"). This has resulted in a large number of studies – some of which are presented below – all of which refuse to dissociate the economic from the geographical aspects and all of which take into account various dimensions of proximity relations. The relational or organizational dimension is combined to the spatial dimension of proximity – which is the most obvious. One may feel close to people located great distances away, and this is true of work and personal relations.

The analysis of proximity relations has subsequently been extended to many other fields, such as that of environmental questions and of urban or transport policies, for example. But the industrial and productive dominance has remained strong, and there has been a marked interest in issues related to innovation and knowledge-based economy. Thus, a large part of the research on the different types of proximity is devoted to two topics related, primarily, to questions of entrepreneurship (see entry "▶ Entrepreneur"), with the idea that a firm must take into account, in its strategies, the two categories of proximity relations. Thus, some studies focus on analyzing interfirm relationships, approached from the perspective of local or long-distance collaboration and of firms' ties with their local environment. Many other research studies have examined innovation questions related to innovative firms and their productive and scientific environments or to firms that wish to acquire or transfer technologies or knowledge (see entry "▶ Innovation and Entrepreneurship").

Definitions

The following definitions of the proximity-based approach are based on a division according to two main dimensions – spatial and nonspatial – which include more refined and detailed categories (Torre and Rallet 2005).

Geographical Proximity

Geographical proximity is above all about distance. In its simplest definition, it is the number of meters or kilometers that separates two entities. But it is also relative in terms of the morphological characteristics of the spaces in which activities take place, of the availability of transport infrastructure, and of the financial resources of the individuals who use these transport infrastructures.

Geographical proximity is neutral in essence, but it can be activated or mobilized by the actions of economic and social actors, in our case, firms, labs, or institutions. Depending on their strategies or strategic choices or according to their perceptions of their environment, the behaviors and attitudes of these actors vary, and they mobilize geographical proximity differently. More precisely, actors might seek to get closer to or further away from certain people or places, or they might feel satisfied or dissatisfied with the geographical proximity of certain people, places, or technical objects. Geographical proximity can be enhanced in the context of an urban area by the creation of localized innovation clusters (see entry "▶ Clusters"), for example, or by the development of local networks of producers, exchanging knowledge and information through face-to-face contacts.

Organized Proximity

Organized proximity too is a potential that can be activated or mobilized. It refers to the different ways of being close to other actors, regardless of the degree of geographical proximity between individuals, the qualifier "organized" referring to the arranged nature of human activities (and not to the fact that one may belong to any organization in particular). Organized proximity rests on two main logics, which do not necessarily contradict each other and which are called the "*logic of belonging*" and the *"logic of similarity."*

The logic of belonging refers to the fact that two or several actors belong to the same relationship graph or even to the same social network whether their relation is direct or intermediated. It can depend on the sector they are operating on; in this case, they share common creative or innovation capital. It can be measured in terms of degrees of connectivity, reflecting more or less high degrees of organized proximity and therefore a more or less great potential of interaction or common action. Cooperation will, a priori, develop more easily between researchers and engineers who belong to the same firm, the same technological consortium, or innovation network (see entry "► Network and Entrepreneurship").

The logic of similarity corresponds to a mental adherence to common categories; it manifests itself in small cognitive distances between some individuals. They can be people who are connected to one another through common projects, or share the same cultural, religious (etc.) values or symbols. Social norms and common languages partake of this organized proximity. It can also, however, correspond to a bond that sometimes emerges between individuals without them having had to talk in order to get to know one another. It facilitates the interactions between people who did not know one another before but share similar references. Engineers who belong to the same scientific community will easily cooperate because they share, not only the same language, but also the same system of interpretation of texts, results.

Temporary Geographical Proximity

Temporary geographical proximity (TGP) constitutes one form of geographical proximity that enables actors to temporarily interact face-to-face with one another, whether these actors are individuals or organizations such as firms or laboratories, for example. It corresponds to the possibility of satisfying needs for face-to-face contact between actors by traveling to different locations. This traveling generates opportunities for moments of geographical proximity, which vary in duration, but which are always limited in time. TGP is limited to certain times; this form of geographical proximity should not be mistaken for a permanent co-location of firms or laboratories.

The development of communication technologies and ICT nowadays facilitates long-distance exchange. A large part of the information and knowledge that are necessary for production or innovation activities can be transferred from a distance, through telephone or Internet-mediated exchanges, for example. Consequently, co-location no longer constitutes an absolute necessity. However, times of face-to-face interaction are necessary and beneficial in this context. Face-to-face interaction cannot altogether be eliminated, including in the case of communities of practice, for example (see Torre 2008). As a consequence, ICT cannot be considered as substitutes for face-to-face relations: Both are useful tools to support or enhance the interaction between two or several individuals. Space matters but in a new way: one that consists of temporary face-to-face contact between two or several individuals.

Theoretical Origins and Debates Regarding the Concept

The first research studies on proximity were conducted in the early 1990s and led to the creation of the so-called Proximity Dynamics group in 1991 and later to the publication in 1993 of a special issue of the *Revue d'Economie Régionale et Urbaine*, entitled "Economies of Proximity" (Bellet et al. 1993). In that special issue, which was written entirely by researchers of this movement and which subsequently resulted in the creation of what is now commonly called the "French School of Proximity," were published various articles, all of which presented the concept and approached in different ways questions pertaining to production and innovation processes. All the articles are devoted to production-related questions and place emphasis on the geographical component of these relations. This journal's special issue advocates the integration of the spatial dimension in the analysis of industrial relations and provides a first interpretation of proximity relations. It introduces two types of proximity, called "geographical proximity" and "organizational proximity," respectively; at the intersection of both categories, one finds the so-called territorial proximity: a notion which deals with the complex interplay between productive relations and spatial relations and their being inextricably linked.

The following publication by the group of a multiauthored book (Rallet and Torre 1995) shows that the authors, most of whom are either industrial economists interested in spatial questions or spatial economists interested in industrial issues, all prove to be passionate about the topic of productive relations, and their development at the level of territories, and have a particular interest in approaches to innovation. Their analysis did not develop out of nothing, nor without any theoretical bases. These authors inherited analyses carried out from a territorial perspective, on questions pertaining to localized production systems, and more particularly of industrial districts and innovative milieus (see entry "▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)"). They are the followers of a relatively heterodox tradition and reject both the idea that the economy is only dependent on commercial relations and that of a separation of the productive dimensions – mostly studied by economists – from the more spatial dimensions, which are generally examined by geographers. Thus, the approach is meant to be multidisciplinary, even though it emerged from economic analyses.

Standard economics has not paid much attention to the questions of proximity and has seldom used the term. Indeed, it generally prefers approaches in terms of distance or location: Space is, at best, treated as data, the effects of which on economic activities and therefore firms must be taken into account. The models are characterized by a tension between interfirm competition – which forces them to go further away in order to obtain selling space for their products – and their search for advantages drawn from location close to clients or to competitors. The benefits of proximity, much praised, are seldom explained and are to a large extent mistaken for the very process of spatial agglomeration, to which proximity can contribute without necessarily being associated to it. Even the New Economic Geography, which is a relatively recent movement, has not shown any interest in the question.

But other studies have attempted to open the "black box" of proximity relations. Whereas the standard approaches consider proximity relations as causative variables, without their content being ever considered, other works have tried to understand proximity relations by attempting to highlight their significance as well as their different contents. This movement has been largely inspired by the highly influential district, milieu, and SPL approaches, which have opened the way to un-self-conscious research on "the local." The authors in this research movement have placed emphasis on the relations between firms and on the networks that develop, mostly at local level. They have highlighted the systematic nature and the importance of these systems' structures and modes of organization. They also showed that industrial districts are not the result of a concentration of firms initially attracted by favorable factors, such as primary resources for instance. Rather, they are built upon an organizational settlement in the territory which makes the "disengagement" from relations to an area or a local system difficult for producers, given the presence of local skills and trained workers.

A second track of research into the origins of the externalities of proximity resides in the approaches that emphasize the horizontal links within localized production areas. The traditional analysis of external economies is challenged here because the frontier of the firm fades in favor of the organization into networks, like that found in the emblematic case of the Silicon Valley (Saxenian 1994). Beyond the characteristics purely linked to the specificity of the technologies in question, three main dimensions are at the origin of the competitiveness of these industrial systems: (a) the existence of local institutions guaranteeing the circulation of a local culture, (b) the specificity of the firm's internal organization, and (c) the presence of a particular industrial structure based on the existence of recurrent contacts between local actors.

The third track of analysis is found in the so-called geography of innovation (Feldman 1994) which emphasizes the process of spatial concentration of innovative activities, be there within regions or smaller geographical areas, and directly introduces the notion of proximity into the analysis. Innovation is concentrated essentially in a few zones in which one can find not only units of production but also public research laboratories or universities (see entries "▶ Invention and innovation as creative problem-solving activities" and "▶ University Research and Innovation"). This empirical evidence reintroduces the idea of the importance of the relations of proximity in the generation of the new technologies. Moreover, the link between this movement and that of the spatial concentration of industrial activities is made: Firms' choice of location can be explained by their need to develop relationships not only with other firms (interfirm relations) but also with science (science-industry relations).

The group has also inherited a great deal from the research conducted on industrial economics, on value chains and industrial groups, or on the microeconomics of imperfect competition and firms' strategies. But it is also largely indebted to evolutionist and institutionalist approaches. The role of institutions is always emphasized, and industrial relations are presented as forces driving the processes of change and of transformation of economies, which mostly rest on innovations and technological changes. Similarly, the research on proximity moves, from the start, beyond methodological individualism by repositioning the individual or the firm within a network of social or economic relations. The firm is never considered as an isolated entity, but it is always regarded as being part of groups of actions, local systems, or long-distance networks.

Applied Studies and Theoretical Advances

On the basis of these principles, a large series of applied studies were conducted, focusing primarily on industrial firms and their relations or on technological interactions, and these applied studies have rested on a proximity-based approach. They have mostly examined the case of France and have focused essentially on productive systems such as the Toulouse, Grenoble, or Marseilles "technopoles" or on organizational structures such as innovation networks or cooperatives for instance. They reveal that the formation of relations between firms located in the same areas is not exclusively related to their geographical proximity. Social ties, interfirm relations, trust, networks of actors, friendships, and successful collaborations all contribute to forming a web locally: a web which matters at least as much as co-location. In light of this network, one clearly understands the factors of what can be called the firms' "ties to their territory." Each tie is fragile and must be nurtured and stands as a veritable resource for firms, which hesitate all the more to move to different locations as the web they have woven with other local actors is strong.

Nevertheless, the development of the research on proximity, which continues to give rise to collective publications that provide provisional assessments of the analysis and of its progress (see, e.g., Torre and Gilly 1999, or Pecqueur and Zimmerman 2004), has quickly led to an in-depth debate on the different forms of proximity. Besides the authors who argue that there are two main types of proximity, called geographical and organized (or organizational) proximity, respectively – as seen above – there is a variant school of thought that considers that the political and institutional dimensions play such a central part that it is necessary to posit the existence of a third category: institutional proximity. The latter is defined as the actors' adherence to a space that is defined by common rules of action, representations, and thought patterns (Kirat and Lung 1999). The authors of this school reckon that the political dimension, the importance of the legal component, of the rules that govern the social and economic relations justify the creation of this category, all the more so as organized proximity is thought to be essentially cognitive in nature. As for the defenders of the first approach, they consider that these dimensions are encapsulated within the logic of similarity.

With the rising popularity of the research on proximity, new, non-French-speaking researchers have, since the 2000s, joined the debate and have contributed new directions and taken into account new concerns. One of the most remarkable contributions has resulted in an increase in the number of proximity categories, which the founding fathers had preferred to limit for the sake of analytical coherence, but which has exploded in order to take into account the different facets of proximity and reveal their extraordinary malleability as tools of reflection. Five types of proximity are nowadays often described: They are called cognitive proximity (common knowledge bases and competences), organizational proximity (the extent to which relations are shared in an organizational arrangement), social proximity (the embeddedness of the trust relations based on friendship, family ties, and experience), institutional proximity (adherence of the economic actors to common rules, such as structures, laws, political rules, and common values), and geographical proximity (Boschma 2005).

Simultaneously, as a result of the emergence of new societal concerns and of the arrival in the group of sociologists, geographers, and land planning experts, there has been an extension of the topics and themes addressed. This extension has taken several directions consisting, for example, in taking into account issues related to the environment, land planning, transport, urban or rural planning, or of a question of particular interest to us: the importance of new information and communication technologies in the relations between firms located in proximity to or far from one another. It has also sounded the knell of the eulogistic way of looking at proximity. The negative dimensions of the various types of proximity are now highlighted, particularly those of geographical proximity, which appears not only to generate land use conflicts in situations where space is scarce but also to be conducive to problems in terms of relations between innovative firms, for example: Indeed, a classic finding is that geographical proximity facilitates industrial espionage and therefore the unwanted appropriation of knowledge by firms' rivals, and also that production systems that give priority to internal relations at the expense of external relationships may find themselves in negative development trajectories.

Many research studies have been conducted, particularly in European countries, on the basis of the proximity-based approaches, and often by using field data and the econometric tools. They often begin with the analysis of one particular sector – software or aeronautics, for example – with a marked interest in knowledge-intensive industries or technological innovation sectors. They seek to test the importance of the different types of proximity in firms' performance and often confirm that geographical proximity cannot alone ensure high performance, nor does it in itself facilitate the exchange or interactive creation of knowledge. Thus, it is the nonspatial dimensions of proximity that now have the place of honor, and more particularly their role in the creation of networks of economic actors, located either in proximity to or far from one another: Indeed, these networks rest mostly on different dimensions – social, relational, cognitive, etc. – which do, indeed, correspond to the components of the different types of proximity (Boschma and Frenken 2010).

Conclusion and Future Directions

The most recent development of the analysis of proximity relations, dating from the second half of the 2000s (Torre 2008), has been the publication of research studies on the temporary dimensions of proximity and particularly of geographical proximity. They have been based on three findings. The first has to do with the increasing number of fairs, trade shows, and conventions, which bring together, in given places and for very short periods of time, people located varying distances away from one another but who nevertheless are able to communicate through ICT. The second finding is related to the increasing mobility of individuals, mobility which concerns private persons but also engineers or business owners or managers. The third and last finding is linked to the analysis of the relations developed by firms that form clusters in specific fields such as that of biotechnologies, for example: Though they reap financial and real estate-related advantages from being located in the same areas as other firms that belong to the same sectors of activity, they often prefer to form relationships with outside firms so as to prevent problems related to the leaking or loss of intellectual property between themselves and rival companies.

This has led some researchers to examine the way in which firms located distances away from one another communicate. One knows that they mostly do so through ICT but also through the inevitable implementation of geographic interfaces: Different cases of communication are examined: long-distance communication, fairs, and conferences, as well as temporary "platforms" of project teams, implemented by large manufacturing groups such as EADS or Renault in order to enable the participants of a project to work together in the same place for short periods of time, participants who will subsequently go back "home" and work together from a distance. As has always been shown since the first research studies on proximity were performed, space and geography do matter, but researchers have moved far beyond the exclusive analysis of clusterized firms, even though these new considerations have considerably enriched it.

References

Bellet M, Colletis G, Lung Y. Économie de proximités. Revue d'Economie Régionale et Urbaine. 1993;3:357–606.

Boschma RA. Proximity and innovation. A critical assessment. Regional Studies. 2005;39(1):61–74.

Boschma R, Frenken K. The spatial evolution of innovation networks: a proximity perspective. In: Boschma R, Martin R, editors. The handbook on evolutionary economic geography. Cheltenham: Edward Elgar; 2010. p. 120–35.

Feldman MP. The geography of innovation. Boston: Kluwer Publishers; 1994. p. 155.

Kirat T, Lung Y. Innovation and proximity. Territories as loci of collective learning processes. European Urban and Regional Studies. 1999;6(1):27–38.

OECD. Innovative clusters, drivers of national innovation systems. Paris: OECD; 2001. p. 420.

Pecqueur B, Zimmerman JB, editors. Economie de Proximités. Paris: Hermès, Lavoisier; 1994.

Rallet A, Torre A. (eds.), 1995, Economie Industrielle - Economie Spatiale, Economica, Paris.

Saxenian AL. Regional advantage: culture and competition in Silicon Valley and route 128. Cambridge, MA: Harvard University Press; 1994. p. 226.

Torre A. On the role played by temporary geographical proximity in knowledge transfer. Regional Studies. 2008;42(6):869–89.

Torre A, Gilly JP. On the analytical dimension of proximity dynamics. Regional Studies. 1999;34(2):169–80.

Torre A, Rallet A. Proximity and localization. Regional Studies. 2005;39(1):47–60.

Psychological Aspects of Entrepreneurial Dynamics

Gerhard Krauss
Faculty of Social Sciences, University of Rennes 2, Rennes, France

Synonyms

Entrepreneurial behavior; Entrepreneurial development; Entrepreneurial personality

Introduction: Basic Concepts and Variables

Both terms "entrepreneurial" and "dynamics" address a non-static perspective, emphasizing the ongoing processes and the driving aggregate forces associated with entrepreneurship. The intervening psychological variables concern the human actors involved in these processes.

On the micro- and intermediate levels, the mentioned concepts refer to entrepreneurs and entrepreneurial interactions, that is, their capacity to act as a motor of move (implying undertaking spirit, initiative, capability of recognizing opportunities, creative imagination, ability of transforming emerging ideas into concrete-projects, etc.). Entrepreneurial actors are often starting up and conducting one or several challenging projects and the related tasks.

On the community and organizational levels, the concepts refer to the enterprise as the formal frame, as well as to the community of the companies contributing together to the collective movement of change. The emergent collective forces generated are the result of the actions of individual entrepreneurs and their companies, which in return influence the entrepreneurial behavior and orientation of individuals and firms.

Entrepreneurial action and the dynamics resulting from it comprise an important psychological component. Its relevance results from the fact that entrepreneurial action is based on interactive activities and that human actors, especially entrepreneurs, cannot be reduced to cold, passionless, emotionless, and rationally calculating actors. On the contrary, it is typical for them to associate their behavior with passions, feelings, emotions, and individual and collective thinking. Human action, in general, and that of entrepreneurs, in particular, is charged with emotions, subjective goals and perceptions. It can be supposed that mental processes, feelings, perceptions, ideas, and ways of thinking and behaving must represent an important aspect of entrepreneurial dynamics.

Psychological variables have a varying influence on entrepreneurship. Many scholars have particularly been interested in the role played by psychology in the early phases of nascent entrepreneurship, where uncertainty is high and the individual entrepreneur is highly involved (eventually assisted by one or more other entrepreneurial persons). Aldrich (1999), in an evolutionary perspective, distinguishes the phases of "conception," "gestation" (nascent entrepreneurs), "infancy" (new firms), and "adolescence" (establishment of the founded firms).

Theoretical Origins and Debates: The Relationship Between Economics and Psychology and its Assimilation by Entrepreneurship Research

The psychology of economic behavior has interested numerous scholars since a long time. An example is the pioneering contribution of Gabriel Tarde in nineteenth-century France who has studied the phenomenon from the point of view of the philosophy of difference (Lazzarato 2002). For Tarde, the concepts of imitation and invention are central which are directly linked to psychological variables (belief and desire). Later on, other famous scholars of the twentieth century known for linking economics and psychology are, for example, James G. March or Herbert Simon. Both were particularly interested in the role that cognitive and psychological variables may play in decision making – an activity which is recognized as central for entrepreneurship.

In the field of entrepreneurship research, there has then emerged a more or less clear and fundamental opposition between two types of schools, which for a long time should mark the development of psychological approaches to entrepreneurship: on the one hand, those who focused on the psychological characteristics of the individual entrepreneur (trait approach), linking entrepreneurship directly to the psychological profile of the entrepreneur, and, on the other, those refuting such an approach, claiming that the entrepreneurial interactive process is central for analysis, independently of any individual characteristics of the entrepreneur.

However, more recently, attempts were made to overcome this opposition and to develop more appropriate and more complex psychology-based explanations by combining the different perspectives. In the following sections, firstly the traditional trait approach perspective will be presented, secondly its critique, and thirdly some of the attempts made to develop more sophisticated and more complex explanation models.

The Trait Approach

The trait approach represents a major psychological perspective applied to entrepreneurship. It has been particularly influent in the 1980s and stimulated a lot of research work during this decade. The starting point is the idea that personal characteristics or "traits" of the people running firms matter and indeed are seen as determinant for the development of these latter. This applies as well as to incumbent as to new firms, but the approach has been used especially for new firms and founders. In this case, in general, attempts were made to explain the success or failure of a start-up company by the psychological profile of its founder(s).

This perspective has important theoretical implications. It includes a rather strange paradox: Whereas the entrepreneur normally is supposed to be a *dynamic* actor, oriented toward innovation and change (economic, technological, institutional, etc.) – which itself logically would require a dynamic theoretical perspective – the conceptualization of this actor in the trait approach in contrast reflects a rather *static* thinking. According to this view, the entrepreneur is supposed to have a fairly stable personality profile, which is innate: either one is an entrepreneur or not. This is seen as a question of psychological character and personality. The basic idea is that an entrepreneur has certain internal characteristics and dispositions which influence or determine his entrepreneurial behavior.

However, it remains an open empirical question if these personality factors are generally dominant, how they interact with situation and context, and what influence these latter have. In addition, the postulate of the relative stability of traits may be questioned: Can traits evolve and change over time? Are they inborn or acquired through socialization and learning? Does "learning by doing" play a role in the domain of entrepreneurship? Do people develop certain entrepreneurial traits thanks to the experience of founding and running a business?

A lot of research has been done in order to identify "who is an entrepreneur" (Gartner 1988) and to study what distinguishes him from non-entrepreneurs. Among the mostly studied attributes figure "need for achievement," "locus of control," or "risk taking," but this short list is not exhaustive; others and less mentioned are, for example, "values" or "age" (Gartner 1988: 11–12). People with high levels of need for achievement are those privileging challenging, but achievable tasks; people with an internal locus of control are those who think being able to determine their destiny themselves (in opposite to people with an external locus of control who feel to be constrained by their external environment); finally, risk taking is generally seen as a typical attribute, but it is also recognized that entrepreneurs are not foolish; their risk taking is rational and calculated. More examples are included in the table presented by Gartner in his article, among which figure "self-discipline and perseverance," "action orientation," "goal orientation," "autonomy," "aggression," "innovative tendencies," "creativity," "desire for money," "tolerance of uncertainty," "tolerance of ambiguity," and so on, quoting only some of the numerous characteristics attributed to the entrepreneur in the literature (Gartner 1988: 16).

The different traits (separately or in combination) were not only used by scholars to differentiate entrepreneurs from non-entrepreneurs, or from managers, but also to compare different types of entrepreneurs, such as "nascent entrepreneurs," "novice entrepreneurs," "habitual entrepreneurs," "serial entrepreneurs," or "portfolio entrepreneurs" (Chell 2008: 9). Different trait approaches can be distinguished. For example, Chell (2008: 84) presents a typology of no less than seven different ways of using trait theories: (1) single trait approach, focusing on one particular trait which is studied; (2) multiple trait approach, studying a combination of traits; (3) personality structure, identifying a coherent system of traits; (4) cognitive traits, focusing on the cognitive dimension of personal characteristics (beliefs, perceptions, cognitive styles); (5) biologically based traits, linking traits to biological differences between people; (6) abnormal traits (e.g., depression, psychopathy, hypochondria, etc.); and (7) psychodynamic theories, insisting on the importance of childhood experiences and the resulting subconscious, firmly implanted, compulsions and anxieties.

Trait theory finally has evolved further, and an emergent consensus is developing around scholars about the necessity to develop more complex models, among others, by recognizing the interrelationship between trait characteristics and situational or more general environmental conditions. In addition, modern trait research is increasingly concerned by a search of and the research on new traits (Chell 2008: 247), alternatively to the dominant classical ones mentioned above (which were need for achievement, internal vs. external locus of control, and risk taking). In her book on the entrepreneurial personality, Elisabeth Chell enumerates several newly emerging traits, among others, for example, “opportunity recognition,” “proactive personality,” “self-efficacy,” “social competence,” and “intuition” (Chell 2008: 247). The emergence of these new traits in the theoretical debate emphasizes not at least the growing importance given to a cognitive view of entrepreneurial action. Studying entrepreneurial cognition may be seen in this context as a promising research strategy that might allow “to bring the entrepreneur back into entrepreneurship” (Krueger 2003: 105) by suggesting that the cognitive infrastructure of entrepreneurs (the way how entrepreneurs think, memorize, and learn to perceive opportunities) differentiates them from other people.

Major Criticism Addressed Toward Trait Research

Trait research developed particularly well since the late 1970s and became rather popular among scholars especially during the 1980s. However, it never formed a very homogenous theoretical school. The field of entrepreneurial trait research was rather heterogenous and dispersed and, in addition, provoked a very critical and conflictual debate among scholars in the second half of the 1980s. The critique of Gartner (1988, 1989) at the end of the 1980s is very instructive in this regard and summarizes the main critiques of that time. One of the arguments presented concerned the difficulty to define the entrepreneur and to identify clearly the traits that would differentiate him from non-entrepreneurs. While Gartner insisted on the impossibility to develop a generic definition, he criticized trait scholars for defying the doubts and attempting to distinguish entrepreneurs from other people by their personality characteristics. Gartner criticized that many different, and often vague, definitions of the entrepreneur were used, many researchers even not taking the effort at all to define the entrepreneur, and that the heterogeneity of the research samples finished by making it completely impossible to distinguish clearly between entrepreneurs and the rest of the population, or between successful and unsuccessful entrepreneurs. A “psychological profile” of the entrepreneur assembled from the different studies, according to Gartner, “would portray someone larger than life, full of contradictions, and, conversely, someone so full of traits that (s)he would have to be a sort of generic ‘Everyman’” (Gartner 1988: 21).

Gartner’s final conclusion was quite radical: He stated that the trait view is inadequate for understanding the entrepreneurial phenomenon. Instead of focusing on the personal and psychological characteristics of the entrepreneur, research should better concentrate on the study of the concrete behavior and activities of entrepreneurs, that is, adopt a process-oriented view (behavioral approach). Gartner illustrated his argument by a comparison with sports. For example, in the case of baseball, “a baseball player is not something one is, it is something one does” (Gartner 1988: 22). What would be important is the baseball *game* and **not** the *player*. In sum, entrepreneurship research should focus on what may be seen as central, which according to Gartner’s interpretation is synonymous with the start-up process, the efforts made by individuals to create organizations, and their outcomes (Gartner et al. 2004).

The general orientation of such criticism at a first glance could appear as a turnabout in the theoretical debate at that time. However, like the classical trait approach, it was based in reality on an artificial isolation of one particular element of entrepreneurship, impeding a full understanding of the phenomenon. In the end, it led to a rather unfruitful opposition between two contrasting perspectives: a trait perspective on the one hand which was strongly criticized and an exclusively behavioral (or process) perspective on the other. While the former put the entrepreneur in the center of its model, the latter, on the contrary, had as a consequence to fade out his potential role in the theory.

Further Developments

In their reaction to Gartner (1988), Carland et al. (1988) argued that it is inappropriate to separate the process of business creation from the characteristics of the founders and entrepreneurs because both aspects are inseparably tied. In a more recent article, Carland and Carland (2000) further criticized the tendency of contemporary economics to favor statistical reasoning and mathematical models, instead of exploratory study, which as a consequence tends to neglect the individual level of entrepreneurship, pushing the entrepreneur out of the explanation model. They suggest on the contrary to pay more attention to the entrepreneur's characteristics and reasoning and to the cognitive process leading to venture creation. This would mean to take into account the individual "entrepreneurial psyche" which may be conceived "as a gestalt of multiple personality factors" (traits, cognitive styles, entrepreneurial drives). Such an argumentation finally may also offer a solution to the problem of differentiating the entrepreneur from non-entrepreneurs, since it does not necessarily imply a dichotomous vision (entrepreneur vs. non-entrepreneur) but allows to interpret the phenomenon as a relative one, which means that it would be compatible with the observation that entrepreneurship can manifest itself in quite heterogenous forms.

While the scientific debate in the 1980 produced an important movement for questioning the common psychological approach of the entrepreneurial personality used at that time, that is, the widespread focus on the psychological traits of the entrepreneur, later research was characterized by attempts to reequilibrate the psychological traits and behavioral perspectives. This meant to bring back the entrepreneur into the theoretical explanations and to develop more complex models which would take into account as well the role of personality as the contextual factors affecting entrepreneurship.

The new trends in research on the psychological aspects of entrepreneurship, after the conflictual debate of the 1980s, went toward the development of more interactionist and cognitive approaches (Chell 2008: 142 ff.). Regarding the different topics studied, Chell (2008: 171) mentions, among others, the cognitive research on heuristics or shortcuts, cognitive scripts, cognitive biases (e.g., illusion of control), overconfidence, errors in decision making, self-efficacy (feeling/perception of personal efficacy), regretful thinking and feelings of disappointment, opportunity recognition and evaluation, and social and cognitive aspects of creativity.

The knowledge developed through this research suggests that if the entrepreneur's psychological dispositions may have some roots in innate traits, the interaction with others, as well as cognitive and social learning processes, plays a decisive role with regard to the construction of the entrepreneurial personality. The scientific field here is rather differentiated, different theoretical schools contributing to the ongoing scientific debate. According to Chell (2008: 204), four major categories of theories can be distinguished: trait theory, social constructionism, social cognitive theory, and social psychological theories.

While trait theory supposes the existence of some, in the middle term, relative stable, behavioral patterns – independently from the question if these are inborn and/or developed throughout primary and secondary socialization (especially during the process of entrepreneurial experience) and more or less independent from situational influences – the other approaches relativize the role attributed to individual, in comparison to contextual and process factors, by linking, in different ways, both dimensions.

The social constructionist approach, for example, is based on the idea that entrepreneurs are not socially isolated individuals. On the contrary, it postulates that the entrepreneurial personality is much a social construction which is permanently created and recreated through social interaction and interpersonal discourse.

Social cognitivist approaches, in comparison, focus especially on the cognitive dimension of entrepreneurial behavior. The consistency of this latter is interpreted as an effect of the cognitive structures in long-term memory (context-specific social knowledge, beliefs, motivations, socially learned behavior, procedural skills, etc.). Again, this perspective tends somewhat to stress the static elements of entrepreneurial behavior and to attribute less attention to its dynamic aspects.

Finally, the fourth category of approaches enumerated by Chell (2008: 204), the social psychological perspective, is different in this respect: Under this theoretical angle, the dynamics resulting from the interaction with the social and institutional environments are conceived as being relatively more important and even central. In this approach, environmental influences are seen to be decisive, especially for the self-development of the entrepreneur.

Recent and current research continues to be interested in the link between personality and entrepreneurship, representing a particular research strategy to approach the psychological aspects of entrepreneurial dynamics. A recent example is the *Journal of Economic Psychology* and its decision to edit a special issue on "Personality and Entrepreneurship" (Journal of Economic Psychology, Vol.33, issue 2, April 2012).

Besides that, the cognitive dimension is still studied by numerous scholars, a rather dynamic research field comprising (and being open to) many different topics (e.g., entrepreneurial cognition, cognitive adaptability, entrepreneurial opportunity recognition and evaluation, entrepreneurial decision making, entrepreneurial intentions, and cognitive motivations).

Finally, another type of research work not mentioned yet, but of certain interest for the topic developed here, concerns the organizational level of entrepreneurship as the aggregate level of individual entrepreneurial behavior. An important indicator for the development of this type of work is the increasing number of research realized during the last years on "entrepreneurial orientation" (firms with entrepreneurial orientation are seen to be characterized by proactiveness, autonomy, innovation, risk taking). While the focus is on organizational issues and firm-level entrepreneurial behavior, it can be easily imagined that the organizational level, being the social arena for human action, is indirectly influenced by the psychological processes initiated on the micro- and intermediate levels of entrepreneurs and entrepreneurial groups.

Conclusion and Future Directions

Psychology plays an important role in entrepreneurial processes, since their basis are *human interactions*. However, it proved to be a challenging task in the past to develop theoretical models allowing to seize appropriately the psychological aspects of entrepreneurship. Important advances in academic knowledge have been realized during the past decades, with different theoretical focus. A very general trend in research seems to be the evolution away from the classical trait models of the 1980s toward more interactionist and/or cognitive approaches. An important point is that this does not necessarily imply questioning the potential role played by personal characteristics of the entrepreneur. On the contrary, current research again is considering the integration of these aspects into the theoretical models.

Cross-References

- ▶ Cognition of Creativity
- ▶ In Search of Cognitive Foundations of Creativity
- ▶ Creative Personality
- ▶ Creativity and Emotion
- ▶ Imagination
- ▶ Individual Determinants of Entrepreneurship
- ▶ Psychology of Creativity
- ▶ Social Psychology of Creativity

References

Aldrich HA. Organizations evolving. London/Thousand Oaks/New Delhi: Sage; 1999.

Carland JA, Carland JW. New venture creation model. J Bus Entrepr. 2000;12(3):29–48.

Carland JW, Hoy F, Carland JA. "Who is an entrepreneur?" Is a question worth asking. Am J Small Bus. 1988;12(4):33–9. Spring.

Chell E. The entrepreneurial personality. A social construction. 2nd ed. Hove (East Sussex)/New York: Routledge; 2008.
Gartner WB. "Who is an entrepreneur?" Is the wrong question. Am J Small Bus. 1988;12(4):10–32. Spring.
Gartner WB. Some suggestions for research on entrepreneurial traits and characteristics. Entrep Theory Pract. 1989;14(1):27–37. Fall.
Gartner WB, Shaver KG, Carter NM, Reynolds PD, editors. Handbook of entrepreneurial dynamics: the process of business creation. Thousand Oaks/London/New Delhi: Sage; 2004.
Krueger NF. The cognitive psychology of entrepreneurship. In: Acs ZJ, Audretsch DB, editors. Handbook of entrepreneurship research. New York: Springer; 2003. p. 105–40.
Lazzarato M. Puissances de l'invention: la psychologie économique de Gabriel Tarde contre l'économie politique. Paris: Les empêcheurs de penser en rond; 2002.

Psychological Determinants

► Individual Determinants of Entrepreneurship

Psychology of Creativity

Liane Gabora
Department of Psychology, University of British Columbia Okanagan Campus, Kelowna, British Columbia, Canada

Synonyms

Creativity research; Empirical aesthetics; Empirical studies of creativity; Empirical studies of the arts

Key Concepts and Definition of Terms

Defining Creativity

Creativity is arguably our most uniquely human trait. It enables us to escape the present, reconstruct the past, and fantasize about the future, to envision something that does not exist and change the world with it. The elusiveness of the construct of creativity makes it that much more important to obtain a satisfactory definition of it. Defining creativity presents difficulties; for example, not all creative works are useful, and not all are aesthetically pleasing, though both usefulness and aesthetic value capture, in some sense, what creativity is about. Nevertheless, psychologists have almost universally converged on the definition originally proposed by Guilford over 60 years ago. Guilford (1950) defined creativity in terms of two criteria: *originality* or novelty, and *appropriateness* or adaptiveness, i.e., relevance to the task at hand. *Surprise* is sometimes added as a third criterion (Boden 1990). Some add *quality* as a separate criterion (Kaufman and Sternberg 2007), while others use the term appropriateness in a way that encompasses quality. Creativity has also been defined as a complex or syndrome, and some would insist that any definition of creativity include such cognitive and personality characteristics as problem sensitivity, flexibility, and the ability to analyze, synthesize, evaluate, and reorganize information, engage in divergent thinking, or deal with complexity. However, it is the "originality and appropriateness" definition that is encountered most often and that appears to have become standard (e.g., Amabile 1996; Feldman et al. 1994; Runco 2004; Sternberg 1988). While this definition provides a much-needed departure point for discussion about and measurement of creativity, there is probably no one-size-fits-all definition of creativity. For scientific or technological enterprises, appropriateness might be more important, whereas in the arts, originality might be weighted more heavily. Thus, creativity must be assessed relative to the constraints and affordances of the task.

The Four P's of Creativity

It is often said that creativity involves four P's: person, process, product, and place. The creative *person* tends to exhibit certain personality traits. Creativity is correlated with independence of judgment, self-confidence, attraction to complexity, aesthetic orientation, risk taking, openness to experience, tolerance of ambiguity, impulsivity, lack of conscientiousness, and high energy. There is some evidence that creative individuals are more prone to anxiety and affective disorders. Creative individuals differ with respect to whether they are internally versus externally oriented, person-oriented or task-oriented, and explorers (who tend to come up with ideas) or developers (who excel at turning vague or incomplete ideas into finished products).

A pioneering effort toward demystifying the creative *process* was Wallas' (1926) classification of the creative process into a series of stages. The first of Wallas' stages is *preparation,* which involves obtaining the background knowledge relevant to the problem, its history (if known), and any instructions or past attempts or preconceptions regarding how to solve it. It also involves conscious, focused work on the problem. The second stage is *incubation* – unconscious processing of the problem that continues while one is engaged in other tasks. The preparation and incubation stages may be interleaved, or incubation may be omitted entirely. Wallas proposed that after sufficient preparation and incubation, the creative process is often marked by a sudden moment of *illumination*, or insight, during which the creator glimpses a solution to the problem, which may have to be worked and reworked in order to make sense. The idea at this point may be ill defined, "half baked," or in a state of *potentiality*; the ability to work with an idea in this state is related to the personality trait of tolerance of ambiguity. Wallas' final phase is referred to as *verification*. This involves not just fine-tuning the work and making certain that it is correct, as the word implies, but putting it in a form that can be understood and appreciated by others.

The creative *product* can take the form of a physical object (e.g., a painting), or behavioral act (e.g., a dance), or an idea, theory, or plan of action.

The last of the four P's of creativity, *place*, concerns the environmental conditions conducive to creativity. Certain individual situations, such as education and training, role models and mentors, and perhaps surprisingly, childhood trauma, are correlated with historical creativity. Economic growth appears to have a stimulating effect on creativity, whereas war appears to have a depressing effect.

Historical Versus Personal Creativity

Although the term "creative" is often reserved for those who are known for their creative output, some make the case that daily life involves thinking things and doing things that, at least in some small way, have never been thought or done before and, thus, that *everyone* is somewhat creative (Beghetto and Kaufman 2007; Runco 2004). Psychologists now distinguish between different kinds and degrees of creativity, such as between historical and personal creativity (Boden 1990). When the creative process results in a product that is new to all of humanity and makes an impact on the course of civilization, it is referred to as *historical creativity* (H-Creativity). Historical creativity is also sometimes referred to as *eminent creativity* because the creator tends to become famous. When the creative process results in a product that is new to the creator, but someone else has come up with it before, or it is not creative enough to exert an impact on human civilization, it is referred to as *personal creativity* (P-Creativity). Although personal creativity does not change the world, it can be a source of pleasure and amusement. Clearly there are shades of gray between these extremes.

A concept that is closely related to personal creativity is *everyday creativity*. Everyday creativity manifests in everyday life; it comes through in how one prepares a meal, decorates a room, or interprets and shares experiences. Everyday creativity generally begins with an innovative, often unconventional approach to life that involves capitalizing on hidden opportunities, undertaking common tasks in uncommon ways, and finding unique solutions to challenges as they arise.

Historical and personal creativity are also sometimes referred to as *Big C creativity* and *Little C creativity*, respectively. Some additionally make the case for *Mini*

C creativity, which involves making novel and personally meaningful interpretations of objects and events, and which can form the basis for more substantial creative acts (Beghetto and Kaufman 2007).

Creativity Versus Discovery and Invention

Creativity is sometimes distinguished from two related concepts, discovery and invention. *Discovery* involves finding something *already present* and sharing it, e.g., Columbus' discovery of America. It is relatively impersonal in the sense that if one person had not discovered it, someone else would have. *Invention* entails unearthing something that was *not present before,* e.g., Alexander Bell's invention of the telephone. Like discover, it is relatively impersonal. Creativity also involves unearthing and sharing something that was not present before. Some psychologists additionally require that for something to qualify as creative, it must be profoundly personal in the sense that one feels the presence of a unique individual in the work, e.g., Leonardo da Vinci's art.

Theoretical Background and Open-Ended Issues

Early Conceptions

In early times the creative individual was viewed as an empty vessel that was filled with inspiration by a divine being. Psychologists initially paid little attention to creativity because it was thought to be too complex and frivolous for scientific investigation. Freud believed that creativity results from the tension between reality and unconscious wishes for power, sex, love, and so forth. While this view is not as prominent now as it was in his time, his notion of the *preconscious* – a state between conscious and unconscious reality where thoughts are loose and vague but interpretable – is still viewed by many as the source of creativity. The year 1950 marks a turning point for psychological interest in creativity, when it was the subject of Guilford's address to the American Psychological Association.

Current Psychological Approaches to Creativity

Creativity is now of interest to many disciplines and approached from many directions. Even within the discipline of psychology, it is addressed in a variety of ways. Cognitive psychologists study cognitive processes considered to be creative, such as analogy, concept combination, and problem solving, and they write computer programs that simulate these processes (e.g., Finke et al. 1992). Those who take a psychometric approach develop tests of creativity, the most widely known being the Torrance Test of Creative Thinking (Torrance 1974). Examples of such tests are the *Unusual Uses Test* in which participants are asked to think of as many uses for a common object (e.g., a brick) as possible, or the Product Improvement Test, in which participants are asked to list as many ways as they can to change a product to make it more useful or desirable (e.g., to change a toy monkey so children will have more fun playing with it). Developmental psychologists study creativity in children and throughout the lifespan. Social psychologists examine how family dynamics, group dynamics, and cultural influences affect creativity. Clinical psychologists look at how art therapy, music therapy, and dance therapy can help patients open up and express themselves in ways that verbal communication may not. Neuroscientists investigate the biological basis of creativity. Organizational psychologists study creativity as it pertains to entrepreneurship and successful business strategies. Finally, comparative, evolutionary, and cultural psychologists address the question of how humans came to possess their superlative creative abilities, how these abilities compare with those of other species, how creativity compares across different cultures, and in what sense creative ideas can be said to evolve over time.

The Relative Contributions of Expertise, Chance, and Intuition

While most psychologists believe that creativity involves a combination of expertise, chance, and intuition, they differ with respect to the degree of emphasis they place on these factors.

Expertise theorists point to evidence that it takes approximately a decade to master a creative domain (Hayes 1989). Experts are better than beginners at detecting and remembering domain-relevant patterns and are more adept at generating effective problem representations and, when necessary, revising initial hypotheses. Expertise theorists posit that creativity involves everyday thought processes such as remembering, planning, reasoning, and restructuring. They claim that no special or unconscious thought processes are required for creativity, just familiarity with and skill in a particular domain (Weisberg 2006).

Critics of this view note that entrenchment in established perspectives and approaches may make experts more prone than beginners to set functional fixedness and confirmation bias. Those who emphasize the role of *chance* include advocates of the Darwinian theory of creativity, according to which the creative process, like natural selection, entails blind generation of possibilities followed by selective retention of the most promising of them (Simonton 1999).

Other psychologists view creativity as not so much a matter of generating and selecting among predefined alternatives but of intuiting an idea and then, by considering the idea from different perspectives or trying it out different ways, taking it from an ill-defined state of potentiality to a well-defined state of actualization (Gabora 2010). Those who emphasize the actualization of potentiality and the role of *intuition* emphasize the association-based structure of memory and note that creative individuals tend to have *flat associative hierarchies,* meaning they have better access to *remote associates*, items that are related to the subject of interest in indirect or unusual ways.

The Relative Importance of Process Versus Product

To many it seems natural to value the creative process for the products it gives rise to; indeed creative products have significantly transformed this planet. Others view the creative process itself as more important than the product. They stress the *therapeutic value of creativity*. In this view the primary value of the creative process is that it enables the creator to express, transform, solidify, or unify the creator's understanding of and/or relationship to the world, while the external product provides a means of tracking or monitoring this internal transformation. This view is more prominent in Eastern than Western cultures. It also figures prominently in creative therapies such as art therapy, music therapy, and drama therapy.

Is Creativity Domain Specific or Domain General?

Psychologists who emphasize the role of expertise tend to view creativity as highly *domain specific;* expertise in one domain is not expected to enhance creativity in another domain. They note that expertise or eminence with respect to one creative endeavor to be only rarely associated with expertise or eminence with respect to another creative endeavor (Baer 2010). For example, creative scientists rarely become famous artists or dancers.

Psychologists who emphasize intuition and associative processes, on the other hand, tend to view creativity as somewhat *domain general* because associative thinking can result in metaphors that connect different domains. Studies involving self-report scales, creativity checklists, and other sorts of psychometric or personality data tend to support the view that creativity is domain general (Plucker 1998). The relevance of these studies to the general versus specific debate has been questioned because they do not actually measure creative outputs but rather traits associated with the generation of creative output. However, those who stress process over product claim that these data tell us about the internal, less visible, but equally important counterpart to the *external* manifestations of the creative process. An emphasis on product rather than process may have resulted in exaggeration of the extent to which creativity is domain specific. That is, if one asks not, "are individuals talented in multiple creative domains?" but, "can individuals use multiple creative domains to meaningfully develop, explore, and express themselves?" the answer is more likely to be affirmative. Most psychologists believe that the truth lies somewhere between the extremes. That is, creativity in one domain may help but not guarantee creativity in another; it is neither strongly domain specific nor domain general.

Is There a Dark Side to Creativity?

Although creativity is clearly stimulating and indispensable to cultural and technological advancement, many believe it has a dark side (Cropley et al. 2010). There is considerable evidence that eminent creativity is correlated with proneness to affective disorders, suicide, and substance abuse. Moreover, it is not necessary for everyone to be creative. We can all benefit from the creativity of a few by imitating, admiring, or making use of their creative outputs. Excessive creativity may result in reinventing the wheel, and absorption in ones' own creative ideas may interfere with assimilation or diffusion of proven effective ideas. Computer modeling suggests that society self-organizes to achieve a balance between relatively creative and uncreative individuals (Leijnen and Gabora 2009). The social discrimination that creative individuals often endure until they have proven themselves may aid in achieving this equilibrium.

Implications for Theory, Policy, and Practice

The psychology of creativity has implications for theory, policy, and practice in a number of arenas. A first area of application is clinical. Creative activities such as art making, music making, dance, and drama are increasingly seen to have therapeutic effects that can be effective in both clinical and nonclinical settings. The transformation that occurs on canvas or on the written page is thought to be mirrored by a potentially therapeutic sense of personal transformation and self-discovery that occurs within. Immersion in the creative task has been referred to as a state of *flow* that may share characteristics with deeply spiritual or religious experiences.

A second, related area of application is child rearing and education. For example, creative play in childhood facilitates access to affect-laden (emotional) thoughts, which may enhance cognitive flexibility and divergent thinking abilities. Amabile's (1996) work on *intrinsic motivation* showed that rewards for creative work may actually inhibit creativity because focusing on an external reward leads people to neglect the internally rewarding nature of creative acts.

A third area of application is in business settings. For example, psychological work on *brainstorming sessions*, in which people get together as a group and put forward ideas in an open and accepting environment, has shown that it may be more effective when group work is followed immediately by individual work or when individuals communicate by writing so as to avoid the problem of everyone talking at once.

Conclusion and Future Directions

It is our creativity that perhaps most distinguishes humans from other species and that has completely transformed the planet we live on. The psychological study of creativity is an exciting area that brings together many different branches of psychology: cognitive, developmental, organizational, social, personality, clinical, neuroscience, and even computational and mathematical models. Past and current areas of controversy concern the relative contributions of expertise, chance, and intuition, whether the emphasis should be on process versus product, whether creativity is domain specific versus domain general, and the extent to which there is a dark side to creativity. Promising areas for further psychological study of creativity include computational modeling and work on the neurobiological basis of creativity as well as environmental influences on creativity.

Cross-References

▶ Creativity Research

References

Amabile T. Creativity in context. Boulder: Westview Press; 1996.

Baer J. Is creativity domain specific? In: Kaufman J, Sternberg R, editors. Cambridge handbook of creativity. Cambridge, UK: Cambridge University Press; 2010. p. 321–41.

Beghetto RA, Kaufman JC. Toward a broader conception of creativity: a case for "mini-c" creativity. Psychol Aesthetic Creativity Arts. 2007;1(2):73–9.

Boden MA. The philosophy of artificial intelligence. New York: Oxford University Press; 1990.

Cropley D, Cropley JK, Runco M, editors. The dark side of creativity. Cambridge, UK: Cambridge University Press; 2010.

Feldman DH, Csikszentmihalyi M, Gardner H. Changing the world: a framework for the study of creativity. Westport: Praeger; 1994.

Finke RA, Ward TB, Smith SM. Creative cognition: theory, research, and applications. Cambridge, MA: MIT Press; 1992.

Gabora L. Revenge of the "neurds": characterizing creative thought in terms of the structure and dynamics of human memory. Creativity Res J. 2010;22(1):1–13.

Guilford JP. Creativity. Am Psychol. 1950;5:444–54.

Hayes JR. Cognitive processes in creativity. In: Glover JA, Ronning RR, Reynolds CR, editors. Handbook of creativity. New York: Plenum Press; 1989. p. 135–45.

Kaufman JC, Sternberg RJ. Resource review: creativity. Change. 2007;39:55–8.

Leijnen S, Gabora L. How creative should creators be to optimize the evolution of ideas? A computational model. Elect Proc Theor Comp Sci. 2009;9:108–19.

Plucker JA. Beware of simple conclusions: the case for the content generality of creativity. Creativity Res J. 1998;11:179–82.

Runco MA. Creativity. Annu Rev Psychol. 2004;55:657–87.

Simonton DK. Creativity as blind variation and selective retention: is the creative process Darwinian? Psychol Inq. 1999;10:309–28.

Sternberg RJ. A three-faceted model of creativity. In: Sternberg RJ, editor. The nature of creativity. Cambridge, UK: Cambridge University Press; 1988. p. 125–47.

Torrance EP. The Torrance tests of creative thinking. Princeton: Personnel Press; 1996.

Torrance EP. Torrance tests of creative thinking-norms and technical manual. Lexington, Massachusetts: Ginn, 1974.

Wallas G. The art of thought. London: Cape; 1926.

Weisberg RW. Creativity. New York: Wiley; 2006.

Public Policy

► Entrepreneurship Policies

Public-Private Partnerships for Research and Technological Development (PPP RTD)

► Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Puzzle

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Q

Quadruple Helix

► Quality of Democracy and Innovation

Quadruple Helix Extended

► Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice

Quadruple Helix Model

► Innovation System of India

Quadruple Helix Structure of Democracy

► Quality of Democracy and Innovation

Quadruple Innovation Helix Systems

► Epidemiology of Innovation: Concepts and Constructs

Quadruple-Dimensional Structure of Democracy

► Quality of Democracy and Innovation

Quality Assurance

► Epistemic Governance and Epistemic Innovation Policy

Quality Assurance and Quality Enhancement in Higher Education and Innovation

Anna Katharina Jacob
Zentrum fuer Hochschul- und Qualitaetsentwicklung (ZfH), Universitaet Duisburg-Essen, Duisburg, Germany

Synonyms

Quality evaluation at universities (of university tuition)

Difficulties in Defining "Quality" Within Higher Education

This entry gives an overview of the intersection of quality assurance/quality enhancement within the

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sector of higher education and innovation. When focusing their function of creating knowledge, the institutions of higher education themselves can be taken as examples for organizations oriented toward innovation. Furthermore, measures of quality assurance and/or quality enhancement are – or at least should be – devised in a way that they foster continuous innovation of the organizations (by means of learning and improvement). This can be seen as a process of change management within institutions often appearing strongly stratified and where the complex interaction of external (e.g., stately) regulations and powerful internal resistance (e.g., of traditional academic demeanor) must be taken into account.

The distinction of "quality assurance" and "quality enhancement" was introduced to point to different aspects of procedures used during the evaluation of the quality of higher education (for the following definitions, cf. Harvey 2004–2012). Thus, quality assurance is supposed to concentrate on regulatory processes when reviewing quality so that external accountability of the institution is ascertained and that stakeholder confidence in the services provided is established. Quality enhancement (or, perhaps stated even more clearly: quality improvement) is meant to emphasize the formative function of such procedures and therefore includes feedback processes with the purpose of changing the practices reviewed to the better.

One of the major difficulties met when dealing with the assurance or enhancement of the quality of higher education is the definition of the quality in question: The kind of quality looked for may differ from the point of view of the different stakeholders (society, state, students, teachers, university management); the good or service delivered is of manifold nature (instruction for a job within professional life or science, creation of new knowledge, formation of reflected personalities and citizens that can make a valuable contribution to society, etc.); the use and value of the education for the ones experiencing it can only be assessed properly when using it; and the organizations supplying the education are complex and have different institutional setups according to their historical and political contexts. So it has become topical within the literature of this subject to comment on that problem of definition, which does not hinder some fundamental understanding of the underlying notion of quality. In a seminal article, Harvey and Green (1993) highlighted the role of stakeholders in higher education (Harvey and Green 1993: 11) and came up with five possible definitions of quality in higher education, describing it as exceptional/excellence, as perfection, as fitness for purpose (one might add: and fitness of the purpose pursued), as value for money, and as transformation. Especially the last dimension of quality – that it had to embrace the potential of the services provided by an institution to change and to improve – became influential for the resulting discussion as Harvey and Knight (1996) made explicit. Furthermore, the three dimensions of quality as described by Donabedian (1980) – originally developed for the system of health care – were largely adopted: When talking about quality in higher education, it has been regarded as a valuable instrument for an analytical approach to differentiate between the quality of the structure (e.g., the institution and its facilities or staff), of the processes (e.g., of teaching or administrating), and of the outcomes (e.g., of numbers of graduates vs. dropouts, of exam results, of rates of employment of alumni within relevant professional fields, etc.). Due to this wide range of applicability of the term "quality" within higher education, some authors thought it more consequent and suitable to speak of different "qualities" rather than one single one.

Quality Assurance Within Higher Education: Path Dependency and Political Factors

In order to understand how the discussion of quality assurance and/or quality enhancement was introduced into higher education and how it was (and still is) led in different countries, one has to consider historical, regional, and political factors: The institutional status and the decisive contexts of the university sector will vary according to the evolution of tertiary education in the countries concerned – relatively young university landscapes in countries still developing face different problems than well-established institutions in OECD countries; a university sector largely based on private institutions, like in the USA, has some characteristics different to a largely state-run system like in Continental Europe, and so on. For the following findings on the rise of the procedure of quality evaluation in higher education, one has to bear in mind the path dependency that policies are submitted to – in surroundings different to the ones outlined here, different discussions and results will be likely to be considered.

The rise of the quality regime within the sector of tertiary education is often associated with a lack of trust of the public (the state) regarding the educational standards held at a number of institutions. This can be read as a result of the massification of higher education when universities no longer host a small elite of their age cohort, but are frequented by large numbers of students, thereby generating a great number of study programs and/or new institutions that do not share the confidence traditionally attributed by the public to universities and their supply of education. Thus, the need for checking standards is incited by a factor that came about from the educational system as a consequence of a historical development of society (the emerging "knowledge-based society"). It is stimulated further by questions concerning the effective use of financial resources spent by the universities (do they offer adequate value for money?) and their capacity to adapt to the new challenges of an altered environment (are they able to innovate and fulfill the new tasks required of them in terms of content as well as organization?).

According to Jeliazkova and Westerheijden (2002), different phases can be discerned in quality assurance systems, which correspond to different measures taken to ensure the desired quality: After a first phase of doubts about educational standards gleaned from descriptive records or performance indicators and resulting in governmental accreditations or reports, there was arguably another phase of doubts regarding the efficiency of the educational system. The issue of public accountability is raised here; by identifying good practices and/or rankings of institutions, the universities seek to make their point as being responsible and quality-oriented institutions. A third phase is identified when doubts about the capacity for innovation and the ability for securing quality have risen. This is another facet of public accountability and often encountered with governmental audit reports or within the institution. When the need to establish a sustainable quality culture is eventually perceived, the focus is widened from mere fulfillment of public demands of accountability (often felt as external to traditional academic tasks by many of the institutional actors) to an improvement-oriented approach that enhances self-regulation of the institution as a means of its active (and autonomous) shaping. As outlined by Vroejenstijn (1995), this relation of accountability and improvement is regarded as being strained by many of the protagonists involved, which is also expressed in the proposition of different concepts of quality assurance and quality enhancement: They seem to be "navigating between Scylla and Charybdis," as the title of Vroejenstijn's (1995) influential handbook suggests. It remains to be seen whether this widely perceived tension between improvement and accountability will be unveiled as an illusionary one, as argued by Harvey and Newton (2007).

Nonetheless, one has to admit that the issue of quality was introduced in the sector of higher education from the outside, due to a lack of trust that should be reestablished by quality assurance and/or quality enhancement systems that on the one hand secure the basic requirements of institutions and their study programs and on the other hand play an active role for their improvement and innovation. It is important to note that the actual establishment of these systems can be interpreted in a quite divergent way within different political contexts: They may be seen as a means of the state ruling the institutions when looking at educational systems with traditional high autonomy of the universities (as in the UK or the USA), thereby diminishing this autonomy. For educational systems that traditionally relied on state guidance of universities (like in many countries of Continental Europe), the opposite can be true: By defining ex-post-standards of tertiary education instead of the former ex-ante-criteria of ministerial rule, the state would hand over greater autonomy to the single institution.

The Impact of Managerialism on Higher Education

Independent of the actual situation of a country's higher education system regarding the aforesaid aspect of institutional autonomy, there is another overlying trend to be observed when it comes to the explanation of the growing spread of the quality agenda within universities: An increasing weight of managerial governance in the running of universities (replacing the former power of the professorial estate) went along with the intrusion of managerial thinking. Thus, the quality discourse reached its peak with the adaptation of ideas of the so-called new public management. This did not only affect organizational structures or employment relations but also the methods thought to be adequate to form and improve universities. Then concepts of quality and quality assurance or quality enhancement became – as Stensaker (2007) put it – a "fashion" for the governance of universities. Management principles originally developed for enterprises, and profit organizations were taken over and/or accommodated in order to fit academic contexts. This could take the form of mere policy copying (like giving monetary incentives to professionals for special efforts, say in the field of research or – less frequent – teaching) or the form of translation (thereby paying more attention to the peculiarities of the academic organization). One might say that the older paradigm of effectiveness of organizations was superseded by that of quality at a certain point of time when the quality discourse leaned strongly toward management literature. Also it seemed to suit the purpose of academic organizations better than merely looking for efficiency, for example, in producing large numbers of graduates without investigating the nature of their acquired qualifications. It is the adaptability to academic contexts that explains to a large extent why certain management ideologies were embraced more eagerly than others. So, for example, a concept like Total Quality Management (TQM) with its "quality chain" – considering aspects like a customer-driven definition of quality ("customer" here often being translated into "student"), cultural change, or organizational structure with the end of constant improvement – was often esteemed as one applicable to academia, albeit even here, the differences between an originally business-oriented thinking and the academic world are obvious. To name but an example given by Harvey and Green (1993): The measurement of results within TQM largely relies on quantitative performance measures – a restriction to such performance indicators (like financial resources or the ratios of students to teachers) is in danger of overlooking the qualitative performance aspects that make a noteworthy share when it comes to approaching "academic quality." Nonetheless, Management principles with a focus on quality – next to TQM, one might think of the model of the European Foundation for Quality Management (EFQM) – had and have a great impact on the governance of higher education institutions.

As not uncommon for management principles – or, in broader terms, for policies in general – changes of approach and methods of quality assurance/quality enhancement may be observed every now and again. Taking the example of the US higher education system, Ewell (2007) identified certain historical phases of what he calls the "quality game." After an era of "Pre-Quality" characterized by a high level of trust in higher education institutions by public officials, a first period of quality assessment took place during the 1980s when universities faced the first calls for accountability from politics, often answering it – still in a rather friendly public atmosphere – with assessment operations at institution level. In the 1990s, this was superseded by a notion of "value for money" in terms of public utility and the feeling of state authorities that they should engage themselves in actively steering higher education so that it served public purposes. The method of choice frequently used during this period was the application of performance measures (a row of examples will follow below) and attaching money to the fulfillment of these indicators. After 2000, a second period of quality orientation took a somewhat different approach in emphasizing issues of institutional improvement and adopting more and new methods of quality review (like academic audits), especially with the participation of third party reviewers. From then on, the process of teaching and learning was the main focus when inquiring about the outcomes of that central activity of universities.

It is important to notice that these changes in policies and methods were mostly stimulated by external events of national or international politics (and/or economy). Also it should be pointed out that the increased burden for the institutions – the rising costs of maintaining and developing sophisticated systems of quality assurance and quality enhancement – may lead to evasive reactions on behalf of the institutions. Especially smaller universities without the necessary financial resources, but also institutions where the leaders are not convinced of the eventual beneficial effects of quality enhancement, the temptation may be great to signal only compliance to external-driven quality evaluation while letting the core functions of academic life remain as protected and unaltered as possible. It is evident that quality assurance merely practiced as a kind of ritual – as enforced by some state authority – has little or no impact on the innovation of institutions.

Conclusion and Future Directions

Although it has been found that the concept of "quality" in higher education in many respects still remains vague to some extent, this has not impeded its career as a paradigm notion for shaping and innovating higher education institutions. As a general observation, it can be stated that measures and programs of quality assurance and quality enhancement have diversified and grown in importance as a consequence of shifts in educational politics (especially the often-quoted "lack of trust") and the intrusion of management principles into academia. The following list – not claiming to be comprehensive – is meant to give an overview on the array of approaches used by giving examples for some of the most popular tendencies:

(a) Accountability and performance indicator reports focus on a variety of factors like: factors of input (e.g., staff-student ratios, staff qualifications, student selectivity, funding, facilities, curriculum plans), process factors (e.g., student and alumni feedback on courses and study programs respectively, hours per course unit, etc.), factors of throughput (intermediate results of exams, resits, grade point averages), and output factors (final results of graduation rates vs. dropouts, the time needed to reach the degree, employment rates).
(b) A movement of assessment-and-outcomes tries to develop performance measures by calling attention to questions of value and learning outcomes.
(c) Total Quality Management focuses on continuous improvement and customer satisfaction.
(d) External Quality Monitoring delegates accountability to third parties (also including measurements of assessment-and-outcomes).

Quality assurance in general uses measures like (all following citations taken from Harvey 2004–2012): accreditation ("establishment of the status, legitimacy or appropriateness of an institution, program or module of study"), audit ("process for checking that procedures are in place to assure quality, integrity, or standards of provision and outcomes"), assessment ("all methods used to judge the performance of an individual, group, or organization"), and external examination ("uses people external to the program or institution to evaluate quality or standards," which can also include techniques of benchmarking, ranking, or report cards). Due to the variety of procedures, the term quality "monitoring" sometimes takes the place of "assurance." A regulatory component is felt within the use of this concept which is not present in the term quality enhancement (described as a "process of augmentation and improvement") that stresses the formative component. Among the teaching and learning activities often encompassed by quality enhancement, there are also qualitative elements like curriculum development to communities of practice.

As can be seen from this short listing of methods, indicators, and procedures, the fields of quality assurance and quality enhancement yield a wide spectrum of activities and practices with sometimes divergent theoretical backgrounds. What seems one of the consequences of the increasingly refined applications of quality-oriented procedures within higher education and the yet ongoing movement toward an improvement-driven concept of quality enhancement is the growing understanding for the necessity of an outcome-based education. That postulated "shift from teaching to learning" will operate by means of an expressed learning intent; it is supposed to result in a process that enables the intended learning to be achieved, and it has to lead to the formulation of criteria for assessing learning.

It is clear that such ambitious goals implying a serious change of academic teaching and learning activities not only rely on the active support of the institutional leaders (which is true for any action of management change) but have to be based on a well-defined analytical framework of the policies of quality assurance chosen. Perellon (2007: 161) suggests five dimensions concerning the choices to be made within quality assurance in higher education:

- *Objectives*: What should be the aims and objectives of quality assurance policy?
- *Control*: Who should control the process of quality assurance?
- *Areas*: What are the domains covered by quality assurance procedures setup?
- *Procedures*: How are the quality assurance procedures set up?
- *Use*: How is the information collected used?

Quality assurance and quality enhancement within higher education claiming to be more than the mere fulfillment of ritualism or tokenism driven by external pressure of public accountability will have to show accountability itself by reflecting on the methods and the outcomes of their activities and procedures. Accordingly, the argument of Harvey and Newton (2007: 235) on behalf of a "research-informed, improvement-led approach to quality evaluation" should be considered if quality assurance and quality enhancement are to make a contribution toward the innovation of the higher education sector. The advantages of this concept seem obvious: A research-informed approach will choose and improve procedures in terms of better efficacy of quality assurance; also it can hope for increased acceptance from academics as it reflects on its methodology in a scientifically valid way; finally, it is appropriate for self-regulating institutions as it largely relies on internal processes and internal motivators (which should motivate the institutional actors, allowing for greater autonomy). However, due to the contingencies of political and economic contexts, it remains an unanswered question if and to what extent such a transformation of quality evaluation procedures toward an improvement-led, self-regulating system within higher education institutions is to be realized in different countries during the coming years.

Cross-References

▶ Global University System
▶ Higher Education and Innovation
▶ Innovations of and in Organizations
▶ Knowledge Society, Knowledge-Based Economy, and Innovation
▶ University Research and Innovation

References

Donabedian A. The definition of quality and approaches to its assessment. Explorations in quality assessment and monitoring. Ann Arbor/Michigan: Health Administration; 1980.

Ewell P. The 'Quality Game': external review and institutional reaction over three decades in the United States. In: Westerheijden DF, Stensaker B, Rosa MJ, editors. Quality assurance in higher education: trends in regulation, translation and transformation. Dordrecht: Springer; 2007. p. 119–53.

Harvey L. Analytic quality glossary. Quality Research International; 2004–2012. http://www.qualityresearchinternational.com/glossary/. Accessed 27 Feb 2012.
Harvey L, Green D. Defining quality. Assess Eval High Educ. 1993;18(1):9–34.
Harvey L, Knight PT. Transforming higher education. Buckingham: Society for research into Higher Education and Open University Press; 1996.
Harvey L, Newton J. Transforming quality evaluation: moving on. In: Westerheijden DF, Stensaker B, Rosa MJ, editors. Quality assurance in higher education: trends in regulation, translation and transformation. Dordrecht: Springer; 2007. p. 225–45.
Jeliazkova M, Westerheijden DF. Systemic adaptation to a changing environment: towards a next generation of quality assurance models. High Educ. 2002;44 (3/4):433–48.
Perellon JF. Analysing quality assurance in higher education: proposals for a conceptual framework and methodological implications. In: Westerheijden DF, Stensaker B, Rosa MJ, editors. Quality assurance in higher education: trends in regulation, translation and transformation. Dordrecht: Springer; 2007. p. 155–78.
Stensaker B. Quality as fashion: exploring the translation of a management idea into higher education. In: Westerheijden DF, Stensaker B, Rosa MJ, editors. Quality assurance in higher education: trends in regulation, translation and transformation. Dordrecht: Springer; 2007. p. 99–118.
Vroejenstijn AI. Improvement and accountability: navigating between Scylla and Charybdis: guide for external quality assessment in higher education. London: Jessica Kingsley; 1995.

Quality Dimensions

► Epistemic Governance and Epistemic Innovation Policy

Quality Enhancement

► Epistemic Governance and Epistemic Innovation Policy

Quality Evaluation at Universities (of University Tuition)

► Quality Assurance and Quality Enhancement in Higher Education and Innovation

Quality Management

► Epistemic Governance and Epistemic Innovation Policy

Quality of Democracy

► Quality of Democracy and Innovation

Quality of Democracy and Innovation

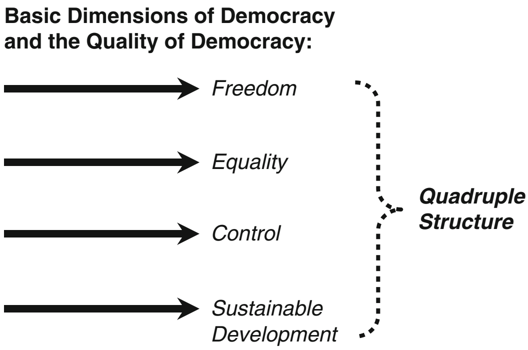
David F. J. Campbell[1,2] and Elias G. Carayannis[3]
[1]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[2]University of Applied Arts, Vienna, Austria
[3]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA

Synonyms

Basic dimensions of democracy; Coevolution; Conceptualization of democracy; Democracy; Democracy, Theory; Democratic innovation; Democratizing innovation; Development; Innovation of democracy; Innovative democracy; Knowledge democracy; Model of quadruple helix structures; Quadruple helix; Quadruple helix structure of democracy; Quadruple-dimensional structure of democracy; Quality of democracy; Sustainable development

The Conceptual Definition of Democracy and of the Quality of Democracy

How can democracy and the quality of democracy be conceptualized? Such a (theoretically justified) conceptualization is necessary in order



Quality of Democracy and Innovation, Fig. 1 The basic quardruple-dimension structure of democracy and the quality of democracy (Source: Author's own concoptualization and visualization, based on Campbell (2008, p. 32) and for the dimension of "control" on Lauth (2004, pp. 32–101))

for democracy and the quality of democracy to be subjected to a democracy measurement, *whereby democracy measurement, in this case, can be examined along the lines of conceptually defining democracy (thus democracy measurement is also to be utilized to improve the theory of democracy)* (see Campbell 2012). Hans-Joachim Lauth (2004, pp. 32–101) suggests in this context a "three-dimensional concept of democracy," which is composed of the following (conceptual) dimensions: *equality, freedom, and control* (see Fig. 1). These dimensions can be interpreted as "basic dimensions" of democracy and of the quality of democracy. Lauth (2004, p. 96) underlines that these dimensions are "sufficient" to obtain a definition of democracy. The term "dimension" offers a conceptual elegance that can be applied "trans-theoretically," meaning that different theories of democracy may be put in relation and may be mapped comparatively in reference to those dimensions. Metaphorically formulated, dimensions behave like "building blocks" for theories and theory development. With regard to democracy and the quality of democracy, every interest in analysis and assessment is confronted with the following point-of-departure question and challenge: whether (1) democracy exclusively refers or should refer to the political system (political dimension) or whether (2) democracy should also include social (societal), economic, and ecological contexts (nonpolitical dimensions) of the political system. This produces implications on the selection of indicators to be used for democracy measurement. How "limited" or "broadly" focused should be the definition of democracy? This is also reflected in the *minimalistic (minimalist)* versus *maximalistic (maximalist)* democracy theory debate (see Sodaro 2004, pp. 168, 180, and 182). In this regard, various theoretical positions elaborate on this concept. Perhaps, it is (was) from an orthodox point of view of theory to limit democracy to the political system (Munck 2009, pp. 126–127). More recent approaches are more sensitive for the contexts of the political system, however, still must establish themselves in the political mainstream debates (see, e.g., Stoiber 2011). Nevertheless, explicit theoretical examples are emerging for the purpose of incorporation into the democracy models the social (societal), economic, and ecological contexts. The theoretical model of the "democracy ranking" is an initiative that represents such an explicit example (Campbell 2008).

Over time, democracy theories are becoming more complex and demanding in nature, regardless, whether the understanding of democracy refers only to the political system or includes also the contexts of the political system. This also reflects on the establishment of democracy models. The most simple democracy model is that of the "electoral democracy" (Helms 2007, p. 19), also known as "voting democracy" ("*Wahldemokratie*," Campbell and Barth 2009, p. 212). An electoral democracy focuses on the process of elections, highlights the political rights, and refers to providing minimum standards and rights, however, enough to be classified as a democracy. Freedom House (2011a) defines electoral democracy by using the following criteria: "a competitive, multiparty political system"; "universal adult suffrage for all citizens"; "regularly contested elections"; and "significant public access of major political parties to the electorate through the media and through generally open political campaigning." The next, qualitatively better level of democracy is the so-called liberal democracy. A liberal democracy is characterized by political rights and more importantly also by civil liberties as well as complex and sophisticated forms of institutionalization. The liberal democracy does not only want to fulfill minimum standards (thresholds) but aims on ascending to the quality and standards of a developed, hence, an advanced democracy. Every liberal democracy is also an electoral democracy, but not every electoral democracy is automatically a liberal democracy. In this regard, Freedom House (2011a) states: "Freedom House's term 'electoral democracy' differs from 'liberal democracy' in that the latter also implies the presence of a substantial array of civil liberties. In the survey, all the 'Free' countries qualify as both electoral and liberal democracies. By contrast, some 'Partly Free' countries qualify as electoral, but not liberal, democracies." Asserting different (perhaps ideal-typical) conceptual stages of development for a further quality increasing and progressing of democracy, the following stages may be put up for discussion: *electoral democracy*, *liberal democracy*, and *advanced (liberal) democracy* with a *high quality of democracy*.

In *Polyarchy*, Robert A. Dahl (1971, pp. 2–9) comes to the conclusion that mostly two dimensions suffice in order to be able to describe the functions of democratic regimes: (1) *contestation* ("public contestation," "political competition") and (2) *participation* ("participation," "inclusiveness," "right to participate in elections and office"). Also relevant are Anthony Downs' (1957, pp. 23–24) eight criteria in *An Economic Theory of Democracy*, defining a "democratic government," but it could be argued that those are affiliated closer with an electoral democracy. In the beginning of the twenty-first century is the conceptual understanding of democracy and the quality of democracy already more differentiated, it can be said that crucial conceptual further developments are in progress. Larry Diamond and Leonardo Morlino (2004, pp. 22–28) have come up with an "eight dimensions of democratic quality" proposal. These include (1) *rule of law*, (2) *participation*, (3) *competition*, (4) *vertical accountability*, (5) *horizontal accountability*, (6) *freedom*, (7) *equality*, and (8) *responsiveness*. Diamond and Morlino (2004, p. 22) further state: "The multidimensional nature of our framework, and of the growing number of democracy assessments that are being conducted, implies a pluralist notion of democratic quality." These eight dimensions distinguish themselves conceptually with regard to procedure, content, and results as the basis (conceptual quality basis) to be used in differentiating the quality of democracy (see Diamond and Morlino 2004, pp. 21–22; 2005; see also Campbell and Barth 2009, pp. 212–213). The "eight dimensions" of Diamond and Morlino may be interpreted as "secondary dimensions" of democracy and the quality of democracy for the purpose of democracy measurement.

"Earlier debates were strongly influenced by a dichotomous understanding that democracies stood in contrast to non-democracies" (Campbell and Barth 2009, p. 210). However, with the quantitative expansion and spreading of democratic regimes, it is more important to differentiate between the qualities of different democracies. According to Freedom House (2011b), in the year 1980 no less than 42.5 % of the world population lived in "not free" political contexts; by 2010, this share dropped to 35.4 %. Democracies themselves are subject to further development, which is a continuous process and does not finish upon the establishment of a democracy. Democracies have to find answers and solutions to new challenges and possible problems. Democracy is in a constant need to find and reinvent itself. Observed over time, different scenarios could take place and could keep a democracy quality going on constantly; however, democracy quality could erode, but also improve. *A betterment of the quality of democracy should be the ultimate aim of a democracy. Earlier ideas about an electoral democracy are becoming outdated and will not suffice in today's era.*

Gillermo O'Donnell (2004a) developed a broad theoretical understanding of democracy and the quality of democracy. In his theoretical approach, quality of democracy develops itself further through an interaction between human development and human rights: "True, in its origin the concept of human development focused mostly on the social and economic context, while the concept of human rights focused mostly on the legal system and on the prevention and redress of state violence" (O'Donnell 2004a, p. 12). The human rights differentiate themselves in civil rights, political rights, and social rights, in which O'Donnell (2004a, p. 47) assumes and adopts the classification of T. H. Marshall (1964). Human development prompts "...what may be, at least, a minimum set of conditions, or capabilities, that enable human beings to function in ways appropriate to their condition as such beings" (O'Donnell 2004a, p. 12), therefore in accordance with human dignity and, moreover, the possibility of participating realistically in political processes within a democracy. O'Donnell also refers directly to the *Human Development Reports* with the *Human Development Index (HDI)* that are being released and published annually by the United Nations Development Program (UNDP) (for a comprehensive website address for all *Human Development Reports* that is publicly accessible for free downloads, see: http://hdr.undp.org/en/reports/global/hdr2011/). Explicitly, Gillermo O'Donnell (2004a, pp. 11–12) points out: "The concept of human development that has been proposed and widely diffused by UNDP's *Reports* and the work of Amartya Sen was a reversal of prevailing views about development. . . . The concept asks how every individual is doing in relation to the achievement of 'the most elementary capabilities, such as living a long and healthy life, being knowledgeable, and enjoying a decent standard of living'" (O'Donnell 2004a, pp. 11–12; UNDP 2000, p. 20). *If the implementation of O'Donnell is reflected upon the initial questions asked in this contribution for the conceptualization of democracy and the quality of democracy, it can be interpreted but also convincingly argued that "sustainable development" can be suggested as an additional dimension ("basic dimension") for democracy, which would be important for the quality of democracy in a global perspective* (for a systematic attempt of empirical assessment on possible linkages between democracy and development, see Przeworski et al. 2003). As a result of the distinction between dimensions (basic dimensions) for democracy and the quality of democracy, the following proposition is put up for debate: in addition to the dimensions of *freedom, equality, and control* as being suggested by Lauth (2004, pp. 32–101), *the dimension of sustainable development should be introduced as a fourth dimension* (see again Fig. 1). Regarding suggestions for defining sustainable development, Verena Winiwarter and Martin Knoll (2007, pp. 306–307) commented: "In the meantime, as described, multiple definitions for sustainability exist. A fundamental distinction within the definition lies in the question whether only the relation of society with nature or if additionally social and economic factors should be considered."

In political context and in political competition, equality often is associated closer with left-wing political positions and freedom with right-wing (conservative) positions (e.g., see Harding et al. 1986, p. 87). *A measure of performance of political and nonpolitical dimensions in relation to sustainable development has the advantage (especially in the case where sustainable development is understood comprehensively) that this procedure is mostly (often) left–right neutral. Such a measure of performance as a basis of the assessment of democracy and quality of democracy offers an additional reference point ("meta-reference point") outside of usual ideologically based conflict positions* (Campbell 2008, pp. 30–32). It can be argued in a similar manner that the dimension of control mentioned by Lauth (2004, pp. 77–96) positions itself as left–right neutral as well. The definition developed by the "democracy ranking" for the quality of democracy is "Quality of Democracy = (freedom & other characteristics of the political system) & (performance of the nonpolitical dimensions)" (Campbell 2008). *This definition is interpreted as a further empirical operationalization step and as a practical application for the measurement of democracy and the quality of democracy, respectively, which is based on the theory about the quality of democracy by Guillermo O'Donnell* (see also O'Donnell 2004b). However, the conceptual democracy formula of the "democracy ranking" has been developed independently (Campbell and Sükösd 2002).

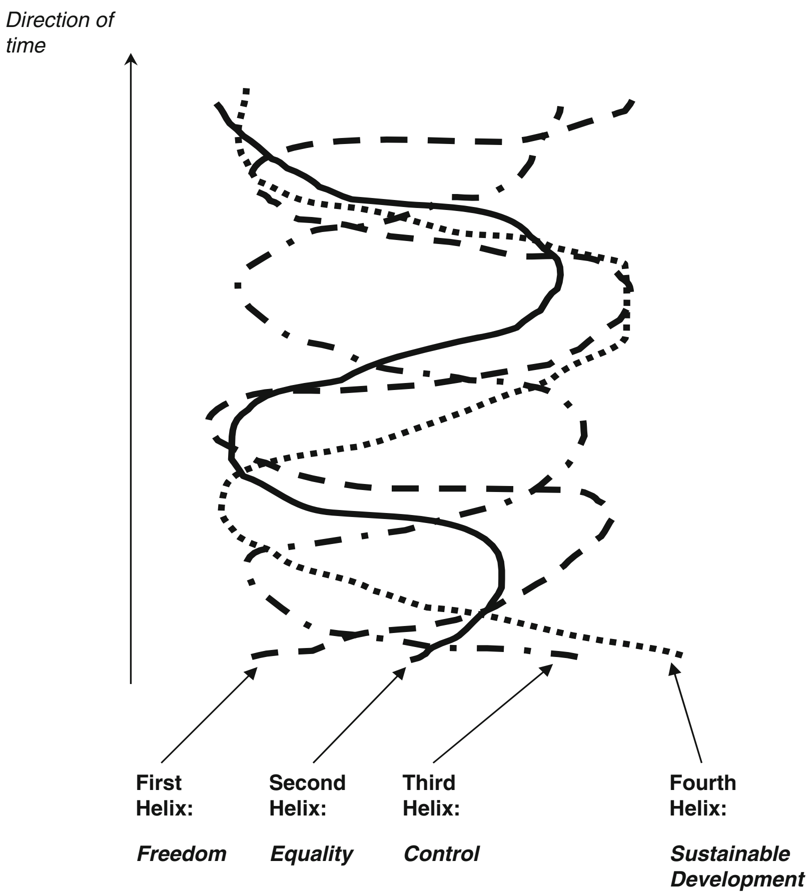
Conclusion and Future Directions

There are different theories, conceptual approaches, and models for knowledge production and innovation systems. In the Triple Helix model of innovation, Etzkowitz and Leydesdorff (2000, p. 112) developed a conceptual architecture for innovation, where they tie together the three helices of academia (higher education), industry (business), and state (government). This conceptual approach was extended by Carayannis and Campbell (2009; 2012, p. 14) in the so-called Quadruple Helix model of innovation systems by adding as a fourth helix the "media-based and culture-based public" as well as "civil society." *The Quadruple Helix, therefore, is broader than the Triple Helix and contextualizes the Triple Helix*, by interpreting Triple Helix as a core model that is being embedded in and by the more comprehensive Quadruple Helix. *Furthermore, the next-stage model of the Quintuple Helix model of innovation contextualizes the Quadruple Helix, by bringing in a further new perspective by adding the "natural environment" (natural environments) of society*. The Quintuple Helix represents a "five-helix model," "where the environment or the natural environments represent the fifth helix" (Carayannis and Campbell 2010, p. 61). In trying to emphasize, compare, and contrast the focuses of those different Helix innovation models, it can be asserted that the Triple Helix concentrates on the knowledge economy, the Quadruple Helix on knowledge society and knowledge democracy, while the Quintuple Helix refers to socio-ecological transitions and the natural environments (Carayannis et al. 2012, p. 4; see also Carayannis and Campbell 2011; European Commission 2009; Fischer-Kowalski and Haberl 2007). *For explaining and comparing democracy and the quality of democracy, a "quadruple-dimensional structure" has been proposed here that refers to four different "basic dimensions" of democracy that are being called freedom, equality, control, and sustainable development* (Fig. 1 offers a visualization on these). Here, actually a line of comparison may be drawn between concepts and models in the theorizing on democracy and democracy quality and the theorizing on knowledge production and innovation systems. This opens up a window of opportunity for an interdisciplinary and transdisciplinary approaching of democracy as well as of knowledge production and innovation, also of "democratic innovation" (Saward 2000) and "democratizing innovation" (Von Hippel 2005). *In conceptual terms, the quadruple-dimensional structure of democracy could also be rearranged (re-architectured) in reference to helices, by this creating a "model of Quadruple Helix structures" for democracy and the quality of democracy*. The metaphor and visualization in reference to terms of *helices* emphasizes the fluid and dynamic interaction, overlap, and coevolution of the individual dimensions of democracy. As basic dimensions for democracy were proposed to identify freedom, equality, control, and sustainable development. Figure 2 introduces a possible visualization from a helix perspective for a theoretical framing of democracy.

Specific challenges for future research but also for future reform and development are as follows:

1. Is there an unfolding relationship, perhaps also coevolution, between democracy, knowledge democracy, and the quality of democracy?
2. Do innovations in and of democracy produce and create an innovative democracy?
3. Does innovative democracy support knowledge production and knowledge application (innovation) in the knowledge society and knowledge economy?
4. Is sustainable development, in the long run, only possible, when democracy, innovation, and entrepreneurship find together by forming in balance a complex and sensitive interaction and coevolution?

Quality of Democracy and Innovation, Fig. 2 The quadruple helix structure of the basic dimension of democracy and the quality of democracy (Source: Author's own conceptualization based on Etzkowitz and Leydesdorff (2000, p. 112), Carayannis and Campbell (2012, p. 14), Danilda et al. (2009), Campbell (2008, p.32) and for the dimension of "control" on Lauth (2004, pp. 32–101))



Cross-References

- ▶ Epistemic Governance and Epistemic Innovation Policy
- ▶ Innovation and Democracy
- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovations of Direct Democracy
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Mode 1, Mode 2, and Innovation
- ▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology
- ▶ Multi-level Systems of Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Nonlinear Innovations
- ▶ Political Leadership and Innovation
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ Systems Theory and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)
- ▶ Triple Helix of University-Industry-Government Relations
- ▶ University Research and Innovation

References

Campbell DFJ. The basic concept for the democracy ranking of the quality of democracy. Vienna: Democracy Ranking (2008). http://www.democracyranking.org/downloads/basic_concept_democracy_ranking_2008_A4.pdf. Accessed 1 Dec 2012.

Campbell DFJ. Die österreichische Demokratiequalität in Perspektive. In Helms L, Wineroither DM, editors.

Die österreichische Demokratie im Vergleich. Baden-Baden: Nomos; 2012.
Campbell DFJ, Sükösd M, editors. Feasibility study for a quality ranking of democracies. Vienna: Global Democracy Award (2002). http://www.democracyranking.org/downloads/feasibility_study-a4-e-01.pdf. Accessed 1 Dec 2012.
Campbell DFJ, Barth TD. Wie können Demokratie und Demokratiequalität gemessen werden? Modelle, Demokratie-Indices und Länderbeispiele im globalen Vergleich. SWS-Rundschau. 2009;49(2):208–33. http://www.sws-rundschau.at/archiv/SWS_2009_2_Campbell.pdf and http://www.ssoar.info/ssoar/View/?resid=12471.
Carayannis EG, Campbell DFJ. "Mode 3" and "Quadruple Helix": toward a 21st century fractal innovation ecosystem. Int J Technol Manag. 2009;46(3/4):201–34. http://www.inderscience.com/browse/index.php?journalID=27&year=2009&vol=46&issue=3/4 and http://www.inderscience.com/search/index.php?action=record&rec_id=23374&prevQuery=&ps=10&m=or.
Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. Int J Soc Ecol Sustain Dev. 2010;1(1):41–69. http://www.igi-global.com/bookstore/article.aspx?titleid=41959.
Carayannis EG, Campbell DFJ. Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the quadruple and quintuple helix innovation concepts and the "Mode 3" knowledge production system. J Knowl Econ. 2011;2(3):327–72. http://www.springerlink.com/content/d1lr223321305579/.
Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development, Springer briefs in business, vol. 7. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3.
Carayannis EG, Barth TD, Campbell DFJ. The quintuple helix innovation model: global warming as a challenge and driver for innovation. J Innov Entrep. 2012;1(1):1–12. http://www.innovation-entrepreneurship.com/content/pdf/2192-5372-1-2.pdf.
Dahl RA. Polyarchy. Participation and opposition. New Haven: Yale University Press; 1971.
Danilda I, Lindberg M, Torstensson B-M. Women Resource Centres. A quattro helix innovation system on the European agenda (2009). Paper http://www.hss09.se/own_documents/Papers/3-11%20-%20Danilda%20Lindberg%20&%20Torstensson%20-%20paper.pdf. Accessed 1 Dec 2012.
Diamond L, Morlino L. The quality of democracy. An overview. J Democr. 2004;15(4):20–31.
Diamond L, Morlino L, editors. Assessing the quality of democracy. Baltimore: The John Hopkins University Press; 2005.
Downs A. An economic theory of democracy. Boston: Addison-Wesley; 1957.
Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and "Mode 2" to a triple helix of university-industry-government relations. Res Policy. 2000;29:109–23.
European Commission. The world in 2025. Rising Asia and socio-ecological transition. Brussels: European Commission (2009). http://ec.europa.eu/research/social-sciences/pdf/the-world-in-2025-report_en.pdf. Accessed 1 Dec 2012.
Fischer-Kowalski M, Haberl H, editors. Socioecological transitions and global change. Trajectories of social metabolism and land use. Cheltenham: Edward Elgar; 2007.
Freedom House. Freedom in the world 2011. Methodology. Washington, DC: Freedom House (2011a). http://www.freedomhouse.org/template.cfm?page=351&ana_page=379&year=2011. Accessed 1 Dec 2012.
Freedom House. Freedom in the world – population trends. Washington, DC: Freedom House (2011b). http://www.freedomhouse.org/images/File/fiw/historical/PopulationTrendsFIW1980-2011.pdf. Accessed 1 Dec 2012.
Harding S, Phillips D, Fogarty M. Contrasting values in Western Europe. Unity, diversity and change, Studies in the contemporary values of modern society. London: Macmillan; 1986.
Helms L. Die Institutionalisierung der liberalen Demokratie. Deutschland im internationalen Vergleich. Frankfurt: Campus; 2007.
Lauth H-J. Demokratie und Demokratiemessung. Eine konzeptionelle Grundlegung für den interkulturellen Vergleich. Wiesbaden: VS Verlag für Sozialwissenschaften; 2004.
Marshall TH. Class, citizenship, and social development. Essays. Garden City: Doubleday; 1964.
Munck GL. Measuring democracy. Baltimore: The Johns Hopkins University Press; 2009.
O'Donnell G. Human development, human rights, and democracy. In: O'Donnell G, Vargas Cullell J, Iazzetta OM, editors. The quality of democracy. Theory and applications. Notre Dame: University of Notre Dame Press; 2004a. p. 9–92.
O'Donnell G. Why the rule of law matters. J Democr. 2004b;15(4):32–46.
Przeworski A, Alvarez ME, Antonio Cheibub J, Limongi F. Democracy and development. Political institutions and well-being in the world, 1950–1990. Cambridge: Cambridge University Press; 2003.
Saward M, editor. Democratic innovation. Deliberation, representation and association. London: Routledge; 2000.

Sodaro MJ. Comparative politics. A global introduction. Boston: Mc Graw Hill; 2004.
Stoiber M. Die Qualität von Demokratien im Vergleich Zur Bedeutung des Kontextes in der empirisch vergleichenden Demokratietheorie. Nomos: Baden-Baden; 2011.
UNDP/United Nations Development Program. Human development report 2000. Human rights and human development. Oxford: Oxford University Press; 2000. http://hdr.undp.org/en/reports/global/hdr2000/.
Von Hippel E. Democratizing innovation. Cambridge, MA: MIT Press; 2005.
Winiwarter V, Knoll M. Umweltgeschichte. Cologne: Böhlau; 2007.

Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice

Elias G. Carayannis[1], Thorsten D. Barth[2] and David F. J. Campbell[3,4]
[1]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA
[2]Political Scientist & Academic Entrepreneur, Vienna Democracy Ranking Organization - Academic Ranking Team, Vienna, Austria
[3]Faculty for Interdisciplinary Studies (IFF), Institute of Science Communication and Higher Education Research, Alpen–Adria–University Klagenfurt, Vienna, Austria
[4]University of Applied Arts, Vienna, Austria

Synonyms

Quadruple helix extended; Social ecology

Introduction

Due to the escalation of "global warming," it is time for humanity to think and act responsibly and determine sustainable solutions. Global warming, in addition to climate change, has caused the world to undertake new responsibilities (see IPCC 2007a), which not only include further climate change but in the long term also hold humanity accountable in the prevention of new political and/or social conflicts, war on resources, new environmental catastrophes, as well as serious crises in the market economies (see UNDP 2007; UNEP 2008). The special challenge of global warming can be tackled by "sustainable development." The definition of the Brundtland Commission states that sustainable development "meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations 1987a, b). Sustainable development concerns us all and takes place on the local as well as global level. Hence, sustainable development has to be understood in the context of "gloCal knowledge economy and society" (see Carayannis and Campbell 2011; Carayannis and von Zedwitz 2005; Carayannis and Alexander 2006). Therefore, we must perceive global warming not as a challenge, but rather as an opportunity to live innovatively and effectively in union with nature for a better tomorrow.

To a large extent, humanity itself has caused the climate change; therefore, something must be done (see IPCC 2007b; Le Monde diplomatique 2009, pp. 72–73; Friedman 2008). However, there are hardly any comprehensive models or concepts to answer the "WHY" that truly show "HOW" we can act and learn accordingly, or provide any demonstrative methods, suggestions, and examples "HOW" we can improve our actions in the present. Our analysis presented here suggests understanding the "WHY" and consequently offers a "model of innovation," which demonstrates a feasible, step-by-step method to tackle the "HOW."

In the current academic debate, it is undisputed that a solution or a suitable answer regarding the challenge of global warming can only be found through utilizing the asset of human knowledge (see Carayannis and Campbell 2010, p. 42; Bhaskar 2010, p. 1). The key to success, as is being determined by our propositions, lies in using the available and newly created "knowledge" in correspondence with the *Quintuple Helix Model* (Carayannis and Campbell 2010, p. 62). The *Quintuple Helix* is a model of innovation that can tackle existing challenges of global warming through the application of knowledge and know-how as it focuses on the social (societal) exchange and transfer of knowledge inside subsystems of a specific state, nation-state (see Barth 2011a, pp. 5–7). The "nonlinear" innovation model of the *Quintuple Helix*, which combines knowledge, know-how, and the natural-environment system together into one "interdisciplinary" and "transdisciplinary" framework, can provide a step-by-step model to comprehend the quality-based management of effective development, to recover a balance with nature, and to allow future generations a life of plurality and diversity on earth (see Carayannis and Campbell 2010, p. 42; Barth 2011a, p. 2). To sum up, our thesis is as follows: The *Quintuple Helix* represents a suitable model in theory and practice offered to society, to understand the link between knowledge and innovation, in order to promote lasting development. This contribution, under the aspect of global warming, focuses on the potential of a nation-state in the twenty-first century and on the following pivotal question: *How can sustainable development, with regard to global warming, be practiced step by step with and within a quintuple helix model?*

The structure of our analysis is as follows. Section "The Challenge of Global Warming and the Resource of Knowledge" is a short delineation about challenges of global warming and the organization of the resource of knowledge. In Sect. "What is a Quintuple Helix Innovation Model?", the *Quintuple Helix* Model is defined. Next comes Sect. "The Challenge of Global Warming in a Quintuple Helix Innovation Model" that visualizes the *Quintuple Helix Model* as a "nonlinear" model of innovation in correspondence with social (societal) subsystems and along with a descriptive step-by-step example of how the challenge of sustainable development (under the aspect of global warming) may be adopted. Section "Conclusion and Future Directions" offers a conclusion in reference to the *Quintuple Helix Innovation Model*.

The Challenge of Global Warming and the Resource of Knowledge

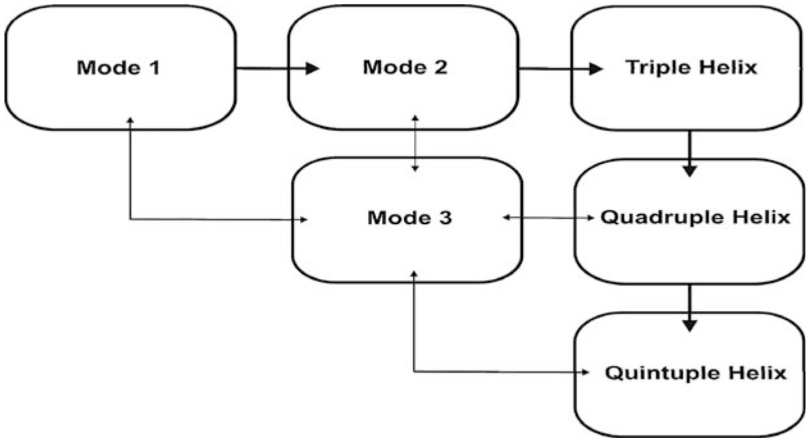
The challenge of sustainable development (under the aspect of global warming) proves that there are currently several crucial questions that need to be answered (see Carayannis 2011): So new political goals must be formulated, in reference with CO_2 emission limits, in the quest for a long-term sustainability. Furthermore, there is rising demand for "new green" knowledge solutions and know-how in order to utilize resources innovatively for society and the economy in an environmentally conscious manner. Moreover, our present way of life and lifestyle must be scrutinized under a sustainable impact assessment. Apart from environmental protection, it also demands the protection of biodiversity (see Barth 2011a; Bhaskar 2010; Le Monde diplomatique 2009, pp. 22–23, 72–73, 92–93; UNDP 2007). Global warming concerns us all as it takes place on a "local" as well as "global" level and implies ramifications for the "gloCal knowledge economy and society" (see Carayannis and Campbell 2011; Carayannis and von Zedwitz 2005; Carayannis and Alexander 2006). It is clear that the challenge of global warming is accompanied with the challenge of sustainability (for the world) in the twenty-first century (see Carayannis 2011). Therefore, there are nine areas, of which Carayannis and Kaloudis write about, that require "sustained action," political and economical "leadership" or "empowerment," and "intelligent use of technology" (Carayannis and Kaloudis 2010, p. 2):

1. "Financial/economic system": The area of "financial and economic system" refers to financial and economic aspects of the effects of climate change. The following question arises (among other things): How should the two systems effectively change or adapt with each other in order to reduce or exclude crises in consequence of climate change (see, e.g., Barbier 2009; Barth 2011a; Green New Deal Group 2008; Hufbauer et al. 2009; Meyer 2008; OECD 2010; Sen 2007)?

2. "Environmental challenges": The area of "environmental challenges" has to do with causes and effects of climate change and which political and social measures should be taken to increase environmental conservation and sustainability (see, e.g., IPCC 2007a, b; Giddens 2009; Høyer 2010a; Müller and Niebert 2009; Stern 2009).
3. "Feed and heal the world challenges": The area "feed and heal the world challenges" emphasizes new and solution-oriented approaches under the aspect of knowledge and care in the course of climate change (see Parker 2010; Höll et al. 2006).
4. "Energy challenges": The area of "energy challenges" highlights new green technologies and renewable energy, which lead to sustainable development (see also Barbier 2009; Green New Deal Group 2008; Høyer 2010b; UNEP 2008).
5. "Educational challenges": The area "educational challenges" is based on a better education as a key for empowerment, equality of chances, and new knowledge for sustainability and development (see, e.g., OECD 2009; O'Donnell 2004; Sen 2007; UNDP 2010).
6. "Political democratic reform across the world": The area "political democratic reform across the world" promotes democracy as being a local and global key for sustainable development. Here, also the themes of democratization, freedom, equality, policy making, gender, and political culture are relevant (see, furthermore, Barth 2011b; Biegelbauer 2007b; Campbell 2007; Campbell and Schaller 2002; Kreisky and Löffler 2010; Otzelberger 2011; Ulram 2006).
7. "Transformative government across the world": The area "transformative government across the world" has to do with the political standing or rating of a nation-state. Examples here are the search for democracy, quality of democracy, types of political systems, etc. (see also Barth 2010, 2011a, b, c; Campbell 2008; Campbell and Barth 2009; Campbell et al. 2010; Diamond and Morlino 2005; O'Donnell 2004; Rommetveit et al. 2010; Schumpeter 1976; Tilly 2007).
8. "Equity and security across the world": The area "equity and security across the world" refers to equity and security as being basic prerequisites to foster and support sustainable development (see, e.g., UNDP 2011; Barth 2011a).
9. "Technology, innovation, and entrepreneurship as drivers of knowledge societies": The area of "technology, innovation, and entrepreneurship as drivers of knowledge societies" emphasizes the fact that a sustainable development in knowledge societies can only be achieved when new knowledge is promoted and produced and when innovations (with a new entrepreneurship) are developed further (see here the idea and concept of the "Academic Firm," Campbell and Güttel 2005; see also and furthermore Bhaskar 2010; Biegelbauer 2007a; Campbell 2006; Carayannis and Campbell 2006, 2009, 2010, 2011; Dubina 2009; Dubina et al. 2012; Kuhlmann 2001; Lundvall 1992; Nowotny et al. 2003).

Let us consider now in greater detail the production of the resource of knowledge. Knowledge (e.g., the advancement of green technology) can act as key to success for sustainable development. Essentially, it should be understood today that nation-states that concentrate on progress of society, a higher competitiveness of their economies or a better and sustainable quality of life, have to apply the resource of knowledge. In the transformation to a knowledge-based society, knowledge-based economy, or knowledge-based democracy (see Carayannis and Campbell 2009, p. 224), also under the aspect of climate change, it is possible to generate new and usable knowledge in conjunction with sustainable development. The resource of knowledge, therefore, turns into the "most fundamental resource" (Lundvall 1992, p. 1), with qualities of a "knowledge nugget" (Carayannis and Formica 2006, p. 152). Knowledge, as a resource, is created through creative processes, combinations, and productions in so-called Knowledge Models or Innovation Models and thus becomes available for society: "We can also call this the creativity of knowledge creation" (Carayannis and Campbell 2010, p. 48). We want to refer here specifically to six currently existing

Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice, Fig. 1 The evolution of the models of knowledge creation (Source: Authors' own conceptualization)



models of knowledge creation and innovation creativity (see also Fig. 1, below):

"**Mode 1**" (see Gibbons et al. 1994): Mode 1 "focuses on the traditional role of university research in an elderly 'linear model of innovation' understanding," and success in mode 1 "is defined as a quality or excellence that is approved by hierarchically established peers" (Carayannis and Campbell 2010, p. 48).

"**Mode 2**" (see Gibbons et al. 1994): Mode 2 can be characterized by the following five principles: (1) "knowledge produced in the context of application," (2) "transdisciplinarity," (3) "heterogeneity and organizational diversity," (4) "social accountability and reflexivity," (5) and "quality control" (Gibbons et al. 1994, pp. 3–4).

"**Triple Helix**" (see Etzkowitz and Leydesdorff 2000): The "Triple Helix overlay provides a model at the level of social structure for the explanation of Mode 2 as a historically emerging structure for the production of scientific knowledge and its relation to Mode 1," and it is a "model of 'tri-lateral networks and hybrid organizations' of 'university-industry-government relations'" (Etzkowitz and Leydesdorff 2000, pp. 118, 111–112).

"**Mode 3**" (see Carayannis and Campbell 2006): "The concept of Mode 3 is more inclined to emphasize the co-existence and co-evolution of different knowledge and innovation modes. Mode 3 even accentuates such a pluralism and diversity of knowledge and innovation modes as being necessary for advancing societies and economies. This pluralism supports processes of a mutual cross-learning from the different knowledge modes. Between Mode 1 and Mode 2 manifold creative arrangements and configurations are possible, linking together basic research and problem-solving" (Carayannis and Campbell 2010, p. 57). Mode 3 "encourages interdisciplinary thinking and transdisciplinary application of interdisciplinary knowledge" as well as "allows and emphasizes the co-existence and co-evolution of different knowledge and innovation paradigms" (see Carayannis and Campbell 2010, pp. 51–52).

"**Quadruple Helix**" (see Carayannis and Campbell 2009): The *Quadruple Helix Model* is based on the *Triple Helix Model* and adds as fourth helix the "public," more specifically being defined as the "media-based and culture-based public" and civil society. This "fourth helix associates with 'media,' 'creative industries,' 'culture,' 'values,' 'life styles,' 'art,' and perhaps also the notion of the 'creative class'" (Carayannis and Campbell 2009, pp. 218, 206).

"**Quintuple Helix**" (see Carayannis and Campbell 2010): The *Quintuple Helix Innovation Model* is based on the *Triple Helix Model and Quadruple Helix Model* and adds as fifth helix the "natural environment." "The Quintuple Helix can be proposed as a framework for transdisciplinary (and interdisciplinary) analysis of sustainable development and social ecology" (Carayannis and Campbell 2010, pp. 51 and 62) (see also later our analysis in Sect. "What is a Quintuple Helix Innovation Model?").

About these six briefly described models can be concluded that in a *knowledge society*, at the national level, a network-style linkage of knowledge is being processed, and each model fulfills a specific contribution for the "creation, diffusion and use of knowledge" (see Carayannis and Campbell 2006 and 2010). In reference to sustainable development, under the aspect of global warming, we should add whether in future a state (nation-state) leading in world politics as well as in the world economy is also being determined by its social (societal) potential to balance new knowledge, know-how, and innovation with nature. Hence, for more detail, we look in the following Sect. "What is a Quintuple Helix Innovation Model?" at the *Quintuple Helix Model*.

What Is a *Quintuple Helix Innovation Model*?

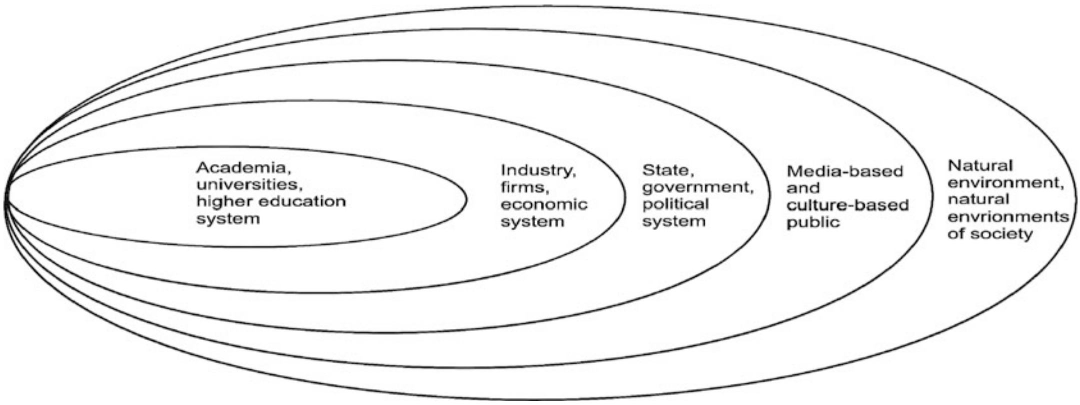
Knowledge in a *Quintuple Helix Model* is the pivotal force and driver for progress. The *Quintuple Helix* is a model, which grasps and specializes on the sum of the social (societal) interactions and the academic exchanges in a state (nation-state) in order to promote and visualize a *"cooperation system"* of knowledge, know-how, and innovation for more sustainable development (see Carayannis and Campbell 2010, p. 62). The specialty of the *Quintuple Helix Model* can thus be described in the following way:

> The Quintuple Helix Model is interdisciplinary and transdisciplinary at the same time: the complexity of the five-helix structure implies that a full analytical understanding of all helices requires the continuous involvement of the whole disciplinary spectrum, ranging from the natural sciences (because of the natural environment) to the social sciences and humanities (because of society, democracy and the economy). (Carayannis and Campbell 2010, p. 62)

Thus, the goal of the *helix conception* is accomplished through the resource of knowledge, which produces additional value for society in order to lead in the field of sustainable development. The pivotal question of the *Quintuple Helix* defines itself in the following way:

> How do knowledge, innovation and the environment (natural environment) relate to each other? (Carayannis and Campbell 2010, p. 42)

The analytical point of origin of the *Quintuple Helix*, as described in Sect. The Challenge of Global Warming and the Resource of Knowledge, is the "*Triple Helix Model*" of Etzkowitz and Leydesdorff (2000) and is the "*Quadruple Helix Model*" of Carayannis and Campbell (2010). The social (societal) cooperation system defines itself based on the model of a *Triple Helix*, which consists of a combination of university (= *education system*), industry (= *economic system*), and government (= *political system*) (see Etzkowitz and Leydesdorff 2000, pp. 111–112). To this combination, the authors (Etzkowitz and Leydesdorff) refer to as "university-industry-government relations," linking together the creation and exchange of knowledge between these three subsystems. Carayannis and Campbell acknowledged the "nonlinear" dynamics within *Triple Helix* and extended this to the "*Quadruple Helix*" (see Carayannis and Campbell 2009, p. 218): The *Triple Helix* is broadened within the *Quadruple Helix* through a "*media-based and culture-based public*" subsystem. The purpose of this extension is to include the public as well as civil society as a fourth subsystem. The *media-based public* supports the diffusion of knowledge in a state (nation-state), but also the *culture-based public* with its values, experience, traditions, and visions promotes knowledge for the knowledge society (Carayannis and Campbell 2009, pp. 217–227). Let us now have a closer look at the *Quintuple Helix Model*. In the year 2010, the authors Carayannis and Campbell developed the "*Quadruple Helix*" further by adding a fifth helix to the modeling of knowledge and innovation, being the *natural environment*. The "*Quadruple Helix*" developed into the "*Quintuple Helix*" (see Fig. 2) (Carayannis and Campbell 2010, p. 62).



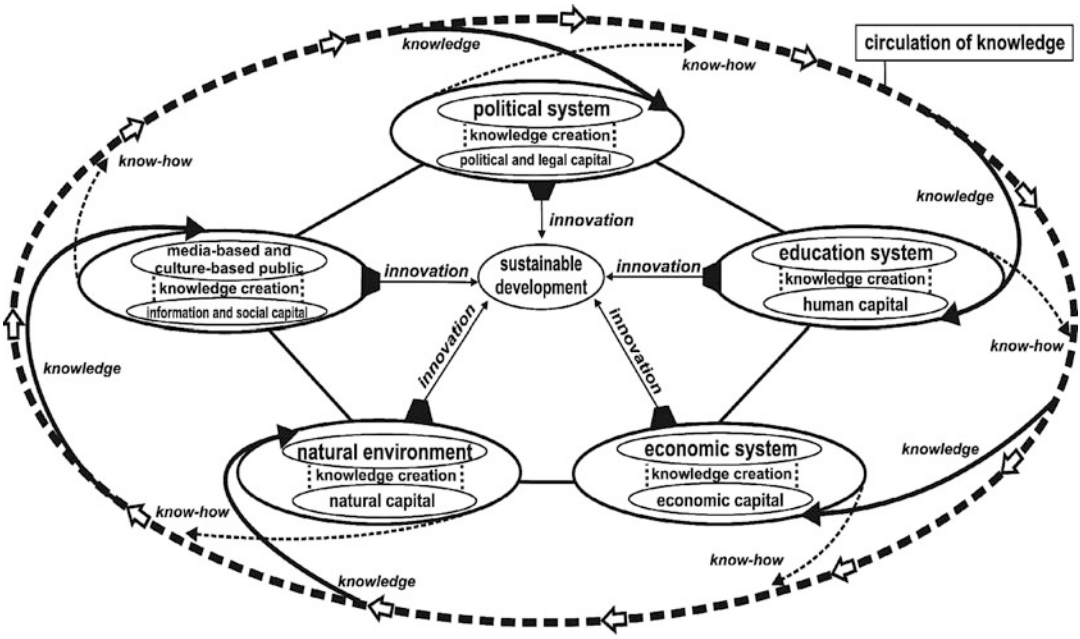
Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice, Fig. 2 The subsystems of the Quintuple Helix Model (Source: Authors' own conceptualization based on Etzkowitz and Leydesdorff (2000, p. 111) and on Carayannis and Campbell (2009, p. 207, 2010, p. 62))

The goal and interest of the *Quintuple Helix* are to include "*natural environment*" as a new subsystem for knowledge and innovation models, so that "nature" becomes established as a central and equivalent component of and for knowledge production and innovation. The *natural environment* is for the process of knowledge production and the creation of new innovation particularly important because it serves for the preservation, survival, and vitalization of humanity, the making-possible of new green technologies, and humankind, after all, should learn more from nature (especially in times of climate change). With the *helix of natural environment*, "sustainable development" and "social ecology" become constituent for social (societal) innovation and knowledge production (Carayannis and Campbell 2010, pp. 58–62):

> The Quintuple Helix furthermore outlines what sustainable development might mean and imply for 'eco-innovation' and 'eco-entrepreneurship' in the current situation and for our future. (Carayannis and Campbell 2010, pp. 62–63)

The most important constituent element of the *Quintuple Helix* – apart from the active "human agents" – is the resource of "knowledge," which, through a circulation (= *circulation of knowledge)* between social (societal) subsystems, changes to innovation and know-how in a society and for the economy (see Barth 2011a, p. 6). The *Quintuple Helix*, thereby, visualizes the collective interaction and exchange of "knowledge" in a state (nation-state) by means of the following five subsystems (= *Helices*): (1) *education system*, (2) *economic system*, (3) *natural environment*, (4) *media-based and culture-based public (also civil society)*, (5) and the *political system* (see Carayannis and Campbell 2010, pp. 46–48, 62). To analyze sustainability in a *Quintuple Helix* and to make sustainable development determining for progress therefore means that each of the five described subsystems (*Helices*) has a special and necessary asset at its disposal, with a social (societal) and academic (scientific) relevance for use (see Fig. 3, below; see also Barth 2011a, p. 6 and 2011b, pp. 30–31; Meyer 2008, pp. 89–95; Carayannis 2004, pp. 49–50):

1. The *education system*: The *education system*, as the first subsystem, defines itself in reference to "academia," "universities," "higher education systems," and schools. In this helix, the necessary "human capital" (e.g., students, teachers, scientists/researchers, academic entrepreneurs, etc.) of a state (nation-state) is being formed by diffusion and research of knowledge.
2. The *economic system*: The *economic system*, as the second subsystem, consists of "industry/industries," "firms," services, and banks. This helix concentrates and focuses the "economic capital" (e.g., entrepreneurship, machines,

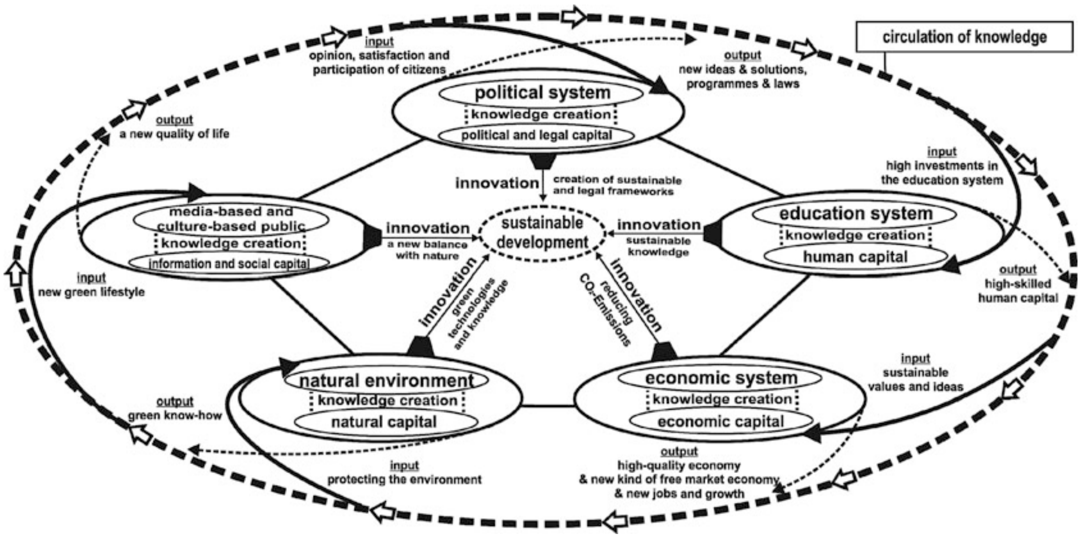


Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice, Fig. 3 The Quintuple Helix Model and its function (functions) (Source: Authors' own conceptualization based on Etzkowitz and Leydesdorff (2000), on Carayannis and Campbell (2006, 2009, 2010), and on Barth (2011a))

products, technology, money, etc.) of a state (nation-state).

3. The *natural environment*: The *natural environment* as third subsystem is decisive for a sustainable development and provides people with a "natural capital" (e.g., resources, plants, variety of animals, etc.).
4. The *media-based and culture-based public*: The fourth subsystem, *media-based and culture-based public*, integrates and combines two forms of "capital." On the one hand, this helix has, through the *culture-based public* (e.g., tradition, values, etc.), "social capital." On the other hand, the helix of *media-based public* (e.g., television, Internet, newspapers, etc.) contains also "capital of information" (e.g., news, communication, social networks).
5. The *political system*: The *political system*, as a fifth subsystem, is also of crucial importance because it formulates the "will," where to the state (nation-state) is heading toward in the present and future, thereby also defining, organizing, as well as administering the general conditions of the state (nation-state). Therefore, this helix has a "political and legal capital" (e.g., ideas, laws, plans, politicians, etc.).

In summary, the *Quintuple Helix Model* can be described in the following way (see Figs. 2 and 3, above): It is a theoretical and practical model for the exchange of the resource of "knowledge," based on "five" social (societal) subsystems with "capital" at its disposal, in order to generate and promote a sustainable development of society (Carayannis and Campbell 2010, pp. 60–62). In this *Cumulative Model of Quintuple Helix*, the resource of "knowledge" moves through a "*circulation of knowledge*" from *subsystem to subsystem* (see Barth 2011a, p. 6). This *circulation of knowledge* from subsystem to subsystem implies that knowledge has qualities of an *input* and *output* of and for subsystems within a state (nation-state) or also between states. If an *input* of knowledge is contributed into one of the five subsystems, then a *knowledge creation* takes place.



Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice, Fig. 4 Effects of investments in education for sustainability (Source: Authors' own conceptualization)

This *knowledge creation* aligns with an exchange of basic knowledge and produces new inventions or knowledge as *output*. The *output* of *knowledge creation* of a subsystem has therefore two routes (ways): (1) The first route leads to an *output* for the production of innovations for more sustainability in a state (nation-state); (2) the second route leads to an *output* on new know-how back into the *circulation of knowledge*. Through the *circulation of knowledge*, the new *output* of newly created know-how of a subsystem changes into *input* of knowledge for a different subsystem of the *Quintuple Helix* (see Carayannis and Campbell 2010; Barth 2011a). About the *input* and *output* of knowledge, it can be said consequently:

> On the one hand, knowledge serves as an input or resource for advanced societies and economies, which increasingly depend on knowledge. On the other hand, knowledge production (knowledge creation) also generates knowledge as an output, which then is being fed back (recycled) as a knowledge input. (Carayannis and Campbell 2006, p. 4)

Therefore, in a *Quintuple Helix* by and with the means of five *helices*, the exchange of knowledge in a state (nation-state) is being dealt with all its conjunctions, in order to promote knowledge-production-based sustainable development.

The Challenge of Global Warming in a *Quintuple Helix Innovation Model*

This brings us to the main question of our analysis: *How can sustainable development, with regard to "Global Warming," be practiced step-by-step within a Quintuple Helix Model?* As we have seen, the resource of knowledge is the most important "commodity" in a *Quintuple Helix*. The *circulation of* knowledge continually stimulates new knowledge. As a result, all systems in a *Quintuple Helix* influence each other with knowledge, in order to promote sustainability through new, advanced, and pioneering innovations. With the example of a targeted investment into the *education system* of the *Quintuple Helix Model*, we will describe "how" more sustainable development can be considered feasible, in reference to "global warming," for the national level and for positive effects that may arise for society (see Fig. 4, below):

Step 1: When more investments flow into the *helix* of the education system to promote sustainable development under the aspect of global warming, the *Quintuple Helix Model* shows and demonstrates that, as an *input*, investments create new impulses and suggestions for *knowledge creation* in the *education system*.

For example, targeted investments produce new equipment, new places for scientists and teachers, and a higher research opportunity. Therefore, a larger *output* of innovations from science and research can be obtained. At the same time, teaching and training can improve their effectiveness. Particularly, the investment in education should have a positive impact on "human capital" as a manifestation of *output* of the *education system:* because of more resources, teaching and training should be more effective, allowing "human capital" to realize chances and to target uses more directly. The *output* that arises from "human capital" for a greener development or sustainable development is in turn also an *input* in the *helix* of the *economic system.*

Step 2: By means of *input* of new knowledge through "human capital" in the *helix* of the *economic system*, the "value" (*values*) of the *knowledge economy* or of an *advanced knowledge economy* consequently increases. Through the enhancement of knowledge, important further production facilities and development opportunities for a sustainable, future-oriented (future-sensitive) green economy, based on *knowledge creation*, can be stimulated and achieved. Not only that such a *knowledge creation* realizes in the *economic system* new types of jobs, new green products, and new green services, also new and decisive impulses for *"green and greener economic growth"* are possible. In this subsystem, new values (like *corporate social responsibility*) are being demanded, enabling and supporting a new *output* of know-how and innovations by the *economic system*. Thus, in addition, Barth writes:

> The economic capital of know-how is in this context sustainability. Here, the output of economic know-how will be a high-quality and sustainable economy, but in fact, the special know-how which the economic system implies now, is probably a new harmony of human beings with nature. (Barth 2011a, p. 8)

Step 3: This new sustainability as an *output* of the *economic system* will be a new input of knowledge in the *helix* of *natural environment*. This new knowledge "communicates" to nature that it will be increasingly protected, as lesser exploitation, destruction, contamination, and wastefulness (extravagance) is taking place. The *natural environment* can, thus, regenerate itself and strengthen its "natural capital," and humanity can also learn again and further more from nature (= *knowledge creation)*. The goal of this *helix* should be to live in balance with nature, to develop regenerative technologies, and to use the available, finite resources sustainably and in a sensitive approach. Here, particularly natural science disciplines come into play to form new green know-how for humans. This know-how as *output* of the subsystem of the *natural environment* can provide more environmental protection and a superior quality of life to people. Moreover, the development of new environmentally friendly technologies can reduce the CO_2 emissions more effectively and can aid in diminishing climate change. In summary, the following can be explained in context with Barth about the *helix* of *natural environment*: "The output of the natural environment hence is a green know-how" (Barth 2011a, p. 9).

Step 4: The *output* of the *natural environment* is followed by an *input* of new knowledge about nature and a green (greener) lifestyle for the subsystem of *media-based and culture-based public*. In this *helix*, it is of crucial importance to communicate and to live a green lifestyle. Here, the *media-based public* receives a new and crucial function (= *"information capital"*), which is spreading through the media the information about a new green consciousness and the new human lifestyle. This capital should provide incentives, how a green lifestyle can be implemented in a simple, affordable, and conscious way (= *knowledge creation*). This *knowledge creation* promotes the necessary "social capital" of the *culture-based public*, on which a society depends for sustainable development. This "social capital," therefore, must pass on information about wishes, needs, problems, or satisfaction of citizens as *output* into politics or the *political system*. The know-how *output* of the *media-based and culture-based public* serves thereby as new *input* for the *helix* of the *political system*.

Step 5: The *input* of knowledge into the *political system* is the know-how from the *media-based and culture-based public* and represents also the collective knowledge from the three other subsystems of society. The important discussions on this new knowledge in the political systems are necessary impulses for *knowledge creation*. The goal of this *knowledge creation* is a "political and legal capital," which makes the *Quintuple Helix* more effective, more high quality, and more sustainable. Consequently, the newly obtained know-how is an *output* of suggestions, sustainable investments and objectives. The new *output* of knowledge and know-how of the *political system* leads across the *circulation of knowledge* back again into the *education system, economic system, natural environment*, and *media-based and culture-based public*.

Conclusion and Future Directions

In summary, as we illustrated by the example of the discussion in Sect. "The Challenge of Global Warming in a Quintuple Helix Innovation Model" ("five-step flow analysis"), it should be clear that all systems in a *Quintuple Helix* perform a pivotal function, influencing each other. If more sustainable development is being considered (and demanded) on a national level, as a result of "global warming," and if, for instance, more targeted investments in a specific *Helix* of the *Quintuple Helix* start flowing, then there will be a positive impact on all other subsystems and on the society as a whole. The *Quintuple Helix Innovation Model* demonstrates that an investment in knowledge and a promotion of knowledge production brings into play new and crucial impulses for innovation, know-how, and the advancement of society. By initiating small steps toward sustainability, *long-term and leading knowledge societies* can emerge, which will live in balance with nature and ultimately, perhaps, lead to a *"green economic wonder."*

To conclude, the *Quintuple Helix Innovation Model* makes it clear that the implementation of thought and action in sustainability will have a positive impact on society as a whole. The new quality management for more sustainability lies therefore in the creation of new knowledge, know-how, and innovation in balance with nature (see Carayannis and Campbell 2010, pp. 58–62). One chief objective of the *Quintuple Helix* is to enhance *"value in society"* through the resource of knowledge. The discussion about the *Quintuple Helix Model* indicates that striving for the promotion of knowledge as a "knowledge nugget" should be regarded as being essential (see Carayannis and Formica 2006, p. 152): This means that knowledge is the key to and for more sustainability and to a new quality of life. Today, knowledge is the "most fundamental resource" (Lundvall 1992, p. 1). Nevertheless, whether a state (nation-state, beyond nation-state) is leading in different fields in the future will be primarily, if not even solely, be decided by its potential to develop new knowledge, know-how, and innovation in balance with nature. However, the improved exchange of knowledge and the striving for knowledge, new know-how, and innovations through the *Quintuple Helix Model* can be or at least offer a solution for the challenges of sustainable development under the aspect of "global warming" in the twenty-first century.

Q

Cross-References

▶ Academic Firm
▶ Mode 1, Mode 2, and Innovation
▶ Mode 3
▶ Quadruple Helix
▶ Quality of Democracy and Innovation
▶ Triple Helics

References

Barbier EB. Rethinking the economic recovery: a global green new deal, United Nations Environment Program (UNEP); 2009. http://www.unep.org/greeneconomy/portals/30/docs/GGND-Report-April2009.pdf

Barth TD. Konzeption, messung und rating der demokratiequalität. Brasilien, südafrika, australien und die russische föderation 1997–2006. Saarbrücken: VDM-Verlag Dr. Müller; 2010.

Barth TD. The idea of a green new deal in a quintuple helix model of knowledge, know-how and innovation. International Journal of Social Ecology and Sustainable Development. 2011a;1(2):1–14.

Barth TD. Freiheit, Gleichheit, Demokratiequalität: Zur Qualitätsmessung in den Top 20 Demokraten des Democracy Rankings [Freedom, equality and the quality of democracy: measuring quality in the Top 20 democracies of the democracy ranking] [Dissertation (Doctoral Thesis)]. Vienna: University of Viennal; 2011b.

Barth TD. Die 20 besten demokratien der welt. Freiheit – gleichheit – demokratiequalität auf einen blick. Norderstedt: Books on Demand Verlag; 2011c.

Bhaskar R. Context of interdisciplinarity: interdisciplinarity and climate change. In: Bhasakar R, Frank C, Høyer KG, Næss P, Parker J, editors. Interdisciplinarity and climate change: transforming knowledge and practice for our global future. New York: Routledge; 2010. p. 1–24.

Biegelbauer P. Learning from abroad: the Austrian competence centre programme Kplus. Science and Policy. 2007a;34(9):606–18.

Biegelbauer P. Ein neuer blick auf politisches handeln: politik-lernansätze im vergleich. Österreichische Zeitschrift für Politikwissenschaft (ÖZP). 2007b;36(3):231–47.

Campbell DFJ. The university/business research networks in science and technology: knowledge production trends in the United States, European Union and Japan. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport, CT: Praeger; 2006. p. 67–100.

Campbell DFJ. Wie links Oder wie rechts Sind österreichs länder? eine komparative langzeitanalyse des parlamentarischen mehrebenensystems österreichs (1945–2007). SWS-Rundschau. 2007;47(4):381–404.

Campbell DFJ. The basic concept for the democracy ranking of the quality of democracy. Vienna: Democracy Ranking; 2008. http://www.democracyranking.org/downloads/basic_concept_democracy_ranking_2008_A4.pdf. Accessed 20 Oct 2011.

Campbell DFJ, Barth TD. Wie können demokratie und demokratiequalität gemessen werden? modelle, demokratie-indices und länderbeispiele im globalen vergleich. SWS-Rundschau. 2009;49(2):208–33.

Campbell DFJ, Güttel WH. Knowledge production of firms: research networks and the — scientification of business R&D. International Journal of Technology Management. 2005;31(1/2):152–75.

Campbell DFJ, Schaller C, editors. Demokratiequalität in österreich – zustand und entwicklungsperspektiven. Opladen: Leske + Budrich; 2002.

Campbell DFJ, Pölzlbauer P, Barth TD. Das "democracy ranking 2010 of the quality of democracy" – erstveröffentlichung (German). Vienna, Austria: Democracy Ranking; 2010. http://www.democracyranking.org/downloads/Democracy_Ranking_Concept_Earlyrelease_German_2010.pdf.

Carayannis EG. Measuring intangibles: managing intangibles for tangible outcomes in research and innovation. International Journal of Nuclear Knowledge Management. 2004;1(1/2):49–67.

Carayannis EG, editor. Planet earth 2011 – global warming challenges and opportunities for policy and practice. Rijeka: Open Access Publisher; 2011. http://www.intechopen.com/books/show/title/planet-earth-2011-global-warming-challenges-and-opportunities-for-policy-and-practice.

Carayannis EG, Alexander JM. Global and local knowledge. Glocal transatlantic public-private partnerships for research and technological development. Houndmills: Palgrave MacMillan; 2006.

Carayannis EG, Campbell DFJ. "Mode 3": meaning and implications from a knowledge systems perspective. In: Carayannis EG, Campbell DFJ, editors. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters. A comparative systems approach across the United States, Europe and Asia. Westport, CT: Praeger; 2006. p. 1–25.

Carayannis EG, Campbell DFJ. "Mode 3" and "quadruple helix": toward a 21st century fractal innovation ecosystem. International Journal of Technology Management. 2009;46(3/4):201–34.

Carayannis EG, Campbell DFJ. Triple helix, quadruple helix and quintuple helix and how do knowledge, innovation and the environment relate to each other? a proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. International Journal of Social Ecology and Sustainable Development. 2010;1(1):41–69.

Carayannis EG, Campbell DFJ. Open innovation diplomacy and a 21st century fractal research, education and innovation (FREIE) ecosystem: building on the quadruple and quintuple helix innovation concepts and the "mode 3" knowledge production system. Journal of the Knowledge Economy. 2011;2(3):327–72. http://www.springerlink.com/content/d1lr223321305579/.

Carayannis E, Formica P. Intellectual venture capitalists: an emerging breed of knowledge entrepreneurs – viewpoint. Industry and Higher Education. 2006;20(3):151–6.

Carayannis EG, Kaloudis A. 21st century democratic capitalism: a time for action and a time to lead. International Journal of Social Ecology and Sustainable Development. 2010;1(1):1–13.

Carayannis EG, Zedtwitz Mv. Architecting GloCal (Global – Local), real-virtual incubator networks (G-RVINs) as catalysts and accelerators of entrepreneurship in transitioning and developing economies. Technovation. 2005;25:95–110.

Diamond L, Morlino L. Introduction. In: Diamond L, Morlino L, editors. Assessing the quality of democracy. Baltimore: The John Hopkins University Press; 2005. p. ix–xliii.

Dubina IN. Управление творчеством персонала в условиях инновационной экономики [Creativity management in the innovation economy]. Moscow: Academia; 2009.

Dubina IN, Carayannis EG, Campbell DFJ. Creativity economy and a crisis of the economy? Coevolution of knowledge, innovation, and creativity, and of the knowledge economy and knowledge society. Journal of the Knowledge Economy. 2012;3(1):1–24. http://www.springerlink.com/content/t5j8l12136h526h5/.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and "mode 2" to a triple helix of university-industry-government relations. Research Policy. 2000;29:109–23.

Friedman TL. Hot, flat and crowded: why we need a green revolution – and how we can renew our global future. London: Penguin; 2008.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.

Giddens A. The politics of climate change. Cambridge/Malden: Polity Press; 2009.

Green New Deal Group. A green new deal: joined-up policies to solve the triple crunch of the credit crisis, climate change and high oil prices – The first report of the Green New Deal Group, London: New Economic Foundation; 2008. http://www.neweconomics.org/sites/neweconomics.org/files/A_Green_New_Deal_1.pdf

Höll O, et al. Entwicklungspolitik. In: Dachs H, editor. Politik in Österreich. Das Handbuch. Vienna: MANZ'sche Verlags- und Universitätsbuchhandlung; 2006. p. 884–904.

Høyer KG. Seven theses on CO_2 reductionism and its interdisciplinary counteraction. In: Bhasakar R, Frank C, Høyer KG, Næss P, Parker J, editors. Interdisciplinarity and climate change: transforming knowledge and practice for our global future. New York: Routledge; 2010a. p. 35–53.

Høyer KG. Technological idealism: the case of the thorium fuel cycle. In: Bhasakar R, Frank C, Høyer KG, Næss P, Parker J, editors. Interdisciplinarity and climate change: transforming knowledge and practice for our global future. New York: Routledge; 2010b. p. 164–82.

Hufbauer GC, Charnovitz S, Kim J. Global warming and the world trading system. Person Institute for International Economics: Washington DC; 2009.

IPCC. Climate change 2007: the physical science basis. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL, editors. The fourth assessment report of the intergovernmental panel on climate change. Cambridge, United Kingdom and New York, USA: Cambridge University Press; 2007a.

IPCC. Climate change 2007: the physical science basis – errata for the working group – fourth assessment report; 2007b. http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-errata.pdf

Kreisky E, Löffler M. Demokratietheorieentwicklung im Kontext gesellschaftlicher Paradigmen. Österreichische Zeitschrift für Politikwissenschaft. 2010;39(1):89–104.

Kuhlmann S. Future governance of innovation policy in Europe – three scenarios. Research Policy. 2001;30:953–76.

Le Monde diplomatique, editor. Atlas der globalisierung – sehen und verstehen, was die welt bewegt. Paris/Berlin: Le Monde diplomatique/taz; 2009.

Lundvall B-Å, editor. National systems of innovation. Towards a theory of innovation and interactive learning. London: Pinter Publishers; 1992.

Meyer B. Wie muss die Wirtschaft umgebaut werden? Perspektiven nachhaltiger Entwicklung, Lizenzausgabe für die Bundeszentrale für politische Bildung. Frankfurt am Main/Bonn: Fischer Taschenbuch Verlag; 2008.

Müller M, Niebert K. Epochenwechsel – Plädoyer für einen grünen New Deal. Munich: Oekom Verlag; 2009.

Nowotny H, Scott P, Gibbons M. Mode 2 revisited: the New production of knowledge. Minerva. 2003;41:179–94.

O'Donnell G. Human development, human rights, and democracy. In: O'Donnell G, Cullell JV, Iazzetta OM, editors. The quality of democracy. Theory and applications. Notre Dame, Indiana: University of Notre Dame Press; 2004. p. 9–92.

OECD. OECD-factbook 2009 – economic, environmental and social statistics – special focus: inequality. Paris: OECD Publishing; 2009.

OECD. OECD-factbook 2010 – economic, environmental and social statistics – special focus: the crisis and beyond. Paris: OECD Publishing; 2010.

Otzelberger A. Gender-responsive strategies on climate change: recent progress and ways forward for donors. BRIDGE: development – gender. Brighton: Institute of Development Studies; 2011. http://www.bridge.ids.ac.uk/vfile/upload/4/document/1107/Gender%20responsive%20strategies%20on%20climate%20change_progress%20and%20ways%20forward%20for%20donors.pdf.

Parker J. Towards a dialectics of knowledge and care in the global system. In: Bhasakar R, Frank C, Høyer KG, Næss P, Parker J, editors. Interdisciplinarity and climate change: transforming knowledge and practice for our global future. New York: Routledge; 2010. p. 205–26.

Rommetveit K, Funtowicz S, Strand R. Knowledge, democracy and action in response to climate change. In: Bhasakar R, Frank C, Høyer KG, Næss P, Parker J, editors. Interdisciplinarity and climate change: transforming knowledge and practice for our global future. New York: Routledge; 2010. p. 149–63.

Schumpeter JA. Capitalism, socialism and democracy. New York: Harper Perennial; 1976.

Q

Sen A. Ökonomie für den menschen – wege zur gerechtigkeit und solidarität in der marktwirtschaft; Aus dem englischen von C. Goldmann. 4th ed. Munich: Deutscher Taschenbuch Verlag; 2007.
Stern N. The global deal – climate change and the creation of a new era of progress and prosperity. New York: Public Affairs; 2009.
Tilly C. Democracy. New York: Cambridge University Press; 2007.
Ulram PA. Politische Kultur der Bevölkerung. In: Dachs H et al., editors. Politik in Österreich. Das Handbuch. Vienna: MANZ'sche Verlags- und Universitätsbuchhandlung; 2006. p. 513–24.
UNDP. Human development report 2007/2008. Fighting climate change: Human solidarity in a divided World. New York: United Nations Development Program; 2007. http://hdr.undp.org/en/reports/global/hdr2007-2008
UNDP. Human development report 2010 (20th anniversary edition) – The real wealth of nations: pathways to human development. New York: United Nations Development Program; 2010. http://hdr.undp.org/en/media/HDR_2010_EN_Complete_reprint.pdf
UNDP. Human development report 2011 – sustainability and equity: a better future for all. New York: United Nations Development Program; 2011. http://hdr.undp.org/en/reports/global/hdr2011/
UNEP. Green jobs: towards decent work in sustainable, low-carbon world, Washington/New York: United Nations Environment Program; 2008. http://www.unep.org/labour_environment/PDFs/Greenjobs/UNEP-Green-Jobs-Report.pdf 2011
United Nations. Report of the World commission on environment and development (42/187). New York: United Nations; 1987a. http://www.un-documents.net/a42r187.htm
United Nations. Report of the World commission on environment and development: "Our common future." New York: United Nations; 1987b. http://worldinbalance.net/pdf/1987-brundtland.pdf

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DOI 10.1007/978-1-4614-3858-8,

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Research on Creativity

Liane Gabora
Department of Psychology, University of British Columbia Okanagan Campus, Kelowna, British Columbia, Canada

Synonyms

Creativity research; Empirical aesthetics; Empirical studies of creativity; Empirical studies of the arts

Key Concepts and Definition of Terms

Defining Research

Research can be defined as an objective, systematic investigation for the purpose of testing theories, establishing facts, and advancing knowledge. Psychology is often subdivided into experimental psychology, which is research oriented, and clinical psychology, which is practice oriented. Thus, psychological research on creativity is primarily, though not entirely, the domain of experimental psychology. Educators, business people, people in the entertainment industry, and others also study creativity.

Defining Creativity

Creativity is arguably our most uniquely human trait. It enables us to escape the present, reconstruct the past, and fantasize about the future to visualize something that does not exist and change the world with it. Defining creativity presents difficulties. For example, not all creative works are useful, and not all are aesthetically pleasing, but both usefulness and aesthetic value capture, in some sense, what creativity is about. Nevertheless, psychologists have almost universally converged on the definition originally proposed by Guilford over 60 years ago. Guilford (1950) defined creativity in terms of two criteria: *originality* or novelty and *appropriateness* or adaptiveness, that is, relevance to the task at hand. *Surprise* is sometimes added as a third criterion (Boden 2004). Some add *quality* as a separate criterion, while others use the term appropriateness in a way that encompasses quality. Creativity has also been defined as a complex or syndrome, and some define it so broadly as to include novelty-generating processes in the biological world or the universe at large. However, it is the "originality and appropriateness" definition that is encountered most often and that has become standard (Sternberg 1988; Feldman et al. 1994; Amabile 1996; Runco 2004). While this definition provides a much-needed departure point for discussion about and measurement of creativity, there is likely no one-size-fits-all definition of creativity. For scientific or technological endeavors, appropriateness might be more important, whereas in the arts, originality might be weighted more heavily. Thus, creativity must be assessed relative to the constraints and affordances of the task.

The Four P's of Creativity

It is often said that creativity involves four P's: person, process, product, and place (Rhodes 1961).

Research focused on the creative *person* can take the form of studies that investigate what personality traits are correlated with high creativity, or case studies of particular creative individuals. It can also include *historiometric methods*, which involve obtaining qualitative data on eminent creators (i.e., number of paintings produced throughout their career), transforming it into quantitative data, and performing statistical analyses, with the aim of finding general laws or statistical relationships that transcend particulars of person, time, or place.

The second P of creativity concerns the *process* by which ideas come about. Process-oriented research can involve testing descriptive models of the stages of the creative process, investigations into what kind of thought processes are contributing to the creative ideation in these different stages, or studies of creative individuals at work. These studies may be observational, involve questionnaires, or neuroscientific methods such as functional magnetic resonance imaging (fMRI).

The third P of creativity, the *product*, can take the form of a physical object (e.g., a painting) or behavioral act (e.g., a dance) or an idea, theory, or plan of action. Western approaches to creativity have tended to focus more on the product than Eastern approaches.

The last of the four P's of creativity, *place*, concerns the environmental conditions conducive to creativity. Certain individual situations, such as education and training, role models and mentors, and perhaps surprisingly, childhood trauma, are correlated to historical creativity. Economic growth appears to have a stimulating effect on creativity, whereas war has an inhibitory effect.

Historical Versus Personal Creativity

Psychologists distinguish between different kinds and degrees of creativity, such as between historical and personal creativity (Boden 2004). When the creative process results in a product that is new to all of humanity and makes an impact on the course of civilization, it is referred to as *historical creativity* (H-creativity).

Historical creativity is also sometimes referred to as *eminent creativity* because the creator tends to become famous. When the creative process results in a product that is new to the creator, but someone else has come up with it before, or it is not creative enough to impact human civilization, it is referred to as *personal creativity* (P-creativity). Although personal creativity does not change the world, it can be a source of pleasure and amusement. Clearly there are shades of gray between these extremes.

A concept that is closely related to personal creativity is *everyday creativity*. Everyday creativity manifests in daily life; it comes through in how one prepares a meal, decorates a room, or interprets and shares experiences. Everyday creativity generally begins with an innovative, often unconventional approach to life that involves capitalizing on hidden opportunities, undertaking common tasks in uncommon ways, and finding solutions to challenges as they arise.

Historical and personal creativity are also sometimes referred to as *big-C* and *little-C creativity*, respectively. Some additionally make the case for *mini-C creativity*, which involves making personally meaningful interpretations of objects and events and which can form the basis for more substantial creative acts (Beghetto and Kaufman 2007). Daily life involves thinking things and doing things that, at least in some small way, have never been thought or done before and thus that *everyone* is somewhat creative (Runco 2004).

Creativity Versus Discovery and Invention

Creativity is sometimes distinguished from two related concepts: discovery and invention. *Discovery* involves finding something *already present* and sharing it, for example, Columbus' discovery of America. It is relatively impersonal because if one person had not discovered it, someone else would have. *Invention* entails unearthing something that was *not present before*, for example, Alexander Bell's invention of the telephone. Like discovery, it is relatively impersonal. Creativity also involves sharing something that was not present before. Some psychologists additionally require that for something to qualify as creative, it must be profoundly personal in the sense that one feels the presence of a unique individual in the work, for example, Leonardo Da Vinci's art.

Theoretical Background

Early Conceptions

In early times, the creative individual was viewed as an "empty vessel" that was filled with inspiration by a divine being. In the first half of the twentieth century, there was little research on creativity because it was thought to be too complex and frivolous for scientific investigation. A pioneering exception to this was Wallas' (1926) classification of the creative process into a series of stages. The first of Wallas' stages is *preparation*, which involves obtaining the background knowledge relevant to the problem, its history (if known), and any instructions or past attempts or preconceptions regarding how to solve it. It also involves conscious, focused work on the problem. The second stage is *incubation* – unconscious processing of the problem that continues while one is engaged in other tasks. The preparation and incubation stages may be interleaved, or incubation may be omitted entirely. Wallas proposed that after sufficient preparation and incubation, the creative process is often marked by a sudden moment of *illumination*, or insight, during which the creator glimpses a solution to the problem, which may have had to be worked and reworked to make sense of it. Wallas' final phase is referred to as *verification*. This involves not just fine-tuning the work and making certain that it is correct, as the word implies, but putting it in a form that can be understood and appreciated by others. Empirical investigation of Wallas' theory yielded mixed results. Another shortcoming is that it is merely descriptive; it does not explain how or why the stages occur.

The year 1950 marks a turning point for research in creativity when it was the subject of Guilford's address to the American Psychological Association. Creativity came to be a subject of interest to many disciplines and to be approached from many directions.

Cognitive Approaches

Cognitive approaches to creativity focus on the mental processes by which creative outputs are generated. These processes include concept combination, expansion of concepts, imagery, metaphor, and divergent thinking. *Divergent thinking* is often assumed to involve the generation of multiple, often unconventional, possibilities (Guilford 1968; for a review, see Runco et al. 2010). Another view is that creative thinking is divergent not in the sense that it generates multiple possibilities, but in the sense that it produces a raw idea that is vague or unfocused and requires processing to become viable (Gabora and Saab 2011).

Some who take a cognitive approach viewed the mind, metaphorically, as a computer (or computer program). They proposed that creativity involves a *heuristic search*, in which rules of thumb guide the inspection of different states within a particular state space (a set of possible solutions) until a satisfactory solution is found (Newell et al. 1957). In heuristic search, the relevant variables of the problem or situation are defined up front; thus, the state space is generally fixed. Examples of heuristics include breaking the problem into subproblems, and working backward from the goal state to the initial state. It has since been proposed that creativity involves heuristics that guide the search for a new state space itself, rather than just a new possibility within a given state space (Boden 1990a; Kaplan and Simon 1990). This involves switching from one representation of the problem to another, sometimes referred to as *restructuring* (Weisberg 1995).

Modifications to Wallas' classic four-stage model of creativity (discussed above) have been proposed. Some incorporate a phase that involves *problem finding* (noticing that something is amiss), problem posing (expressing the problem), problem construction (developing a detailed representation of the problem), or problem definition and redefinition (Amabile 1996; Guilford 1950). Problem finding may involve sensing gaps or disturbing missing elements (Torrance 1963). It may take the form of identification of a "seed incident" around which the creative project takes shape. Another modification of the four-stage model is the addition of a frustration phase prior to incubation, in which straightforward attempts to solve the problem prove unfruitful. Not all modifications *add* to the four stages; for example, Geneplore is a two-stage model involving *generation* of crudely formed ideas referred to as pre-inventive structures followed by *exploration* of them through elaboration and testing (Finke et al. 1992). Defocused attention, by diffusely activating a broad region of memory such that everything seems to be related in some way to everything else, may be conducive to the divergent thought that characterizes idea generation. Focused attention, by activating a narrow region of memory and treating items in memory as distinct chunks that can be readily operated on, may be conducive to the convergent thought that characterizes elaboration (Gabora 2010).

Psychometric Approaches

Those who take a psychometric approach develop tests of creativity as well as methods for improving creativity.

The most widely known creativity test is the Torrance Test of Creative Thinking (Torrance 1974). It consists of multiple components or subtests. Examples include the *unusual uses test*, in which participants are asked to think of as many uses for a common object (e.g., a brick) as possible, or the product improvement test, in which participants are asked to list as many ways as they can to change a product to make it more useful or desirable (e.g., to change a toy monkey so children will have more fun playing with it). Since then, other tests of creativity have been proposed. Perhaps the most successful of these is Amabile's (1996) consensual assessment technique, in which a panel of expert judges is asked to rate the creativity of products in their area of expertise, for example, story writing, poetry, or collage making.

The most well-known technique for improving creativity is *brainstorming*, which takes place in groups and involves encouraging them to suggest all the ideas they can, no matter how seemingly "crazy," and discouraging criticism of ideas. Such techniques are used by businesses and organizations to develop successful business strategies and in business schools to foster entrepreneurship.

Developmental and Personality Approaches

Developmental research focuses on creativity in children and throughout the lifespan. One interesting set of findings to come from this research concerns the relationship between emotions and creative play during childhood. The extent to which children access affect-laden (emotional) thought is correlated with ratings of associative thinking, cognitive flexibility, and creativity, and the extent to which children engage in fantasy and play (Russ 1993). Moreover, the degree of fantasy and imagination at ages six to seven was shown to be related to the divergent thinking ability in high school.

Personality approaches to creativity focus on the personality traits associated with creativity (Feist 1998). Creativity is correlated with independence of judgment, self-confidence, aesthetic orientation, risk-taking, openness to experience, tolerance of ambiguity, impulsivity, lack of conscientiousness, high energy, attraction to (and ability to handle) complexity, problem sensitivity, flexibility, the ability to analyze, synthesize, evaluate, and reorganize information, and the ability to engage in divergent thinking. There is also evidence that creative individuals are more prone to anxiety and emotional (affective) disorders. Creative individuals differ from one another with respect to whether they are internally versus externally oriented, person-oriented or task-oriented, and explorers (who tend to come up with ideas) or developers (who excel at turning vague or incomplete ideas into finished products).

Social and Cultural Approaches

Social and cultural approaches examine how family dynamics, group dynamics, and cultural influences affect creativity, and how creativity compares across different cultures.

Maslow believed that creativity is fostered by environments that are supportive and free of evaluation, which he claimed are conducive to self-actualization. However, it is not the case that positive social environments necessarily lead to creativity. For example, highly creative people tend to experience a lack of parental warmth and are more likely to have experienced the death of a parent at an early age, and raise fewer children, than average.

According to the *systems approach*, creativity occurs through an interaction between (1) the *individual*, that is, the creator, (2) a *field* which is a set of relevant individuals in society, that is, the people involved in same creative endeavor as the individual, and (3) the *domain*, that is, a set of relevant ideas in the culture (Csikszentmihalyi 1997; Sawyer 2006). The creative process is thus viewed as highly entwined with the process of persuasion.

Case Studies

In the early days of scientific psychology, experiments in strictly controlled laboratory conditions were encouraged; case studies of individuals, and particularly introspective accounts, were not taken seriously. Recently, researchers have acknowledged the artificiality of many laboratory studies, and here is stronger appreciation for taking an *ecological* approach. This involves studying people in their everyday environments engaged in everyday tasks and treating individual differences not just noise, but as interesting in their own right. Individual differences are particularly important in the study of creativity. Thus, although case studies and introspective accounts are notoriously flawed and will never take the place of more controlled approaches, they have a place in the scholarly effort to achieve a nuanced and multifaceted understanding of the creative process.

Case studies of scientists have led to enhanced appreciation of the importance of problem finding. Einstein, for example, famously claimed that real advance in science is marked by regarding an old problem from a new angle and the formulation of a problem is often more challenging than its solution. Real-time studies of individual artists and designers have also yielded interesting insights. For example, they have shown that creative ideation involves elaborating on a “kernel idea,” which takes shape through ongoing interaction between artist and artwork (Feinstein 2006; Locher 2010).

Clinical Approaches

As mentioned previously, there is evidence that creative individuals are more emotionally unstable and prone to affective disorders such as depression and bipolar disorder and have a higher incidence of schizophrenic tendencies than other segments of the population (Andreason 1987; Flaherty 2005; Jamieson 1993). There is also evidence that they are more prone to suicide (Goodwin and Jamison 1990) and to abuse drugs and alcohol (Ludwig 1995).

Clinical approaches to creativity are not focused exclusively on the negative. Freud's notion of the *preconscious* – a state between conscious and unconscious reality where thoughts are loose and vague but interpretable – is still viewed by many as the source of creativity. Clinical approaches to creativity also investigate how art therapy, music therapy, and dance therapy can help patients open up and express themselves in ways that verbal communication may not. Ironically, the notion of verification, as it has traditionally been construed since it was first proposed by Wallas as the final stage of the creative process, involves making the idea appealing to others takes into account the minds of those who will be exposed to the creative work, while not taking into account the effect of the idea on the mind of the one who creates it. Researchers are now beginning to take this into account.

Biological Approaches

Biological approaches investigate the extent to which there is a genetic basis to creativity as well as the underlying neural and physiological mechanisms underlying creativity. Twin studies and other sorts of evidence suggest creative abilities are, at least to some extent, genetically inherited (Eysenck 1995). One way to go about investigating the brain mechanisms underlying creativity involves dissecting the brains of people who were particularly creative during their lifetimes. It has been shown that Einstein's brain had (1) a partially absent Sylvian fissure, which may have facilitated communication between different parts of the brain, and (2) a high ratio of glial cells to neurons in both area 9 of prefrontal cortex, which is associated with planning, attention, and memory, and area 39 of the left inferior parietal cortex, which is associated with synthesizing information from other brain regions.

A less dramatic but more common way to investigate the brain mechanisms underlying creativity involves examining brain activity when people engage in creative activities using *electroencephalography* (EEG) or *functional magnetic resonance imaging* (fMRI). Though application of such methods is stymied by the fact that many brain areas are active during creative thought, some interesting findings are emerging (Bristol et al. 2012). There is evidence that different kinds of creativity (deliberate vs spontaneous and emotional vs cognitive) involve different neural circuits (Dietrich 2004). Creative thought appears to be facilitated by lower levels of noradrenaline and dopamine – catecholamines directly linked to cognitive control, prefrontal functioning, and cortical arousal. EEG experiments show that divergent thinking tasks produce decreased beta range synchrony and increased alpha range synchrony over the frontal cortex, providing further evidence for a loosened cognitive control and lower prefrontal cortical arousal during creative thought. There is also indirect neuroscientific support for the contextual focus hypothesis, that is, the notion that creativity involves the ability to match where one's mode of thought lies on the spectrum from associative to analytic. Prior to finding the solution to an insight problem, there is neural recruitment of the prefrontal and executive memory networks as well as the so-called default network associated with spontaneous mind wandering. This suggests that mind wandering has a utilitarian function and provides neurological support for the notion of expanded receptivity through neural recruitment during divergent thought.

This is further supported by physiological research into creativity, which has revealed evidence of an association between creativity and high *variability* in physiological measures of arousal such as heart rate, spontaneous galvanic skin response, cortical activity, and EEG alpha amplitude (Jausovec and Bakracevic 1995). For example, although creative people tend to have higher *resting* arousal levels, when engaged in creative problem solving, they tend to have lower than average arousal levels. These findings in conjunction with the cognitive findings discussed previously suggest that during creative activities, creative individuals are particularly prone to enter a state that is quite different from their normal resting state, a state that has both a physiological aspect (low arousal level) and a cognitive aspect (associative mode of thought).

Biological approaches to creativity also address what is going on at the level of neurons. The vagueness of a "half-baked" idea, the sense that it holds potential, as well as its capacity to actualize in different ways depending on how one thinks it through may be the side effects of interference. *Interference* refers to the situation wherein a recent memory interferes with the capacity to recall an older memory because they are encoded in overlapping distributions of neurons in the brain. It is generally thought of as detrimental, but it may be a side-effect of a phenomenon that is on the whole beneficial with respect to creativity. When two or more items are encoded in overlapping distributions of neural cell assemblies they may get evoked simultaneously, a new idea may be the result. This phenomenon has been referred to as *creative interference*. The vagueness of the new idea may reflect that it is uncertain how, in the context of each other, the interfering components come together as a realizable whole. The ability to work with an idea in this state is related to the personality trait of tolerance of ambiguity.

Evolutionary Approaches

Comparative and evolutionary approaches address the question of how humans evolved their superlative creative abilities, how these abilities compare with those of other species, and in what sense ideas can be said to evolve.

The earliest preserved signs of human creativity include primitive stone tools approximately 2 million years ago (Mithen 1998). Since this corresponds with an increase in brain size, it has been suggested that this enabled memories to be encoded in more detail, such that there were more ways in which one experience could evoke a reminding of another. This provided more ways of chaining thoughts and experiences into an integrated understanding of the world, which both enabled and constrained the generation of creative ideas. Computational modeling has provided support for this hypothesis (Gabora and Saberi 2011).

The Middle/Upper Paleolithic marks the beginnings of art, science, and religion and has been referred to as the "big bang of creativity" (Mithen 1998). It has been suggested that this is due to onset of the previously-mentioned capacity to spontaneously shift between divergent and convergent modes of thought. Once it was possible to shrink or expand the field of attention and thereby tailor one's mode of thought to the demands of the current situation, the fruits of one mode of thought could be used as ingredients for the other, resulting in a richer understanding of the world and enhanced potential to creatively change it. Tasks requiring either mode of thought or both at different stages of the creative process could be carried out more effectively.

Another evolutionary approach uses societies of artificial agents that invent ideas and imitate neighbors' ideas to understand how ideas evolve over time. This approach has provided evidence that the evolution of ideas gives rise to many of the phenomena observed in biological evolution, such as (1) an increase in complexity and fitness (usefulness) over time and (2) an initial increase in diversity as the space of possibilities is explored followed by a decrease associated with convergence on the fittest possibilities. If even a small fraction of agents are creative, new ideas spread by imitation in waves throughout the society, reaching other creators who put another spin on them, and over time they evolve. The more creative the agents are, the fewer of them there must be in order to maximize the evolution of fitter ideas, suggesting that more creativity is not always better. In collaboration with archaeologists, creativity researchers also trace the process by which one creative idea or technological invention paved the way for another (Dasguptas 1996). They are using evolutionary theories and computational models to aid the process of organizing human-created artifacts into cultural lineages.

Computational Approaches

We saw that computational modeling is particularly useful to those who investigate hypotheses concerning the mechanisms by which humans became creative. Because the onset of such mechanisms left no detectable trace, one begins by establishing which hypotheses are at least computationally feasible. However, researchers studying the evolution of creativity are not the only ones to take a computational approach; indeed, efforts to develop computational models of creativity date back to the 1950s and 1960s. Herbert Simon developed a computer program called BACON that came up with scientific laws. The 1990s and early 2000s witnessed a plethora of computer programs that generate music, art, stories, screensavers, and so forth. Computational models have been used to model incubation and insight (Helie and Sun 2010), concept combination (Thagard and Stewart 2011), and the shifting between two distinct modes of thought in the creative process (Martindale 1995).

Open-Ended Issues

The Relative Contributions of Expertise, Chance, and Intuition

While most psychologists believe that creativity involves a combination of expertise, chance, and intuition, they differ with respect to the degree of emphasis they place on these factors.

Expertise theorists point to evidence that it takes approximately a decade to master a creative domain. Experts are better than beginners at detecting and remembering domain-relevant patterns and are more adept at generating effective problem representations and, when necessary, revising initial hypotheses. Expertise theorists hypothesize that creativity involves everyday thought processes such as remembering, planning, reasoning, and restructuring. They claim that no special or unconscious thought processes are required for creativity, just familiarity with and skill in a particular domain (Weisberg 2006).

Critics of this view note that entrenchment in established perspectives and approaches may make experts more prone than beginners to psychological phenomena that reinforce familiar perspectives and approaches such as set, functional fixedness, and confirmation bias. Those who emphasize the role of *chance* include advocates of the Darwinian theory of creativity, according to which the creative process, like natural selection, entails blind generation of possibilities followed by selective retention of the most promising of them (Simonton 1999).

Some view creativity as not so much a matter of generating and selecting among predefined alternatives but of intuiting an idea and then, by considering the idea from different perspectives or trying it out different ways, taking it from an ill-defined state of potentiality to a well-defined state of actualization (Gabora 2010). Those who study the role of *intuition* and the actualization of potentiality emphasize the association-based structure of memory and note that creative individuals tend to have *flat associative hierarchies*, meaning they have better access to *remote associates*, items that are related to the subject of interest in indirect or unusual ways (Mednick 1962).

The Relative Importance of Process Versus Product

While the tradition in the West is to focus almost exclusively on creativity as the process by which a new and useful or entertaining product is generated, Eastern conceptions focus more on creativity as a process that can bring about therapeutic change, that is, that expresses, transforms, solidifies, or unifies the creator's understanding of and/or relationship to the world. In the extreme, the external creative work can be viewed as a mere by-product of the internal transformation brought about through engagement in a creative task. In this view, the primary value of the creative process is that it enables the creator to express, transform, solidify, or unify the creator's understanding of and/or relationship to the world, while the external product provides a means of tracking or monitoring this internal transformation. This view figures prominently in creative therapies such as art therapy, music therapy, and drama therapy.

Is Creativity Domain Specific or Domain General?

Psychologists who emphasize the role of expertise tend to view creativity as highly *domain* *specific;* expertise in one domain is not expected to enhance creativity in another domain. Support for domain specificity comes from findings that expertise or eminence with respect to one creative endeavor is only rarely associated with expertise or eminence with respect to another (Baer 2010). For example, creative scientists rarely become famous artists or dancers.

Psychologists who emphasize intuition and associative processes tend to view creativity as more *domain general* because associative thinking can produce metaphors that connect different domains, and we gain understanding and control over experiences by translating and reexpressing them through the constraints of different domains. This view is supported by studies involving self-report scales, creativity checklists, and other sorts of psychometric or personality data that tend to support the view that creativity is domain general (Plucker 1998). It is also supported by experiments showing that if you recognize someone's creative style in one domain, for example, creative writing, there is an above-chance probability of recognizing works by that individual in another domain, for example, art (Gabora et al. in press).

Most researchers probably believe that the truth lies somewhere between the extremes. A focus on product as opposed to process, and on *talent*, which is treated as one-dimensional, as opposed to *style*, which is multidimensional, may have resulted in exaggeration of the extent to which creativity is domain specific. Creativity in one domain may help but not guarantee creativity in another; it is neither strongly domain specific nor domain general. Although social recognition of achievement in multiple domains may be rare, individuals use multiple creative domains to meaningfully develop, explore, express, and understand themselves and their world. Characteristic stylistic elements of these explorations may be transported from one domain to another since all of an individual's creative outputs are expressions of an individual's particular uniquely structured internal model of the world.

Is There a Dark Side to Creativity?

Although creativity is clearly stimulating and indispensable to cultural and technological advancement, many believe it has a dark side (Cropley et al. 2010). In addition to the evidence that eminent creativity is correlated with proneness to affective disorders, suicide, and substance abuse, discussed above, excessive creativity may result in reinventing the wheel, and absorption in ones' own creative ideas may interfere with assimilation or diffusion of proven effective ideas. Moreover, it is not necessary for everyone to be creative. We can all benefit from the creativity of a few by imitating, admiring, or making use of their creative outputs. Computer modeling suggests that society self-organizes to achieve a balance between relatively creative and uncreative individuals (Leijnen and Gabora 2009). The social discrimination that creative individuals often endure until they have proven themselves may aid in achieving this equilibrium.

The Relationship Between Creativity and Intelligence

Early research suggested that creativity and intelligence are correlated up until an IQ of approximately 140, after which point they diverge; thus, an individual can be very smart but not terribly creative, or highly creative but not terribly smart. Recent research suggests that the relationship between the two is more complex. Clearly it depends on how the constructs of creativity and intelligence are being measured.

Implications for Theory, Policy, and Practice

Research in creativity has implications for theory, policy, and practice in a number of arenas. A first area of application is clinical. Creative activities such as art making, music making, dance, and drama are increasingly seen to have therapeutic effects that can be effective in both clinical and nonclinical settings. The transformation that occurs on canvas or on the written page is thought to be mirrored by a potentially therapeutic sense of personal transformation and self-discovery that occurs within. Immersion in the creative task has been referred to as a state of *flow* that may share characteristics with deeply spiritual or religious experiences (Csikszentmihalyi 1997).

A second, related area of application is childrearing and education. For example, creative play in childhood facilitates access to affect-laden (emotional) thoughts, which may enhance cognitive flexibility and divergent thinking abilities. Amabile's (1996) work on *intrinsic motivation* showed that rewards for creative work may actually inhibit creativity because focusing on an external reward leads people to neglect the intrinsic rewarding nature of creative acts.

A third area of application is in business settings. For example, psychological work on *brainstorming sessions*, in which people get together as a group and put forward ideas in an open and accepting environment, has shown that it may be more effective when group work is followed immediately by individual work or when individuals communicate by writing so as to avoid the problem of everyone talking at once.

Conclusion and Future Directions

It is our creativity that perhaps most distinguishes humans from other species and that has completely transformed the planet we live on. Research in creativity is an exciting area that brings together many different fields: neuroscience, education, and business, as well as computational and mathematical modeling. Past and current areas of controversy concern the relative contributions of expertise, chance, and intuition, whether the emphasis should be on process versus product, whether creativity is domain specific versus domain general, and the extent to which there is a dark side to creativity. Promising areas for further research in creativity include computational modeling, and work on the neurobiological basis of creativity, as well as environmental influences on creativity.

Cross-References

▶ Psychology of Creativity

References

Amabile T. Creativity in context. Boulder, CO: Westview Press; 1996.
Andreason NC. Creativity and mental illness; prevalence rates in writers and their first degree relatives. Am J Psychiatry. 1987;144:1288–92.
Baer J. Is creativity domain specific? In: Kaufman J, Sternberg R, editors. Cambridge handbook of creativity. Cambridge UK: Cambridge University Press; 2010. p. 321–41.
Beghetto RA, Kaufman JC. Toward a broader conception of creativity: a case for "mini-c" creativity. Psychol Aesthet Creativity Arts. 2007;1(2):73–9.
Boden M. The creative mind: myths & mechanisms. London: Basic Books; 1990a/2004.
Boden MA. The philosophy of artificial intelligence. New York: Oxford University Press; 1990b.
Bristol A, Vartanian O, Kaufman J, editors. The neuroscience of creativity. New York: Oxford University Press; 2012.
Cropley D, Cropley JK, Runco M, editors. The dark side of creativity. Cambridge UK: Cambridge University Press; 2010.
Csikszentmihalyi M. Creativity: flow and the psychology of discovery and invention. New York: Harper Perennial; 1997.
Dasgupta S. Technology and creativity. New York: Oxford University Press; 1996.
Dietrich A. The cognitive neuroscience of creativity. Psychon Bull Rev. 2004;11:1011–26.
Eysenck HJ. Genius: the natural history of creativity. New York: Cambridge University Press; 1995.
Feinstein JS. The nature of creativity. Stanford CA: Stanford University Press; 2006.
Feist GJ. A meta-analysis of personality in scientific and artistic creativity. Pers Soc Psychol Bull. 1998;2:290–309.
Feldman DH, Csikszentmihalyi M, Gardner H. Changing the world: a framework for the study of creativity. Westport, CT: Praeger Publishers; 1994.
Finke RA, Ward TB, Smith SM. Creative cognition: theory, research, and applications. Cambridge, MA: MIT Press; 1992.
Flaherty AW. Frontotemporal and dopaminergic control of idea generation and creative drive. J Comp Neurol. 2005;493:147–53.
Gabora L. Revenge of the 'neurds': characterizing creative thought in terms of the structure and dynamics of human memory. Creativity Res J. 2010;22(1):1–13.
Gabora L, Saberi M. How did human creativity arise? An agent-based model of the origin of cumulative

open-ended cultural evolution. Proceedings of the ACM Conference on Cognition & Creativity; 2011 Nov 3–6. Atlanta, GA. 2011. pp. 299–306.
Gabora L, O'Connor B, Ranjan A. The recognizability of individual creative styles within and across domains. Psychol Aesthet Creat Arts. (in press).
Gardner H. Frames of mind: the theory of multiple intelligences. New York: Basic Books; 1993.
Goodwin FK, Jamison R. Alcohol and drug abuse in manic-depressive illness. In: Goodwin F, Jamison K, editors. Manic-depressive illness. New York: Oxford University Press; 1990. p. 210–26.
Guilford JP. Creativity. Am Psychol. 1950;5:444–54.
Guilford JP. Intelligence, creativity and their educational implications. San Diego: Knapp; 1968.
Helie S, Sun R. Incubation, insight, and creative problem solving: a unified theory and connectionist model. Psychol Rev. 2010;117(3):994–1024.
Jamieson KR. Touched by fire: Manic-depressive illness and the artistic temperament. New York: Free Press; 1993.
Jausovec N, Bakracevic K. What can heart rate tell us about the creative process? Creativity Res J. 1995;8: 11–24.
Kaplan CA, Simon HA. In search of insight. Cogn Psychol. 1990;22:374–419.
Leijnen S, Gabora L. How creative should creators be to optimize the evolution of ideas? a computational model. Elect Proc Theoret Comp Sci. 2009;9: 108–19.
Locher P. How does a visual artist create an artwork? In: Kaufman J, Sternberg R, editors. Cambridge handbook of creativity. Cambridge UK: Cambridge University Press; 2010. p. 131–44.
Ludwig AM. The price of greatness. New York: Guilford Press; 1995.
Martindale C. Creativity and connectionism. In: Smith SM, Ward TB, Finke RA, editors. The creative cognition approach. Cambridge, MA: MIT Press; 1995. p. 249–68.
Mednick S. The associative basis of the creative process. Psychol Rev. 1962;69:220–32.
Mithen S. Creativity in human evolution and prehistory. London: UK; 1998.
Newell A, Shaw C, Simon H. The process of creative thinking. In: Gruber HE, Terrell G, Wertheimer M, editors. Contemporary approaches to creative thinking. New York, NY: Pergamon; 1957. p. 153–89.
Plucker JA. Beware of simple conclusions: the case for the content generality of creativity. Creativity Res J. 1998;11:179–82.
Rhodes M. An analysis of creativity. Phi Delta Kappa. 1961;42:305–10.
Runco MA. Creativity. Annu Rev Psychol. 2004; 55:657–87.
Runco MA, Millar G, Acar S, Cramond B. Torrance tests of creative thinking as predictors of personal and public achievement: a fifty year follow-up. Creativity Res J. 2010;22(4):361–8.
Russ SW. Affect and creativity. Hillsdale NJ: Erlbaum; 1993.
Sawyer RK. Explaining creativity: The science of human innovation. New York: Oxford University Press; 2006.
Sawyer K. Explaining creativity: the science of human innovation. 2nd ed. New York: Oxford University Press; 2012.
Simonton DK. Creativity as blind variation and selective retention: is the creative process Darwinian? Psychol Inq. 1999;10:309–28.
Sternberg RJ. A three-faceted model of creativity. In: Sternberg RJ, editor. The nature of creativity. Cambridge, England: Cambridge University Press; 1988. p. 125–47.
Thagard P, Stewart TC. The AHA! experience: creativity through emergent binding in neural networks. Cognit Sci. 2011;35:1–33.
Torrance EP. Education and the creative potential. Minneapolis: University of Minnesota Press; 1963.
Torrance EP. Torrance tests of creative thinking-norms and technical manual. Lexington, Massachusetts: Ginn, 1974.
Wallas G. The art of thought. London: Cape; 1926.
Ward TB, Smith SM, Finke RA. Creative cognition. In: Sternberg RJ, editor. Handbook of creativity. New York: Cambridge University Press; 1999. p. 189–212.
Weisberg RW. Prolegomena to theories of insight in problem solving: Definition of terms and a taxonomy of problems. In: Sternberg RJ, Davidson JE, editors. The nature of insight (pp. 157196). Cambridge MA: MIT Press; 1995.
Weisberg RW. Creativity. New York: Wiley; 2006.

Research Productivity

▶ Networks and Scientific Innovation

Resourcefulness

▶ Creativity: Cultural Capital in Mathematics

Resources and Innovation

▶ Organizational Slack and Innovation

Restoration Theology and the Church

▶ Church and Entrepreneurship

Reticulation

▶ Network and Entrepreneurship

Retrodiction

▶ Imagination

Retrospection

▶ Imagination

Revival

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Risk

▶ Heroic Entrepreneur, Theories

Risk Management

▶ Venture Capital and Small Business

Risk, Uncertainty, and Business Creation

Yvon Pesqueux
Conservatoire National des Arts et Métiers, Développement des Systèmes d'Organisation, Paris, France

Synonyms

Mission; Vision

Definitions

Entrepreneurship

Entrepreneurship is an activity involving the discovery, evaluation, and exploitation of business opportunities in order to introduce new goods and services, new organizational structures, markets, processes, and materials using resources that may not have existed before.

Uncertainty

Uncertainty pertains to not knowing future events.

Business Opportunity

Business opportunities stem from social norms, which shape individuals' behavior and make them predictable and reliable by building an economic environment favorable to the transgression of those norms.

Risk

Risk is an advantage or disadvantage to which an individual is exposed. It occurs when the fallouts

Yvon Pesqueux is a professor at CNAM (Conservatoire National des Arts et Métiers) and head of the Chair "Développement des Systèmes d'Organisation". He earned his Ph.D. in Economics from the University of Paris 1 Panthéon-Sorbonne (1975); his special interests are management, philosophy and ethics, business and society, and corporate social responsibility. He has published several scientific articles and books. He is also an editor of Society and Business Review (Emerald Publishing – www.emeraldinsight.com/sbr.htm).

of a taken decision or undertaken action are *more or less likely*.

Theoretical Background and Discussion

Today, uncertainty is portrayed as the lie of the land of a changing and unstable world where the rhetoric of adaptation and anticipation stands as a bulwark against unexpectedness, which generates business opportunities. Adaptation and anticipation are elevated to useful modes of action and reduce uncertainty to a discursive object that actually aims to legitimate them. The project laid out in this way is coupled with a substitution process, that is, if not conceptual at least language based: uncertainty fades away to risk. This discursive development can be viewed as resulting from the substitution of one concept for the other. It may also reveal a shift from a general and, say, economic conception to commerce-oriented thinking. The latter assumption implies that the two notions are distinct in substance. Are uncertainty and risk only related notions or are they clearly distinct from one another, as common sense seems to suggest? While the first one has a largely negative connotation today, the second one has been mythologized in ways that blur the original sense ascribed to it in management or political sciences (Méric et al. 1999).

Where is the dividing line between uncertainty and risk? Language, dictionaries, and their usage suggest that uncertainty is about not knowing future events and risk the direct result of this ignorance, which occurs when the outcomes of a taken decision or undertaken action are unknown. In the business field, F. Knight (1921) makes a clear distinction between uncertainty and risk. According to Knight, an uncertain situation refers to the impossibility to form a distribution of the different possible outcomes, for two types of reasons: the ignorance of the future course of events and the lack of relevant probability models. An event is described as uncertain when one does not know for certain if it will happen, regardless of its probability. Accordingly, risk occurs in uncertain situations where uncertainty has been reduced through the use of information and the implementation of probability measurement tools. Thus, the distinction between uncertainty and risk hinges upon the degree of accuracy of the knowledge.

> To preserve the distinction (. . .) between the measurable uncertainty and an unmeasurable one we may use the term "risk" to designate the former and the term "uncertainty" for the latter (. . .) If our reasoning so far is at all correct, there is a fatal ambiguity in these terms, which must be gotten rid of, and the use of the term "risk" in connection with the measurable uncertainties or probabilities of insurance gives some justification for specializing the terms as just indicated. (Knight 1921, Part III, Chapter IV, p. 1)

The French word "risque" may trace back to the sixteenth century, and its etymology may be related to maritime business activity (the risk born by goods traveling by sea), which expresses the danger related to an enterprise and, in its military version, the soldier's luck or misfortune. As B. Laperche (2003) observes, there is a clear connection between "risk, an expression of danger, and the necessity to reward or reduce it." Drawing upon scholastic exegesis (twelfth to thirteenth centuries), F. Braudel (1997) bridges "risk" with "capital" to account for interest, due to the risk taken by the loaner, at a time when insurance activity was expanding.

To risk is synonymous with to attempt, to undertake, which underpins the distinction throughout the development of capitalism between the risk to undertake (profit) and the risk of financing (interest). These two risks are complemented by the risks on human capital in the sense that today's firms are large-sized organizations viewed as risky collectives. This kind of risk focuses specifically on the manager's talent and their willingness to take risks given that the resulting profit is a major aspect at stake. Besides, technical risk is also viewed as related to business opportunity.

The two theorists of the "entrepreneur – opportunities" link are J. A. Schumpeter (1990) and I. M. Kirzner (1975). The former argues that the existence of new information is critical to understanding new opportunities and working out the appropriate response, whereas the latter holds that the incompleteness of knowledge on resources is what creates gains and shortages of those resources and generates opportunities.

He introduces notions such as process (entrepreneurial), learning (and its corollary, learning time), and knowledge (due to entrepreneurial alertness). J. A. Schumpeter conceived of the entrepreneur as a disruptive force contrasting with I. M. Kirzner's equilibrium-based conception: "entrepreneurship and competition are two sides of the same coin." Entrepreneurial spirit is not only worthwhile in the long run ("new ideas," "departures") but also in the short term, as price-based competition is viewed as equally entrepreneurial. Thus, I. M. Kirzner incorporates advertising and information (given or requested) in the entrepreneurial process.

J. B. Say is credited with having promoted the figure of the entrepreneur in economic life. The following quotes taken from *Catéchisme d'économie politique* illuminate this statement: "*Whom do you give the name of industrious*? The name industrious or industrial is given to men who draw their main income from their industrial skills; still, they can also be capitalists, if they earn an income from any capital, and landowners, if they earn an income from a property. *What do you first observe about the incomes of industry entrepreneurs?* They are variable and uncertain because they depend on the value of products, and the needs of men and the price of products aimed for them cannot be predicted beforehand. *What do you further observe*? That of all industrious men, industry entrepreneurs are those who can lay claim to the highest profits. If several of them go bankrupt, the greatest riches also lie with them. *How do you account for this effect when it does not result from an unexpected circumstance?* Because the kind of service that entrepreneurs provide to production is scarcer than the kind of service of other industrious men. *Why is it scarcer?* First, because one cannot form a business without owning, or at least without being equipped to borrow the necessary capital, which rules out many competitors. Second, because this advantage must be paired with qualities that are not common to all, such as judgment, activity, consistency, and some knowledge of men and things. Those who do not have all these prerequisites are not competitors, or at least they are short-lived competitors as their enterprises cannot sustain themselves. What are the most profitable enterprises? Those whose products are the most consistently and unfailingly in demand, and therefore those that contribute to the making of food products and the most necessary objects."

On Risk

The economic sense of risk is probably one that has led to the most important developments. This holds for the categories related to incentive contracts, which are justified by the expected potential benefits with a view to balancing risks and incentives in relation to business opportunities. As P. A. Samuelson (1973) points out, "A person is risk-averse when the pain from losing a given amount of income is greater in magnitude than the pleasure from gaining the same amount of income (...) People are generally risk-averse, preferring a sure thing to uncertain levels of consumption: people prefer outcomes with less uncertainty and the same average values." In this definition, risk stands as a counterforce to the legitimacy given to an essentially entrepreneurial society. It is about actively addressing potential perils ahead.

Risk can be "objective" – resulting from a noninterpretive rational approach to risk – or "perceived" depending on the agent's position in their exposure to risk and/or their psychology (Goddard et al. 2003). In this respect, it is worth mentioning the importance of cognitive biases and the weight of representations, and distinguishing between "riskophiles" and "riskophobes" as risk is ultimately undefined by and of itself. As vehicles of representation, the media play a major role in this duality as they reinforce the weight of perception over a rational approach. N. Luhman (1993) distinguishes between the "risky object" (for our purposes, the risk of business opportunities) and "risk perpetrators" (here, the entrepreneur who takes them) and points out that risk springs from a linkage between the two. This approach is based on an individualistic and behaviorist conception of social issues. In fact, this compensation-based perspective implies that anything (including life) has a price that dooms the average "risk-averse" individual to consolation. Two anthropologies of risks are here stated, one is economic and the other is moral and negative.

Arguably, risk emerges as a major theme in contrast to the overestimation of individual interest in the late twentieth century. Thus, our societies have attributed a normative value to risk (see Beck 2001). Interest, of individualistic nature, may contrast with risk, of generalist nature, from a cognitive and emotional standpoint. Risk can only be "reflected upon" from an individualistic perspective as it occurs at the same time as the Other. In other words, the absence of the Other is risk-free. An individualistic philosophical anthropology based on interest contrasts with a general anthropology and a heroization of the risk-taker in what could be called risk aesthetics, adding to its ethics. Risk, thus, emerges as one of the current eschatologies, yet one that culminates into business opportunities. Risks and their embracing seem to be all beneficial: they open up prospects of returns resulting from activity creation by bringing to the fore a proactive dimension. Thus, risk is a sort of phylogenetic factor as business opportunities are viewed as unplanned experiences leading to "happy outcomes."

Business Opportunities and Entrepreneurship

In this area, one should first mention the importance of institutionalized clichés such as "the entrepreneur is the person who seizes opportunities" as well as the frequent and indeterminate shifts between "leader" and "entrepreneur," on one hand, and "leadership" and "entrepreneurship" (a process-based occurrence), on the other. This also applies to the "entrepreneurship – innovation" overlap.

When it comes to entrepreneurs, innovators, or leaders, there are three approaches to consider:

– A theory of facts that represents the entrepreneur, innovator, or leader based on three personality traits. The pursuit of these traits supposedly helps single out an entrepreneur and/or innovator or leader. The two generic traits emphasized are focus (on a project, therefore a projective focus) and passion, which are then viewed as constituents of their identity. However, it is important to stress the limiting obscurity of this essentialist perspective.
– A situationist perspective which premises that an individual becomes an entrepreneur and/or innovator or leader through situations. The limitation of this consequentialist perspective is its relativism.
– An interactionist perspective grounded on the interweaving of personal dimensions and situations. The limitation is its indeterminacy. However, it is relevant insofar as it consolidates previous positions by addressing contextual elements, either personal (relatives, family background), biographical (encounters, events), or environment-derived (cultural background, responsiveness of society, education system, level of development – businesses created in developing countries differ from those of developed countries).

Empirically, entrepreneurship pertains to the creation of new businesses and self-employment. Organizing is the process that leads the entrepreneur to create or alter an organization based on market and context rationales that he/she will use to exploit a business opportunity. Organizing is an uncertain process because it is implemented before any feedback on the validity of the opportunity is available, with many questions still unanswered. It is implemented based on the entrepreneur's knowledge with regard to their education, past experiences, etc. But even if entrepreneurs draw upon existing aspects (they imitate what other companies do), the organizing process implemented is driven by creativity. In order to leverage an opportunity, the entrepreneur chooses a mode of exploitation that shapes the scope of the new organization.

It is based on the following premises: the existence of business opportunities and differences between individuals (and the entrepreneur is a risk taker). Thus, it is a process that interweaves innovation and organizational activities.

The term "entrepreneur" is also bound up with the very popular notion of "stakeholder," which justifies the management-centered conception prevalent in "stakeholder theory" (Freeman 1984). The theory emphasizes the growing instability of identifying and classifying stakeholders as one edges away from the core of the firm. This classification of "entrepreneurship" may then result in substituting an event-based description of the firm for a political description in which the firm's action is to seize business opportunities. In this respect, stakeholders are "firm-based" (they are its substance somehow). They point to a self-produced image of the firm catered toward citizens for the agonist purposes of virtuous interaction, excluding the resort to an outside third party, mostly the State.

The relationships between the entrepreneur and entrepreneurship are routinely examined in management sciences as they highlight the logic that underpins the shift from the figure to actual action. To refer to entrepreneurship rather than the entrepreneur is to assert the institutionalization of business opportunity. The person is the reference, whereas the notion is institutionalized action and the possibility of extensiveness. This also applies to "intrapreneurship," which operates in and around the corporation (spin-off/out is also the term in usage). It is about recapturing the drive of the entrepreneur by building the conditions for seizing business opportunities. More trivially, it is also a mode of reclassification for laid-off employees. One could also add the notion of "exoentrepreneurship," which characterizes the creation and development of a business in a given country from the assets and/or skills of an expatriate.

Conclusion and Future Directions

Finally, one should note the emphasis on the foundational character of the entrepreneur figure, an emphasis that intertwines "mission" and "vision" within the notion of "business opportunity." The notion of mission should be understood in its religious sense (the notion of belief is here emphasized; a missionary is someone who believes in their mission) as well as its sense of priority (a mission builds a contingency, a heteronomy that outweighs the subject's autonomy). The forms of engagement related to the mission range from activism to consistency. But there cannot be a mission without a vision. In the sense discussed here (note that vision is also related to eyesight), vision can be viewed as a resilient guide since vision changes in response to significant changes (supposedly, at least). This makes it opportunistic. The term vision derives from "to see/visualize," but it is anchored in time. To have a vision is to see into the future. Coupled with rationalist logic, the vision is both the representation of a desirable future and a possible future, in other words a somewhat "acceptable prediction" that can ground a commitment. In that way, "vision" is close to "representation" as it indicates individual energy focused toward the formalization and fulfillment of the vision. This is why vision leads to mission. The vision of a business opportunity is somewhat of a performative image spawned by a form of inspiration based on beliefs and values, something intangible made tangible and therefore possible. This is at the core of the phrase "strategic vision of the entrepreneur." From a political point of view, vision is both inclusive and engaging. This definition is supposedly a characteristic of the entrepreneur, innovator, and leader alike. Vision is a direction (from the instigator to the outside). This is why mission and vision are connected to the figure of the entrepreneur.

References

Beck U. La société du risque – sur la voie d'une autre modernité. Paris: Flammarion, collection Champs; 2001.

Braudel F. (1997). Civilisation matérielle, économie et capitalisme XVième-XVIIIième siècle, Tome 2: Les jeux de l'échange, Armand Colin, Paris, p. 201 et suivantes.

Freeman EE. Strategic management: a stakeholder approach. Boston: Pitman; 1984.

Goddard O, Henry C, Lagadec P, Michel-Kerjean E. Traité des nouveaux risques. Paris: Gallimard; 2003.

Knight FH. Risk, uncertainty and profit. Boston: Houghton Mifflin, Dover Publications; 1921 (Original ed. 1921).

Kirzner IM (1975), Competition and entrepreneurship, University of Chicago Press, 1975 (trad. R. Audouin, Concurrence & Esprit d'entreprise, Economica, Paris, 2005)

Laperche B. L'innovation orchestrée – Risque et organisation, L'Harmattan, série "Economie et innovation." Paris, 2003, p. 8.

Luhman N. Risk, a sociological theory. New York: A. de Gruyter; 1993.
Méric J, Pesqueux Y, Solé A. (1999), La "société du risque" – analyse et critique, Economica, Paris, 2009, Chapitre 2.
Samuelson PA. L'Economique, tome III. Paris: Armand Collin; 1973. p. 355.
Schumpeter JA. Capitalism, socialism and democracy. New York: Harper and Row; 1962 (trans: Fain G, Capitalisme, socialisme et démocratie, Payot, Paris, 1990).

Role of Intuition in Creativity

Cyndi Burnett[1] and Janice Francisco[2]
[1]International Center for Studies in Creativity, Buffalo, NY, USA
[2]BridgePoint Effect, Ottawa, Canada

Synonyms

Gut feelings; Tacit knowledge

What Is Intuition?

Definitions and Perspectives

Intuition has been described as a natural, but complex, process that occurs at an unconscious level. The process provides new information, usually about a topic of importance, through a range of "unusual" mechanisms. These include sudden "aha's," internal dialogues regarding what is right or wrong about a situation, and unexplained feelings – either physiological or emotional. From the recipient's perspective, the actual process is opaque. There is no obvious means by which one could explain, or justify, the conclusion; it is almost as if the information is created out of thin air.

Even though the intuitive process is shrouded in mystery, several schools of thought have emerged, each with their own explanation of how intuition works and what is required for its development. The differences between the schools are largely explained by their stances on where the underlying information originates. Broadly speaking, scientific researchers regard intuition as the product of subconscious processing: tacit sensory perception, domain expertise, and past experiences. Adherents to more spiritual paths explain intuition by reference to hidden knowledge, and divine communication.

Irrespective of the actual explanation, intuition could therefore be seen as a process through which people unconsciously make meaning from internal sources of information and integrate it into their conscious thinking.

Words commonly associated with intuition are hunch/gut feeling, tacit knowledge, unconscious, sensing patterns, knowing without knowing why, insight, and visionary.

Logic Versus Intuition

Logic can be defined as reasoning conducted, or assessed, based on recognized principles of validity that rely on concrete evidence, proof, or inference on the same. When logic is employed in a creative process, it is typically experienced as external to the individual and used as a means to gather information, understand the situation at hand, and explore and weigh options. Logical thinking provides people with the capacity to link decisions and actions to specific knowledge, evidence, or proof and create a chain of justification that can be externally validated. In this way, a person's thinking processes become evident and communicable.

Intuition, by its nature, operates in a very different manner. It acts as a data source and a conduit to the internal world of the individual, offering information and synthesizing emotion without conscious evidence of how it came to be. Intuition functions on trust and uses a touchstone of validity which is simply an individual's experience or "feeling" that it is right, or not right, to take a specific action.

Intuitive and Cognitive Insight

The terms "intuition" and "insight" are often used interchangeably. While it is true that insights are often produced via intuition, it is important to recognize that it is possible to gain deep understanding through purely cognitive mechanisms. The key distinction between these two forms is that in the case of a cognitively derived insight, the individual could explain the development of their understanding, whereas, with an intuitively derived insight, the mechanics of its apprehension are hidden within the process.

Myths of Intuition

Intuition, like creativity, is a much debated and often misunderstood phenomenon. When this is coupled with the arcane nature of the intuitive process, it is not surprising that the topic has acquired a number of myths. Some of the more common myths include the following: intuition does not exist; that it exists and is reserved for only a chosen few; that it is the domain of the supernatural; and that using intuition as the basis for decision making is ungrounded and foolhardy.

The truth about intuition is that it is innate to all humans and available to everyone. However, just as with creativity, the intuitive capability of any one individual is largely a function of their commitment to its development. Developing one's intuition is therefore a personal choice that demands expertise of self which is described as a composite of self-awareness, self-esteem, self-acceptance, and the capacity to trust one's self. Those who value intuition as a source of information tend to have developed their respect by paying attention to their intuitive insights and gradually gaining comfort in using them as a guide post for sensemaking and decision making.

The myth that making decisions based on intuition is ungrounded or foolhardy is derived from cultural preference toward logical and rational thought. Clearly, the careful application of logic is a hugely powerful tool that allows people to evaluate decisions, before leaping into action. Externalized, rational decision-making has played a major role in the development of humanity. Many of the luminaries who have been responsible for these advances, however, have also credited their intuition in the development of their ideas. It is therefore important to note that just because intuition is not deeply understood does not mean that its "products" are wrong, or any less valid than those produced through a more transparent, logical process. In fact, recent developments in the fields of neurology, and behavioral science, lend validity to the complex set of circumstances that produce intuitive "hits."

Several neurological studies have uncovered physiological evidence of intuition as a literal "gut feeling." These sensations result from a chain of biological and neurological events, triggered by heuristics, which are derived from experience and strengthened through feedback loops. The loops are created through the application of the heuristics and their subsequent unconscious evaluation. It appears to be the case that as one means of preparing oneself to deal with future uncertainties, heuristics are stored in the brain centers associated with emotions, feelings, and memories (the basal ganglia and the amygdala parts of the brain known as the emotional or limbic brain). When encountering a new and ill-defined situation, one's brain draws upon these decision rules and synthesizes cumulated learnings to make a decision. These parts of the emotional brain therefore provide a source of wise conclusions and communicate primarily through activating the circuitry extending into the gastrointestinal tract, hence, the "gut feeling."

Other research into decision making has uncovered new information that shows that decisions are made across a spectrum of logic and intuition and whether a decision proves to be good or foolhardy is not so much about whether the decision was made based on intuition or logic but rather the process by which the decision was made, and the level of awareness and trust the decision maker has in the sources drawn upon to make the decision. Many executives and highly trained professionals admit to a decision-making protocol that relies on their intuition as the first or final steps, regardless of the logic or rational evidence that supports doing so. In reality, the validity of a decision, whether intuitively or logically made, is not always immediately evident. Details about the adequacy, appropriateness, efficiency, and effectiveness of a decision unfold over time. In the past, mankind rationalized the world was flat, the earth the center of the universe, and that time was an absolute phenomenon. Through the intuitive insights of creative individuals and the willingness to hold that there may be another possibility, it is now recognized that the world is round, the sun the center of our universe, and that time is relative.

The Role of Intuition in Creativity and Innovation

Locating Intuition Within Deliberate Creative Processes

Is intuition an element within a creative process or is the creative process an intuitive activity, which has had logical elements added to it?

Discussion in the creativity literature regarding the role of intuition in creativity falls all over the map. Some researchers position intuition within the incubation phase of the creative process. Others describe the whole creative process as intuitive. The truth may be found as a blend of these perspectives; exactly how the blend is calculated depends upon one's understanding of both intuition and creativity and how one views the interaction of person with process.

Certainly from the perspective of creative problem solving, a significant proportion of the work designed to support deliberate creativity has approached the topic from a logical, cognitive, and semantic perspective. For adherents of this school, creativity is a process that can be both understood and amplified through the application of the right tools and techniques. It is also true that this view has been ascendant within the business and scientific spheres.

However, creativity researchers also recognize that the emphasis on logical, rational process and tools does not accord with the reported experience of highly creative people. Both Steve Jobs and Albert Einstein are frequently held up as examples of eminent creators who relied heavily upon their intuition. And there is little doubt that they demonstrated the significance of harnessing this important way of knowing. But, perhaps more interestingly, Tim Cook (the new CEO of Apple) also cites the role of intuition in his professional life, suggesting that Apple itself might have an organizational predilection toward intuition: "Engineers are taught to make a decision analytically but there are times when relying on gut or intuition is most indispensable." As a result of recognizing this mismatch between theory and practice, a number of researchers have called for the deliberate development of intuition in order to create a more holistic creative problem solving process.

Regardless of where researchers land in their recognition of the role of logic versus intuition in creativity, it is clear that intuition is intrinsically aligned with the core creative process. Creativity, by its very nature, requires that we take a leap of faith, keep open to possibility, and trust in our intention to create something new, particularly when the reasons and means for doing so are not known, ambiguous, and yet to be discovered.

Intuition as Data

Intuition, by its very nature, emerges through an opaque process. In the field of creativity, this raises the question of how one might assess the validity of data gained in this manner. There are two schools of thought on this topic. One group of researchers holds that intuition is an inherently unreliable process and that the insights will be distorted through emotional and experiential biases. The other group argues that intuition offers a route to "deep" knowledge by allowing people to access their tacit knowledge and associated heuristics.

In the end, there is no clear answer to the question, "is intuitive data valid"? Each situation must be judged on its own merits. However, what is clear is that intuition does offer an additional, and potentially important, source of data. Granted, the data could be distorted based on how the receiver interprets the information or chooses to use it and the same could hold true for logical data.

The key point is that there is value in spending time reflecting upon one's data sources, whether intuitively or logically derived, and working to understand their potential significance. Deliberate creative processes benefit from a diverse set of data. Enhanced understanding – through any mechanism – is likely to strengthen the quality of the resulting decision. For this reason, involving intuition in the creative process offers important benefits.

Strategies for Leveraging Intuition in Creative Problem Solving

Creativity research suggests intuition is favored when faced with working in ambiguous, poorly structured, and uncertain contexts. Creative Problem Solving (CPS), the most widely used and researched model for creative problem solving in the world, is particularly suited to organize thinking and support the discovery and resolution of open-ended, ambiguous, challenging, and multifaceted predicaments or opportunities.

Despite its suitability to ambiguous situations, CPS as a model for creative problem solving is observed as being rationally, cognitively, and semantically oriented. This presents a bit of a conundrum and certainly highlights the necessity for having strategies for the deliberate use of intuition in CPS. Originally introduced by Osborn (1953), it elevates a strictly intuitive process to being highly explicit, offering a means to flexibly employ distinct process steps based on the task at hand. Additionally, it integrates underlying principles of creative thinking (divergence followed by convergence) and establishes challenge questions as an organizing principle (how to, how might, in what ways might, and what might be all the ways) to its use.

When learning about Creative Problem Solving (CPS), students are often reminded to "trust the process." If one were to focus on strategies for leveraging intuition in creative problem solving, the same sage advice would apply – trust intuition as a process for providing information and learn how to use it. As indicated in the discussion on myths about intuition and creativity, one's capacity to leverage intuition in CPS is related to one's self-awareness and how one values and understands intuition as a data source.

Assuming one has made the commitment to develop and use intuition, there are specific strategies that can be employed to leverage intuition in CPS and return it to a more explicit, rather than inferred existence. These strategies include allowing time for incubation, encouraging participants to consciously engage their intuitive capabilities, and using intuitive skills to function more effectively across the entire model.

Allowing for Incubation

Reviews of the history of inventions and major innovations as well as creativity research studies have repeatedly demonstrated the connection between incubation and the production of intuitive insights. Researchers do not agree on an explanation for this connection. Some think that incubation allows the mind to recuperate, while others suggest that it provides an opportunity to forget incorrect solutions or to make new connections with outside stimuli.

Irrespective of the explanation, creating the opportunity for incubation is an important step toward fostering intuitive insights. There are many ways to promote incubation, and some of the more commonly cited methods include taking breaks, going on excursions, engaging in a completely different activity such as cooking, painting, or even, most notably in the literature, by going to sleep.

While incubation provides clear benefits, it is not without its detractors. Building time for incubation is often viewed as inaction or "wasting time," particularly in very action-oriented cultures. These views can discourage people from engaging in incubation and ultimately may damage their thinking process. If there is insufficient time to incubate, there is the chance that intuitive insights will not be reached, and some of the most effective and useful ideas missed.

A group, or individual, may not be allowing themselves sufficient time for incubation if they are not producing the desired results from a CPS workshop; if the group is not naturally taking advantage of incubation opportunities within a process; if, at the end of the session, the group feels that there is unexplored territory but is unable to define it rationally; or if the group is "stuck" and unable to determine why. In any of these situations, making a conscious effort to create greater opportunities for incubation might provide a significant shift in thinking.

Directly Soliciting Input from Users' Intuitive Capabilities

The more deliberate use of intuition in CPS involves directly soliciting input from participants' intuitive capabilities. This, obviously, requires specific tools and techniques that allow people to call upon their intuition.

Some researchers suggest that the existing CPS tool set – given its orientation to rational, cognitive, and semantic-based approaches – lacks the tools to encourage intuition. Others have observed that a tools-based focus misses the opportunity to more actively engage intuition by evolving the entire process. An evolved CPS process would actively encourage affective skills, as well as work to establish a creative climate that normalizes and honors gut feeling insights.

Within the context of the current CPS process, a facilitator might directly solicit input from participant's intuitive capabilities by employing one of the following techniques: encouraging participants to share gut reactions throughout the process, conducting an unstructured dialogue by asking participants to free-flow their ideas, using metaphors and analogies, employing tools in the traditional CPS tool set indicating that logical and intuitive data sources are welcome, and improvising tools and techniques from other domains that are more holistic in nature or that rely predominantly on right-brain thinking strategies. In the case of individual users of CPS, the same approaches could apply.

Using Intuitive Skills

The most recent evolution of CPS, the Creative Problem Solving Thinking Skills Model (CPSTSM) developed by Puccio, Mance, and Murdock (2010), introduces enhancements to creative thinking guidelines and comprises three broad stages – clarification, transformation, and implementation. Related to these broad stages are six cognitive and one meta-cognitive process steps, each with a primary and nonexclusive thinking skill, each of which in turn is correlated to a primary and nonexclusive affective skill. As a process map with thinking tools, CPSTSM, like its predecessors, is particularly suited for use in complex, ambiguous, and multifaceted situations.

The affective skills introduced through the CPSTSM refer to the ways in which one deals with the attitudinal and emotional aspects of learning, recognized as including feelings, appreciation, enthusiasm, motivations, attitudes, and values. While their research linked specific affective skills (mindfulness and sensing gaps), and the requirement to stay focused while converging, to intuition, further research conducted by Burnett (2010) identified certain affective skills in the CPSTSM model as intuitive skills, either because of their reliance on intuition as a data source or because they specifically enable intuitive insights to emerge.

These intuitive skills include tolerance for ambiguity, mindfulness, sensing gaps, and sensitivity to environment. They fall within the domain of expertise, are developed through deliberate practice, and are a by-product of metacognition, time, and experience in the self-aware.

Tolerance for ambiguity in CPSTSM is what allows one to deal with uncertainty and to avoid leaping to conclusions (Puccio et al. 2010). When viewed through the lens of intuition and creativity, it seems as though there are two separate, and related, aspects to this skill – one affective and the other intuitive. The affective aspect relates to the ability to manage one's emotions in such a way as to tolerate the ambiguity. The intuitive aspect gives one the ability and tools to navigate the ambiguity. Without affective capacity, a person might find ambiguous situations too stressful to allow them to engage in an intuitive exploration. Likewise, without intuitive capacity, ambiguous situations may persist beyond anyone's tolerance. These two aspects therefore reinforce and support one another.

Mindfulness is the conduit for intuitive insights on progress, next steps, and actions. When using CPS, one must navigate the spectrum of process, content, context, and self. Mindfulness is what allows us to regulate our focus of attention across this spectrum with curiosity, openness, and acceptance by attending to thoughts, feelings, and sensations relative to the present situation (Bishop et al. 2004). Its underlying principle is metacognition which draws upon reflective thinking as a means to allow us to think about our thinking and awareness as a means to direct cognitive process.

Without regulation of one's attention, it would be difficult to hear the "quiet voices" of intuition and bring them into awareness. Without curiosity, openness, and acceptance, it would be difficult to avoid the trap of logic acting as the tacit censor of one's intuitive thoughts. Ultimately, without mindfulness, it would be difficult to recognize where we are across the spectrum of process, content, context, and self in achieving an outcome and to engage intuition in service of creating that outcome.

Sensing gaps is what allows one to become "consciously aware of discrepancies between what currently exists and what is desired or required" (Puccio et al. 2010) and relates to the innate ability to recognize that something "is not working" or "not adding up." Sensing gaps as an intuitive skill is developed over time, reinforced by experience, i.e., experts are more able to perform this function, and relative to one's capacity for mindfulness and sensitivity to environment. This gives greater weight to the idea that intuitive skills can be developed, irrespective of whether that development is deliberate or simply a side effect of time and experience.

Sensitivity to environment is a gauge to quantify the degree to which we are aware of our physical and psychological environment and our capacity to understand "the interrelated conditions and circumstances that will support or hinder success" (Puccio et al. 2010). The context, or environment, within which we work, provides a frame of reference for status quo, the rules, values, beliefs, and other boundaries within which we must perform. The greater our understanding of the environment within which we operate, the greater our potential for recognizing opportunity and navigating our way through the subtle nuances of our creative challenges. By being sensitive to the environment, we learn to become aware of "decision rules" and develop expertise on what is acceptable and unacceptable within a culture. By taking the time to understand the nature of the box within which we are operating and its underlying assumptions, we increase our capacity for finding entry points to new realities. As Louis Pasteur so astutely observed, "chance favors only the prepared mind."

Conclusions and Future Directions

Intuition is a fundamental part of human thinking. It provides a mechanism by which our subconscious mind can communicate perspectives and insights to our conscious mind. Intuition, however, is a quiet process. It speaks through a range of channels and can only be perceived if one pays attention. Unfortunately, because we lack a thorough understanding of the intuitive process, the products of our subconscious mind tend to be given less credence than those of its louder, cognitive counterpart. This means that in an age in which creativity is seen as increasingly important, there is an even greater need to encourage the development of intuitive skills.

In the future, there is an opportunity to restore a balance between the logical and intuitive aspects of human creativity and to normalize the use of intuitive data in creative process. What if, instead of continuing the debate that places logic and intuition as polar opposites, we recognized that it is possible that they could be equally important data sources, each possessing a synthesis of learned knowledge and both subject to evaluation in service of creative outcomes? What if all data sources, like ideas, were welcome in your next creative problem solving session?

As creativity professionals and researchers, we can make a commitment to develop our intuitive skills and help others to do the same. Through encouragement and literature support, we can leverage more than 60 years of research into the development and application of the CPS process by complementing rational, cognitive, and semantic-based approaches with an expanded, more intuitive tool set and by improvising holistic applications of tools in the existing tool set. By being deliberate in our efforts to nurture and employ intuition, its value to creative process becomes explicit, its voice heard, and our capacity to be creative all the more.

Cross-References

▶ Creativity and Emotion
▶ Divergent Versus Convergent Thinking
▶ Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
▶ Imagery and Creativity

References

Bishop SR, Lau M, Shapiro S, Carlson L, Anderson ND, Carmody J, et al. Mindfulness: A proposed operational definition. Clin Psychol Sci Pract. 2004;11:230–241.

Burnett C. Holistic approaches to creative problem solving [unpublished doctoral dissertation]. Ontario: Ontario Institute for Studies in Education at the University of Toronto; 2010.

Francisco JM, Burnett CA. Deliberate intuition: giving intuitive insights their rightful place in the creative problem solving thinking skills model. Paper presented to Creativity and Innovation Management Journal Conference; 2008 May; Buffalo.

Osborn A. Applied imagination. New York: Scribners; 1953.

Puccio GJ, Mance M, Murdock M. Creative leadership: skills that drive change. Thousand Oaks: Sage; 2010.

Rote Learning

▶ Creativity and Confucianism

Rule-Based Expert Systems

▶ State Space Paradox of Computational Research in Creativity

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Schumpeterian Entrepreneur

Francis Munier
BETA, Université de Strasbourg,
Strasbourg, France

The Portrait of the Entrepreneur

The author, J.A. Schumpeter (1934), presents a portrait of this very particular economic agent as follows. Being an entrepreneur is not a profession at all, and certainly not a conventional rule, or even a comfortable state. Very briefly, a person is an entrepreneur if he performs new combinations, even if he is not the creator of the materials of the new combinations (in fact, this is not the most important for the author). J.A Schumpeter uses also the metaphor of a closed circuit in order to explain that when the entrepreneur loses this specific character, he continues to operate, but only within a circuit created by the company. The entrepreneur could be either a founder or an employee. But the image of a "captain of industry" or a creator seems to be a more consistent concept according to the Schumpeterian entrepreneur.

J.A. Schumpeter (1934) insists on the very specific character of the entrepreneur. He compares the entrepreneur to people who belong to a particular species. The implementation of new combinations is a picky function, a kind of privilege for only a few people who are able to recognize the opportunities of new combinations and to implement them. This agent has rare qualities such as intelligence, intuition, ability of vision, etc.

J.A. Schumpeter considers that the entrepreneur belongs to the quarter highest group (top 25% group) of the population, and forms a type that characterizes the extent of these outstanding qualities in the sphere of the intellect and the will. The motives of the Schumpeterian entrepreneur are three. He wants first to make his dream come true and he has the will to found a private kingdom. The will of the conqueror is essential. The joy of finally creating a new economic form is a third group of motivation. The entrepreneur should therefore be able to demonstrate a willingness in order to impose the novelty, to "break" the routine. This implies that he is also able to act as a real leader.

What the Schumpeterian Entrepreneur Is Not

J.A. Schumpeter notes that during the nineteenth century, the entrepreneur is defined within the generic term of "management" which means control, hierarchy, or discipline. This observation does not agree with the idea that this management work is too much administrative, or bureaucratic. It means that the entrepreneur is not a kind of intermediary, in the process of economic cycles, between the one who holds the resources and the final consumer. Hence J.A. Schumpeter (1939, 1951) comes to the

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conclusion that the source of evolution lies in the supply. In the end, the needs of consumers do not impose their will upon the unit of production. The author considers rather that the producers guide the consumers" needs. But what it is important is the focus on the assertion that not just any producer is able to guide the need of consumers, but only a handful of them, namely, the entrepreneurs.

At this stage, it is also important to distinguish between the inventor and the entrepreneur. Generally, the functions of the inventor or the engineer and, that of the entrepreneur do not coincide.

Moreover, the entrepreneur is also distinguished from the capitalist. This distinction allows the author to highlight the importance of credit, and the process of the creation of money in economic development. To summarize, the implementation of new combinations requires the input of resources provided by the banker, the capitalist. Thus the "*bourgeoisie*" plays a crucial role in society in the sense that it offers a kind of shelter for people who want to innovate.

This difference between these roles as economic agents allows then J.A. Schumpeter to go further away from the notion of *knightian* risk (F. Knight 1921) who considers the entrepreneur as a risk taker. In the Schumpeterian vision, it is only the capitalist who bears the risk of novelty.

Entrepreneur, Innovation, and Creative Destruction

The Schumpeterian entrepreneur is also considered as the real cornerstone of capitalism. Within the capitalism system, the development of the economy is considered as a dynamic process. It is important to insist on the fact that this idea of dynamics is quite different according to the mainstream concept of equilibrium. The entrepreneur needs always evolution and of course, it is not possible to consider that his dynamics could be ending because of an ultimate equilibrium point. In other words, the evolution does not cease in order to avoid a regime without innovation.

This dynamics provides a sense of the figure of entrepreneur.

As Schumpeter points out, innovation is the main source of economic development, but the entrepreneur is the real fundamental catalyst of the innovation process. As we have already specified, his function is to perform new combinations. These could be the following possibilities listed by J.A. Schumpeter:

- Manufacture of a new good
- Introduction of a new method of production
- Opening a new market
- Conquest of a new source of raw material
- Creation of a new organization

For J.A. Schumpeter, the essence of the entrepreneur is then the ability to break away from routine, to destroy existing structures, to move the system away from equilibrium. It means that the most important element is not a quantitative evolution of variables but rather a kind of qualitative evolution or mutations which express the dynamics of the process of innovation. The author uses the metaphor of blood inside the body in order to explain the notion of flow within a closed circular.

The entrepreneur is the disruptive force that dislodges the market from the somnolence of equilibrium.

The primary consequence of the Schumpeterian entrepreneur is the importance allocated to the long-run economic development of the capitalist system. This so-called creative destruction is the process of industrial mutation that continuously revolutionizes the economic structure from within, incessantly destroying the old one, continually creating a new one. This process is the essential feature of capitalism and the focal point of the Schumpeterian entrepreneur.

Entrepreneur and Monopoly

This basic principle of creative destruction, which is deduced from the primacy of the entrepreneur in the implementation of innovation, allows the author to explain the nature of profit. Since only the entrepreneur is able to create a profit from the output of the innovation, it is different in particular from rent, wages, or the normal return on capital.

This distinction is decisive to qualify the link between profit and monopoly. When new products appear for the first time in the market, the entrepreneur has no competitors; their prices are formed, wholly or within certain limits, according to the principles of monopoly prices. Thus, besides the fact that some basic conditions are observed, the entrepreneur grants himself an advantage because he creates a monopoly.

However, this monopoly, and the resulting benefits are not sustainable and lead to a difference between the concept of profit and the gain from a monopoly. This dichotomy between the benefit of the entrepreneur and the return linked to the monopoly analysis prefigures J.A. Schumpeter' vision concerning the disappearance of capitalism due, in reality, to the appearance of sclerotic corporate monopoly because of the lack of entrepreneurial initiatives.

The Obsolescence of the Schumpeterian Entrepreneur

The collapse of capitalism is explained by its own logic (J.A. Schumpeter 1942). In addition to the disappearance of opportunities of investment, which leads also to the disappearance of the shelter of the "bourgeoisie," it is primarily the decline of the function of the entrepreneur which is the cause of the transformation of capitalism into socialism. The only solution for society to survive is to evolve toward a socialist system because of the destruction of the support for the entrepreneur which provides him with the capability to be and to do.

Considering a situation of satiation, the author considers that capitalism, which is essentially an evolutionary process, will be in a situation of atrophy. The entrepreneur would be deprived of any field of activity. The profits and, simultaneously, interest rates will converge toward zero. The layers of bourgeoisies, who live in profits and interest, would tend to disappear. Companies would all lead to bureaucracy. These ideas summarize the causes and the consequences of the disappearance of capitalism according to the obsolescence of the Schumpeterian entrepreneur.

This destruction of the institutional framework of the capitalist society is accompanied by a destruction of the protective *shelter* provided by the "bourgeoisie." The decay of this class illustrates precisely the breakdown of the defenses of capitalism, including the fact that the "bourgeoisie" is detached from its own values. In this regard, the author considers that faced with the hostility growing around them and then the consequences, in terms of practice legislative, administrative, and judicial, generated by this hostility, entrepreneurs and capitalists – in fact all the social strata who accept the program of bourgeois existence – will eventually stop performing their duties. The growing hostility experienced by capitalism in this respect is the final factor in the process of disappearance.

Size of the Firm and the Schumpeterian Entrepreneur

Two visions of the relationship between the size of the firm and innovation are attributed to Schumpeter. The first, called "Schumpeter Mark I," is developed in *The Theory of Economic Development*. Small firms play a major role in the process of innovation. Entrepreneurs perform new combinations, create new firms. In this approach, only the small business is the vector of technical progress. The second vision, "Schumpeter Mark II," is developed in *Capitalism, Socialism, and Democracy*. Innovation is initiated by large companies with a research laboratory and only the large companies innovate.

Innovation is the engine of economic development, notably for the capitalism. The factor of innovation is the entrepreneur. In this – theoretical – context, since the entrepreneur is no longer the reference, capitalism is led to decline. The main reason for the disappearance of the function of entrepreneur is based on the appearance and development of R&D departments in large firms, a source of bureaucratic and "routinized" technological progress. The big companies are responsible for the disappearance of the entrepreneurial function and of the capitalism. The emergence of large structures destroys the institutional framework based on small businesses: the process inevitably destroys the economic foundations on which small business enterprises are built.

Conclusion and Future Directions: The Concept of the Manager-Entrepreneur

Since the work of F. Munier (1999a, b), one future direction has been to highlight the concept of manager-entrepreneur.

F. Munier defines a kind of hybrid agent called the "manager/entrepreneur." The dichotomy of the behavior of manager/entrepreneur is as follows: on the one hand, he takes care of ongoing activities that are more short term, the pursuit of profit and reduction of transaction costs; on the other hand, he tries to mobilize knowledge, to find and develop sources of learning, manage and develop individual and collective skills. This involves a tradeoff between the forms of centralization and decentralization needed to encourage the creation of knowledge while providing a pipeline for new useful knowledge.

The manager/entrepreneur is faced with several dilemmas to simultaneously maintain authority, stimulate creativity, and motivation of individuals. The manager/entrepreneur must solve the tensions between centralization and decentralization, between control and commitment, between change and stability, between order and disorder in the firm.

Centralization is a source of coherence, but also a source of inertia if it seems too heavy. However, decentralization is about creativity, but an extreme situation can cause the disappearance of the organizational structure, thus wiping out all references and codes. To allow the creation of skills in the firm, the manager/entrepreneur must consider both the advantages and disadvantages of each mode of governance.

The concept of manager/entrepreneur leads to the concept of duality of the firm (Munier 1999b) which provides meaning to the Schumpeterian entrepreneur as the cornerstone of creativity within the firm.

Cross-References

▶ Creative Destruction
▶ Developing Radical Inventions
▶ Entrepreneur
▶ Heroic Entrepreneur, Theories
▶ Individual Determinants of Entrepreneurship
▶ Innovator

References

Knight FH. Risk, uncertainty, and profit. Boston, MA: Hart, Schaffner and Marx/Houghton Mifflin Company; 1921.

Munier F. L'entreprise fondée sur les compétences: Définitions et axiomatique. In: Basle M, Delorme R, Lemoigne J-L, Paulré B, editors. Approches évolutionnistes de la firme et de l'industrie: théories et analyses empiriques. Paris: L'Harmattan; 1999a.

Munier F. *Taille de la firme et innovation: approches théoriques et empiriques fondées sur le concept de compétence*, Ph.D. Thesis, France: Université Louis Pasteur; 1999b.

Schumpeter JA. The theory of economic development. Cambridge: Harvard University Press; 1934 (First published in German, 1912).

Schumpeter JA. Business cycles: a theoretical, historical and statistical analysis of the capitalist process. New-York and London: McGraw Hill; 1939.

Schumpeter JA. Capitalism, socialism, and democracy. New York: Harper and Brothers; 1942.

Schumpeter JA. Economic theory and entrepreneurial history. In: Clemence RV, editor. Essays on economic topics of Joseph Schumpeter. Port Washington, NY: Kennikat Press; 1951.

Science of Creativity

Andrei G. Aleinikov
International Academy of Genius, Monterey, CA, USA

Synonyms

Creatology; Sozidonics

Definition

The science of creativity is the study of the complex phenomenon of creativity.

Introduction

As with any new field of research, the creativity research at a certain moment of time develops into a science. Creating (structuring, designing) a new science is an act of creativity. If scientists create new methods of research, new models, new hypotheses, new theories, new devices, new experiments, and these are all creative acts, then the creation of a science can be considered one of the largest creative acts in the field of science. In the history of science, the founders of new sciences are often referred to as "fathers," such as Gregor Mendel, the father of genetics, or Norbert Wiener, the father of cybernetics.

On the ontological level, the humanity as a whole exists, works, and creates newness of all kinds without thinking about creativity. Then there appears a group of thinkers (philosophers, scientists) who detect some patterns in the acts of creation and begin to observe this process and reflect its regularities. This reflection constitutes the gnoseological level – the level of knowledge. After gathering lots of data and creating a few theories, there appears a need to create a science of creativity for the world of creation to become reflected scientifically. The data on creativity gathered by the efforts of hundreds of scientists around the globe becomes the pool for shaping the science of creativity. This is how creativity in science shapes the science of creativity.

From a Field of Research to a Science: Sozidonics or Creatology

Millenniums of technological inventions, poetic and artistic explorations that resulted in cultural masterpieces, scientific discoveries, and theoretical breakthroughs had to be scientifically explained. Creativity, the most human of all human abilities, called for explanation. During the last century, scholars researched:

- Relationship between creativity and intelligence
- Neurological processes associated with creative activity
- Creative abilities
- Genetic factors versus training in creativity
- Correlation between creativity and personality types
- Relationship between creativity and mental health
- Educational methodologies and human potential for fostering creativity
- Educational applications for improving the efficiency of learning
- Technological augmentations of creative abilities
- Creativity boosters and creativity squelchers
- Effect of chemical substances on creativity
- Relationship between teaching creativity and recidivism reduction
- Top creative achievers (genius), etc.

The list of scholars who contributed to the development of science of creativity is so long that it goes well beyond the references pattern of this encyclopedia. Nevertheless, at least mentioning the names of the most prolific ones is a must to give them credit for their dedication and enormous work. Often their scientific work is "irretrievably interwoven," as Sidney G. Roth (1963) says, with education and training, but they still find time to do their research. Here are the names of these heroes of science whose creativity in science builds the science of creativity (in alphabetic order): T. M. Amabile (Componential Model of Creativity, Consensual Assessment), G.S. Altshuller (TRIZ), J. Arnold (Useful Creative Techniques), M.S. Basadur (Creative Problem Solving in Business, Simplex), B. Bleedorn (Education Track for Creativity), T. Buzan (Mind mapping, Everyday Genius), B. Crammond (Creativity in the Future), M. Csikszentmihalyi (Creativity: Flow), G. Davis (Creativity is Forever), E. De Bono (Serious Creativity), I. Dubina (Creativity as a Phenomenon of Social Communications), G. Ekvall (Creative Climate), R. Epstein (Behavioral Approaches to Creativity, Generativity Theory), F. Eysenk

(Genius: The Natural History of Creativity), R. Firestien (Leading on the Creative Edge), M. Fisher (The IdeaFisher), R. Florida (The Rise of the Creative Class), S. Freud (Creativity and the Unconscious), H. Gardner (Creating Minds), M. Gelb (How to Think Like Leonardo da Vinci), W. Gordon (Synectics), K. Goff (Everyday Creativity: an Easy-to-Read Guide), J.K. Gowan (Right Hemisphere Imagery), H.E. Gruber (Systems Approach to Creative Work, Creativity and Human Survival), S. Gryskievicz (Positive Turbulence), J. Guilford (Intellect Model), N. Hermann (The Creative Brain, HBDI), D. Horth (Creative Competencies for Contemporary Leadership), S.G. Isaksen (Creativity Model, CPS, Frontiers of Creativity Research), M. Kirton (Styles in Creativity and Problem Solving, KAI), P. Kline (The Everyday Genius), A. Koestler (The Act of Creation), L. Kubie (Neurotic Distortion of the Creative Process), I. Magyari-Beck (Creatology), A.H. Maslow (Towards a Psychology of Being), J.H. McPherson (Creative Problem Solving Methods), M. Michalko (Cracking Creativity, Thinkertoys), M. Murdock (Nurturing and Developing Creativity), K. Neethling (Whole-Brain Sexuality, South African Creativity Foundation), R. Noller (Creativity Formula), V.M. Odrin (Morphological Synthesis), A. Osborn (Creative Problem Solving, Brainstorming, Creative Education Foundation), S.J. Parnes (Creative Problem Solving, Creative Education Foundation, Magic of the Mind), K.H. Pribram (Brain and the Creativity Act, Languages of the Brain), G. Prince (The Practice of Creativity), S. R. Pritzker (Encyclopedia of Creativity), G.J. Puccio, (Buffalo Creative Process Inventory, etc.), M. Runco (Theories of Creativity, Encyclopedia of Creativity), D.K. Simonton (Creativity, Eminence, Genius, Darwinian Approach, Historiometry), M. Stein (Stimulating Creativity, Creativity and Culture), R.J. Sternberg (The Nature of Creativity), E. P. Torrance (Torrance Test of Creative Thinking, Torrance Kids), D. Treffinger (Creativity Definitions, Creative Thinking), A. Van Gundy (Idea Power, Organizational Creativity and Innovation), R. von Oech (Creative Think), G. Wallas (The Art of Thought), W. Wenger and S. Wenger (Project Renaissance), M. Wertheimer (Productive Thinking), F. Zwicky (Morphological Analysis), and many others (see ► Research on Creativity).

Their research and publications show that the advent of the science of creativity was actually predetermined. The only variables were when, where, and by whom?

Origin and History of Research

It is generally accepted that research on creativity started with G. Wallas' work in which he dissected the act of creativity into four stages: preparation, incubation, illumination, and verification (Wallas 1926). Prior to this publication, creative people were referred to as "marked by God"; no explanation was given either by these people or by researchers on how creativity appears, how it develops, how it works, etc. Some brilliant insights on the issue were scattered and were so insignificant that they can be considered only some kind of pre-research.

The next major advance in igniting interest to topic happened thanks to J.P. Guilford's famous speech for the American Psychological Association in 1950, in which he called for action on the sorely neglected area of creativity research (Guilford 1992).

Dr. Sidney Parnes, one of the co-founders (with Alex Osborn) of Creative Problem Solving (CPS) (see ► Creative Problem Solving) and Creative Education Foundation (CEF), Buffalo, NY, sketched the following periods in the development of creativity research domain:

- 1940s – cry in the dark
- 1950s – the hope and hunch stage
- 1960s – the research, replication, and report stage
- 1970s – the widespread application stage
- 1980s – the mainstream application stage (Parnes 1992)

This sequence of stages vividly shows the formation of applied science, i.e., research going together with practice and returning to practice immediately. These first steps provide the foundation for building a science.

Trends and Approaches

The history of science in general demonstrates three major approaches in creating sciences:

- Bottom-up
- Top-down
- Cross-section

The bottom-up approach happens when a researcher discovers something so unusual and important that it later leads to unveiling a new field of research built on this discovery. Typical examples are Gregor Mendel who discovered and described similarities in bean coloring generation after generation (later he was considered the “father of genetics”) and Wilhelm Conrad Röntgen who discovered x-rays in 1895 and thus “fathered” the field of radiology.

The second type, the top-down approach, occurs when somebody generalizes the huge amount of data under one concept. Good examples are the general systems theory by Ludwig von Bertalanffy (1968) and cybernetics by Norbert Wiener (1948).

The third type, the cross-section approach, happens when a scientist works at the borderline of two sciences and proves that there is a field of research between the two. A bright example is Hermann von Helmholtz who mastered two disciplines (medicine and physics) and with his synthesizing approach to science is now considered to be the “father of biophysics” (the cross-section between biology and physics).

In the field of creativity, there is no groundbreaking discovery of one fact, but there is a huge amount of data to generalize. Therefore, it is obvious that the science of creativity is being developed by the top-down approach. However, since it deals with other sciences and is derived from the other fields of research, the process has the features of the cross-section (interdisciplinary) approach.

In addition to the approaches mentioned above, there are trends in development of the concept. The major trends in the development of the creativity concept are:

- From exclusive to inclusive
- From nonscientific (popular) to scientific

The trend from exclusive to inclusive means that the ability to create was first ascribed only to God and the true creation was only from nothing to something (exclusive). Later in history, the ability to create was ascribed to poets, then to artists, then to actors, and so on and so forth to include actually everybody (inclusive).

The second trend means that researchers move from explaining creativity to the public in popular terms (just for the public to know what it is to apply it to business, education, etc.) to scientific reflection that may be less popular or less understood but more adequate and more precise in nature.

Trends and approaches explaining creativity are best seen in the search of proper definitions (see ► Creativity Definitions, Approaches) and theoretical models of creativity.

Conceptual and Graphic Models

After Wallas, mentioned above, there appeared many other models. In 1968, McPherson conducted a comparative analysis of 18 models and presented them in one table. These models included two to eight stages (McPherson 1968).

The first models were simplistic and gave little in defining the operational steps. As a response to the practical needs, there appeared operational models. One of the most famous operational models belonged to Alex Osborn and later was improved by Sid Parnes and is now known as Osborn-Parnes model.

Quite popular are graphic models:

- The 4 Ps model picturing creativity as intersection of *P*eople, *P*rocess, *P*roduct, and *P*ress (Isaksen 1987)
- The Torrance’s model showing creative behavior as a mix of abilities, motivation, and skills (see ► Creative Behavior)
- The Amabile’s componential model depicting creativity as an intersection of expertise, creativity skills, and task motivation (Amabile 1997)
- The divergent/convergent thinking model consisting of splitting and then converging arrows (see ► Convergent Versus Divergent Thinking)

- The two-stage "great idea" dynamic model that showed diverging from the beaten path to a great idea and then applying this idea (Davis 1981)
- The five-stage dynamic creative act model that depicted a new result as well (Aleinikov 1989) that paved the way to Creative Pedagogy (see Aleinikov 1990a, 1991, ▶ Creative Pedagogy)
- And many others (see ▶ Multiple Models of Creativity)

An original approach was offered by G.P. Guilford whose graphic model of intellect (box) included divergent/convergent thinking (Guilford 1968).

The development of conceptual and graphic models for creativity, creative acts, and creative problem solving is going on and contributes to the new science of creativity. However, a major theoretical breakthrough was needed to create the science itself.

The New Science's Place in the Classification of Sciences

The new science of creativity has to belong to the field of social sciences that study human behavior and societies, as opposed to natural sciences, like physics and chemistry, and formal sciences, like mathematics and logic.

Within the social sciences, the science of creativity is grounded in psychology, most closely related to education (see ▶ Creative Pedagogy), linguistics (see ▶ Creative Linguistics), and certainly related to anthropology, archaeology, history, sociology, and other sciences.

Historically, the science of creativity, like all other sciences, started as empirical research (that continues all the time), got through the stages of experimental research and separate theories (see ▶ Creativity, Experiential Theories), and now is in its theoretical design stage that crowns the formation of the science.

During this formation, one has to remember that social sciences are much younger than natural and formal sciences that were established centuries ago. That is why in the process of creating a new science, the well-established sciences can be viewed as examples to follow or sources for borrowing the concepts and methods of research.

The Science of Creativity

As all well-established sciences, the science of creativity has to have the following elements:

- Name
- Objective
- Subject of study
- (New) vision of the subject (definition)
- Classification
- Model of the subject
- Special methods of research
- Units and measurements
- Results (some practical applications that illustrate the power of the theory)
- Predictions

So the task is either to find them or formulate them.

Name for the New Science

There are two candidates for the name of the science of creativity: creatology (Aboganda and Cortez 1972, Magyari-Beck, 1977–2008) and sozidonics (Aleinikov 1994).

Creatology

The term creatology consists of two roots derived from Latin *creō, creatus*, the past participle of *creare*, meaning *to make, bring forth, produce, beget* plus *logy* coming from *logos* meaning *word, the study of.*

The Psychology Wiki site states, the term Creatology, as a new science of creativity, was first used by Rafael Nelson M. Aboganda and Ricardo S. Cortez in a paper entitled "Towards a Positive Understanding of Creativity – Creatology: The Science of Creativity" published in October 1972 by the Philippine Inventors Commission (PIC), now Technology Application and Promotion Institute (TAPI) an agency of the Department of Science and Technology (DOST), in the Philippines.

Creatology was later introduced and proposed by a Hungarian scholar Dr. Istvan Magyari-Beck in his presentation "About the Necessity of Complex Creatology" made on the International Sociology of Science Conference in Budapest, in 1977. In 1979, this paper was published in the book *Sociology of Science and Research*, edited by János Farkas, Akadémiai Kiadó, Budapest, pp. 175–182.

Dr. Sayed Mahdi Golestan Hashemi (Founder and Head of Iran Research Center for Creatology and International Center for Science of Creatology) is developer of Creatology as an interdisciplinary (GTC): Creatology is Scientific Study of various aspects of Creativity, Invention and Innovation by different approaches. Creatology has many sub-disciplines such as:

- Analytical Creatology
- Psychological Creatology
- TRIZ-based (TRIZical) Creatology
- Inventology
- Bionical Creatology"

Retrieved from http//: psychology.wikiw.com/wiki/Creatology psychology.wikia.com/on February 4, 2012.

It was Dr. Magyari-Beck's article titled "Creatology" in the *Encyclopedia of Creativity* that made the term popular (Magyari-Beck 1999). In 2008, Dr. Magyari-Beck also published an article titled "Creatology from 1977 to 2007" in the *Society and Economy* journal that summarized 30 years of concept development.

Sozidonics

The term sozidonics was published first in English in 1994 (Aleinikov 1994).

It is related to a Russian word созидание/*sozidanie* that has only one meaning "*creation of positive things*" – a very rare case in the language because usually words have several meanings. This word has a neutral variant создание/*sozdanie* with the meaning *creation* that can be used for both positive and negative things. The prefix со-/*so-* means *together*, like *co-* in English. The root of the word -зида-*(*-зда-*)*/-зьдъ/-*zida (zda)-* is a Proto-Slavic root "*zida*" *clay* (not used separately anymore), but seen in Russian words здание/*zdanie* (*building*), зодчий/*zodchiy (architect)*, Bulgarian *zid*, Serbo-Croatian **zidъ/-zid*, and Romanian *zid* in the meaning *wall*. The final part of the term sozido*nics* is usual for sciences and may be seen in mathem*atics*, cyberne*tics*, bio*nics*, gene*tics*, etc.

The etymological connection here is obvious: *so-zid* means building together, like in creativity, something is created for the benefit of others. Clay as the building material was certainly used for house walls, church walls, and town walls. Going back into history, clay hypothetically might be the first material that could provoke a primitive human mind for a creative act. Clay's plasticity when wet and ability to harden when dried might have sparked an ancient human to create some objects or even first sculptures out of it. Ceramics started from clay pieces dropped in fire. As opposed to clay sculptures, wood carving and stone sculptures would have required much more elaborate tools and techniques, which place them much later in the history of arts and crafts (Aleinikov 1994).

Comparison

The term creatology is more traditional. It is coined from the well-known Latin roots and easily understood. This advantage, however, can turn into disadvantage: it makes it prone to parallel usage in technology and marketing which overshadows the scientific meaning and usage. For example, the Google search on "creatology" delivers hundreds of items *not* related to the science of creativity, like Creatology™ coloring poster, Creatology™ 3D Kits, Creatology Wooden Puzzle, photo of Creatology®, Creatology Doll Furniture, Creatology Wooden Temple of Heaven review, Creatology: an experimental blog coupling creativity and science...

Obviously, this word, registered and trademarked, is widely used for technologically based toys as well as for experimenting. As a result, after some time, it may look like creatology as a science of technological advances of the company called creatology. Also, most importantly, what was supposed to be a term (a word with one meaning) has become a usual word with numerous meanings and, therefore, has stopped being a term.

Finally, according to the founders, the word creatology is used for the science of creativity, invention, and innovation. So it is *not* the term specifically for the science of creativity.

The term sozidonics, on the contrary, is nontraditional. It has the following advantages: First of all, it is a term, not a usual word: it has one sound (or graphic) form related to one meaning. Second, etymologically, it relates to the first creative acts in the past. Third, it refers to positive and only positive creativity (as it should be in the ideal!). Fourth, it sounds original (not boring, not traditional) as the term for the science of creativity implying *originality* should be. Finally, what is most important, it precisely names the science of creativity, *not* the science of creativity, invention, and innovation.

The issue may be resolved after analyzing the subjects of study covered by creatology and sozidonics (see below). History will make the final selection.

Objective of the Science of Creativity

Since science (from Latin *scientia*, "knowledge") in general is the activity of building and organizing "knowledge in the form of testable explanations and predictions about the universe," the objective of the science of creativity is to build and organize knowledge about creativity.

Creativity as a Subject of Study

The main task for the researchers shaping the science of creativity is to define the volume of the concept, i.e., to place it where it belongs. A theorist of science has to determine the most probable place between the two extremes: maxi-creationism (longing for eternity) and mini-creationism (longing for zero).

The first one states that creativity is everything and everywhere. God (nature) created universe, so God (nature) is creative. Atoms create molecules, molecules create organisms, organisms create psyche and societies, psyche creates reflection and reflections of reflections (knowledge), etc. So God (nature) is creating and recreating the universe and its own reflection; the science of creativity, therefore, has to study everything (∞).

The opposite approach states that creativity is a very specific (extremely short, like a flash) moment that happens in the mind of an individual (or God). So, actually, there is nothing (0, zero) or a close-to-nothing moment to study.

Science of Creativity, Table 1 Creatology and its subscience domains

Science name	Creatology = the science of		
Subject studied	creativity,	invention, &	innovation
Subscience name	?	Inventology	?
Sub-subject studied	Creativity	Invention	Innovation

The majority of scientists are somewhere in between, but here begins the heated discussion on where creativity belongs and how it is separated from all the other concepts like imagination, innovation, invention, etc. (see ▶ Nature of Creativity).

The analysis of creatology concept makes it a good example. As it is seen from the blog text cited above, creatology claims to study various aspects of creativity, invention, and innovation. Thus, the subject of creatology is not only creativity but also invention and innovation. Since creatology founders also offer a separate science for studying inventions, the structure of the subject and sub-subjects claimed to be covered by creatology (as mentioned above) looks like Table 1.

If the name inventology is offered for the study of inventions (one of three subsciences), then the question marks in the Table 1 indicate the absence of specific names for the science of creativity as well as for the science of innovation.

Research shows that Russian scientists introduced the science of innovation, called Инноватика/*Innovatica* (or better *innovatics*) in 1980–1990s. There are departments of innovatics at some universities. Books on innovatics are published (Poskryakov 1988). Obviously this term and this science fit the structure of domains depicted in Table 1 and fill the empty cell on the right.

With the innovation domain covered by innovatics, the only subdomain left uncovered is that of creativity. Sozidonics, described above as the science of creativity specifically dedicated to this (and only this) subject, meets the need and can be placed in the left empty cell.

Science of Creativity, Table 2 Creatology, sozidonics, inventology, and innovatics

Science name	Creatology = the science of		
Subject studied	creativity,	invention, &	innovation
Subscience name	**Sozidonics**	Inventology	**Innovatics**
Sub-subject studied	Creativity	Invention	Innovation

The terms added to Table 2 are in bold

In this case, the structure of sciences covered by creatology could look like that in Table 2.

New Vision of Creativity

Dr. Magyari-Beck in his article "Creatology" states that "the word creativity has already lost its previous, merely linguistic meaning and has gradually acquired a position of a new scientific term which should be defined in a new and much larger way within its own frame of reference" (Magyari-Beck 1999). Then there follows the reference to the article *Definitions of Creativity*, which offers *no* definitions of creativity at all.

The article on creatology does not offer any new vision (new definition) of creativity either.

Sozidonics has to fill the gap.

To help people visualize the place of creativity as a phenomenon and the new vision of creativity, here is the explanation and the logic behind it.

Big Picture

The new vision, or a new approach to creativity, is a top-down approach, i.e., a theoretical approach rather than empirical one built from bottom-up. It starts from the vision of nature as a whole.

Nature, whether it is the creation of God or a self-developing entity, is an everlasting process of newness production. Humans are both the largest producers and the largest consumers of newness: new products, new events, new presidents, new movie stars, new tragedies and comedies, new discoveries and mistakes, new. . .new. . .new....

Since newness is everywhere in nature, it makes for a huge object of study, and the task of a researcher is to discover the general mechanism of newness production, to classify this newness, to find the laws of newness production, and to find the ways of predicting the future development. Novology (see ► Novology), the science of newness, does this (Aleinikov 2002b).

There are five main, easily identifiable levels of organization in nature and, therefore, five levels of newness: physical (particles, rays, atoms), chemical (molecules), biological (cells and organisms), psychological (self-reflecting, or psyched organisms, called individuals), and social (societies). Numerous sublevels are available within every level, but this is beyond the scope of this article. These levels are interconnected and interdependent. When placed in the hierarchical order, they look better like this:

5. Social (societies)
4. Psychological (organisms with psyche, individuals)
3. Biological (cells, organisms)
2. Chemical (molecules)
1. Physical (particles, atoms)

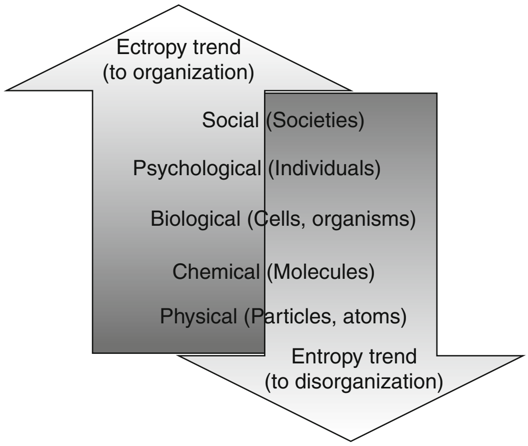
One essence unites all these levels. This is order or organization as a state. Obviously, the higher the level, the more organized it is (because it incorporates the organization of the previous level and adds its own organization) and vice versa: the lower the level, the less organized it is. The movement from the lower level to the higher level is called ectropy (the trend to higher order, the process of organization), while the movement to the lower level is called entropy (the trend to lower order, the process of disorganization).

The trends, levels, and elements of nature development are shown on Fig. 1.

Creativity definitely belongs to the ectropy trend on the psychological level (level 4, Fig. 1), while innovation belongs to the social level (level 5, Fig. 1). **Creativity is the production of newness (new order of things and processes, new organization), while innovation is the consumption of this newness by the society**.

However, creativity is not just production of newness but the process of accelerated newness production. The point is that new images, new emotions, new thoughts, new associations, etc., exist in the everyday life of every individual. This is *not yet* creativity. This is the natural speed

Nature Trends and Levels (Elements)



Science of Creativity, Fig. 1 Trends, levels, and elements of nature development

psychological life. Only when this natural process gets accelerated, and as a result, new ideas, new thoughts, new products are produced faster than is considered natural, then people call the person doing it "creative."

Therefore, the scientific definition of creativity is the following: **creativity is a human activity of accelerating the natural process of organization and/or decelerating the natural process of disorganization**, or even shorter: **creativity is a human activity of accelerating organization and/or decelerating disorganization** (see ► Creativity Definitions, Approaches).

In everyday life, the organization processes are called birth, growth, development, etc., while the disorganization processes are called decline, decrease, withering, death, disintegration. Any entity in the universe, including universe itself, has its birth, development, peak of development, and then decline and death.

The following figure illustrates the essence of creativity.

Notice how Fig. 2 shows that at a certain moment of time (T_1 or T_2), the organization level O_1 (accelerated development) of any entity is higher than O_2 (natural speed development), and the organization level of O_3 (restoration, repairing to decelerate the decline) is higher than O_4 (natural speed decline).

Business people, trainers, consultants, and engineers favor this scientific explanation of creativity because now they request funds for *better organization*, for *faster processes*, and for *accelerated production* (not just for creativity training that looks "fluffy" to some managers and corporate leaders).

On a bigger scale, society needs individual creativity for *better organization* of the society. Moreover, the society (country, state, city, business, educational institution, etc.) that encourages creativity and provides training in creativity increases the creative output of its members and thus is developing (to better organization) in an *accelerated manner*, i.e., faster.

Examples are convincing:

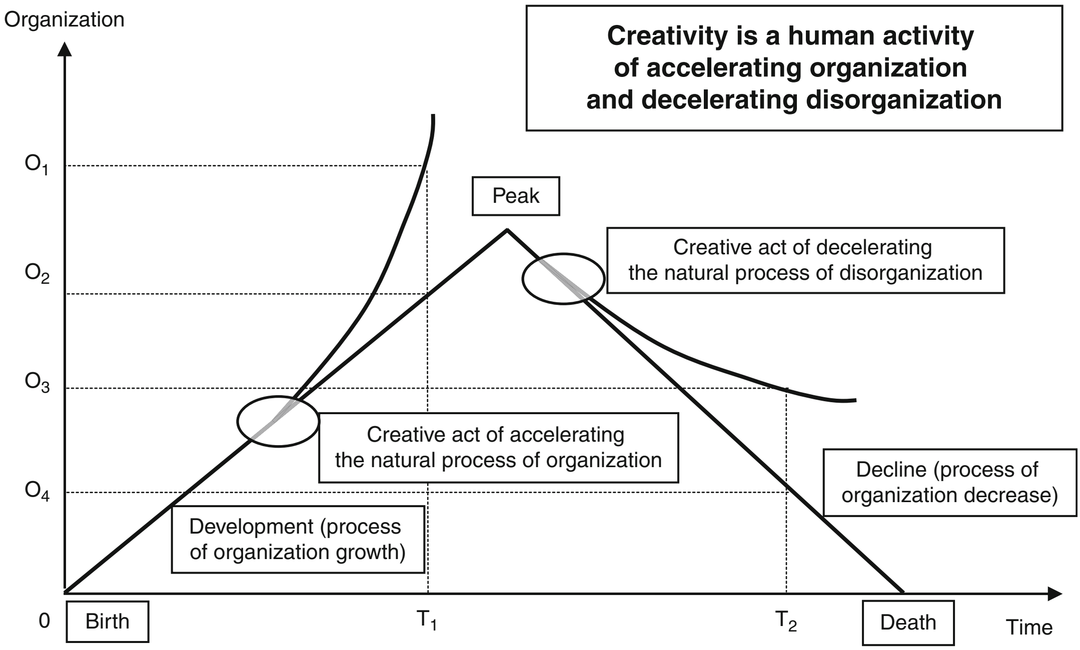
- The Soviet Union (and socialist bloc) was *not* allowing the flow of information, restricted freedom of speech, excluded the free market business relationship, expanded bureaucratic control, eliminated patenting (technological creativity), minimized royalty for creative output in arts, and thus slowed down the society development, began to fall apart, and finally disintegrated (to lower organization).
- Democratic societies, on the contrary, allow more creativity in all spheres of life thus encouraging creative output from individuals, and therefore, these societies gain better technology, better results in sports, medicine, and social activities, and finally climb to *better organization*.

This explains why and how democracy wins over all other political systems and certainly over dictatorships. Creativity – the accelerator to better organization – is the key to faster development!

Sozidonics, the science of creativity, explains not only what creativity is but also how it influences the accelerated development of the society.

New Models of Creativity: Strive for Universality

The new science of creativity needs a model of creativity that is applicable to all domains, all levels, styles, types, and kinds of creativity. It has to reflect the smallest creative act (like a speech act) and the largest creative act,



Science of Creativity, Fig. 2 The essence of creativity

like a discovery. Even God's act of creation (not to mention all the other human acts) should be reflected by the model. Universality is the #1 requirement for science. Repeatability and testability are #2 and #3, respectively.

Analysis of available creativity models demonstrates that they miss one greatly important aspect: all ideas/solutions/decisions have to be expressed, i.e., pronounced, written, performed, sculptured, painted, etc. The system of expression has to be in the model. It may be a language system or any other system of signs, but it has to be material to represent the ideal idea/solution/decision. Otherwise, neither the simplest idea nor the most complex solution can be transferred to others or, in the final run, even detected.

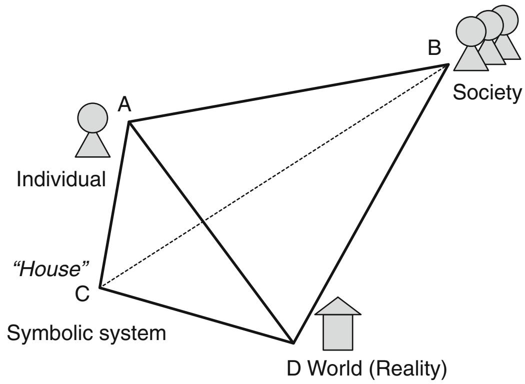
In everyday life, an idea should be worded, voiced, articulated, written, jotted down, and scribbled. In case of the top-level creative achievement, the genius idea should be expressed in some semiotic system, the system of symbols, and then published, exhibited, and publicized. Whether it is a formula, a theory, a discovery, a melody, a painting, a sculpture, or a pedagogical approach, it must be expressed in a system of signs (see ▶ Genius).

With this element added, the creative act situation becomes a particular case in the universal state of order reflected by the universal model of sign, language, language awareness, speech and heuristic acts, first developed in 1977 and then adapted for creative linguistics (see ▶ Creative Linguistics and Aleinikov 1988a). This is a four-sided model in 3D (Aleinikov 1985; 1988b).

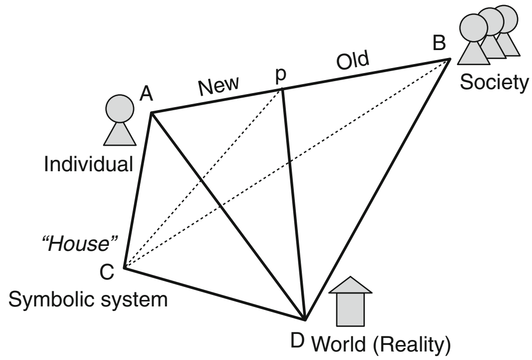
The universal model of sign, language, speech act, and heuristic act looks like Fig. 3.

In general, as Fig. 3 shows, an individual (A) is the person who creates a vision of the world (D), expresses it in symbols of the system (C), and sends it to the society (B). Society is understood as any person, or persons, speaking the same language or using the same semiotic system. The message (AB) is received by the society (B), evaluated, and appreciated or not appreciated.

The real human mind in the process of thinking/creating may run over this model in different directions: from A to B, from A to D, from A to C, from C to D, from D to B, from C to B, and in all



Science of Creativity, Fig. 3 Universal model of sign, language, language awareness, speech and heuristic acts



Science of Creativity, Fig. 4 The new/old plane in the model

directions back. The human mind may do it several times, loop after loop, before delivering the message (AB), but invariably in any speech and creative act, there will be the reflection of all four absolutely necessary (universal) elements:

- Who (A, individual, sender, creator)
- To whom (B, society, receiver, evaluator)
- What (D, world, vision of the world)
- Expressed by what (C, symbolic system)

  Here is the test:

- A fine artist or a sculptor (A) expresses his unique vision of the world (D) in his/her personal manner (C) and shows it to public (B) that evaluates it.
- A scientist (A) finds a new fact, process, regularity of one's field (D), writes an article in scientific terms (C), and sends it to the publisher (B) for publication.
- A teacher (A) creates a new method of teaching in education domain (D) and makes a report (C) for her colleagues (B).
- An actor (A) in his/her specific manner (C) performs a role in a play about the world of love (D) on stage for spectators (B).

In the particular case of a genius (top creativity level), the message (AB) is so uniquely expressed in a symbolic system (C) and reflects such a highly innovative vision of the world (D) that it is top-valued by the society (B). That is why this individual (A) is named a genius (see ▶ Genius).

Notice how the pattern repeats itself in the explanations above. It is exactly what science is: it provides testable and repeatable knowledge.

The next issue to address here is how much newness is expressed by the individual (A) for the expression (AB) to be evaluated by the society (B) as low creative, quite creative, or highly creative.

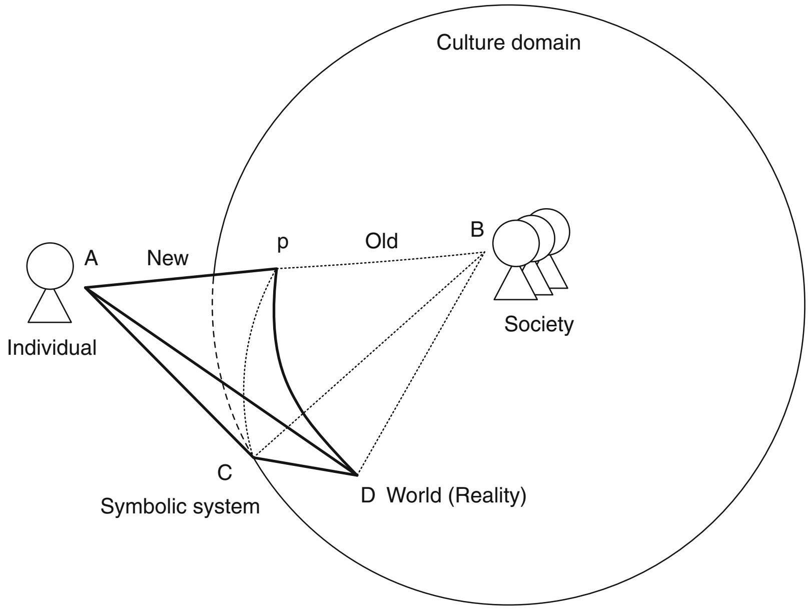
For this purpose, the model contains a special plane that cuts the old and the new in the message. The cutting plane (CDp) looks in general like Fig. 4.

As is illustrated by Fig. 4, any creative act (statement, report, article, book, research, painting, show music, theatrical performance, etc.) consists of the old (BCDp) and the new (ACDp) parts. In the case of everyday creativity, this newness part is smaller. In the case of theater performance, conference presentation, or gallery show, this newness part should be bigger. In the case of genius, this "new" part (what genius has discovered and now communicates to the society) is much larger than the "old" part (what society already knows).

The model of interaction between the individual creator and the society with its culture in general looks like Fig. 5.

As Fig. 5 demonstrates, an individual (A), who discovered, found, invented, thought up, learned something new, or in other words created a new vision of the world (D), has to pack this new vision into an acceptable code (language)

Science of Creativity, Fig. 5 Model of creative act expanding culture



or express it in some symbolic system (C) also known to the society (B) and then sends a message (AB) consisting of known volume (pBCD) and also new volume (pACD) that is expanding the volume of culture (knowledge, experience, customs, beliefs, etc.). This is the modification of the figure published first in the article titled "Humane Creativity" (Aleinikov 1999a).

This model of creative act is universal, repeatable, and testable. It works for any creative act (including God's creation), and it also promotes deeper analysis of the creativity act, such as systems' organization levels (function, substance, structure), coding planes, and so on when needed (see ▶ Creative Linguistics). It permits profiling newness (see ▶ Novology) and picturing genius results (see ▶ Genius).

Classification of Creativity

In addition to traditional classification of creativity as artistic creativity, technological creativity, scientific creativity, etc., which follows the domain of human activities, sozidonics offers a new classification that is based on the described above five levels of nature organization.

Sozidonics differentiates the following types of creativity:

- Existential (how to exist physically, how to survive)
- Communicational (how to relate, to communicate, to interact)
- Instrumental (how to develop tools, new organization)
- Orientational (how to select the social goals and objectives, where to use the tools)
- Innovational (how to implement the found newness)

This new classification allows sozidonics and geniusology that stemmed from it to detect new types of geniuses, or in new science terms, "the most powerful accelerators to better organization" (see ▶ Genius).

Units and Measurements for Measuring Creativity

Measuring human mental characteristics in general is quite popular. Some websites list about 4,000 commercially available tests. Measuring creativity is a significant part of it (see ▶ Measurement of Creativity). As Gerard Puccio, the Head of the International Center for Creativity

Studies, Buffalo, NY, states, "since 1950 researchers have developed an array of formal methods for measuring creativity" (retrieved from http://www.acsu.buffalo.edu/~stferry/ March 6, 2012). It can be measured by self-assessment, aptitude, and ability tests; by interviews and observations; by rating scales in peer, parent, and teacher rating/nomination; by products created; by awards (recognition), etc.

According to the above-mentioned Isaksen's model of creativity, there are 4 P's that can be measured: person, process, product, and press (environment pressure).

- Just to mention a few that assess the *person*: Creativity Attitude Survey, Creativity Tests for Children, Creative Behavior Inventory, Khatena-Torrance Creative Perception Inventory, Myers-Briggs Type Indicator, Hermann Brain Dominance Instrument (HBDI) by Ned Hermann, Neethling Brain Instrument by Kobus Neethling, etc.
- The most well known among measurements that address the *process* are Buffalo Creative Process Inventory (by G. Puccio) and Kirton Adaptation-Innovation Inventory (KAI).
- The instruments that assess characteristics of creative *products* include Consensual Assessment Technique and Creative Product Semantic Scale.
- One tool that assesses the *press* or the climate for creativity and innovation is KEYS (originally called Work Environment Survey) developed by the Center for Creative Leadership.

According to the Creatology Matrix, introduced by Magyari-Beck, it is the abilities, process, and product of the person, group, organization, and culture that need to be measured. In 1990, A. Aleinikov designed the ALEANDR creativity test battery that measured individual and group creativity at the same time (Aleinikov 1990).

The most well-known system of evaluating creativity as **ability** is the Torrance Creative Thinking Test (Torrance 1986). This test presents some tasks to people and then rates their abilities. Longitudinal research is possible with such an approach, and Dr. Torrance made a colossal effort to follow up his "Torrance kids" for 50 years (see ▶ Creativity Tests).

Another well-known system of evaluating creativity that measures the **style** of creativity (not **level of abilities**) and differentiates "innovators" (tending to change the system) and "adaptors" (tending to preserve and improve the system) with "bridgers" in between is called the Kirton Adaptation-Innovations Inventory, KAI (Kirton 1994) (see ▶ Adaptive Creativity and Innovative Creativity).

Despite numerous attempts to measure various aspects of creativity, there is still no such a thing in creativity research as unit of measurement, like meter, second, gram, Ohm, Hertz, or Volt in physics, like parsec in cosmology and byte in cybernetics.

The presence of units in this or that field of research to some extent shows whether it is a science or not. Qualitative units and quantitative units of measurement are a must. Measurements are the foundation of any science.

Therefore, in general, when transforming the creativity research field into the science of creativity, one has to move from general measurements to specific measurements and from empirical measurements (often commercial use oriented, used for testing and training purposes) to theoretically based measurements.

With the development of the new vision of creativity and new definition of creativity that emphasize the acceleration to higher organization (discussed above), sozidonics developed a new measurement system and a new unit that measures the efficiency of creative output, i.e., the number of ideas per second. The new unit of measurement established as 1 idea per second is called Alein just as in physics, 1 cycle per second is called Hertz.

This measurement allows researchers not only to evaluate individual performance but also objectively to evaluate the creative power of methods that boost creativity.

Illustration

Case A. Alex Osborn mentioned that brainstorming allowed people to generate 90 ideas in one and a half hours (Osborn 1953). Truly, brainstorming is the most famous technique in the creativity enhancement market; it made history!

Case B. Max Fisher many years later offers a new "revolutionary" (as he claims) method "IdeaFisher" in the book with the same title *IdeaFisher*. This is how it is described, "Those without the list (of words) only worked an average of 55 min, when they "ran out of ideas." Those with the list worked an average of 78 min – a 42% increase. There was also a statistical difference in the number of ideas. Those without the list produced an average of 55 ideas. Those with the list produced an average of 86 ideas – an increase of 56%" (Fisher 1996).

Comparison

Calculation shows that the efficiency of creative output in the brainstorming session in *Case A* equals 1 idea/min (90 ideas/90 min).

The efficiency of creative output in *Case B* (without lists) is exactly the same as in brainstorming (*Case A*): 1 idea/min (55 ideas/55 min). The efficiency of creative output in the session with the lists is 86 ideas divided by 78 min = 1.1 ideas/min.

So when the author states a 42% increase in time of work and 56% increase in idea output, these are calculations in absolute numbers. The result looks good and may sound "revolutionary." However, in objective calculation (new measurement), using the concept "specific creativity," the increase in creative output efficiency is only 10%, (1.1 vs. 1). This result is quite far from "revolutionary" – not 10 times (1,000%) or 100 times (10,000%) increase.

If calculated in new units, the creative output efficiency of brainstorming is 1 idea/1 min = 1 idea/60 s = 0.017 Alein, and the creative output efficiency of IdeaFisher is 1.1 ideas/60 s = 0.018 Alein. The word "revolutionary" is certainly out of context here.

The introduction of the new type of measurement made it possible to compare the generative power of techniques, methods, and methodologies for boosting creativity and finally led to the development of methods delivering 1,000 ideas/min (kilocreativity), 1,000,000 ideas/min (megacreativity), and more (Aleinikov 1999b, 2002a). Teaching these methods allows human beings (whether children or adults) to overcome the generative power of natural genius (about 100 ideas/min = 1.8 Alein) 10 times and even 10,000 times.

This is how the new scientific approach expanded the natural human creativity power.

Practical Applications of the Science of Creativity: Improving and Accelerating the Existing Results

The formation of the new science of creativity is worth doing only if it leads to outstanding results, only if it shows a leap to unusual achievements (like genetics led to genetic engineering, cybernetics led to the computer age, etc.), thus demonstrating that the new science is much more powerful than the prescientific approaches or the situation without established science.

The first applications of the new science showed significant achievements in the four main areas: science and arts, business and education, as well as some other areas.

- **When applied to the field of science**, the new scientific understanding of creativity led to the *accelerated creation* of 7 new sciences and 3 new fields of research, as well as the *accelerated discovery* of 11 new laws of conservation and 12 new measurement units, not to mention new models, new theories, new concepts, etc.
- **When applied to the field of education**, the new science led to the *most accelerated methodologies* of human mind reorientation from passive, disinterested, negative, lazy, and having low goals into active, interested, positive, ready to work hard, and having high goals.
- **When applied to the field of business** (in this particular case, the business of publishing), the new science led to the Guinness World Record results, i.e., *most accelerated* – (certified) top world accelerated speeds in publishing.
- **When applied to the field of arts**, the new science allowed a group of students in

Psychology of Creativity class to create a new style of arts. So what usually needs 50–100 years *was accelerated* to 10 h of classes.

- **When applied to the field of creativity** itself, the new science led to the design of the *most accelerated methods* of boosting creativity to the megacreativity level and above.

Some details are as follows:

Result #1. The new scientific definition of creativity (see ▶ Creativity, definition entry, and ▶ Creativity Definitions, Approaches) leads to establishing the science of creativity (sozidonics). Thus, what was called the "emerging discipline" or "the field of research" is *accelerated to a higher organization* – transformed into a well-organized science.

Result #2. The research and the experience of structuring the new science of creativity led to general understanding on structuring new sciences. As a result, new sciences, such as agogics (see ▶ Creative Leadership), geniusology (see ▶ Genius), novology (see ▶ Novology), organizology, and intensiology (Aleinikov and Gera 2006), as well as new fields of research, such as creative linguistics (see ▶ Creative Linguistics) and creative pedagogy (see ▶ Creative Pedagogy), have been designed and introduced for scientific research. This is expanding the modern science horizons. The discovery of these new sciences and research domains not only corroborates the process of *acceleration* in science development (seven new sciences and three new fields of research) but also clearly illustrates a direct giveback from the new science of creativity to the creativity of science.

Result #3. The research of new discovery methodologies, in particular Robert Oros di Bartini's achievements, led to the discovery of a new law of conservation (Aleinikov 2007a) and then 10 more new laws of conservation by a California-based group of researchers (Aleinikov and Smarsh 2010). For comparison, the previous (natural) development of physical science showed the tempo of one conservation law per 50–100 years. Now, the new understanding of creativity and research of genius methods of thinking from this new point of view allowed researchers to *accelerate the physical science organization* to two new laws per year, i.e., about 200 times acceleration.

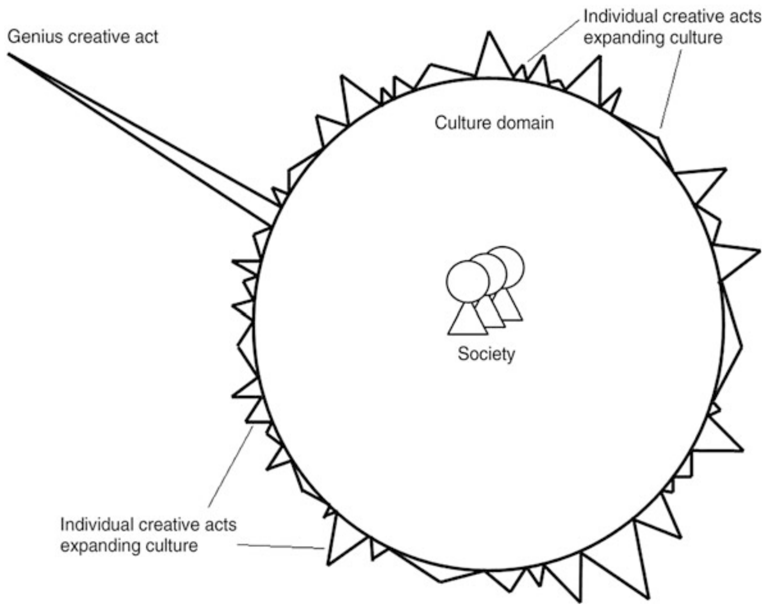
Result #4. Search for new creativity-enhancing methods and techniques led to introduction of simple techniques like 4Delays4GeniusWays and semiotic modeling (Aleinikov 2002a) but also to the introduction of methods that *accelerated* creative output many times to achieve kilocreativity (1,000 ideas/min), megacreativity (1,000,000 ideas/min), and more (Aleinikov 1999b, 2002a). See comparison of brainstorming and IdeaFisher above. For more techniques, see ▶ Creativity Techniques.

Result #5. New measurement units for measuring objective and subjective newness, quantitative and qualitative newness, as well as the efficiency of creative output have been developed to *accelerate* the application of mathematical means to creativity research (see ▶ Novology and, for comparison, and ▶ Measurement of Creativity).

Result #6. New tools of research, such as a universal model of creative act, which generalizes and explains everything from a speech act to a heuristic act (see ▶ Genius as well as *Models of Creativity*), have been introduced. Since it is a graphic model (in terms of graph theory), it allows researchers to visualize creative activities (one picture is worth a thousand words), thus *accelerating* the comprehension of complex concepts and processes. Moreover, having one model for many phenomena follows the principle of economy of force in education, thus *accelerating* the learning process.

Result #7. New definitions (new understandings) led to the development of new educational methodologies and new pedagogy aiming at creation of ideal learner, active, interested, enthusiastic, and ready to work hard, which *accelerates* the study of *any* material, whether it is languages, natural or social sciences (see ▶ Creative Pedagogy). Some of these new

Science of Creativity, Fig. 6 Genius creative act expanding culture



methods like *M*ethod of *A*pplied *N*onverbal *Do*minance (MANDo) and genius expectations, genius achievements (GEGA) have been published and republished as "Classic" by the *Teaching for Success* online magazine (Aleinikov 2007b, 2009). The new approach to education has been published as an editorial by the *International Journal of Innovative Higher Education* (Aleinikov 1995). These methodologies change children and adults, teachers and professors, schools and colleges. Students and teachers who learn to apply these new methodologies receive their educational institutions' and even countries' top awards. Some description of the educational results may be found in Aleinikov (1996) and Aleinikov (1990b) (see ▶ Creative Pedagogy and ▶ Genius).

Result #8. New educational methodologies, based on the new definitions, turned out to be so effective that they allowed educators to raise the plank from traditional education goals (learning some material and testing well) to nontraditional goals, like changing the mind set and aiming at the highest levels of self-improvement – the top creativity level – genius. Genius Education Methodology (GEM) has proven to be saving geniuses and revealing hidden genius in the children – even those seemingly lost by traditional education (see ▶ Genius and ▶ Creative Pedagogy). This *accelerates* the natural process of genius growth. Also, in the future, these "geniuses" will *accelerate* the development of the countries that initiated the process (see Fig. 6). As Fig. 6 demonstrates, the Genius creative act is much more powerful and much more advancing the society than usual individual creative acts. That's why geniuses cause much more accelerated society development, or, in new term, accelerated expanding of culture domain.

Result #9. New university-level subjects have been introduced to the higher education field: Creative Linguistics (ENG2210), Psychology of Creativity (PSY3390), and Foundations of Creative Pedagogy (EDU6625). This introduction *accelerated* the exposure of adult students to creative learning while learning languages, psychology, and education.

Result #10. The new definition of creativity as accelerating organization led to such outstanding business applications as the Guinness World Record in publishing for the fastest written, printed, and published book titled "Making the Impossible Possible" (15 h and 46 min "from scratch to publication") in 2001 in South Africa. It has proven that such a tedious task as book writing (traditionally from a year to 25 years) and book publishing (from 6 months to a year) can be reorganized in such a manner that the process is *accelerated* over 300,000 times.

From the list above, it becomes obvious that the correctly defined **scientific essence** of the phenomenon of creativity, as it usually happens with any science, can make correct predictions, boost practical results, and lead to accelerated development in any field.

Conclusion and Future Directions

Since in the history of humanity creativity was used for solving problems in practically all fields, it varied greatly in its outlook, and that is why it was often not even seen as creativity. After a century of thorough studying, when the creativity phenomenon had been investigated by numerous sciences, the convergent stage of collecting and rethinking the data has been mainly completed. The processes of generalization, restructuring, and designing of the new understanding led to a logical conclusion – the science of creativity.

As a new science, the science of creativity has a new name – sozidonics. It formulates its objectives and the subject of study. It offers a new vision of creativity (new definition), new model of creativity, new classification of creativity, new units and measurements for measuring creativity, thus fulfilling the main criteria for becoming a science.

The new scientific concepts, models, and theories have been tested in the domains other than creativity: in science and arts, business and education where they helped achieve high level results. With the theoretical and practical results so advanced and the proof of success so obvious, sozidonics has proven its right to be considered a science and is now ready for its next divergent move.

First of all, the pattern of creating new sciences (like sozidonics, novology, and geniusology) would be applied for the development and description of already announced new sciences. Organizology and intensiology are waiting for their turn.

Second, at present, in addition to already developed directions, sozidonics is spreading to such diverse areas as:

- New ways of resources conservation
- New ways of treatment in medicine
- New methods of training in sports
- New methods of education in early childhood
- New engines and tools in the financial arena
- New methods of gang fighting and crime prevention

Thus, the new science of creativity in the terms of Sid Parnes, the "father of creative problem solving," opens "for new challenges." The prediction is that with most accelerated methodologies, it will achieve outstanding results in these areas too.

Third, and final, sozidonics, as with any science, is never completed. It should and it will continue to develop itself: the horizons and the opportunities are unlimited.

Cross-References

▶ Adaptive Creativity and Innovative Creativity
▶ Convergent Versus Divergent Thinking
▶ Creative Behavior
▶ Creative Leadership
▶ Creative Linguistics
▶ Creative Pedagogy
▶ Creative Problem Solving
▶ Creativity
▶ Creativity Tests
▶ Creativity, Experiential Theories
▶ Genius
▶ Measurement of Creativity
▶ Multiple Models of Creativity
▶ Nature of Creativity
▶ Novology
▶ Psychology of Creativity
▶ Research on Creativity

References

Aboganda RNM, Cortez, RS. Towards a positive understanding of creativity – creatology: the science of creativity. Philippine Inventors Commission, Department of Science and Technology, 1972 October.

Aleinikov AG. Speech activity model (in terms of graph theory). In: Sorokin YuA, Tarasov AF, Ufimtseva NV, editors. Speech communication: objectives, motives, means. Moscow: Institute of Linguistics, USSR Academy of Sciences; 1985. p. 11–21. russ. Алейников АГ. Модель речевой деяльности (в терминах теории графов). Речевое общение: цели, мотивы, средства.

Aleinikov AG. Creative linguistics (foundations, problems and perspectives). In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, USSR Academy of Sciences; 1988a. p. 77–89. russ. Алейников АГ. Креативная лингвистика (обоснование, проблемы и перспективы). Языковое сознание: стереотипы и творчество.

Aleinikov AG. Sign. Four-side essence. Universal creative model. In: Sorokin YuA, Tarasov EF, Ufimtseva NV, editors. Language awareness: stereotypes and creativity. Moscow: Institute of linguistics, USSR Academy of Sciences; 1988b. p. 89–115. russ. Алейников АГ. Знак. Четырехсторонняя сущность. Универсальная креативная модель. Языковое сознание: стереотипы и творчество.

Aleinikov AG. On creative pedagogy. Higher Educ Bull. 1989;12:29–34. russ. Алейников АГ. О креативной педагогике. Вестник высшей школы.

Aleinikov AG. Creative orientation in teaching and learning theoretical disciplines. Moscow: Military Institute; 1990a. russ. Алейников АГ. Творческая ориентация в преподавании и изучении теоретических дисциплин.

Aleinikov AG. Grammar creation and creation grammar: creatively-oriented course of grammar and history of english. Moscow: Military Institute; 1990b. russ. Алейников АГ. Созидание грамматики и грамматика созидания.

Aleinikov AG. Test battery "ALEANDR." Moscow: Russian Academy of Sciences Center for Creative Research and Krasnodar Center for pedagogic innovations; 1990c. russ. Алейников АГ. Анкета "АЛЕАНДР".

Aleinikov AG. Sozidolinguistics for creative behavior. J Creat Behav. 1994;28(2):104–23.

Aleinikov AG. An approach to innovative education (Editorial). Int J Innov High Educ. 1995;11:5–7.

Aleinikov AG. Super effective communication. Alabama English. 1996;8(Spring):28–31.

Aleinikov AG. Humane creativity. In: Runco M, Pritzker S, editors. Encyclopedia of creativity, Vol. 1. San Diego: Academic; 1999a. p. 837–44.

Aleinikov AG. Mega-creator: from creativity to mega-, giga-, and infi-creativity. Montgomery: MIMII; 1999b.

Aleinikov AG. MegaCreativity: five steps to thinking like a genius. Cincinnati: Walking Stick Press/F&W Publications; 2002a.

Aleinikov AG. Novology, the science of newness, for creativity and innovation research. In: The future of creativity: Dr. E. Paul Torrance lecture series at the University of Georgia. Bensenville: Scholastic Testing Services; 2002b. p. 114–41.

Aleinikov AG. Gera R. Mathematical predictions of organizology, the new science of organization. Allied Academies International Fall Conference; 2006 October; Reno, NV.

Aleinikov AG. The conservation of extencia: a new law of conservation. J Econ Econ Educ Res. 2007a;8(3): 49–65.

Aleinikov AG. Openness – It's that simple! Teaching for Success. 2007b Sept, p. 3.

Aleinikov A, Smarsh D. Eleven new laws of conservation: the discovery of the century. Allied Academies' Spring International Conference; 2010 Apr; New Orleans, Louisiana, p. 37.

Aleinikov AG. On creative pedagogy. Higher Educ Bull., 12:29–34. Алейников АГ. О креативной педагогике//Вестник высшей школы.

Amabile TM. Motivating creativity in organizations: On doing what you love and loving what you do. California Management Rev. 1997;40:39–58.

Bertalanffy L. General system theory: foundations, development, applications. New York: George Braziller; 1968.

Davis G. Creativity is forever. Cross Plains. Wisconsin: Badger Press; 1981.

Fisher M. The ideafisher. Princeton: Peterson's/Pacesetter Books; 1996.

Guilford J. Intelligence, creativity, and their educational implications. San Diego: Knapp; 1968.

Guilford JP. Creativity in retrospect. In: Parnes SJ, editor. Source book for creative problem solving. Buffalo: Creative Education Foundation Press; 1992. p. 69–74.

Isaksen SG. Frontiers of creativity research. Buffalo: Bearly Limited; 1987.

Kirton M. Adaptors and innovators: styles in creativity and problem solving. London/New York: Routledge; 1994.

Magyari-Beck I. Creatology. In: Runco M & Pritzker S, editors. Encyclopedia of creativity. San Diego, CA: Academic Press; 1999. Vol. 1, p. 433–441.

McPherson JH. The people, the problem and the problem solving methods. J Creat Behav. 1968;2:103–110.

Osborn A. Applied imagination. NYC: The Creative Foundation Press; 1953.

Parnes SJ, editor. Source book for creative problem solving. Buffalo: Creative Education Foundation; 1992.

Poskryakov AA. Innovatics: science and learning discipline. Moscow: MIFI; 1988. russ. Поскряков АА.
Roth SG. Creativity in an academic atmosphere. In: Coler MA, editor. Essays on creativity in the sciences. New York: New York University Press; 1963. p. 42–73.
Torrance EP. Torrance creativity test collection. Athens: The University of Georgia Libraries; 1986.
Wallas G. The art of thought. New York: Harcourt, Brace; 1926.
Wiener N. Cybernetics: or control and communication in the animal and the machine. Paris/Cambridge, MA: Hermann & Cie/MIT Press; 1948. 2nd revised ed. 1961.

Scientific Creativity as Combinatorial Process

Dean Keith Simonton
Department of Psychology, University of California, Davis, CA, USA

Synonyms

Blind-variation and selective-retention theories of scientific discovery

Introduction

The progress of science depends on creative ideas. An idea is creative if it is novel, useful, and surprising. A novel idea has never appeared before; a useful idea entails a theory, technique, or empirical result that advances a particular scientific discipline; and a surprising idea is one that is not an obvious derivation from an already existing idea. These three criteria closely parallel those that the US Patent Office uses in evaluating whether inventions warrant patent protection. Given these definitions, the fundamental question then becomes: Where do scientists get their creative ideas? One answer is to make appeals to "strokes of genius," "flashes or insight," "brilliant intuitions," or some other romanticized concept. Such responses do not provide a scientific basis for understanding creativity in the sciences. They seem to suggest that creative ideas can emerge de novo. Yet for science to constitute a cumulative enterprise, even the most creative scientists must build upon the theories, techniques, and results of their predecessors. Even Isaac Newton admitted that he stood on the "shoulders of giants."

The mathematician Henri Poincaré (1921) provided a superior answer: Creativity is combinatorial. Old ideas are recombined to generate new ideas. He even suggested that this combinatorial procedure is effectively random. Nonetheless, it is not necessary that the combinations be random so long as they are blind, that is, the ideas are generated without knowing in advance, which combinations will prove fruitful and which will fail. This latter provision is assumed in blind-variation and selective-retention theories of scientific discovery (Campbell 1960). Although all random combinations are blind, not all combinations are random. To illustrate, a systematic search is blind without being random.

Combinatorial models have made important contributions to comprehending scientific creativity (e.g., Fowler 1987; Thagard 2012). To provide an overview, the three systems involved in creativity are defined first. Then implications are drawn for each of the systems.

Three Systems

Scientific creativity requires the interaction of three systems: the domain, the field, and the individual (Simonton 2010). The domain and the field together constitute a scientific discipline. The domain consists of a set of ideas that define a particular discipline. The field consists of the fellow scientists who are actively contributing to that domain. These colleagues are ultimately responsible for deciding whether any scientist has contributed to the discipline. This decision is made in peer review and citation practices. Fields can also vary in size: New fields tend to be small, old fields large. Finally, the individual is one of the members of the field. In most combinatorial models, he or she is the actual locus of creativity (e.g., Simonton 1988; Thagard and Stewart 2011; but see Fowler 1987).

Combinatorial creativity cannot begin until each individual scientist first obtains a sample of ideas from the domain. Presumably, these ideational samples are acquired during education and training, albeit a significant portion can be acquired through independent reading and study. Furthermore, the samples are not identical for each scientist, even for scientists active in the same field. For one thing, scientists can vary in the sheer size of their ideational samples. Whereas some scientists may be extremely focused on a very narrow specialty area, other scientists will exhibit much broader interests that encompass most or all of the ideas representing a given domain. Another important difference is whether the samples of ideas are confined to a particular domain or instead cut across two or more domains. An instance of the latter is the scientist who changes fields, bringing the knowledge of one domain to bear on the new knowledge acquired in another domain. A final contrast is related to the previous two: to what extent the scientist's sample of ideas overlaps the samples of other scientists working in the same domain.

Each individual's ideational sample is then subjected to combinatorial procedures. These procedures may be either implicit (intuitive and haphazard) or explicit (conscious and systematic). Of all the combinations generated, only a small number will prove sufficiently creative. These ideas will then undergo development and elaboration into a completed paper that can be submitted for publication. If the paper passes peer review, its creative ideas become part of the domain and thus can enter the ideational samples of other scientists. The upshot is a cyclical process that allows for the accumulation of knowledge.

Individual System

Combinatorial models at the individual level attempt to describe the key features of scientific productivity (Simonton 1988). One of these features is how scientists vary in total lifetime output. This variation is characterized by an extremely skewed distribution with a long upper tail. As a result, a smaller percentage of the scientists in any field account for a disproportionate amount of the creative products. Specifically, the top 10 % may account for as much as half of all output. This skewed distribution is surprising insofar as most individual-difference variables underlying creativity – such as intelligence, openness to experience, and divergent thinking – would be expected to be normally distributed. Nevertheless, if it is supposed that the domain samples of each type of scientist are of unequal size, and if it is assumed that the size of these samples is normally distributed across members of the field, then it follows that the total number of ideational combinations that can be generated must be described by a highly skewed lognormal distribution. That results because the number of combinations increases exponentially with the number of ideas being combined.

More complex are the combinatorial models that attempt to try to explain how total output is distributed across the course of a scientist's career (Simonton 2004). The simplest models predict that creative ideas will be randomly distributed across the career. That prediction arises under the assumption that the combinatorial process operates according to BVSR, that is, blind variation and selective retention. That is, because the scientist cannot anticipate the novelty and utility of a combination until after it is generated and tested, creative combinations will come and go throughout the career. In contrast, if the combinatorial process were highly sighted, then the best ideas would be produced first, and the less creative ideas would appear later in the career. In short, in the absence of BVSR, scientists should show a progressive decline in creativity with age.

The previous model is highly simplified. It just assumes that scientists are merely pulling balls randomly out of an urn and then saving the combinations that satisfy some criterion. For example, the balls might be marked with integers, and the individual must identify those combinations that represent prime numbers (as in the sieve of Eratosthenes). More sophisticated models allow for the fact that the creative process is more complex than that (Simonton 2010). For instance, one model posits that creativity consists of the two-step process of ideation and elaboration. Combinations of ideas are generated in the ideation stage, but these combinations must then be elaborated into final creative products. Because of the temporal delay imposed on the combinatorial procedure, creative ideas will be distributed unevenly over the course of the career. In particular, annual output will rise rapidly to a peak productive age after which a gradual decline sets in, approaching a zero productivity rate asymptotically. With the addition of further complications, such models can account for the finer features of output. For instance, if the ideation and elaboration rates are allowed to vary across domains (to reflect the nature of the ideas in those domains), then different output trajectories will be predicted for various domains. Thus, because the ideation and elaboration rates are much faster in mathematics than in the earth sciences, mathematicians will have earlier career peaks than holds for earth scientists.

These and other predictions have been successfully tested against empirical data, lending support to the conjecture that individual creativity depends on combinatorial procedures (Simonton 2004). Moreover, computer simulations have provided insights into how the combinatorial process might operate (Thagard and Stewart 2011). Lastly, it should be noted that the hypothesized combinatorial process is compatible with those psychological theories of the creative process that assume the involvement of remote association, divergent thinking, and defocused attention (Simonton 2010). These provide the means for freely linking the ideas making up a scientist's domain sample.

Domain System

It was said that the three-system cycle permits the accumulation of scientific knowledge. This growth raises the issue of how fast that knowledge accumulates. As a first approximation, because the total number of scientists has been increasing exponentially, one might suppose that scientific knowledge has also been increasing exponentially. Yet this inference neglects the repercussions of having the domain size increase as well. If the addition of new ideas is a joint function of field size and domain size, then the growth will be accelerated even more (Fowler 1987), providing the basis for the "information explosion." One consequence of this explosion is that disciplines will much more quickly fragment into largely independent subdisciplines. The domains and fields become too vast to continue as coherent endeavors. Of course, this accelerated trend also puts more pressure on scientists to become much more specialized, reducing the prospects for grand integrative theories.

Field System

Among the most dramatic episodes in the history of science and technology is the frequent appearance of multiple discoveries and inventions (Simonton 1988). These occur when two or more scientists independently arrive at the same idea. Two famous examples include the theory of evolution by natural selection contributed by Charles Darwin and Alfred Wallace and the invention of calculus by Isaac Newton and Gottfried Leibniz. Many sociologists and anthropologists adopted multiples as proof of sociocultural determinism. That is, at a particular moment in the development of a discipline, certain discoveries or inventions become inevitable.

Even so, the phenomenon of multiples can be easily explicated in terms of combinatorial models (Simonton 2010). If a field consists of individuals who are recombining ideas obtained from the same domain, then it necessarily follows that two or more scientists may generate identical or nearly identical combinations. At the same time, combinatorial models provide a useful means for predicting the details of this phenomenon. As an example, consider how multiples vary regarding their grades. The grade of a multiple is the number of scientists who independently arrive at the same idea. Combinatorial models predict that frequency of a given multiple grade will be a negative monotonic function of the grade – as described by a Poisson distribution. In other words, high-grade multiples will be very rare, the majority of multiples will be doublets, and the most common outcome will be a singleton, that is, a discovery made by a single scientist. This prediction has been borne out in investigations using different data sets.

Besides predicting the distribution of multiple grades, combinatorial models can also predict

(a) the temporal separation of multiples (i.e., how much time lapses between first and last discovery), (b) multiple congruence (i.e., how many ideas are actually shared, given that most multiples are not perfectly identical), and (c) individual differences in how many multiples each scientist contributes. So far, these predictions have also received empirical support (Simonton 2004). Because combinatorial models are probabilistic rather than deterministic, their predictive success undermines the inference that discoveries and inventions must be inevitable.

Conclusion and Future Directions

Although this entry has focused on applying combinatorial models to scientific creativity, it should be apparent that other forms of creativity can also be so viewed, including artistic creativity (Simonton 2010). In fact, in some respects, creativity in the arts may rely more on combinatorial processes than holds in the sciences. The reason for the greater dependence is that artists generally operate under fewer logical and factual constraints than scientists do. The most obvious example is so-called artistic license. If novelists, poets, painters, or filmmakers wish to have a character defy the energy conservation law, nothing prevents them from doing so. That option is not available to a physicist, chemist, or biologist. Furthermore, because artistic domains are more loosely defined, artists have more freedom to use idiosyncratic samples of ideas in their combinatorial creativity. Many novels and poems are partially autobiographical, the ideas coming from life experiences that make each novelist or poet unique. These differences between artistic and scientific creativity help explain why multiples are extremely rare in the arts.

The explanatory value of combinatorial models can certainly undergo elaboration and extension in future research. Although combinatorial procedures have already been translated into both mathematical and computer models, these translations remain preliminary. A complete account of scientific creativity will require more advanced versions of current models. Perhaps the most conspicuous problem is that much contemporary scientific creativity occurs in research teams, a fact documented by the large number of coauthors on most journal articles. Consequently, it would seem advisable to include collaborative groups in the systems perspective. The resulting mathematical and computer models would then have to be modified.

Cross-References

▶ Age and Creative Productivity
▶ Creativity and Age
▶ In Search of Cognitive Foundations of Creativity

References

Campbell DT. Blind variation and selective retention in creative thought as in other knowledge processes. Psychol Rev. 1960;67:380–400.

Fowler RG. Toward a quantitative theory of intellectual discovery (especially in physics). J Sci Explor. 1987;1:11–20.

Poincaré H. The foundations of science: science and hypothesis, the value of science, science and method (Halstead GB, Trans.). New York: Science Press; 1921.

Simonton DK. Creativity in science: chance, logic, genius, and zeitgeist. Cambridge, UK: Cambridge University Press; 2004.

Simonton DK. Creativity as blind-variation and selective-retention: constrained combinatorial models of exceptional creativity. Phys Life Rev. 2010;7:156–79.

Simonton DK. Scientific genius: a psychology of science. Cambridge: Cambridge University Press; 1988.

Thagard P. Creative combination of representations: scientific discovery and technological invention. In: Proctor R, Capaldi EJ, editors. Psychology of science: implicit and explicit processes. New York: Oxford University Press; 2012.

Thagard P, Stewart TC. The AHA! experience: creativity through emergent binding in neural networks. Cogn Sci A Multidisciplinary J. 2011;35:1–33. doi:10.1111/j.1551-6709.2010.01142.x.

Scientific Creativity, Discourses

▶ Creativity, Discourses

Scientific Elite

► Networks and Scientific Innovation

Scientific Invention

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Scientific Inventive Thinking Skills in Children

Kamisah Osman
Faculty of Education, Universiti Kebangsaan Malaysia, The National University of Malaysia, Bangi Selangor, Malaysia

Synonyms

Creative scientific enquiry; Guided creative idea; Supervised imaginative activity

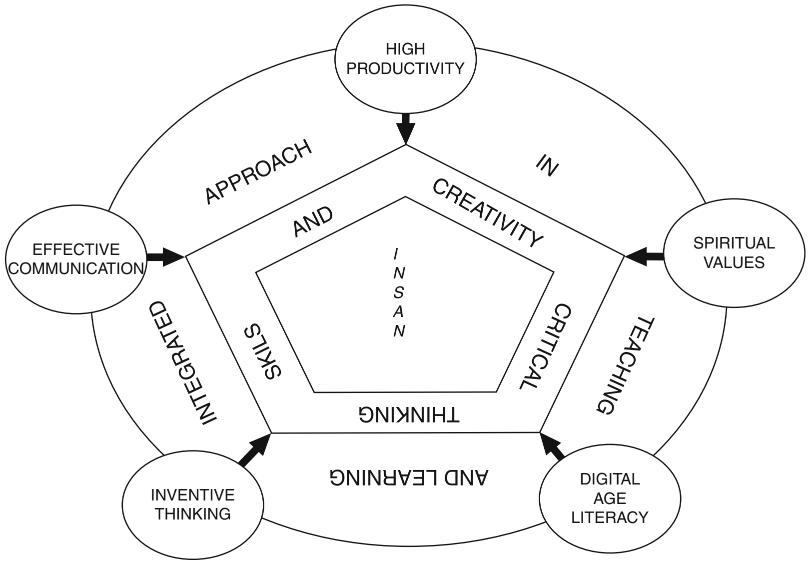
The terms "scientific," "inventive," and "thinking" seem, at first glance, to be incongruent with the word "children." Nevertheless, historical evidence of diaries, notes, interviews, and oral histories of earlier and contemporary inventors emphasized the role of childhood play experiences as the critical development of "inventive thinking" skills. According to Judd et al. (2002) through play, children develop essential inventive thinking skills such as exploring using all senses, imagining and pretending, social play and communicating, and playing with puzzles and patterns. During the earlier times, these activities were done in a leisurely way, with children freely exploring the inventiveness side of themselves while having fun playing, alone or with friends. Inventive thinking in children is rooted in curiosity, creativity, and the ability to understand and manipulate the properties of material world in order to adapt and adjust to the surrounding environment. This shows that, somehow, inventive thinking is part of children's natural ability.

However, nowadays, with everything digital, children's playground has become more "virtual" instead of "physical" and "real." Although the "fun" element is still there and in fact boosted with what is called "virtual reality," there is growing concern that students are not being encouraged to think and are losing some basic skills for defining, understanding, and solving problems (Raviv 2000). Computer games and the Internet have dominated children's life, and so the element of inventive thinking skills is deliberately dissipated as most of the thinking is being done for them by the computer. In spite of this, the notion of "inventive thinking" skills has become more of a necessity where the skills are seen as valuable intellectual capital that is increasingly important to the children entering the work force in the twenty-first century. There are demands for the children to be inventive; namely, they must be able to adapt and manage the complexity of globalization and the World Wide Web and have self-direction fuelled by curiosity, creativity, and risk taking while at the same time capable of making higher-order thinking and sound reasoning. Now, there are efforts to integrate "scientific inventive thinking" in schools science teaching and learning with the aim of nurturing children's scientific inquisitiveness and attitudes toward the subject. The scientific inventive thinking skills stressed in this entry are a combination of twenty-first-century skills, inventive thinking skills, and scientific thinking skills. The relationship between these skills is to be discussed and the underpinned educational theoretical background will be further explained.

Scientific Inventive Thinking Skills in Children

Twenty-First-Century Skills

In order to meet the demands and expectations of twenty-first-century workforces, twenty-first-century skills become key skills that must be acquired by all students. Knowledge-based



Scientific Inventive Thinking Skills in Children, **Fig. 1** Domain of twenty-first-century skills (Source: Kamisah et al. 2010)

economy requires tremendous manpower competent in twenty-first-century skills. The enGauge twenty-first-century skills framework listed four main skills that are important for twenty-first-century students: digital age literacy, inventive thinking, effective communication, and high productivity. The present author included spiritual values to the existing enGauge framework; the rationale of this action is aimed at producing a holistic human capital (INSAN) in the intellectual, spiritual, emotional, and physical aspects (Kamisah et al. 2010) (see Fig. 1).

As the world becomes boundless, due to globalization and the World Wide Web, with the richness of this knowledge around them, children today can construct a science project, build their own tree house, invent a new toy for themselves, or even make a bomb and assemble a homemade gun. These activities perhaps show the inventiveness of children but the last two touch on the ethical ground of how children should act with all the knowledge that is easily within their reach. There is increasing concern about the recent phenomenon of children being involved in criminal acts and irresponsible behavior, and so spiritual values besides other twenty-first-century skills should be inculcated in children's educational programs including the implementation of scientific inventive thinking skills. Figure 1 illustrates the modified twenty-first-century skills which include the inventive thinking and the spiritual value domains (Kamisah et al. 2010).

Inventive Thinking Skills

Invention is the breaking down of conventional similarities and the making of new and unusual connections. Most of society relates invention to something irrational. Thus, invention is not easily accepted by everybody. Definitions of inventive thinking have never been monotonous. Much of the literature about inventive thinking skills especially in children has discussed various aspects of the skills such as curiosity, creativity, exploring using all senses, imagining and pretending, ability to manage complexity, risk taking, making higher-order thinking, sound reasoning, and problem solving. These components are essential tools in developing children's inventive thinking where it required students to be critical and creative.

Using the enGauge twenty-first-century skills framework, the inventive thinking skills implied here comprise the following skills: adaptability and managing complexity, self-direction, curiosity, creativity, risk taking, higher-order thinking, and sound reasoning. These skills grasp the aspect of inventive thinking that is important for students as highlighted above. The six skills are described as follows:

1. *Adaptability and managing complexity* refers to the ability to handle changes, sophisticated problem, or obstacles calmly, confidently, and positively while planning successfully for resource management.
2. *Self-direction* refers to the ability to be an independent learner, able to set his/her own goals, to do planning to achieve goals, and to evaluate his/her own work from the learning experience.
3. *Curiosity* refers to the intrinsically motivated desire to know and make an active attempt to learn about it.
4. *Creativity* refers to the ability to produce original, unique, novel, and genuinely new ideas, products, or alternative solutions either individually or culturally.
5. *Risk taking* refers to daring to tackle challenging tasks or unconventional problems without obvious solutions with high integrity.
6. *Higher-order thinking and sound reasoning* include the cognitive domains of analysis, comparison, inference, interpretation, evaluation, and synthesis applied in academic fields and problem-solving contexts.

Scientific Thinking Skills

Science emphasizes inquiry and the problem-solving process. Scientific thinking skills are utilized because they are a mode of thinking suitable for all scientific subjects, contents, and problems. Scientific thinking skills require systematically and structured steps to carry out the experiment or scientific investigation. Intellectual standards in scientific thinking include clarity, accuracy, precision, relevance, depth, breadth, logic, significance, and fairness. They also, as in inventive thinking, require students to be critical and creative.

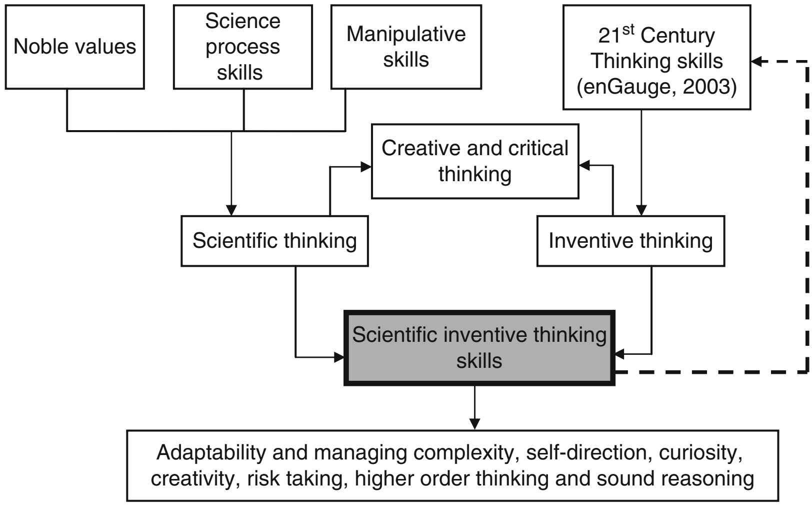
In order to acquire scientific thinking skills, science process skills must be mastered. Science curricula include science process skills such as observing, classifying, measuring and using numbers, inferring, predicting, communicating, using space-time relationship, interpreting data, defining operationally, controlling variables, hypothesizing, and experimenting. At the same time, manipulative skills are also an important component of scientific thinking. Manipulative skills in scientific investigation are psychomotor skills that enable students to:

- Use and handle science apparatus and laboratory substances correctly
- Handle specimens correctly and carefully
- Draw specimens, apparatus, and laboratory substances accurately
- Clean science apparatus correctly
- Store science apparatus and laboratory substances correctly and safely

Meanwhile, scientific attitudes and noble values must be inculcated during science teaching and learning process. The rationale of inculcating scientific attitudes and noble values in scientific inventive thinking is to ensure that children have the mind-set to invent something beneficial to mankind and not to bring a destructive element into the world. These attitudes and values encompass the following:

- Having an interest and curiosity toward the environment
- Being honest and accurate in recording and validating data
- Being diligent and persevering
- Being responsible about the safety of oneself, others, and the environment
- Realizing that science is a means to understand nature
- Appreciating and practicing clean and healthy living
- Appreciating the balance of nature
- Being respectful and well mannered
- Appreciating the contribution of science and technology
- Being thankful to the Creator
- Having critical and analytical thinking
- Being flexible and open minded
- Being kind hearted and caring
- Being objective
- Being systematic
- Being cooperative
- Being fair and just
- Daring to try
- Thinking rationally

Scientific Inventive Thinking Skills in Children, **Fig. 2** Scientific inventive thinking skills



- Being confident and independent
- Understanding and practicing the skills of critical thinking

Considering the interrelation between scientific thinking, inventive thinking, and twenty-first-century skills, scientific inventive thinking is referred to as guided creative idea or supervised imaginative activity that could enhance children's innate ability. A scientific inventive thinker must be a person who is systematic, guided by some rules, and has these features: adaptability and managing complexity, self-direction, curiosity, creativity, risk taking, higher-order thinking, and sound reasoning. Figure 2 below shows the relationship between twenty-first-century thinking skills, inventive thinking, science process skills, manipulative skills, noble values, creative and critical thinking, and scientific inventive thinking.

Educational Theoretical Background

With the idea of instigating the scientific inventive thinking skills in schools, researchers and educators have produced teaching and learning approaches and methods that can, by implication, enhance students' scientific inventive thinking skills. These teaching and learning approaches and methods depict educational theories that support inventive thinking skills. Here are some of the educational theories which support scientific inventive thinking skills in children.

Jean Piaget's Cognitive Development Theory

The theory of cognitive development by Jean Piaget (1896–1980) figured out that children at the stage of preoperational (2–7 years old) are very highly imaginative. They also are egocentric and find it difficult to accept the viewpoint of others. They see the world differently from adults. Inventive thinking requires an imaginative mind. That is why children are more creative than adults.

The ability to think inventively is a natural feature among most children; they do not need to attempt to do so. It involves mainly both creativity and problem-solving skills. Normally, creativity leads to problem solving, an important skill which should be inculcated in children's early years. To be inventive means to be able to find out connections and similarities in unusual ways. Children are naturally inventive and unaware of adults' responses and perspectives toward the world. They tend to connect something not usually connected and disconnect what adults think to be similar. However, this natural ability diminishes as the child grows up. His expectation and perception start to dictate his thinking. He begins to expect before things happen and to see without really looking. His life becomes routine, bored, and stereotyped.

Normally, school curriculum tends primarily to evaluate memory skills, and there is less emphasis on the thinking skills which are more important after formal education ends. Undoubtedly, basic factual knowledge is a necessity, but cannot make a child become an inventive thinker. Inventing lets the children work like a scientist. The creative and critical thinking develops automatically in the process of inventing. An inquiring approach is highly related to the invention process. Children explore and construct their own knowledge. They are motivated and gain the skills which can be used throughout their lives. Preparing plenty of engaging materials is the first step in inspiring an inventive spirit in children. Allow them enough time to investigate and to do experiments with the material. In fact, ordinary material is enough to encourage children to think inventively. The teacher should be able to ask good and right questions to facilitate children to think in many different dimensions. Appropriate comments from the teacher also can stimulate inventive thinking in children. It is very important for the teacher to be a role model who always practices inventing skills as a part of life.

Revised Bloom's Taxonomy (2001)

The Revised Version of Bloom's Taxonomy was proposed in 2001 based on the findings that most of the skills can be gained simultaneously; the old version of the taxonomy suggests that the tougher knowledge only can be acquired once we have mastered the basic. The new version of the taxonomy also emphasizes the idea that knowledge and thinking must be joined in the learning processes. Table 1 shows the revised Bloom's Taxonomy.

Integration of content knowledge with the advanced cognitive domain into teaching and learning makes it easier for the children to acquire the content knowledge. Through the continuum of the cognitive domain skills, teachers need to push students up to the top of the taxonomy – creating. Creating is the most advanced cognitive domain which requires students to produce something entirely novel or original. It could be a new idea, a unique product, or an alternative solution to a problem. Explicit skills can be retrieved from the creative domain which includes inventing. Inventing is categorized as a higher-order thinking skill and requires sophisticated and complex thinking. During the inventing process, it could be argued that the rest of the higher-order thinking is applied at the same time. However, there is no rigid sequence in the continuum. No rule could state that the cognitive domains should follow a certain order.

Creative Problem Solving

Creative Problem Solving (CPS) is a well-known model in nurturing inventive thinking skills, by linking the learner's natural creativity and problem-solving approaches. The latest version of CPS is Version 6.1 as shown in Fig. 3. CPS Version 6.1™ guides the learner to use both his/her creative and critical thinking skills in harmony, either individually or in group. The four main cognitive processes involved are as follows: understanding challenges and opportunities, generating ideas, developing effective plans for solving problems, and managing change. Convergent and divergent thinking are both employed through the whole system in the CPS (Treffinger et al. 2000). By employing this creative model of solving problem, individuals or groups will be able to act on chances, respond to challenges, balance creative and critical thinking, build collaboration, overcome concern, and, more importantly, managing change.

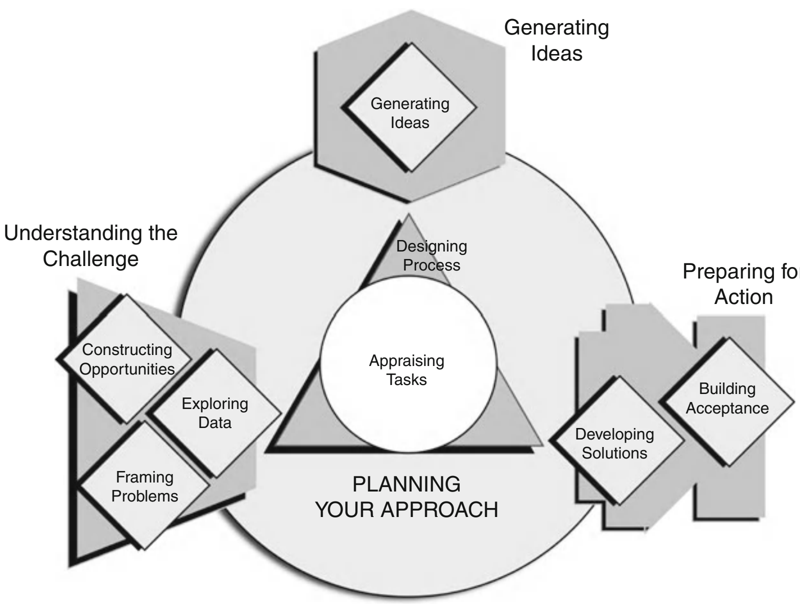
TRIZ (Theory of Inventive Problem Solving)

Another educational theory that supported scientific inventive thinking skills is TRIZ. TRIZ is the acronym in Russian, which means "theory of inventive problem solving." TRIZ has been used worldwide across many fields. At first, TRIZ was established in an engineering field. However, utilization of TRIZ has now expanded to the nontechnical field of education. TRIZ is a method of inventive problem solving based on logical data and is not intuitive. Figure 4 shows the TRIZ problem-solving method.

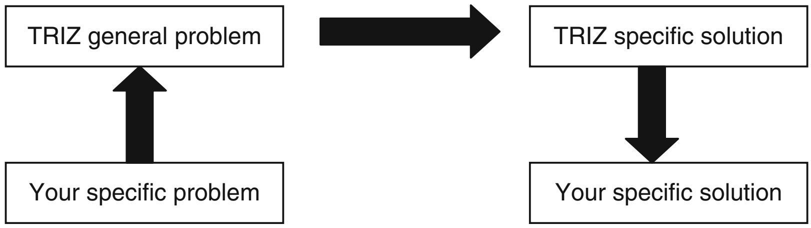
Marsh et al. (2002) redefines the contradiction matrix for business and management into educational contradiction matrix and 40 educational

Scientific Inventive Thinking Skills in Children, **Table 1** Revised bloom's taxonomy (2001) (Source: David 2002)

Cognitive domains	Descriptions	
Create	Generating new ideas, products, alternative solutions, and new way to view things. Examples of skills: designing, constructing, planning, producing, inventing,developing, formulating etc.	Higher order thinking
Evaluate	Justifying a decision or course of action. Examples of skills: Checking, hypothesising, critiquing, experimenting, judging, selecting, valuing, defending, appraising etc.	
Analyse	Breaking information into parts to explore understandings and relationships in depth. Examples of skills: Comparing, organizing, deconstructing, interrogating, finding, distinguishing, examining, criticising etc.	
Apply	Using information in another context or new situation. Examples of skills: Implementing, carrying out, using, executing, employing, solving, sketching, illustrating, operating etc.	Lower order thinking
Understand	Explaining ideas or concepts. Examples of skills: Interpreting, summarising, paraphrasing, classifying, explaining, describing, identifying, reporting etc.	
Remember	Recalling information. Examples of skills: Recognizing, listing, describing, retrieving, naming, finding, memorizing, stating, reproducing	



Scientific Inventive Thinking Skills in Children, **Fig. 3** Creative problem solving version 6.1 © 2011, Center for Creative Learning, Inc. and Creative Problem Solving Group, Inc. (Reproduced by permission)



Scientific Inventive Thinking Skills in Children, Fig. 4 TRIZ problem-solving method (Source: Marsh et al. 2002)

inventive principles, which address both administration and classroom examples. The 40 inventive principles are:

1. Segmentation
2. Taking out
3. Local quality
4. Asymmetry
5. Merging (combining)
6. Universality
7. "Nested doll" (Matryoshka)
8. Anti-weight (counterweight)
9. Preliminary anti-action (prior counteraction)
10. Preliminary action
11. Beforehand cushioning (cushion in advance)
12. Equipotentiality
13. The other way around (inversion)
14. Spheroidality – curvature
15. Dynamics
16. Partial or excessive actions
17. Another dimension
18. Mechanical vibration
19. Periodic action
20. Continuity of useful action
21. Skipping (rushing through)
22. "Blessing in disguise" (turn lemons into lemonade)
23. Feedback
24. "Intermediary"
25. Self-service
26. Copying
27. Cheap short-living object
28. Mechanics substitution
29. Pneumatics and hydraulics (intangibility)
30. Flexible shells and thin films
31. Porous materials
32. Color changes
33. Homogeneity
34. Discarding and recovering (rejecting and regenerating parts)
35. Parameter changes (transformation of properties)
36. Phase transitions
37. Expansion of events or processes
38. Boosted interactions
39. Inert atmosphere
40. Composite materials

Conclusion and Future Directions

The idea of nurturing scientific inventive thinking skills in children needs a detailed debate between educational stakeholders, researchers, practice communities (e.g., scientist and inventor), and policy makers. This debate should take into account of how, what, who, when, and where; it should address some or all of the points at issue and should also consider a practical route map for developing strategy and policy around integrating scientific inventive thinking skills in school and learning.

Although there are many arguments made about the importance of scientific inventive thinking skills in children, there remains significant ambiguity about how the skills should be integrated in the teaching and learning process. Educational theories in this topic (e.g., Piaget's cognitive development theory and Bloom's Taxonomy) have stated the ground information for educators especially teachers on cognitive domain where inventive thinking took place and how it can be manipulated via activities such as creating and designing. However, there is a lack of research evidence on how to integrate scientific inventive thinking skills successfully in teaching and learning process in schools. Moreover, the education concepts like twenty-first-century inventive thinking skills, CPS, and

TRIZ are new concepts that need further exploration especially in terms of implying and applying the concepts in the actual classroom teaching and learning activities.

Apart from the need for more research in this topic, support for teachers is also essential in order to make sure that the effort to implement scientific inventive thinking skills in students' learning is successful. As in any other new concept, teachers may be unfamiliar with scientific inventive thinking skills and lack training or support on how to implement and meaningfully integrate it in the classroom. The provision of teacher professional development support materials, supplemented with the research evidence report, will enable teachers to explore practical use of the skills in science teaching and learning process. It is suggested that a pilot program for both student teachers and professional teachers is implemented to identify the practical strategies for a scalable and sustainable training initiative of scientific inventive thinking skills. Another important measure is to ensure "classroom thoughtfulness," in which students' learning environment is conducive toward the development of inventive thinking skills.

Also recommended is the establishing of a national center for scientific inventive thinking skills dedicated to exploring aspects of the implementation of scientific inventive thinking in educational contexts. Perhaps the center could be a think tank for the younger generation and provide them with opportunity to access the relevant technologies of various activities and encourage them to become creative and inventive. It would also provide a knowledge-sharing facility for teachers and educators to access accounts and case studies of others' experiences, of advice, support, and training. In order to attract practice communities of scientific inventive thinking into educational contexts, there should be some incentive to encourage their powerful and influential role in children's lives. Opportunity should be given for them to share their experiences of specialist topics so that their view could have an impact on the formal education system in terms of applying scientific inventive thinking skills. Finally, students' ability to employ scientific inventive thinking should also be part of the assessment process. This is because as commented by Torrance (1993; p. 158) "no educational innovation can succeed and endure unless it is supported by appropriate retooling in the forms of methods, instructional materials, assessment procedures, and statement of objectives."

Cross-References

- ▶ Convergent Versus Divergent Thinking
- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity Techniques: Use of Creativity Techniques in Innovation Processes
- ▶ Invention Versus Discovery
- ▶ Promoting Student Creativity and Inventiveness in Science and Engineering
- ▶ Science of Creativity
- ▶ Thinking Skills, Development

References

Donald JT, Scott GI. Creative problem solving: the history, development, and applications for gifted education and talent development. Gift Child Q. 2005;49(4):342–53.

David RK. A revision of bloom's taxonomy: an overview. Theory Pract. 2002;41(4):213–8.

Judd M, Lacasse J, Smith M, Reilly K. Invention at play: educators' manual, vol. 37. Washington, DC: Smithsonian National Museum of American History; 2002.

Kamisah O, Tuan MTS, Nurazidawati MA. Development and validation of the Malaysian 21st century skills instrument (M-21CSI) for science students. Proced Soc Beh Sci WCLTA. 2010;2010(9):599–603.

Marsh D, Waters F, Mann D. Sing TRIZ to resolve educational delivery conflicts inherent to expelled students in Pennsylvania. The TRIZ J. 2002. http://www.trizjournal.com/archives/2002/11/c/03.pdf. Accessed 23 Jan 2009.

Marsh DG, Waters FH, Marsh TD. 40 Principles with applications in education. 2002. http://www.bmgi.com/sites/bmgi.com/files/40%20Inventive%20Principles%20with%20Applications%20in%20Education.pdf. Accessed 20 Feb 2009.

NCREL & METIRI Group. EnGauge 21st century skills. Literacy in the digital age. 2003. http://www.ncrel.org/engauge. Accessed 23 Jan 2009.

Raviv D. Teaching Inventive Thinking. Recent Advances in Robotic Conference; Florida; 2000.
Treffinger DJ, Isaken SG, Dorval KB. Creative problem solving: an introduction. 3rd ed. Waco: Prufrock Press; 2000.
Torrance EP. Experience in developing technology for creative education. In: Isaken SG, Murdock MC, Firestien RL, Treffinger DJ, editors. Understanding and recognizing creativity: the emergence of a discipline. Norwood: Ablex; 1993.
What is TRIZ. http://www.triz-journal.com/whatistriz.htm

Scientist Entrepreneurship

► Academic Entrepreneurship

Sectoral Innovation Systems

► National Innovation Systems (NIS)

Seed Funding

► Entrepreneurship and Financial Markets

Seed Money

► Entrepreneurship and Financial Markets

Self Entrepreneurship

► Microfirms

Self-Brainstorming

► Idea-Marathon System (IMS)

Self-made Man

Divya Leducq
School of Geography and Planning, University of Lille 1, Villeneuve d'Ascq, France

Synonyms

Autodidact; Entrepreneur; Pioneer

Being a Self-made Man

Whether described as a "great man" or a "man of genius," the self-made man represents the archetype of successful men - and more and more women - who start from low stations in life, with poor educational backgrounds, and climb the social ladder to become key figures in society.

Origins of the Myth: The Roots of the "American Dream"

Frederick Douglass, an escaped slave and a leader of the Abolitionist movement, provided the first definition of the "self-made man" in a lecture in 1859 (Douglass 1955). This new man, based on the Roman idea of *"novus homo,"* played a prevalent role in public life. Preceding Douglass, Benjamin Franklin, one of America's Founding Fathers, was one of the best-known examples of a self-made man. His autobiography described his rise from working-class origins to his life as a powerful inventor, businessman, and politician (Franklin 1793). Abraham Lincoln also captured the public imagination, making the improbable leap from lowly log cabin to the White House.

During the so-called Second Industrial Revolution, the concept became popular and began to encompass economic success. New inventions quickly made men rich and famous, and factories sprung up throughout the country. Inspired by real-life examples like Andrew Carnegie, the self-made man became a common archetype in literature and popular culture, especially in the "rags to riches" stories of authors like Horatio Alger Jr. (Wyllie 1954). These stories gave the poor hope that they too could rise to a better situation. In some societies, this sense of social mobility is an important part of the national identity. This concept is strongly tied to the notion of the American Dream, which took hold in the early to mid-twentieth century.

Predisposing Factors of the Self-made Man: Learning from Well-Known Cases

The purpose here is not to provide an all-inclusive list of self-made men. In reading the biographies of several famous self-made men, however, one can observe recurring phenomena in their pasts and draw conclusions regarding certain common characteristics among them.

Deficits During Childhood

Many people described as self-made men have experienced difficulties, both physical and emotional, in their childhood. Some experience the absence of one of both parents, as was the case for Larry Ellison (Oracle), or abandonment, as for Leonardo Del Vecchio (Luxottica), who lived in an orphanage, and Steve Jobs (Apple), who was given up for adoption. Others felt the lack of a stable and loving family structure. For example, US Senator Harry Reid grew up with an alcoholic father who worked as miner and possessed only an elementary school education. Amancio Ortega Gaona (Zara) was a railroader's son who left school at age 14. These self-made men share beginnings in economic disadvantage and sometimes discouraging surroundings. Some were born to parents who were uneducated (Thomas Edison), immigrants (Andrew Carnegie), or working class. For some, the difficulties were tangible, with primary needs such as food and safety going unmet. These difficulties and disadvantages left them to forge their own successful paths, as Oprah Winfrey did.

Adolescence: A Time of Struggle

Many of our exemplars of the self-made man had difficult relationships with parents and teachers. Some left the educational system during secondary school, often easily distracted and underestimated by their teachers. John Paul DeJoria (John Paul Mitchell Systems) was told by a math teacher that he would "never succeed at anything in life"; he accepted that criticism as a challenge to succeed at whatever he undertook.

Some had to leave school to work due to economic necessity. They found part- or full-time work to help provide for their families. Andrew Carnegie's first job was working as a bobbin boy at a textile factory, making $1.50 a week. Some went to high school and also held a job; Ray Kroc (McDonald's) worked nights as a security and Sam Walton (Walmart) was a lifeguard, newspaper delivery boy, and waiter A common theme is that many attained their first job by employing a bit of dishonesty, such as an exaggeration about previous work experience. For various reasons, many self-made men have not completed college (Steve Jobs graduated high school in 1972. He left college after six months even if he continued to audit classes; Dell dropped out of Univ. of Texas, but was making thousands of dollars already as a high school student; Ralph Lauren dropped out of Baruch College after two years; and François Pinault).

Sociologists and public policy experts stress the effects of poverty and culture in determining an individual's success. During times of difficulty or struggle self-made men learn how to survive in a world where poor people taken for granted; they learn the qualities of perseverance and self-discipline (e.g., Ross Perot, Electronic Data Systems).

Unlike children who come families where an enterprising ethic has been present for generations, self-made men are focused on survival. Relying neither on good luck nor waiting for a godsend, they have learned early to invest and fructify a small – and often borrowed – amount of capital (Sam Walton) and then religiously saved their money and reinvested it in the business (Larry Ellison, Oracle).

Adulthood: On the Road to Prosperity

Except in the cases of computer hardware and software (Apple, Dell, Oracle), self-made men rarely get the "idea of the century"; rather, they focus on some unexplored economic niches of development. They all put passion, time, and sweat in their work, having previously had to fight against others and society as a whole. As new businessmen, they have courage and an indomitable will to be useful and independent citizens. They want to be judged by the kind of success they achieve. As was the case with John D. Rockefeller, none of these self-made men want to leave their business or any part of it to anyone else. They use both vertical and horizontal integration.

Wisdom of Age

At the end of their lives, self-made men who have managed to pull themselves up through hard work and determination don't especially seek to distinguish themselves from the common man. Though a person of this class does not need to claim to be a hero or to be worshipped as such, there is a genuine heroism in their struggle and something of sublimity and glory in their triumph. Every instance of such success is an example and benefit to humanity. Self-made men hope to inspire others to join their ranks. Rockefeller donated much of his fortune in hopes of providing others with similar opportunities for success. Andrew Carnegie wrote "The Gospel of Wealth," a philosophy in which a man should aim to acquire as much fortune as possible and finally give it away to philanthropic causes.

Controversies Around this Sociotype

Some controversies exist concerning the making of the self-made man and also about his dynamic position in the society.

Social Darwinism Versus the Labor Movement

American sociologists were the first to deeply explore and analyze the concept behind the notion of social upward mobility. Indeed, various conservative and liberal schools of thought enhance the figure of "self-made man," but not for the same reasons. In fact, the former believes that any individual can flourish without any outside help and thus without subsidies from the government. This conception deeply nourishes the myth that every citizen, regardless of race, wealth, creed, color, or gender, can not only expect, but also receive, justice and fair play from society, on only one condition: doing one's best.

At the same time, the latter group of academics and public policy experts believe that the "rise of plebeians" will only happened in a state able to make a right place for every meritocratic man and ask for ambitious policies to product efficient social lifts. This concept of meritocracy, in developed as well as in the emerging countries, enhances the capability of a nation to give birth to new elites, refreshing an existing social order, represents a central issue.

Whatever the point of view is conservative or liberal, a romanticism and sentimental glamour envelops the self-made man, magnifying his proportions. Their examples are often used to justify social Darwinism and to oppose labor movements. It can be argues that the illusion of the "self-made man" helps to keep the working class in line and prevents them from agitating for an overall collective change in the direction of social equality.

The term *meritocracy* is defined as a society that rewards those who show talent and competences as demonstrated by past actions or competitive performances. It refers to a utopian future in which one's social place is determined by IQ and effort. The counter-argument to the self-made man concept is that there is *not* a correlation between hard work and economic success. In fact, the people who work the longest hours and expend the most energy are usually the poorest; and really big money doesn't come from working, it comes from owning assets.

Self-made Man as a Networked Person

Self-made men attain their success through hard work, diligence, sometimes education, and faith in the system; however, one knows that "no man is an island." Indeed, the notion of "self" in creating industries is probably out-of-date in a world where everyone is multilayered in his/her mobility across borders, always connected to someone else thanks to information and communications technologies, embedded in multiple social networks and forums. Mark Granovetter (1985) argues in favor of the "strength of the weak ties" and about the potential influence of institutional frameworks to overcome great obstacles and achieve goals. The case of John Sperling (Apollo Group) provides a good illustration. Born to a poor sharecropping family, Sperling struggled in school because of dyslexia, however, with encouragement from some of his teachers, he was able to graduate with a PhD from Cambridge University.

From an evolutionary perspective influenced by social Darwinism theories, the concept of the self-made man sees an individual's success constrained by market, competitiveness and technological path dependency.

Conclusion and Future Directions

The most important feature of self-made men is their resilience. Self-made men are mobile, active, and ambitious. Knowledge is passion not learning. Having grown up in difficult circumstances, they are dedicated to modify their original attributions within a competitive culture that values only winners. The path of self-made men is non-linear. He (or she) is constrained by successive adaptations, challenges, breaks, which all together transform a captain of his own destiny into a tycoon, and vice-versa. They always try to be in full control of their destiny – personal or professional – and thus work harder, faster, and with greater efficiency.

To scrutinize the process of enterprise creation this model, it is essential to undertake face-to-face interviews (prosopography) with several exemplars. Understanding the "bifurcations" in their lives is helpful; the life of a self-made man is made of such experiences. The setbacks and grief that he endures make him bigger and helps him to marching onward (even if sometimes he cannot realize it in the moment). Then, success is measured not so much by the position that one has reached in life as by the obstacles that one has had to overcome while trying to succeed.

Cross-References

▶ Entrepreneurship
▶ Innovator

References

Douglass F. My bondage and my freedom: part I- life as a slave, part II – life as a freeman. New York: Miller, Orton & Mulligan; 1955.

Franklin B. The autobiography of Benjamin Franklin. London: Parson; 1793.

Granovetter M. Economic action and social structure – the problem of embeddedness. Am J Sociol. 1985;91(3):481–510.

Wyllie IG. The self-made man in America: the myth of rags to riches. New Brunswick: Rutgers University Press; 1954. p. 210.

Self-Regulation

▶ Strategic Thinking and Creative Invention

Sell-Off

▶ Spin-off

Semantic Survey

▶ Two Hs from Harvard to Habsburg or Creative Semantics About Creativity: A Prelude to Creativity

Semantic Technologies in Knowledge Management and Innovation

Nowshade Kabir
Knolee Group, Toronto, ON, Canada

Synonyms

Innovation management; Knowledge in innovation; Technology impact on innovation

Introduction

Innovation is one of the most decisive factors in gaining and attaining competitive advantage for an organization. Competition in globalized world requires rapid development and implementation of innovative products, processes and business models. In the innovation value chain knowledge is a primary resource and its effective integration, absorbency and use are imperative for attaining favorable outcome from the innovation process. In order to avail sustainable efficacy in knowledge amalgamation, synthesis and utilization organizations adopt technology to manage its knowledge related processes, procedures and routines. As a result, knowledge management is becoming a critical aspect in the organization's innovation strategy. At various nodes of knowledge management process use of semantic technologies allow substantial improvement in knowledge-related activities that in turn affect the innovation process and its outcome positively.

With the advent of new technologies, globalization and changing market conditions companies are facing heightened competition not just from industry peers but also from new entrants from other industries and geographical areas. In this changing environment where product and service life cycle are shortening in lighting speed, need for innovation is becoming a question of paramount importance (Drucker 2002; Tatikonda and Rosenthal 2000).

As a result, increasingly more company executives are accepting the fact that innovation is a critical component in their firm's success (Sawhney et al. 2006). Researches also posit that innovation capability is the most significant determinant of firm performance (Mone et al. 1998), and innovation is indeed a base for organizational survival (Hurley and Hult 1998). Moreover, a company's ability to innovate continuous is considered as a primary competitive advantage (Lengnick-Hall 1992). Consequently, for the firm the question is no longer why to innovate but how to improve its innovation capabilities and how to continue innovating in a faster speed.

One of the most vital resources for innovation is knowledge. Innovation depends essentially on access to the right knowledge at the right time. However, tapping into the available knowledge resource with its expanding boundary and depth is becoming increasingly difficult. Recognizing the complexity of this problem of controlling knowledge resource effectively, firms adopt various knowledge management strategies. In the case of innovation, knowledge management is not only capable of managing existing knowledge as a contributory input to the innovation process but also enables managing knowledge that is created in the innovation process (Cavusgil et al. 2003).

While knowledge management is the mechanism and systematic approach of managing knowledge, the information technology based infrastructure – Knowledge Management System (KMS) – is required to manage knowledge related routines, processes and procedures that focus on knowledge creation, aggregation, storage and distribution. Over the last 20 years or so, there have been many different strategies and information systems developed and implemented to maximize the productivity of knowledge workers and efficiency in the use of the knowledge available to the firm. To ensure the best result from a KMS, firms try and test advanced technologies when they become available. One group of cutting-edge technologies, Semantic Web Technologies (SWT), are increasingly becoming popular and used by many KMS to manage knowledge activities including knowledge related to innovation.

Innovation

Ever since Schumpeter initiated the notion of innovation as an instrument for an entrepreneur to make sustainable change in the economy and defined it as the first introduction to a new product, process, method or system; (Schumpeter 1934) there had been many studies done on the various aspects of innovation from multiple angles. Even several decades before Schumpeter's seminal work, Veblen described similar concept in his book about leisure class. Although, he did not use the term innovation, he did mention about the importance of the processes related to technology shift and their impact on the economy and society (Veblen 1899). Since then scholars have defined innovation from various perspectives depending on their research focus, as a result, these definitions are also remarkably diverse.

In research literature, most definitions can be viewed from two-dimensional perspectives of innovation: innovation as a process and innovation as an outcome. From the process point of view innovation can be defined in a wider perspective such as "the process of bringing any new problem solving ideas into use" (Kanter 1984, p. 20). Defining innovation as a process gives an opportunity to study each of the innovation activities separately (Greve and Taylor 2000; Myers and Marquis 1969) and classify innovation from strategic points of view as closed or open innovation (Chesbrough 2003) and Continuous or discontinuous (Tushman and Anderson 1986).

On the other hand, from outcome perspective it can be defined as "An invention that has reached market introduction in the case of a new product, or first use in a production process in the case of a process innovation" (Utterback 1971, p. 77). The focal points of outcome perspective are the novelty and benefits of the innovation (Jaffe et al. 1993; Levitt 1960; Utterback 1971). The typology of innovation from outcome perspective is categorized as product or process (Damanpour 1991), radical or incremental (Freeman 1974), disruptive or sustaining (Christensen 1997), and modular or architectural (Henderson and Clark 1990).

A possible working definition which covers today's context and based on Damanpour's original definition, is "Innovation is a creation and implementation or adoption of a new or modified device, system, policy, program, process, product, service, business model or strategy which produces social or economic value"(Damanpour 1991).

Innovation Process

Innovation is a non-linear dynamic process with various converging, diverging and iterative activities (Van de Ven 2007) over several stages that include multilevel acceptance, absorbency and refinement of knowledge, exploration of required knowledge and synthesis of knowledge.

The innovation value chain comprises of three stages: idea generation, conversion and diffusion. Ideation is the first step in the value chain, research and development along with a product or process development are the conversion process, and commercialization is the final stage (Hansen and Birkinshaw 2007).

An innovation strategy is necessary for the firm in order to start an innovation process that also works as a precursor to building awareness of a need or a problem to solve. The step of ideation within the innovation process is concerned about identifying one or several ideas than can create innovation opportunities. Since killer ideas are not often easy to get by the right idea has a tremendous impact on subsequent steps of innovation value chain. Girotra et al. (2010) offer four variables that influence the quality of best ideas: the quality level of ideas, the quantity of ideas generated, the quality diverseness of the ideas and the capability to identify the best idea. The sources of ideas could be in-house, from cross-pollination or external. Idea generation and evaluation are usually separated in order to maximize the amount of ideas. Management of ideation stage includes activities such as idea generation, collection, evaluation, screening and ranking. The idea management process can be visualize as a funnel model, where a large numbers of ideas from multifarious sources after due evaluation transformed into a small number of potential concepts. These potential concepts create an innovation portfolio of projects that the firm maintains.

The innovation portfolio is vital for the success of a firm involved in innovation because a firm's efficacy in managing its R&D is one of the key factors in determining its competitive advantage (Bard et al. 1988). Innovation portfolio management is also necessary for risk aversion by diversifying risk as investment in innovation always carries some uncertainty (Bard et al. 1988) and for budgeting the resources for individual projects. The innovation portfolio deliverable is expected to be a precisely defined strategy along with a number of concepts that show the possibility of future success (Say et al. 2003).

Once a concept is identified as a viable innovation project the conversion stage starts. Project management in innovation cycle covers the processes that converts a concept to a marketable product and consists of linear, iterative and simultaneous activities (Adams et al. 2006). Innovation projects differ significantly from other organizational projects in their inherent risk of failure, nebulous nature of a preliminary concept that gets refined only after trials and tests, and difficulties in predicting eventual outcome. Effective innovation project management also requires use of knowledge-based tools and practices.

Diffusion is the final stage of the innovation value chain. In the book "Diffusion of Innovation," Everett Rogers (1995, p. 35) defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of a social system." For the firms if the purpose of innovation is to develop and market a product, it entails the process of marketing and commercialization.

Knowledge and Knowledge Management

Innovation by nature is highly knowledge intensive (Kanter 1988), and knowledge is a critical component of a firm's innovation strategy (Dougherty 1992) and innovation process (Hull 2000). A firm's capabilities to combine its organizational dynamic capabilities with future potential of a technology by applying existing knowledge allow the firm to develop new applications from prior knowledge (Kogut and Zander 1992, p. 361). Grant argues that to improve the efficiency and quality of a number of organizational processes it is necessary to understand how knowledge integrates and flows throughout the firm (Grant 1996). He also stresses that firm's competitive advantage and operational success largely depend on its ability to identify, integrate and utilize knowledge successfully (Grant 1996; Volberda 1996; Zahra and George 2002). Indeed, the better is the sharing, learning, absorbing and overall flow of knowledge within various parts of an organization and with external sources the more chances of new knowledge generation and creation of new combinations (Birkinshaw et al. 2008; Tsai 2002; Inkpen 1996).

According to Walsh and Ungson (1991) knowledge resides in five venues of an organization: people, roles and organizational structures, operating procedures and practices, culture, and the physical structure of the workplace. The knowledge which is general, conventional and easy to express in commonly comprehensible language and possible to share, codify and convert as principles, formulae, data, processes and information is called explicit (Polanyi 1958; Nonaka and Takeuchi 1995). Explicit knowledge is easy to access and transfer and also refer as "knowing about," subjective or declarative knowledge (Kogut and Zander 1992). Although, it is a necessary prerequisite for innovation and value creation, unless protected by patents, copyrights or vigilantly guarded, it is also easy for competitor to imitate and any competitive advantage gained from using explicit knowledge in innovation as a result becomes short-lived (Dierickx et al. 1989).

The knowledge embodied in people learnt from experience, insights, heuristic procedures etc. that are difficult to express and codify in a manner so that it could become transferable is called tacit knowledge (Polanyi 1958; Reed and DeFillippi 1990). Tacit or unarticulated knowledge is more personal, experiential, context-specific, and hard to formalize (Saviotti 1998; Leonard and Sensiper 1998).

While some tacit knowledge is impossible to pass on due to their extreme stickiness (Szulanski 1996) most tacit knowledge can be disseminated by socialization – apprenticeships, dialogues and observations (Von Krogh et al. 2000). At an organizational level tacit knowledge is present not only in an individual; it is also available in the processes, culture and values. Since tacit knowledge is not easy to aggregate or disseminate and it embodies the knowledge, which creates sustainable competitive advantage in part through innovation, managing this type of knowledge is of utmost strategic importance for a firm (Grant 1996).

Organizational knowledge literature also specifies that knowledge is a key strategic asset and firms have to learn how to manage effectively this resource in order to stay profitable (Bollinger et al. 2001). Moreover, failure to create, integrate, manage, and use the knowledge endemic to the firm and acquired from exogenous sources may cause demise of the competitive advantage of the firm (Alavi et al. 2001). The importance of knowledge in a firm was clearly noted by renowned management guru Drucker as he declared that knowledge is the only resource for sustainable competitive advantage (Drucker 1993).

There are two categories of knowledge activities: Knowledge exploration and knowledge exploitation (Levinthal and March 1993; Choo and Bontis 2002). Both activities are vital in firm's innovation process. Exploration provides the new knowledge that can be used in combination with the existing one to create a knowledge base for innovation in new areas. Exploitation of this knowledge, on the other hand, creates the economic value (Zack 1999).

These two broad categories encompass a large number of different processes: knowledge creation, identification, integration, acquisition, sharing, storage, and replication (Edvinsson and Malone 1997; McNamara 2000). Knowledge management strategy at corporate level is a balancing act of these processes. Depending on the set goals of innovation and knowledge creation, emphasis is given on certain processes more than others (Hansen, et al. 1999; Revilla et al. 2009; Bierly and Chakrabarti 1996; Gupta et al. 2006).

Knowledge management is the mechanism and systematic approach of managing an organization's tacit and explicit knowledge. It refers to the processes and practices through which the firms generate value from knowledge (Gold et al. 2001). This means to acquire, store, deliver and use knowledge in a manner so that the knowledge can be accessed, developed, shared and distributed whenever is necessary in order to create sustainable competitive advantage. The processes mentioned are key components of knowledge management (Alavi et al. 2001).

Researches confirm that knowledge management is highly interlinked with process innovation, and knowledge acquisition, use and other knowledge related activities work as an enabler of improved coupling connection between new knowledge creation in innovation and firm's existing knowledge (Jang et al. 2002).

Although, successful knowledge management depends on several factors such as leadership, culture, structure, roles and responsibilities, technology and measurement (Hassanali 2002; Liebowitz 1999). One of the most vital components of knowledge management is information technology. In reality, the advent of new technologies in early 90s has given the true impetus to widespread adoption of knowledge management including in innovation life cycle.

Knowledge management system (KMS) is the Information technology based infrastructure to manage knowledge related routines, processes and procedures and focuses on knowledge creation, aggregation, storage and distribution in order to facilitate innovation and other activities that bring economic value to the firm.

Semantic Web Technologies

Semantic Web, which is a logical extension of the existing World Wide Web, aims to provide a common framework that would allow data to be effectively found, processed and integrated by software agents thanks to the underlying semantic description of the content (Berners-Lee et al. 1999, 2001).

The semantic web has evolved from fundamental conceptual ideas like a need to simplify the perception of complex realities surrounding us with the help of abstract terms, an endeavor to build a machine that can reason and take decision based on available knowledge and a seamless ability to aggregate, store and diffuse knowledge whenever necessary (Hitzler et al. 2010). Although, between semantic web technologies and semantic technologies there are some differences for the purpose of this paper these differences are not substantial. Hence the terms are used interchangeably.

While the scale and the domains of challenges are different, Semantic web in a bigger context is set to resolve some of the very similar issues that KMS faces:

- The need to assign data with semantic meaning and formalize the information derived from the data in significant way.
- To have intelligent agents that can examine the data, evaluate consistency, aggregate and extract new knowledge.
- To deliver best available answers based on natural language query.
- To define who may access what part of the information (Grigoris et al. 2008).

Semantic technologies are increasingly used in various KMS applications. Some examples are: Data aggregation from multiple external and internal organizational sources in varied formats, ontology based document categorization, application to assess the quality of data, queries using natural languages, transforming information into business intelligence, etc. (Schäfermeier 2010; Feigenbaum et al. 2007).

Semantic technologies in KMS can produce positive impact on the company innovation processes. Within the innovation life cycle companies often encounter problems related to effective collaboration of geographically disperse teams, access to precise and adequate amount of information and just in time learning. KMS with semantic web technologies eliminate and reduce many of these issues allowing improved innovation processes.

In knowledge-based economy KMS is intertwined with the organizational resources, capabilities and strategies. KMS with semantic web technologies not only contributes in cost reduction, increased knowledge reuse, better decision making, faster flow of knowledge, rapid product development, effective collaboration, better customer service, it also brings much needed strategic flexibility to a company in order to maneuver in competitive environment.

Many knowledge repositories of organizational KMS have accumulated a vast array of information. However, in most firms a considerable portion of the valuable knowledge in the repositories is unstructured, unevaluated, and scantly accessible. The Semantic technologies are transforming organizational databases to true knowledge base by providing: globally unique names through the Uniform Resource Identifiers (URI's), semantic based languages such as the Resource Description Framework (RDF), RDF Schema (RDFS) for modeling data, the Web Ontology Language (OWL) for developing ontologies and a standard query language – SPARQL for research purposes (Hitzler et al. 2010; Kashyap et al. 2008). With the help of these and other tools and technologies knowledge-intensive firms are addressing the issues of content organization, archiving, displaying and finding quite successfully.

Within the organization's KMS ecosystem, there are various tools and applications that can make substantial positive impact on innovation processes if deployed with semantic technologies. Some of them are outlined here:

Knowledge Repositories

Knowledge repository is an integral component of a knowledge management system. Organizations are implementing repositories from the early days of KMS as a part of their knowledge managing strategy. A knowledge repository at organization's level is a digital database of articles, whitepapers, best practices, business intelligence reports, customer related information, various company domain related materials and others. Although, most knowledge intensive firms incorporate digital repositories for knowledge management, success varies widely depending on the company strategy, information technology used and prevailing company culture (Davenport and Prusak 2007). The barriers to successful use include general reluctance of some workers to access the repository before taking business decisions (Haansen and Haas 2001), difficulties in finding required information, unstructured representation of the needed knowledge and lack of informal knowledge in the repository. According to Bhatt, if the knowledge available to the firm is not easily accessible in user-friendly format, it is difficult for the firm to keep its competitive edge, creativity and innovativeness at the right level (Bhatt 2001). A semantic knowledge repository based on ontology and semantic web agents could have necessary elements to overcome these hurdles.

Information Integration

One of the biggest impediments to the effective use of the early KMS was the issue related to integrating information to knowledge repository. In early days of KMS deployment, it was difficult to convince the workers to participate actively in adding information to the KMS (Haansen and Haas 2001). The key to resolving this problem was to embed integrated application into the job process itself. While formalized information like patients record, supply chain documents, database input etc. is easy to integrate the problem still remained how to add unstructured, spontaneous data and multimedia information in a way so that these data could be a meaningful part of the knowledge base. The solution is to provide the data with semantic annotation and use semantic inference engine to retrieve the data from ontology based knowledge repository.

Automated Decision-Making Applications

Firms generate and store a large amount of information each day and often require taking real-time decisions based on these data. In innovation process often it is necessary to have access to this information in tailored format.

Semantic decision making applications help producing business intelligence and making subsequent decisions by analyzing and synthesizing information from disperse locations and multifarious formats.

Semantic Innovation Portal

Firms can improve the effectiveness of innovation KMS by integrating an innovation portal that provides range of knowledge, moderated access tool to classified knowledge and other permission-based application from one single online space.

Virtual Community Support System

Nonaka often referred to a subtle concept under the name "Ba," which was first proposed by the Japanese Philosopher Kitaro Nishida. The underlying idea of this concept points to a place, which facilitates generating new knowledge through interactions and sharing of implicit and explicit content by participants. Semantic social network platform is a virtual community support system surrounding content where organization's members can participate, collaborate, and create new knowledge. This virtual community should be an integral part of any KMS. It is a highly similar concept that Nonaka propagates as "Ba" (Nonaka and Takeuchi 1995).

E-Learning

Knowledge absorbency capability of the innovation team members is crucial for further knowledge integration. This capability is based on existing knowledge of the firm and individual innovation team member. Absorptive capacity is also equated to a firm's innovative capability and this is seen as a function of prior knowledge (Cohen and Levinthal 1990).

One of the biggest challenges for organizations is how to deliver necessary knowledge for learning to the employees just in time as per individual's requirement. E-learning applications based on semantic technologies facilitate creating and delivering information tailored to user's need with highly intuitive teaching mechanism.

Ontology

Ontologies are fundamental attributes of the semantic technologies. Ontology is an explicit specification of a conceptualization. Natural language is full of ambiguous words. A single word in various contexts might mean different things. For a program to identify similar terms from two different databases it needs to have a mechanism that specifies the domain of the context. This specification of domain defines the terms and their properties. The collection of information that resolves this issue is called ontology. Ontologies with metadata are essential tools to systematize and supply constructive descriptions of diverse arrays of content. A typical ontology is a document that consists of taxonomy and related inference rules. Semantic KMS repository uses ontologies as a key structural layer and fundamental concept for the repository system (Guarino 1998).

Conclusion and Future Directions

Semantic technologies are still situated at nascent stage of development. While in this article the focus was, in particular, use of semantic technologies on innovation process through improvement of knowledge related activities, semantic technologies are already powering systems targeted in resolving pressing issues that business world is presently facing such as cloud, big data, predictive analytics, social network, and other areas.

Gartner (2007) predicts that mainstream use of semantic technologies will go through various evolutionary steps and a transformation of the Web itself in terms of semantic environment will take place by 2027. Semantic technologies in searching, extracting, aggregating, storing, disseminating knowledge and semantic modeling, reason and analysing applications are already being used in the fields such as social networks, 3D technologies, mobile technologies, NFC and RFID, and new media technologies, and helping develop new products, processes, programs and apps. This process will continue in accelerating speed in coming years resulting innovations in vital areas of knowledge economy affecting health care, media, organizational management, entertainment, energy and education.

Cross-References

- ▶ Antitechnology Movements: Technological Versus Social Innovation
- ▶ Art of Innovation: A Model for Organizational Creativity
- ▶ Ideas and Ideation
- ▶ Knowledge Capital and Small Businesses
- ▶ Product Innovation, Process Innovation
- ▶ Techno-globalization and Innovation

References

Adams R, Bessant J, Phelps R. Innovation management measurement: a review. Int J Manag Rev. 2006; 8(1):21–47.

Alavi M, Cook L, Cook J. Review: knowledge management and knowledge management systems: conceptual foundations and research issues. MIS Quart. 2001;25:107–136.

Bard JF, Balachandra R, Kaufmann PE. An interactive approach to R&D project selection and termination. IEEE Trans Eng Manag. 1988;35:139–46.

Berners-Lee T, Fischetti M, Dertouzos TM. Weaving the web: the original design and ultimate destiny of the World Wide Web by its inventor. San Francisco: Harper Business; 1999.

Berners-Lee T, Hendler J, Lassila O. The semantic web. Sci Am. 2001;284:34–43.

Bhatt GD. Knowledge management in organizations: examining the interaction between technologies, techniques, and people. J Knowl Manag. 2001;5(1):68–75.

Bierley P, Chakrabarti A. Generic knowledge strategies in the U.S. pharmaceutical industry. Strat Manag J 1996;17(Winter Special):123–35.

Birkinshaw J, Hamel G, Mol MJ. Management innovation. Acad Manag Rev. 2008;33(4):825–845.

Bollinger AS, Smith RD. Managing organizational knowledge as a strategic asset. J Knowl Manag. 2001;5:8–18.

Cavusgil ST, Calantone RJ, Zhao Y. Tacit knowledge transfer and firm innovation capability. J Bus Ind Mark. 2003;18(1):6–21.

Chesbrough H. Open innovation: how companies actually do it. Harv Bus Rev. 2003;81(7):12–14.

Choo CW, Bontis N. The strategic management of intellectual capital and organizational knowledge. Oxford: Oxford University Press; 2002. p. 11.

Christensen CM. Making strategy: learning by doing. Harv Bus Rev. 1997;75(6):141–6. Nov–Dec.

Cohen WM, Levinthal DA. Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q. 1990;35(1):128–152.

Damanpour F. Organizational innovation: a meta-analysis of effects of determinants and moderators. Acad Manag J. 1991;34.

Davenport TH, Prusak L. Working knowledge: how organizations manage what they know. Boston: Harvard Business School Press; 1998.

Dierickx I, Cool K, Barney JB. Asset stock accumulation and sustainability of competitive advantage. Manag Sci. 1989;35(12):1504.

Dougherty D. Interpretive barriers to successful product innovation in large firms. Organ Sci. 1992; 3:179–202.

Drucker P. Managing in the next society. New York: Truman Talley; 2002.

Drucker PF. Postcapitalist society. New York: Herper Collins Publishers; 1993.

Edvinsson L, Malone S. Intellectual capital: realizing your company's true value by finding its hidden brainpower. New York: Harper Business; 1997.

Feigenbaum L, Herman I, Hongsermeier T, Neumann E, Stephens S. The semantic web in action. Sci Am. 2007;297:90–97.

Freeman C. The economics of industrial innovation. 1st ed. Harmondsworth: Penguin; 1974. 2nd ed. London: Frances Pinter; 1982.

Gartner Research Paper. ID number: G00148725, Gartner Inc; 2007.

Girotra K, Terwiesch C, Ulrich KT. Idea generation and quality of the best idea. Manag Sci. 2010;56(4): 591–605.

Gold AH, Malhotra A, Segars AH. Knowledge management: an organizational capabilities perspective. J Manag Inform Syst. 2001;18.

Grant RM. Toward a knowledge-based theory of the firm. Strateg Manag J. 1996;17:109–122.

Greve HR, Taylor A. Innovations as catalysts for organizational change: shifts in organizational cognition and search. Adm Sci Q. 2000;45:54–80.

Grigoris A, Harmelen FV. A semantic web primer. 2nd ed. Cambridge, MA: The MIT Press; 2008.

Guarino N. Formal ontology in information systems. Proceedings of FOIS, Trento, Italy, 1998.

Gupta AK, Smith KG, Shalley CE. The interplay between exploration and exploitation. Acad Manag J. 2006;49(4):693–706.

Hansen MT, Haas M. Competing for attention in knowledge markets: electronic document dissemination in a management consulting company. Adm Sci Q. 2001;46:1–28.

Hansen MT, Birkinshaw J. The innovation value chain. Harv Bus Rev. 2007;85(6):121–130.

Hansen MT, Nohria N, Tierney T. What's your strategy for managing knowledge? Harv Bus Rev. 1999; 77(2):106–116.

Hassanali F. Critical success factors of knowledge management. APQC; 2002.

Henderson RM, Clark KB. Architectural innovation: the reconfiguration of existing product technologies and the failure of established firms. Admin Sci Quart 1990;35(1)1:9–30. Special Issue: Technology, Organizations, and Innovation.

Hitzler P, Krötzsch M, Rudolph S. Foundations of semantic web technologies. London: Chapman & Hall/CRC/ Taylor and Francis Group, LLC; 2010.

Hull R. Knowledge management and the conduct of expert labour. In: Pritchard C et al., editors. Managing knowledge. Basingstoke: Macmillan; 2000.

Hurley R, Hult T. Innovation, market orientation and organizational learning: an integration and empirical examination. J Mark. 1998;62:42–54.

Inkpen A. Creating knowledge through collaboration. Calif Manag Rev. 1996;39(1):123–140.

Jaffe AB, Trajtenberg M, Henderson R. Geographic localization of knowledge spillovers as evidenced by patent citations. Q J Econ. 1993;108:577–98.

Jang S, Hong K, Bock GW, Kim I. Knowledge management and process innovation: the knowledge transformation path in Samsung SDI. J Knowl Manag. 2002;6(5):479–485.

Kanter RM. The change masters: innovation and entrepreneurship in the American Corporation. New York: Simon and Schuster; 1984. p. 20.

Kanter RM. When a thousand flowers bloom: structural, collective and social conditions for innovation in organizations. In Straw BM, Cummings LL, editors. Research in organizational behavior, vol 10. Greenwich: JAI Press. p. 123–167; 1988

Kashyap V, Bussler C, Moran M. The semantic web: semantics for data and services on the web. Berlin: Springer; 2008.

Kogut B, Zander U. Knowledge of the firm, combinative capabilities, and the replication of technology. Organ Sci. 1992;3:361.

Lengnick-Hall C. Innovation and competitive advantage: what we know and what we need to learn. J Manag. 1992;18:399–429.

Leonard D, Sensiper S. The role of tacit knowledge in group innovation. Calif Manag Rev. 1998;40: 112–132.

Levinthal DA, March JG. The myopia of learning. Strateg Manag J. 1993;14:95–112.

Levitt T. Growth and profits through planned marketing innovation. J Mark. 1960;24:1–8.

Liebowitz J. Key ingredients to the success of an organization's knowledge management strategy. Knowl Process Manag. 1999;6(1):37–40.

McNamara P. Managing the tension between knowledge exploration and exploitation: the case of UK Biotechnology [Ph.D. Thesis]. London: City University Business School; 2000.

Mone MA, McKinley W, Barker VL. Organizational decline and innovation: a contingency framework. Acad Manag Rev. 1998;23:115–132.
Myers S, Marquis DG. Successful industrial innovation: a study of factors underlying the innovation in selected firms. Paper No. NSF 69-17. Washington, DC: National Science Foundation; 1969.
Nonaka I, Takeuchi H. The knowledge creating company: how Japanese companies create the dynamics of innovation. Oxford: Oxford University Press; 1995.
Polanyi M. Personal knowledge: towards a post-critical philosophy. Chicago: University of Chicago Press; 1958.
Reed R, DeFillippi RS. Casual ambiguity, barriers to imitation, and sustainable competitive advantage. Acad Manag Rev. 1990;15:18–102.
Revilla E, Rodríguez-Prado B, Prieto I. Information technology as knowledge management enabler in product development: empirical evidence. Eur J Innov Manag. 2009;12(3):346–363.
Rogers EM. Diffusion of innovations. New York: The Free Press; 1995. p. 35.
Saviotti PP. On the dynamics of appropriability, of tacit and of codified knowledge. Res Policy. 1998;26(7):843.
Sawhney M, Wolcott RC, Arroniz I. The 12 different ways for companies to innovate. MIT Sloan Manag Rev. 2006;47:75–81.
Say TE, Fusfeld AR, Parish TD. Is your Firm's Tech portfolio aligned with its business strategy? Res Technol Manag. 2003;46(1):32–38.
Schäfermeier R. Corporate semantic web: the semantic web meets the enterprise. 3rd International SOA Symposium; 2010; Berlin.
Schumpeter J. The theory of economic development. Cambridge, MA: Harvard University Press; 1934.
Szulanski G. Exploring internal stickiness: impediments to the transfer of best practices within the firm. Strat Manag J 1996;17(Winter Special):27–44.
Tatikonda MV, Rosenthal SR. Technology novelty, project complexity and product development project execution success. IEEE Trans Eng Manag. 2000;47.
Tsai W. Social structure of competition within a multiunit organization: coordination, competition, and intraorganizational knowledge sharing. Organ Sci. 2002;13:179–190.
Tushman ML, Anderson P. Technological discontinuities and organizational environments. Admin Sci Quart. 1986;31(439):65.
Utterback JM. The process of technological innovation within the firm. Acad Manag J. 1971;14:77.
Van de Ven AH. Engaged scholarship: a guide for organizational and social research. New York: Oxford University Press; 2007.
Veblen T. The theory of the leisure class. An economic study in the evolution of institutions. New York: Macmillan; 1899.
Volberda HW. Toward the flexible form: how to remain vital in hypercompetitive environments. Organ Sci. 1996;7(July/August):359–74.
Von Krogh G, Ichijo K, Nonaka I. Enabling knowledge creation: how to unlock the mystery of tacit knowledge and release the power of innovation. New York: Oxford University Press; 2000.
Walsh JA, Ungson GA. Organizational memory. Acad Manag Rev. 1991;16(1):57–91. ISSN: 0363–7425.
Zack M. Managing codified knowledge. MIT Sloan Manag Rev. 1999;Summer:45–58.
Zahra S, George G. Absorptive capacity: a review, reconceptualization, and extension. Acad Manag Rev. 2002;27(April):185–203.

Semi-retirement

► Cross-Retirement (Cross-Employed Cross-Retired) and Innovation

Serious Game

► Alternate Reality Games as Inventions

Services

► Microfirms

Setting Up a Venture

► Start-Up and Small Business Life

Shape Grammars

► State Space Paradox of Computational Research in Creativity

Sickness

► Technological Invention of Disease

Simplexity Thinking

Min Basadur[1], Tim Basadur[2] and Gordana Licina[3]
[1]Michael G. DeGroote School of Business, McMaster University, Hamilton, ON, Canada
[2]College of Business, Krauss Hall 215, Concordia University Chicago, River Forest, IL, USA
[3]Michael G. DeGroote School of Business, McMaster University, Brampton, ON, Canada

Introduction

Rapidly accelerating societal and economic change is posing new, more complex challenges for management researchers seeking to improve organizations. Many organizations that prospered during more stable times – times that rewarded routinized efficiency – now find themselves poorly adapted to today's new economic and social realities. In every direction, traditional structures are abruptly being reshaped or falling down. Once successful companies are finding that their sure-hit formulas no longer work. Long revered icons of organizational excellence have been humbled, and even bailed out of bankruptcy and imminent demise by government intervention. Individuals, families, and entire communities are finding the world shifting beneath their feet as traditional markets, industries, and sources of employment disappear under the impact of new information technologies, global competition, lack of regulation of financial institutions, uncertainty about global warming, transitioning to new energy sources, and a restructuring of the world economy. It is not surprising that organizations whose main virtues during previous times were predictability and reliability should find it difficult to adapt to this increasingly dynamic environment. Their employees, too, are struggling to deal with these changing times as the vast scale of change has resulted in an unprecedented need for information processing and problem-solving skills. There has been a dramatic increase in psychological research aimed at better understanding the cognitive capabilities of employees, in order to improve employee productivity and well-being (Hodgkinson and Healey 2008).

This entry addresses the need for organizations to develop more innovative ways of thinking and behaving in order to succeed in a turbulent world. While many organizations possess ample efficiency and analytical capability, successful organizations must also learn tointegrate effective adaptability and creative capability into their repertoire. Creativity attitudes, behaviors, and cognitive skills, embedded into a specific organization-wide problem-solving process, must be learned, and developed such that they are second nature if organizations are to survive and thrive. Innovative thinking ability must be made a way of organizational life, side by side with analytical thinking ability, not as a "sometimes thing" or "once in a while thing." Research has established that efficiency and adaptability are both necessary for organizational effectiveness (Mott 1972). Operationalizing adaptability can be achieved through Simplexity Thinking, a system comprised of a number of attitudinal, behavioral, and cognitive skills embedded within a multistage problem finding, defining, solving, and implementing creative process. This system does not exclude analytical thinking and analytical tools; on the contrary, it is clear that organizational creativity competency enhances and complements incumbent analytical capabilities. One of our goals is to help the field of creativity become better understood in its applicability to real world work, rather than a discretionary, once in a while add-on.

In management research up until the late twentieth century, the primary determinant of a firm's performance was perceived to lie *outside* the firm; that is in its external environment. This was the standard industrial organizational (IO) neo-classical economics viewpoint (Porter 1980a, b; Caves and Porter 1977; Caves 1980). In other words, according to the IO perspective, the source of a firm's profits was ultimately determined by its market position and the structure of the industry to which it belonged, and protected by barriers to entry into the market. This perspective led to the notion that leaders need only to design appropriate organizational structures and continue to make well-reasoned decisions (Edmondson 1996) in order to achieve continued economic success**.** An opposing point of view perceives that the source of superior profitability lies *inside* the firm. Known as the resource-based view, this perspective regards the firm as a bundle of resources not dependent on external market and industry structures (Ambrosini 2003; Rumelt 1984; Amit and Shoemaker 1993). It suggests these resources – primarily the people of the firm – are responsible for a firm's sustainable competitive advantage, as they are capable of adapting to changing external circumstances. The resource-based approach of Simplexity Thinking focuses specifically on the capability of the people inside the firm to use their creativity to deliberately and proactively make valuable changes internally or externally, and adapt to new situations that arise, in order to continuously develop and sustain healthy profitability. One well-cited example of this is how Southwest Airlines, which is famous for its people-centered management style, continued to be profitable in the post 9/11 period while most US airlines went into near or full bankruptcy.

Organizational Effectiveness, Adaptability, and Creativity

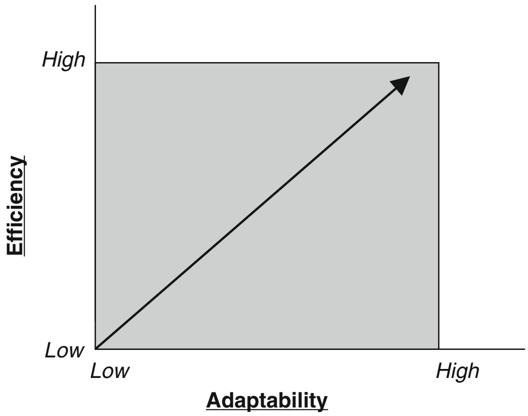
Research has shown that effective organizations have two major but very different characteristics: efficiency and adaptability. Efficiency means perfecting routines in order to attain the highest quantity and quality for the lowest possible cost. High efficiency means mastery of routine, or standard, prescribed methods by which the organizational unit carries out its main tasks. The efficient organization follows well-structured, stable routines to deliver its products or services in high quantities with high quality and at low cost. On the other hand, adaptability means continually and intentionally changing routines and finding new things to do and better ways to do current work. Adaptability means scanning the environment to anticipate new opportunities and problems and deliberately changing methods in order to attain new levels of quantity, quality, and cost. Adaptability yields both new methods and new products and services. High adaptability means a high rate of positive change of routine.

In a stable world, efficient organizations may be successful. But in today's changing world, organizations need adaptability. While efficiency implies mastering routine, adaptability means mastering the *process of deliberately changing* internal and external environments. Adaptable organizations anticipate problems and opportunities, and develop timely solutions and new routines. The people in such organizations accept new solutions promptly and the acceptance is prevalent across the whole organization. While adaptability is a *proactive* process of looking for ways to change, efficiency includes *reacting* quickly to unexpected turns of events and maintaining routines with minimal disruption and without getting mired in organizational bureaucracy. According to Mott's research (1972), the most effective organizations are both efficient and adaptable simultaneously, while the least effective organizations lack the right amount of either or both attributes. The following equation summarizes the findings:

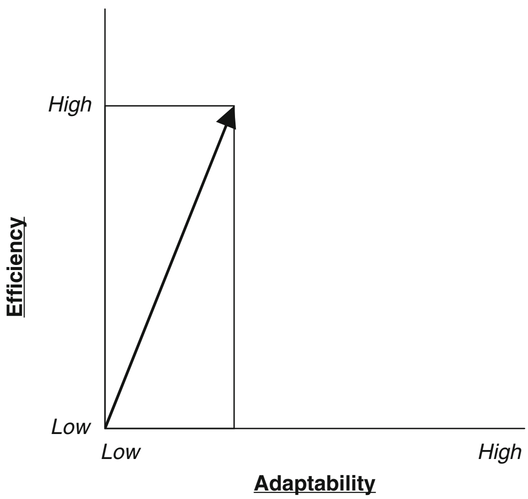
$$\begin{aligned}&\text{Organizational Effectiveness}\\&\quad= \text{High Skill in Efficiency}\\&\qquad+ \text{High Skill in Adaptability}\end{aligned}$$

High skill in adaptability (or efficiency) means the ability to implement higher or lower levels of adaptability (or efficiency) performance as desired (Fig. 1).

Through the years, many organizations whose success was built on predictable technologies, markets, or other environmental factors learned to become highly efficient but neglected to build capacity for adaptability (Fig. 2). For example, prior to the 1970s, North American consumers bought almost all of their cars from one of the Big Three domestic automakers. American automakers became accustomed to building large, fuel-inefficient vehicles suitable for a stable

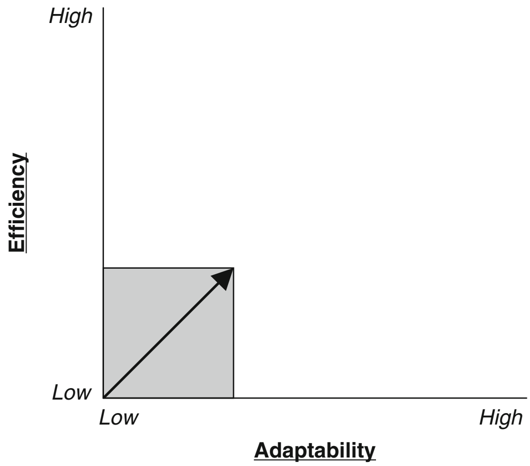


Simplexity Thinking, Fig. 1 Balance of efficiency and adaptability appropriate for a rapidly changing, unstable environment



Simplexity Thinking, Fig. 2 Balance of efficiency and adaptability appropriate for a predictable, stable environment

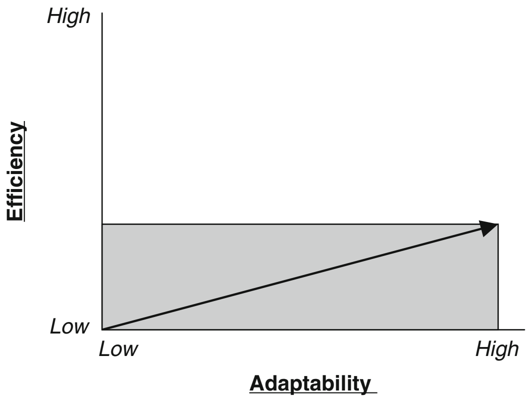
environment in which fuel was plentiful and inexpensive. Industry innovation was largely limited to cosmetic style changes each model year (low adaptability). As a result, when Japanese automakers began introducing more reliable cars, better options, and smaller vehicles that addressed new problems such as the 1970s oil crisis, they were quickly able to take advantage of the lack of attention the Big Three had paid to both efficiency and adaptability (Fig. 3).



Simplexity Thinking, Fig. 3 Balance of efficiency and adaptability inappropriate for any environment

A similar story can be told about the North American tire industry during the same time period. The radial tire introduced by France's Michelin in 1945 was displacing the bias-ply tire everywhere but in North America. Until about 1975, North America's automotive tire industry enjoyed a predictable environment. Consumers bought their tires every 20,000 miles or so from Goodyear, Firestone, or any of their well-known competitors. With the tires basically of the same quality, consumers shopped for the best price and friendly service and suppliers concentrated on providing these efficiency factors (Fig. 2). However, by failing to adapt to the radial tire innovation, due to management resistance, much of the North American market was lost virtually overnight to Michelin and Japan's Bridgestone, which found a public receptive to the advantages of the new tires. For the North American suppliers, what had appeared to be a predictable environment became anything but. They should have been operating according to Fig. 1; instead they were operating according to Fig. 2 (efficient enough but not adaptable enough).

It is also possible for an organization to be too adaptable but not efficient enough (Fig. 4). Some highly successful organizations – such as 3M, which is famous for continuously creating new products – carefully monitor their own activities so as not to overemphasize adaptability at the



Simplexity Thinking, Fig. 4 Balance of efficiency and adaptability overemphasizing adaptability at the expense of efficiency (inappropriate except in the most extremely unstable, unpredictable environments)

expense of efficiency (which would be an appropriate balance only in the most extremely turbulent environment). Microsoft has been criticized for introducing new products too hastily, before ensuring they have been optimized and are error free. Mediocre organizations compromise unnecessarily, trading off efficiency against adaptability in a zero-sum fashion. However, the most effective organizations ensure they have the right amount of both efficiency and adaptability. In today's highly competitive North American car market, many companies – North American, Japanese, and German – stress both high efficiency and high adaptability. Their consumers demand high levels of both quality and innovation. In a rapidly changing, unstable environment, both high efficiency and high adaptability are necessary (Fig. 1).

While all organizations need skills in both efficiency and adaptability in order to be effective, most organizations understand the concept of efficiency and find it easier to mainstream than that of adaptability. One of the most important factors in determining the appropriate ratio between efficiency and adaptability is the volatility of an organization's environment.

Early approaches to improving organizational effectiveness by researchers and practitioners centered on embedding humanistic ideals and values, including personal development, interpersonal competency, participation, commitment, satisfaction, and work democracy (French and Bell 1999; Mirvis 1998), into the workplace. These approaches became part of a field known as "organizational development," which has evolved adding interventions almost too numerous to mention.

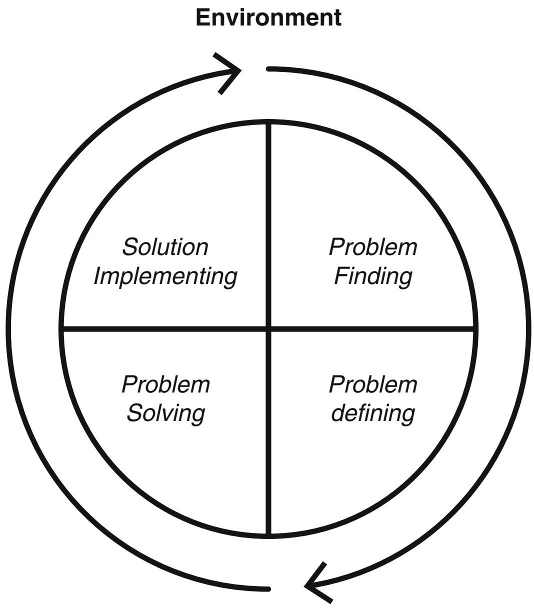
Many of these interventions have been useful in improving organizations in the short run. But many seemingly successful and permanent changes regress or disappear within a relatively short time after their implementation. This is sometimes called the fade-out effect (Hinrichs 1978). The specific intervention called total quality management (TQM) has often failed to live up to expectations (Spector and Beer 1994), partly because it has often been introduced as a grab bag of tools (and management rhetoric) without any change-making skills or process (Basadur and Robinson 1993). However, TQM has succeeded when installed not only as a tool (intervention), but as part of a continuous process of change making supported by a comprehensive, well-planned system of skill training, additional tools, management leadership, and employee engagement toward well-understood, specific, strategic goals (Basadur and Robinson 1993). Top managers must look at what they practice versus what they preach. If they truly want change, they must become proficient in change making. One of the most obvious examples of the lack of understanding of change making among managers is the inconsistency between organizational rewards and desired behaviors (Kerr 1995). Table 1 details these examples.

While creative strategies abound, many organizations struggle to effectively translate those strategies into action because employees are not sufficiently equipped to respond in ways that yield positive individual and collective outcomes (Hodgkinson and Healey 2008). Discrete interventions and tools continue to be the mainstay of organizational development work, with interventions perceived as the activities "through which changes in elements of an organizational work setting are implemented" (Robertson et al. 1993).

Simplexity Thinking, a process of organizational creativity with embedded creativity skills

Simplexity Thinking, Table 1 Examples of inconsistencies between desired behaviors and reward systems

We hope for.....	But we reward....
Long-term growth; environmental responsibility	Quarterly earnings
Setting challenging "stretch" objectives	Achieving goals: "making the numbers"
Commitment to total quality	Shipping on schedule, even with defects
Teamwork and collaboration	The best team members
Innovative thinking and risk-taking	Proven methods and not making mistakes
Development of people skills	Technical achievements and accomplishments
Employee involvement and empowerment	Tight control over operations and resources
High achievement	Another year's effort



Simplexity Thinking, Fig. 5 Creative activity in an organization

at all levels and across all disciplines, can be used to effect ongoing change making as an everyday way of life. Very importantly, it requires equipping internal organizational members with the ability to apply the process and skills for self-sufficiency, that is, without interventionist help from the outside. In this approach, change making is a continuous process of finding and solving problems and implementing solutions, which is synonymous with the Simplexity Thinking process. Without a precise change-making process that people can follow, and the necessary attitudinal, behavioral, and cognitive skills needed to make the process work, organizations cannot mainstream adaptability, that is, make it an ongoing routine way of organizational life.

Simplexity Thinking: A Specific Method of Operationalizing Adaptability

Simplexity Thinking can be defined as a system of knowledge, process, skills needed to make the process work, tools (e.g., creativity techniques such as brainstorming), and appreciation of process style differences (Basadur and Gelade 2006). Unlike traditional OD approaches, which lack a strategic perspective and rely on single or multiple interventions to change making, Simplexity Thinking is comprised of employees at all levels, highly skilled in constantly executing a process of finding relevant internal and external problems, strategic and tactical, solving them, and implementing the solutions for organizational adaptability. In effect, this defines Simplexity Thinking as "implemented change." The most effective organizations know that creative attitudes, behaviors, and cognitive skills and a creative process are necessary for successful sustained implemented change (Kriegesmann et al. 2005). Real sustained organizational change comes as a result of a structured process of applied creativity and attitudinal, behavioral, and cognitive skills employed by organizational members and modeled by leadership.

Studying and discussing creativity can be quite difficult and complex, because no single, agreed-upon definition of this quality exists and because researchers have taken vastly different approaches to its understanding. We focus on demonstrating a circular process of creativity as part of a continuous system of adaptability (Fig. 5). We have chosen to describe creativity in organizations as a continuous process of deliberate problem finding, problem solving, and solution implementation (Kabanoff and Rossiter 1994) and attitudes, behaviors, and cognitive skills that enable the process to work (Basadur et al. 1982; Basadur 1994a). Problem finding means continuously finding new problems to address. This includes addressing things that are going wrong, but also anticipating and seeking out current or future changes, trends, challenges, and opportunities. Problem finding also includes taking the time to explore problems in depth rather than merely finding quick solutions or "fixes" (Senge et al. 1994). This permits the discovery of not only underlying issues but also new opportunities and recognition of the interconnectedness of decisions within the organization. This recognition is the essence of systems thinking and the starting point for making long-term, permanent improvements. Problem solving means developing new and useful solutions to identified problems. Solution implementation means making new solutions succeed. Implementation usually leads the organization to find new problems to solve. As Runco (2004) noted, creativity is not only reactive – a response to problems and challenges – but also proactive, as a contributor to change. Thus new problems arise as the system and its environment react to each newly implemented solution. Therefore, organizational creativity can be understood as the fundamental driver of, and virtually synonymous with, adaptability, including a circular process of continuously finding, defining, and solving important problems and implementing new solutions which represent valuable changes that enable the organization to succeed (Fig. 5).

This approach also removes any distinction between creativity and innovation (despite views of some researchers who distinguish between creativity as the generation of an idea and innovation as its implementation). Here, creativity is defined as a multistage complete and continuous process driven by attitudinal, behavioral, and cognitive creativity skills in each stage, including problem generation and formulation, idea (solution) generation, and solution implementation. This inclusive process is described as Simplexity Thinking.

In addition, there are various creativity tools which can be applied in the various stages. However, such tools are of little value, and may even be harmful, without the prerequisite creativity skills to apply them. An example of such a tool is "brainstorming" which is frequently misused due to lack of skill and misunderstanding by researchers who lack experience in real world situations (Basadur and Basadur 2009).

Effective organizations know how to establish a well-understood process and set of skills for adaptability. They do not expect adaptability to be achieved without effort. For example, 3M sets a corporate objective that every 5 years, 30 % of their products must be new. Effective organizations also create a positive climate toward problems and seek them out as opportunities for disruptive change (Mott 1972). As solutions are implemented, new problems (or opportunities for innovation and improvement) are discovered. For example, Basadur (1992) reported that top Japanese corporations place newly hired R&D scientists and engineers into sales departments to begin their careers. The intent is for them to learn experientially the problems of the customer, and recognize that such learning is the beginning of innovation. Thus, a positive mindset toward creativity begins with a positive attitude toward *problem finding*, meaning the behavior of continuously and deliberately discovering and formulating new and useful problems to be solved.

The Four Distinct Stages of the Simplexity Thinking Process

The evolution of models of multistage creative thinking and problem-solving processes began with Wallas's (1926) four main stages: preparation, incubation, illumination, and verification. Later process models incorporated additional stages, but all include, as a first step, a process in which a problem is recognized, identified, and constructed (Reiter-Palmon and Robinson 2009). This is where the problem is formulated. However, all the preexisting models tend to assume that a problem, task, or goal requiring creativity already exists or has been presented and that a creative process is subsequently applied. This reduces these models to mere tools, or problem-solving interventions or episodes which start with a problem and end with a solution. A more complete process of creativity begins before a problem is available to be formulated (Basadur et al. 1982, 1990). Figure 5 outlines a continuous circular process that begins with the deliberate seeking out (*generating*) of new problems and opportunities. The second stage of the process is *conceptualizing*, or formulating, defining, and constructing a newly generated problem. In the third stage, *problem solving*, evaluation and selection of solution ideas takes place, while the fourth stage results in *solution implementation*. The process then begins anew, as every implemented solution (action) results in the opportunity to discover (generate) new problems and opportunities. For example, the automobile's invention provided not only a new solution to an old problem (improving transportation) but created many brand-new problems (e.g., pollution, energy, and accidents). Each stage of the process requires specific attitudinal, behavioral, and cognitive skills in order to be successfully completed.

While effective innovation requires strong performance in each of the four stages of the creativity process, research has found that individuals, teams, and organizations may prefer some stages of the creative process more than others. Effective leaders must learn to synchronize these different creativity preferences or *styles* (Basadur 2004). In teams, for example, the members must learn to combine their individual preferences and skills in complementary ways. Basadur and Head (2001) showed that heterogeneous teams composed of people with different preferences outperformed homogeneous teams whose members had similar preferences.

How Organizations Can Become Skilled in Simplexity Thinking

Many shortcomings in attitudinal, behavioral, and cognitive creativity skills plague individuals, teams, and organizations. As detailed in Basadur (2004), for many individuals, problem finding is a foreign concept. Many people wait for others to find problems to solve rather than actively seeking out problems, or avoid important problems that cross departmental lines ("That's not our problem"). Conceptual skills in defining problems are lacking and much time is wasted "working on the wrong problem." Even after finding and defining problems, some people find it difficult to solve them creatively and imaginatively. Some individuals are also critical of new ideas, which can prevent productive thinking. While many people may be able to implement routine solutions to routine problems, few can implement creative solutions to new, non-programmed problems. Teamwork is also often uncreative. Group members are unable to communicate clearly in simple terms, for example. Unaware of variations in individual thinking styles, groups fail to synchronize these differences, jump into "solving the problem" without first considering what the real problem is, and then flounder. Inter-functional teams become stalled arguing about territorial issues. Meeting leaders steer toward their own points of view rather than facilitating the group to work open-mindedly and cohesively. The design of many organizations remains along bureaucratic, functional lines – a design that itself minimizes creativity. Jobs are programmed for maximum control, highest quality, and lowest cost per unit. Creativity skills and change making are limited to short-term quick-fixes during emergencies. For organizations without a positive mindset toward creativity, problems and changes stemming from new technology, customer tastes, and foreign competition are viewed as irritants that disrupt well-functioning, established routines, despite the fact that the essence of adaptability and the first phase of the creative process is problem finding. Basadur et al. (1982), demonstrated that many of these shortcomings can be overcome by developing specific skills. Training to build these skills is based on two central concepts.

1. **Change making is a process with distinctly different stages:** In practice, it is useful to break the four-stage change process shown

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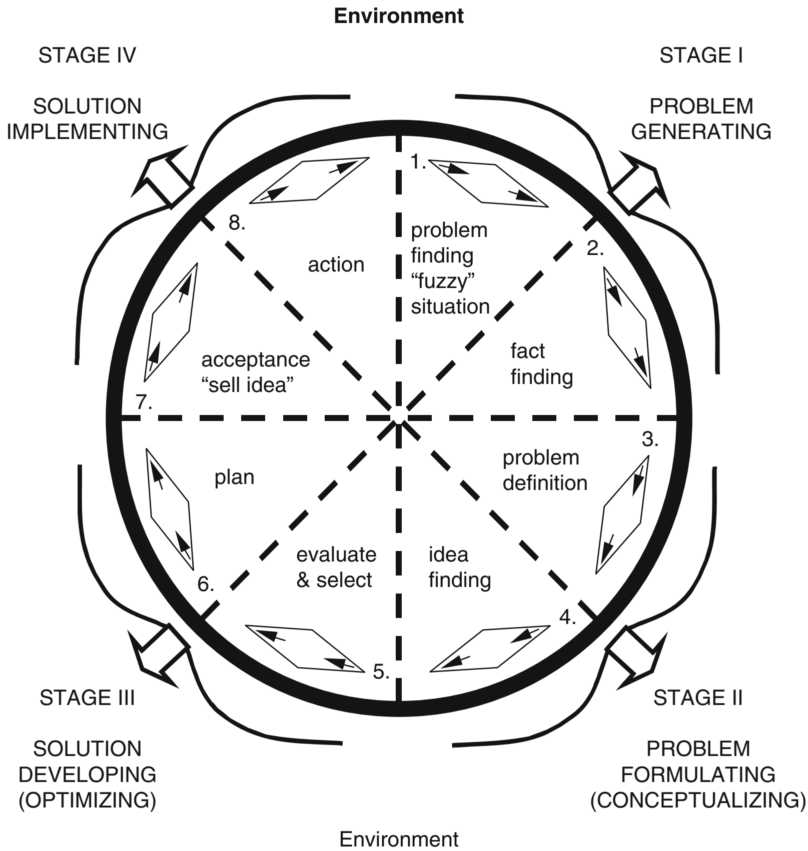


Simplexity Thinking, Fig. 6 The organizational change-making process

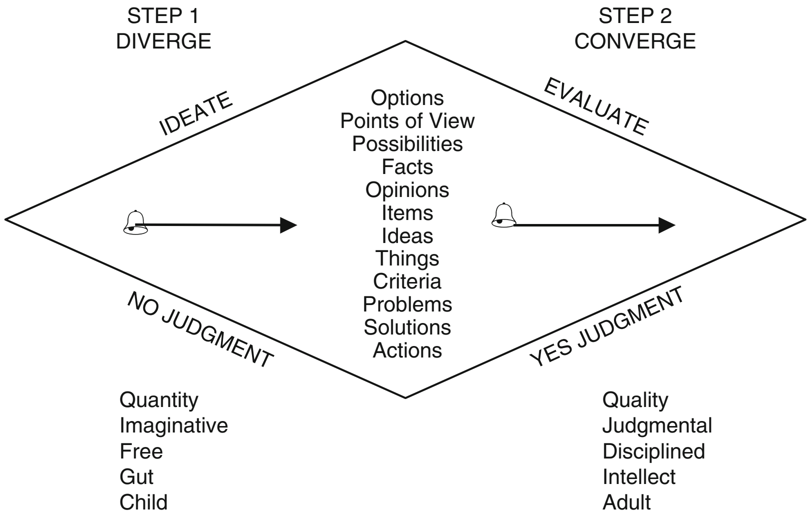
in Fig. 5 into a circular process of eight smaller steps as shown in Fig. 6. These steps include problem finding and fact finding, which collectively make up "problem generation," or Stage 1; problem definition and idea finding ("problem formulation," or Stage 2); idea evaluation and selection, and planning for implementation ("problem solving," or Stage 3); and gaining acceptance and taking action ("solution implementation," or Stage 4).

2. **An ideation-evaluation process occurs in each stage:** It is vital to use an ideation-evaluation mini-process within each of the eight smaller steps across all four stages as shown in Fig. 7. The mini-process is shown in Fig. 7.

Three distinct skills are needed to execute this two-step mini-process effectively (Basadur and Finkbeiner 1985): deferral of judgment, active divergence, and active convergence. By separating divergent thinking from convergent thinking, deferral of judgment resists the tendency to prematurely evaluate and select options, and encourages active divergence. Deferral of judgment also prevents people from leaping to solutions before properly formulating problems, and helps them separate assumptions from facts. Active divergence enables generation of many options without judging or analyzing them. Active convergence, which resists the tendency to linger in divergent thinking, then selects and acts on the options that ultimately lead to implementation of change. These three skills all have attitudinal, behavioral, and cognitive components.

Becoming Competent

It is much easier to understand the need for a systematic process to achieve organizational creativity and adaptability (as modeled in Fig. 6) than it is to become skilled in using such



Simplexity Thinking, Fig. 7 Ideation-evaluation: A sequential creative thinking mini-process

a process. Learning how to use the process involves developing skills in finding, defining, solving, and implementing new opportunities. Most managers have undergone rigorous training in analytical, optimizing, and efficiency thinking processes in high school and college and on the job training. Creativity requires a different set of skills in which competency must now be built belatedly. Building competency has three main components:

(1) Competency in executing the process as a whole; (2) Competency in respecting and helping synchronize different styles in the process and (3) Competency in executing each step and stage of the process. Competency in executing the process as a whole includes being able to distinguish the different steps from each other; for example, executing, communicating, and separating (1) problem finding activity from (2) problem defining activity and from (3) solution development activity and from (4) implementing activity. It also includes avoiding unconsciously leapfrogging the process steps, such as jumping backward from discovering a fresh new problem (step 1) into immediate action (step 8) only to discover later that the problem was not what it seemed to be at all and regretting the time wasted by not permitting the process unfold naturally from 1 ***through*** 8.

Competency in respecting and synchronizing different process styles includes understanding how the creative process depends upon different ways of apprehending knowledge and understanding and utilizing knowledge, however apprehended. Not only are both necessary for creative performance, but frustration and inefficiency in working together can be avoided. For example, if some individuals on a team prefer stage 2, conceptualization, while others on the same team prefer stage 4, implementation, it is important that these individuals understand and respect each others' opposite preferred ways of apprehending knowledge (experientially and concretely vs. theoretically and analytically) and of utilizing knowledge (to create options divergently vs. evaluate options convergently).

Competency in executing each step of the process includes competency in executing the ideation-evaluation mini-process described previously which combines the three necessary creativity thinking skills within each step: (1) creating options within the step (divergent thinking); (2) evaluating and selecting the most important options within the step (convergent thinking); and (3) skill in separating divergent from convergent thinking within each step (deferral of judgment). Integrated into early creative problem-solving theories and models, including Osborn (1953), Guilford (1967), and Parnes, Noller, and Biondi (1977), these skills in the mini-process have been more deeply explored in more recent empirical research which has described them more completely and identified their attitudinal, behavioral, and cognitive components. For example, in a multi-method, multi-measure field experiment, Basadur et al (1982) identified attitudinal, behavioral, and cognitive effects of training which were readily observable back on the job (along with performance effects). The effects included:

- Attitudinal: More openness to new ideas; more positive reaction when confronted with new unusual ideas
- Behavioral: More likely to pause to try new, unusual approaches to solving problems; less time spent in negative evaluation while creating options; less likely to jump to conclusions as to the nature of the real problem
- Cognitive: Increased quantity and quality of options created; more time spent in divergent thought prior to evaluating; more options created prior to selecting one as best

Additional examples of the attitudinal, behavioral, and cognitive components of each of the three process skills throughout the complete eight step process are provided in Tables 2, 3, and 4 (Basadur and Robinson 1993; Basadur et al. 2000a, b). It should be noted that the examples below overlap a great deal across attitudinal/behavioral/cognitive distinctions and also across the three process skills distinctions.

Simplexity Thinking, Table 2 Examples of deferral of judgment skill

ATTITUDINAL
Tackle problems with an optimistic "can do" attitude
Enter meetings open to ideas that might disrupt one's own department's routine
BEHAVIORAL
Visibly value, appreciate, and welcome other points of view
Avoid making premature, negative judgments of fledgling thoughts
COGNITIVE
Recognize hidden, unconscious, unwarranted assumptions
Maintain an awareness that some facts are more difficult to perceive than others
Understand that some problems require a longer time to solve, and do not expect immediate results

Simplexity Thinking, Table 3 Examples of active divergence skill

ATTITUDINAL
Deliberately push oneself to create unusual, thought-provoking ideas
Turn premature, negative evaluations of ideas into positive challenges to keep the creative process flowing; when others say "We can't because..." counter with "How might we...?"
BEHAVIORAL
Show leadership in pinpointing changes, trends, problems, and opportunities for improvement throughout the organization
Share information and ideas freely with other people and departments
Share "bad news" as quickly as "good news" to aid organizational problem solving
Facilitate teams to formulate problems in ways that transcend departmental considerations
COGNITIVE
Search out many different facts and points of view before attempting to define a problem
Define problems in multiple and novel ways to get a variety of insights

The field research by Basadur et al (1982), provided evidence that unless creativity training was sufficiently impactful to successfully *unfreeze and change* participants, no improvement in creativity skills and performance would be achieved. In other words, to achieve meaningful increases in problem finding, defining, and solving, and solution implementation performance, the impact of training must be sufficient to increase acceptance and practice of the attitudinal, behavioral, and cognitive creativity skills within the multistage creativity process. However, their research also suggested that to *refreeze* the acceptance and application of the new skills built in training to on the job creativity performance, specific strategic structural organizational factors must be developed and put into place to reinforce and motivate their on the job practice (Basadur 1994b). Basadur, Graen, and Scandura (1986) found that the training effects in creativity process and skills as shown in Fig. 7 on manufacturing engineers persisted back on the job were more permanent when they were trained together in intact teams. Team members learn to accept and share their members' diverse

Simplexity Thinking, Table 4 Examples of active convergence skill

ATTITUDINAL
Be willing to accept and participate in consensus decisions and move on in the change-making process
Accept ownership of measures of success of new ideas being implemented
Take the risk of failing or being criticized for implementing new ideas
BEHAVIORAL
Take reasonable risks to get action taken within time limits rather than waiting for the "perfect" option to emerge
Follow up on implementation; do whatever it takes to ensure successful installation of a chosen solution
COGNITIVE
Select, clarify, and focus on the most significant facts available prior to attempting to define a problem
Develop unbiased criteria for selecting from among options rather than letting preconceptions or hidden motives sway decisions
Understand how clear, simple, and specific implementation plans motivate action and overcome inertia
Understand the importance of including both long- and short-term decision-making criteria

experience more completely, support differing viewpoints, and risk implementing novel ideas (Basadur et al. 1982). This helps to avoid "group think," the tendency for members to follow the crowd into inadequate solutions instead of offering possibly controversial, superior viewpoints. Applying the process makes participation in problem solving safe and fun because people no longer fear advancing fledgling points of view and do not feel they must be constantly on guard.

Getting Two for the Price of One

Organizations which provide the right skill training, create the right infrastructure, and participate in and reward continuous problem finding and solution implementing, achieve several outcomes. Some creativity outcomes are directly economically oriented and others are not. Creativity leads directly to new and improved products and methods; these are economic outcomes associated with adaptability. However, creativity also leads to specific people outcomes, including motivation and commitment, which serve as intermediate steps leading to economic outcomes associated with efficiency (Basadur 1993).

Motivation and Commitment Are Outcomes of Creative Activity

Workplaces that establish adaptability as a daily, continuous process of problem finding and defining, problem solving, and solution implementation may experience increased employee commitment and motivation. Numerous research studies have shown that curiosity, activity, and exploration are intrinsically enjoyable and motivating. People develop negative attitudes toward repetitive tasks and experience fatigue and boredom. Permitted to engage in finding and solving problems, workers become motivated and desire even more participation in creative activity. They also work harder at perfecting their routine jobs to increase quality and quantity and reduce costs, thus increasing organizational efficiency and short-term organizational effectiveness. Workplace accomplishments improve self-esteem and human need for achievement, while creative activity stimulates team-building as people help each other to solve problems. Some research has also suggested people are more motivated to achieve goals that they have been given a chance to choose, which supports the importance of problem finding as an employee motivator, as well as an organizational necessity.

By giving employees the encouragement and opportunity to find and solve their own challenging problems, and implement their own solutions, organizations can provide intrinsically rewarding work and tap into the need for achievement for motivation.

Reducing Turnover, Absenteeism, and Increasing Personal Development

The link between inducing creativity on the job and increasing job satisfaction and commitment is important not only from the perspective of having happier and more motivated people at work, but in other ways as well. Industrial and organizational psychology research has identified substantial correlations between job satisfaction and commitment and direct economic variables such as lower turnover and lower absenteeism (Locke and Latham 1990; Organ 1988). Other outcomes which are both people and economically oriented include better selection, placement, career planning, and personal development for organizational members. For example, if we understand peoples' unique individual thinking and creative problem-solving process styles better, we can match them with jobs better (Basadur and Gelade 2003).

Setting Up the Internal Environment to Encourage Creative Work

While the commitment of an individual is the prerequisite for the development of expertise, the study of expert performance acknowledges the support structure surrounding individuals as crucial to facilitating eventual success. In developing of the creative competency of employees, the internal environment of an organization and its managers must act like the coaches, teachers, and parents studied in athletic and artistic expert performance. While the motivation and drive of employees to develop creative thinking skills is critical, management must structure the environment so that it enables the continuous growth of employees' expertise, and leaders must monitor the performance of employees and instruct them using methods that challenge them to reach ever higher levels of competence.

Despite research showing that most people at work are multi-motivated, the majority of global business and industry is still organized and managed on the overly simplistic "scientific management" concept made popular in the early twentieth century by Frederick Taylor (1967). Taylor believed that employees are motivated by one dominant factor – money. Fortunately, using creativity as a formula for motivation can be almost as simple as using money. There are many straightforward ways to encourage people to be creative on the job and achieve a motivated organization. Top Japanese organizations manage their world-class employee suggestions systems to induce creative behavior and to drive creative output including cost savings and new products and procedures. The primary objective of these suggestion systems is not to improve economic outcomes directly but to motivate people and increase their commitment (Basadur 1992).

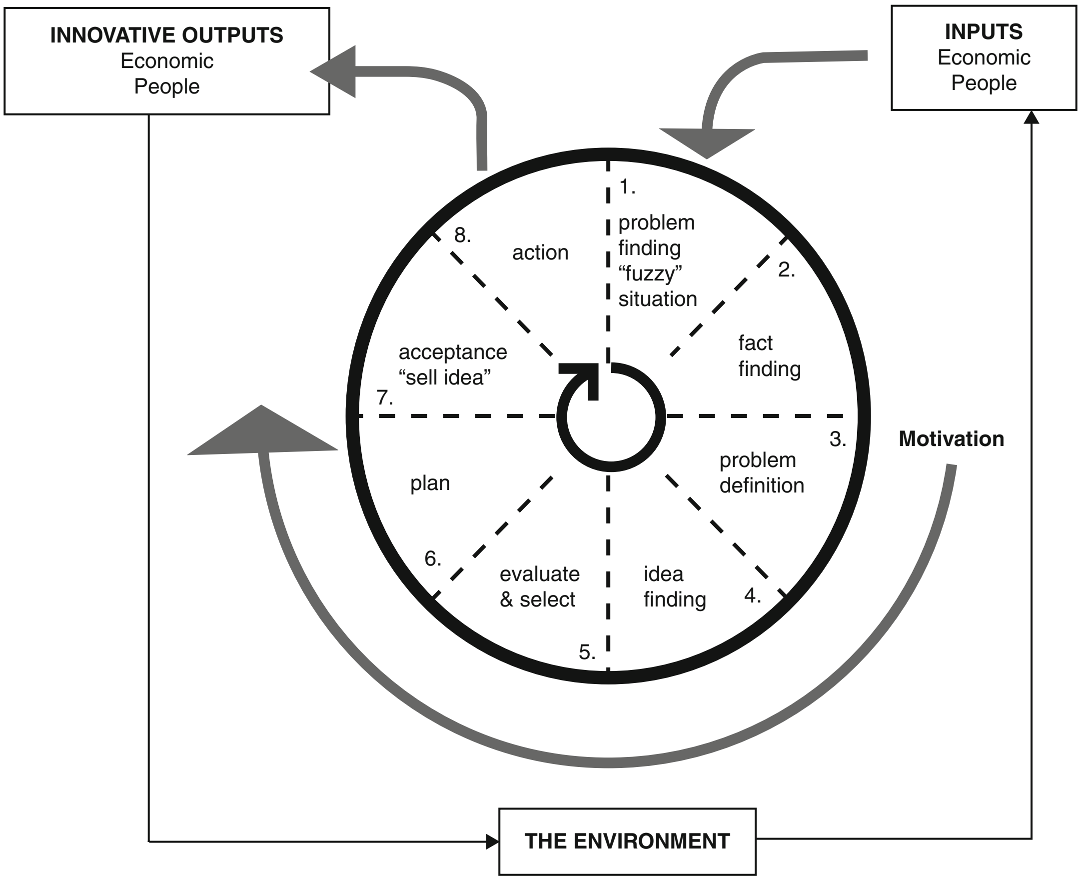
Creativity for Job Enrichment

Proactive creative activity, or adaptability, leads to a continuous flow of new methods and new products. However, acceptance of change by employees is assured because they are taking ownership of finding and solving their own problems, and implementing changes themselves. In effect, they are redesigning their own jobs, which is consistent with a well-documented axiom of social psychology: people do not resist change; they do resist being changed (Coch and French 1948). Employees enrich their own jobs by being creative.

Simplexity Thinking as the Transformational Engine

Simplexity Thinking accelerates the identification and solution of problems and opportunities across an organization. These problems and opportunities may originate in either the external or internal environments of the organization, and as they are moved through fact finding, problem definition, and then solution optimization and implementation, the organization is transformed into a state of adaptability.

Figure 8 illustrates how Simplexity Thinking works to operationalize adaptability. As problems and opportunities for change are "inhaled" into Step 1 and then "spun around" the eight step circular process ("the wheel"), the resulting implemented change (Step 8) is projected out as innovative output to be mixed in with the

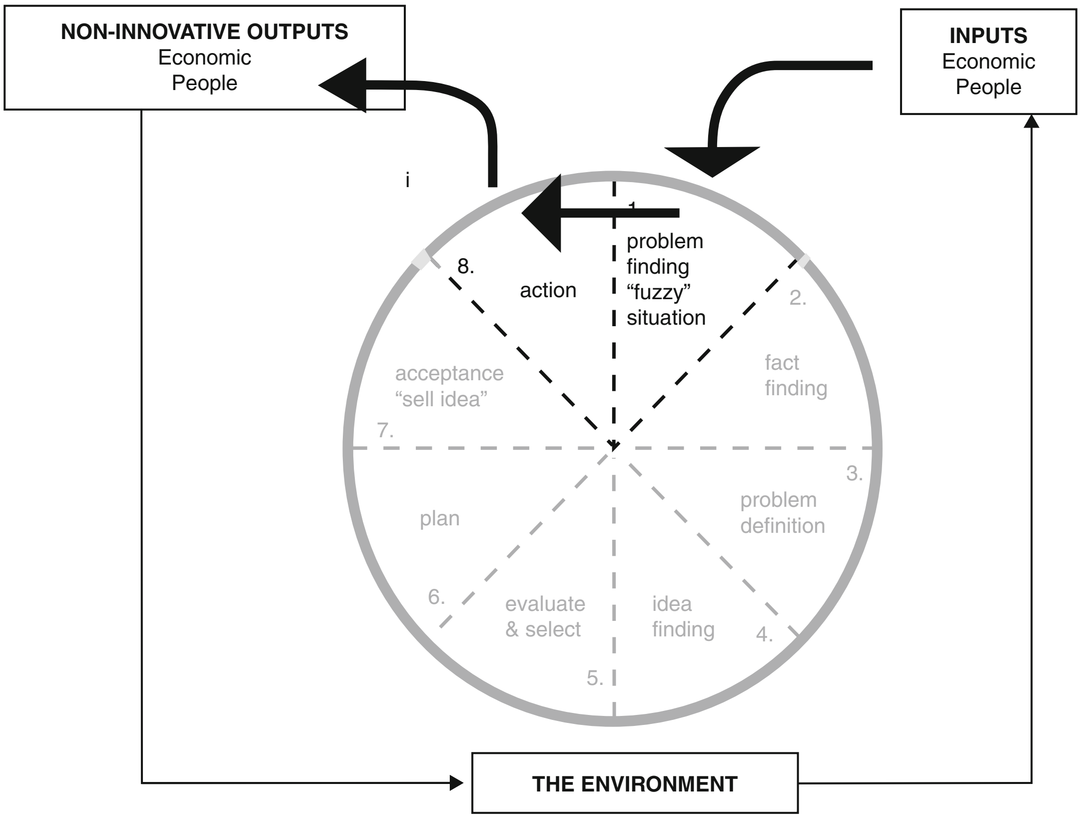


Simplexity Thinking, Fig. 8 An organization skilled at using Simplexity Thinking to operationalize adaptability and achieve innovative outputs

environment and cycled back through Step 1. This creative activity not only results in a continuous supply of new and improved products and methods, it also leads to intrinsically motivated, committed, and job-satisfied people. The motivation induced is the power that drives "spins" the wheel from Step 1 to Step 8.

In contrast, Fig. 9 models an organization unskilled in Simplexity Thinking. Unable to think problems through creatively, they instead move them directly in from Step 1to Step 8. Without the help of the creative process, the outputs are not innovative and the people are not motivated.

Although adaptability skills are essential, it would be naïve to believe that all that is needed is to train employees at all levels in the Simplexity Thinking process and the skills to make it work. This would only be one third of the battle. In order to make adaptability performance a normal way of life, an organization must integrate creativity thinking skills and process with a clear-cut business need and infrastructure to encourage employees to experience success applying the skills and process. Creativity skills and process must be accompanied by communication and acceptance of a well understood and motivating organizational business need for adaptability. People need to understand why they suddenly need to use their creativity on the job. The business need must be translated into a specific goal(s) to pursue. Measurable adaptability goals must be placed into the corporate strategy alongside efficiency goals. As well, a complementing infrastructure must be created which makes it easy and encourages people to



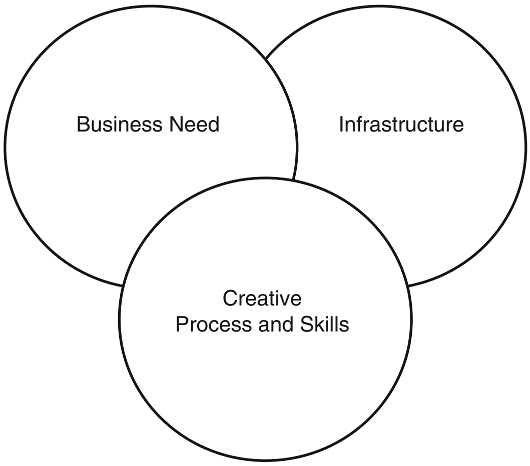
Simplexity Thinking, Fig. 9 An organization not skilled at using Simplexity Thinking moves directly to action without benefit of creative process, and achieves non-innovative outputs

routinely use their skills to pursue the goals. An ideal scenario, for example, might see employees receive creativity training based on application of training to specific company real world problems rather than non-work-related "practice" or theoretical problems. Thus, progress is made against the goals during the training itself. Of course the infrastructure must extend beyond the training. Figure 10 illustrates how these three components support each other.

Many worthwhile interventions have floundered because the organization lacked at least one of these three components: business need, infrastructure, and change-making process and skills (Basadur and Robinson 1993). If senior leaders wish to introduce an intervention, they must spell out what specific business need they intend to address (such as lower costs, higher sales, fewer defects or customer complaints, better teamwork, shorter turnaround times or faster time to market, better products or services) to ensure that employees buy in to the intervention and can measure success. The organization must also ensure an effective infrastructure, such as performance appraisal systems or membership on interdepartmental teams, is in place so new philosophies and tools are applied regularly. Along with clear business needs, and infrastructures for implanting new initiatives, organizations must also avoid underestimating the effort required to establish people's change-making skills, attitudes, and behaviors, and must provide adequate training.

Conclusion and Future Directions

Simplexity Thinking offers a new approach to organizational adaptability in which deep skill in executing creativity as a standard everyday



Simplexity Thinking, Fig. 10 The three necessary components of a successful effort to institutionalize adaptability

process is the key, equally important to traditional deep skill in executing traditional efficiency processes. Most of today's executives lack this creative skill and many have turned out to be inadequate leaders, especially in recent times of accelerating change and ambiguity. However, many organizations are not as effective as others because they value short-term results above all, and reward successful implementers of routines disproportionately. Simply put, organizations favor efficiency at the expense of adaptability.

Many companies still regard innovation as an irritant, something that gets in the way of the "real work." They are content to turn out standard quantities of standard products and achieve the sales, cost, and profit goals for this month, this quarter, this year. Their response to greater competition is to cut staff, reduce costs, lower service levels and, in some cases, lower quality. Too few respond creatively. Sometimes this is because they simply do not know how to go about it. It may be that various concepts of creativity and innovation are demystified through integration into a single simplified approach focused specifically on improving organizational performance short and long term.

Perhaps, more managers would be willing to give this simplified approach a try, especially if they could be shown how it helps them achieve even short-term results more efficiently. Perhaps, future research could focus on strategies for helping managers grasp and increase comfort with the innovation process, skills, techniques, and style described.

Simplexity Thinking is a deliberate and continuous change-making system of attitudes, behaviors, and cognitive skills driving a process of problem generation, conceptualization, problem solving, and solution implementation, which is virtually synonymous with adaptability. It requires attitudinal, behavioral, and cognitive skills in deliberate change making and incorporates interventions into the process as tools. Under the new approach, organizations can learn to mainstream adaptability by doing two things: encouraging employees to master new skills which increase their creativity, motivation, and engagement; and creating an infrastructure that ensures that these skills will be used regularly.

More research is needed to reassure innovating organizations that they are on the right track, particularly when the results of emphasizing adaptability may take considerably longer to appear than the results of an emphasis on efficiency. A clue may be found in Japan: whereas much North American decision making is driven by the next quarter's results, Japanese organizations favor long-term planning and reporting (Dertouzos et al. 1989). Well thought out strategies that enable organizations to confidently shift the balance between adaptability and efficiency will help them prosper over the long term and prevent their being surprised and damaged by a volatile environment.

An additional avenue for further research is to identify factors which enable an organization to effectively alter its "appropriate" balance of adaptability and efficiency rather than being caught unaware by upcoming environmental changes. What are the signals that prompt senior management to request more creativity, that motivate middle managers to act upon a top management requirement for more creativity, and that encourage individuals in the organization to act more creatively (assuming in each case that they know how to do so)? A clue may be found in several North American corporations that had the appropriate balance for an earlier era but had to drastically change that balance during the 1980s in order to react to changes in their environment or circumstances. While suffering through 13 consecutive quarters of huge losses in the early 1980s, Ford made massive top-down training interventions to become a less authoritarian, more innovative, and more efficient organization with higher employee involvement. In order to respond to new competition, Xerox reinvented itself from a copier company into a document company and instituted a continuous process to fundamentally change how its employees work and manage. More recently, IBM reorganized itself after seeing its stock price plummet when smaller competitors capitalized on the market shift to personal computers from mainframes. An excellent research question would be how these organizations might have recognized the need to shift their balance much sooner than they did.

Implications for Leadership

Today's leaders must understand creativity as an ongoing continuous change-making organizational process, not just a sometime occurrence, or a program of discrete interventions and philosophical values of "what's good" for organizations. Effective leadership is really implanting and sustaining a system of organizational creativity that can be learned and mainstreamed to provide continuous and deliberate adaptability. Leaders must learn and adopt the corresponding new skills and new ways of thinking and behaving. To provide effective leadership in the twenty-first century, managers must become effective change agents in their everyday work (rather than to leave this as a "sometime thing" to others). In future, managers, who may have been accustomed to a command and control style which includes creating strategy and policy by themselves and then passing it down to a waiting organization, will need to learn skills in engaging their subordinates in cocreating strategy. By engaging a wider range of people in the process of developing new strategies, ownership and successful implementation of the new strategy is more likely to occur (Coch and French 1948). Porras and Robertson (1992) describe the characteristics of an effective change agent as (1) interpersonal competence (relational skills, ability to support, nurture, and influence others), (2) theory-related problem solving and change skill (the ability to conceptualize and diagnose, to present options to others), (3) skill as an educator (able to create learning experiences), and (4) self-awareness (ability to have a clear understanding of one's own needs and motivations). These are all different from purely analytical thinking and problem-solving characteristics. To supplement these analytical skills, today's managers must learn to think and behave in new ways and to lead others to think and behave in new ways. Mintzberg (1973) documented that most managers operate primarily as short-term implementation doers. Other research (Basadur and Basadur 2010) supports this finding, suggesting many managers are especially under-skilled in problem finding and problem definition, which represent the essence of strategic thinking and adaptability. Thus, the training of managers to improve conceptual thinking skills to combine with optimizing and implementation thinking must become an important intervention to improve fundamental leadership skill.

References

Ambrosini V. The resource-based view of the firm. In: Ambrosini V, editor. Tacit and ambiguous resources as sources of competitive advantage. New York, NY: Palgrave MacMillan; 2003. p. 3–6.

Amit R, Shoemaker P. Strategic assets and organizational rent. Strateg Manag J. 1993;14:33–46.

Basadur MS. Managing creativity: A Japanese model. Acad Manag Exec. 1992;6(2):29–42.

Basadur MS. Impacts and outcomes of creativity in organizational settings. In: Isaksen SG, Murdock MC, Firestein RL, Treffinger DJ, editors. Nurturing and developing creativity: the emergence of a discipline. Norwood, NJ: Ablex; 1993. p. 278–313.

Basadur MS. Managing the creative process in organizations. In: Runco MJ, editor. Problem finding, problem

solving and creativity. Norwood, NJ: Ablex; 1994a. p. 237–268.
Basadur MS. Managing the creative process in organizations. In: Runco MJ, editor. Problem finding, problem solving and creativity. Norwood, NJ: Ablex; 1994b.
Basadur MS. Leading others to think innovatively together: creative leadership. Leadersh Q. 2004;15:103–121.
Basadur MS, Basadur TM. Where are the generators? Psychology Aesthetics Creativity and the Arts. 2011;5(1):29–42.
Basadur MS, Gelade G. The role of knowledge management in the innovation process. Creativ Innov Manag. 2006;15(1):45–62.
Basadur MS, Finkbeiner CT. Measuring preference for ideation in creative problem solving training. J Appl Behav Sci. 1985;21(1):37–49.
Basadur MS, Gelade G. Using the creative problem solving profile (CPSP) for diagnosing and solving real-world problems. Emergence Journal of Complexity Issues in Organizations and Management. 2003;5(3): 22–47.
Basadur MS, Head MM. Team performance and satisfaction: a link to cognitive style within a process framework. J Creative Behav. 2001;35(3):227–245.
Basadur MS, Robinson S. The new creative thinking skills needed for total quality management to become fact, not just philosophy. Am Behav Sci. 1993;37(1):121–138.
Basadur MS, Graen GB, Green SG. Training in creative problem solving: effects on ideation and problem finding in an applied research organization. Organ Behav Hum Perform. 1982;30:41–70.
Basadur MS, Graen GB, Scandura TA. Training effects on attitudes toward divergent thinking among manufacturing engineers. J Appl Psychol. 1986;71:612–617.
Basadur MS, Graen GB, Wakabayashi M. Identifying individual differences in creative problem solving style. J Creative Behav. 1990;24(2):111–131.
Basadur S, Pringle P, Speranzini G, Bacot M. Collaborative problem solving through creativity in problem definition: expanding the pie. Creativ Innov Manag. 2000a;9(1):54–76.
Basadur MS, Runco MA, Vega L. Understanding how creative thinking skills, attitudes and behaviors work together: a causal process model. J Creative Behav. 2000b;34(2):77–100.
Basadur MS, Basadur TM. Creativity skills and problem solving style: impact on creativity social network position. Presented at Academy of Management Annual Conference, Chicago; 2009.
Basadur MS, Basadur TM. How creativity relevant attitudes trigger behaviors, skills and performance. Presented at Society for Industrial and Organizational Psychology (SIOP) Annual Conference, Atlanta; 2010.
Caves RE. Competition in an open economy: a model applied to Canada Cambridge. Boston: Harvard University Press; 1980.
Caves RE, Porter M. From entry barriers to mobility barriers: conjectural decisions and contrived deterrence to new competitors. Quart J Econ. 1977;91:241–262.
Coch L, French J. Overcoming resistance to change. Hum Relat. 1948;1:512–532.
Dertouzos ML, Lester RK, Solow RM. Made in America. Cambridge: MIT Press; 1989.
Edmondson AC. Three faces of Eden: the persistence of completing theories and multiple diagnoses in organizational intervention research. Hum Relat. 1996; 49(5):571.
French WL, Bell CH. Organization development: behavioral science interventions for organization improvement. Upper Saddle River: Prentice Hall; 1999.
Guilford JP. The nature of human intelligence. NYC: McGraw-Hill; 1967.
Hinrichs JR. Practical management for productivity. Unpublished manuscript; 1978.
Hodgkinson GP, Healey MP. Cognition in organizations. Annu Rev Psychol. 2008;59:387–417.
Kabanoff B, Rossiter JR. Recent developments in applied creativity. Int Rev Ind Organ Psychol. 1994;9:283–324.
Kerr S. More on the folly-executive fax poll results. Acad Manag Exec. 1995;9(1):15–16.
Kriegesmann B, Kley TM, Schwering MG. Creative errors and heroic failures: capturing their innovate potential. J Bus Strateg. 2005;26:57–64.
Locke EA, Latham GP. Work motivation and satisfaction: light at the end of the tunnel. Psychol Sci. 1990;1(4): 240–246.
Mintzberg H. The nature of managerial work. New York: Harper Collins; 1973.
Mirvis PH. Practice improvisation. Organ Sci. 1998;9(5): 586–592.
Mott PE. The characteristics of effective organizations. New York: Harper & Row; 1972.
Organ DW. Organizational citizenship behavior: the good soldier syndrome. Lexington: Lexington Books; 1988.
Osborn AF. Applied imagination: principles and procedures of creative problem solving. New York: Charles Scribner's Sons; 1953.
Parnes SJ, Noller RB, Biondi AM. Guide to creative action. New York: Scribner's Sons; 1977.
Porras JI, Robertson PJ. Organizational development: theory, practice, and research. In: Dunnette MD, Houg LM, editors. Handbook of industrial and organizational psychology, vol. 3. 2nd ed. Palo Alto: Consulting Psychologists Press; 1992. p. 719–822.
Porter M. Generic strategies and performance: an empirical examination with American data. New York: Sage; 1980a.
Porter M. Competitive strategy. New York: Free Press; 1980b.
Reiter-Palmon R, Robinson EJ. Problem identification and construction: what do we know, what is the future? Psychol Aesthet Creativ Arts. 2009;3(1):43–47.
Robertson PJ, Roberts DR, Porras JI. Dynamics of planned organizational change: assessing empirical support for a theoretical model. Acad Manag J. 1993; 36(3):619–634.
Rumelt RP. Towards a strategic theory of the firm. In: Lamb RB, editor. Competitive strategic management.

Englewood Cliffs, NJ: Prentice-Hall; 1984. p. 566–570.
Runco MA. Creativity. Annu Rev Psychol. 2004;55: 657–687.
Senge P, Kleiner A, Roberts C, Ross R, Smith B. The fifth discipline fieldbook. New York: Doubleday; 1994.
Spector B, Beer M. Beyond TQM programmes. J Organ Change Manag. 1994;7(2):63–70.
Taylor FW. The principles of scientific management. New York: W.W. Norton & Company; 1967.
Wallas G. The art of thought. New York: Harcourt Brace; 1926.

Simulacrum

► Interaction, Simulation, and Invention

Situated Creativity

► Entrepreneurship in Creative Economy

Six Sigma

Uwe H. Kaufmann
Centre for Organisational Effectiveness/COE, Singapore, Singapore

Synonyms

Black belts; Green belts; Process excellence

Introduction

> "Globalisation and instant access to information, products and services continue to change the way our customers conduct business.
>
> Today's competitive environment leaves no room for error. We must delight our customers and relentlessly look for new ways to exceed their expectations. This is why Six Sigma Quality has become a part of our culture." General Electric, /1/

What Is Six Sigma?

Six Sigma is a highly disciplined approach that helps all kinds of companies focus on developing and delivering near-perfect products and services.

Where does the name come from? The word "Sigma" is a statistical term that measures how far a given process deviates from perfection. The central idea behind Six Sigma is that if you can measure how many "defects" you have in a process, you can systematically figure out how to eliminate them and get as close to "zero defects" as possible. To achieve Six Sigma Quality, a process must produce no more than 3.4 defects per million opportunities. An "opportunity" is defined as a chance for nonconformance, or not meeting the required specifications. This means a Six Sigma process is nearly flawless in delivering what customers expect.

General Electric's Evolution to Six Sigma /1/

The objective of Six Sigma is usually manifold (Table 1). More and more companies use the improvement approach to not only getting better in their processes but also to unleash the potential in their employees. Giving the responsibility for their own process to employees and motivating them to find a way to deliver better quality drives continues improvement efforts in many organizations. One key success factor therefore is "involvement."

Successful Six Sigma project leaders, Black Belts or Green Belts, are obviously able to lead a team and a project, collect and analyze data, see through the implementation and deliver results. Hence, they show leadership qualities and should sooner or later be considered for this kind of

Six Sigma, Table 1 Objectives of Six Sigma

Status before Six Sigma	Status after implementation of Six Sigma
1. Spotty use of quality improvement approaches and tools	1. Disciplined and consistent use of proven quality tools at all levels
2. Frequent "ship-and-fix" attitude	2. Do it right the first time, based on customers' requirements
3. Ignore costs of poor quality	3. Calculate and communicate costs to all employees
4. Function-focused values, mindset, and practices	4. Process-focused values, mindset, and practices
5. Frequent guesswork in making decisions	5. Measure and analyze objective data to help make decisions

position. Six Sigma becomes the entry point and the first step of a leadership development programme, i.e., it forms the leadership selection grid and builds basic leadership skills in a way that benefits the organization immediately.

Where Did It Come From?

Although, General Electric has made Six Sigma as famous it is now, the real inventor of the concept was Motorola. Motorola – under economic pressure in their TV business in the 1980s – were looking for ways to improve the quality of their products.

In 1986, Bill Smith, a senior engineer and scientist within Motorola's Communications Division, introduced the concept of Six Sigma in response to increasing complaints from the field sales force about warranty claims. Six Sigma was a new method for looking at defects. Smith developed the original concepts that formed the beginning of Motorola's Six Sigma initiative. He took his ideas to his CEO Bob Galvin, who recognized the approach as key to addressing their quality problems. Six Sigma became central to Motorola's strategy of delivering products that were fit for use by customers.

Following a common Six Sigma methodology through the phases Measure, Analyze, Improve, and Control, Motorola began its journey of aligning processes to critical customer requirements and installing measurement and analysis systems to continuously improve processes.

Elements of Six Sigma

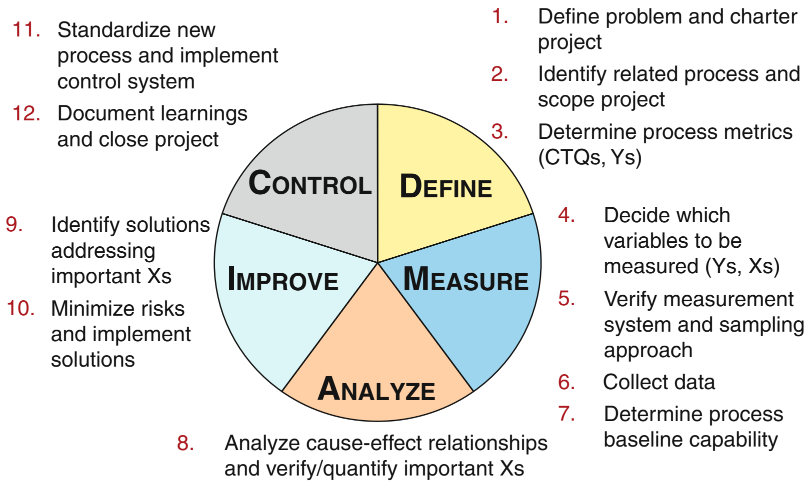
In the Six Sigma philosophy, there are three key elements of quality: customer, process, and employee.

Customers are at the center of each organization because they define what quality means. They expect performance on time, long-term reliability, competitive prices, and much more. Today, many organizations deliver similar products or services for a comparable price. Therefore, just delivering what the customer expects is not enough. In order to not only survive but win in the current environment organizations need to delight their customers.

The first step to get there is to understand the customer perspective completely. Taking this perspective and looking at the *processes* of an organization is a major leap. This enables to understand the customer's point of view not only on the quality of the product or service but also on the whole lifecycle of the transaction related to products or services. With this knowledge, new areas for improvement or even for creating more value for the customer can be identified und worked upon. *People* make things happen. All employees must have knowledge, skills, and motivation to design, improve, and run processes successfully.

Key players in Six Sigma world are

- Champions, who are leaders. They steer a Six Sigma initiative, select projects to work on and staff involved.
- Black Belts, who are the project leaders for Six Sigma projects. They are responsible for application of tools and for leading a Six Sigma team.
- Green Belts, who are on the development path for a Black Belt. They often lead smaller projects or participate in Black Belt projects.
- Master Black Belts, who are well experienced in Six Sigma and serve as coaches for above mentioned players. They are often part of the senior management team.



Six Sigma, Fig. 1 Five phases of a Six Sigma project

All of them receive extensive training in Six Sigma tools for process improvement as well as in soft skills like team leadership, coaching, influencing, and presentation skills reaching from about 2 days for Champions to more than 4 weeks for Master Black Belts. Only after passing an exam and delivering project results, they are allowed to carry the respective title.

Since Quality is the responsibility of everyone in an organization, the implementation of Six Sigma requires everyone to undergo basic training of up to 1 day per year.

Five Steps to Improvement

Typical Six Sigma projects undergo an improvement cycle of five steps (Fig. 1): Define, Measure, Analyze, Improve, and Control. Whereas Motorola started with Measure, other companies have added the phase Define after recognizing that especially improvement projects in service environments need a proper definition of the process to be improved as well as the metrics applied to measure the improvement.

Define is "Organizing Success." In this phase, the problem gets defined and linked to critical business issues. Related process is determined and the scope laid out. The probably most important step in Define for many organizations is a thorough and comprehensive collection and analysis of the Voice of the Customer and consequentially the definition of a defect from customer's perspective. Last but not least, a measurable goal for the project is being set.

Measure is "Collecting Information." Hence it is about Data Collection. In this phase, potential drivers for the problem are identified and their importance for the problem estimated. Based on this information, a data collection plan is established that describes the conditions for data collection after evaluating whether the data gathering process delivers repeatable and reproducible data. After the data collection, baseline performance data are calculated and targets are defined. A major strength of the Six Sigma approach is the wide range of tools for any kind of situation. This becomes obvious in the different kind of graphs available for plotting the collected data at the end of this phase.

Analyze is "Identifying the Vital Few." With powerful process and data analysis tools the relationship between problem and potential root causes is identified. If there is a relationship, i.e., if the factor, the potential root cause changes and at the same time the problem happens, a vital few root cause for the problem is recognized. More than 20 tools form the two data analysis approaches: graphical analysis and statistical analysis. With the latter one the Vital Few can be verified. This is an essential prerequisite for the next phase.

Improve is "Designing and Implementing Solutions." This phase often needs extensive creativity techniques in order to develop out-of-the-box solution ideas for the root causes identified in the previous phases. During Improve these ideas get transformed into solutions. Advantages and disadvantages of different solutions are considered. Risk assessment and implementation planning build further cornerstones of this phase. Often change management interventions are needed at this stage of the improvement project.

Control is "Sustaining the Gains." It is important for any organization to make the improvements lasting and the investments paying back over time. Therefore, this phase deals with building process control mechanisms as well as monitoring systems to keep the process under observation until the improved process has "burnt in." Additionally, a continuous improvement system similar to PDCA will be discussed to keep the process up to speed under changing conditions and increased customer requirements.

The goal of Six Sigma is to establish certain habits by going through these five rigorous phases. These habits benefit the culture of any organization and are the basis for the cultural change shown in Table 1. The timeframe for such a Six Sigma project usually lasts from 3 to 6 months.

Application and Benefits

During the last 20 years, companies like General Electric or Motorola have moved from counting defects in their product manufacturing to managing variation and systematically improving all their processes. Most important, they have moved from Six Sigma as a tool for improving product quality to Six Sigma as an overall business improvement methodology. The new Six Sigma combines the power of good business application of statistics with the critical elements of effective business strategy. It uses an overall business improvement framework to expand the organization's ability to realize its strategic objectives.

The results are impressive: "GE's success with Six Sigma has exceeded our most optimistic predictions. Across the company, GE associates embrace Six Sigma's customer-focused, data-driven philosophy and apply it to everything we do. We are building on these successes by sharing best practices across all of our businesses, putting the full power of GE behind our quest for better, faster customer solutions." /1/

Now, Six Sigma applications are showcased in all kind of industries all over the world. Apart from manufacturing it has become the way for managing and improving the business for financial services companies like banks and insurances, for Healthcare institutions, and even for governments, who are aiming to streamline their processes.

Although, the principles of Six Sigma are applicable in all kind of industry, there are some differences that need to be paid attention to in order to make it successful in service environments:

- Processes are not clearly defined like in a manufacturing environment. It means the early stages of the improvement cycle need more attention since the "identification" and definition of processes, customer needs, and defects are critical.
- Processes are driven by human beings with all their shortcomings. Hence, the soft-factor needs much more attention than in manufacturing companies.
- Measurements are more often manual rather than automated. Data collection is more complicated, focuses on discrete data and needs manual intervention. Therefore, to achieve high-quality data, more effort is needed.
- All these factors result in a constant need to motivate and attain people buy-in throughout the whole initiative.
- Rewards and recognition as well as success stories are critical to on-going success, not only but especially in Service environments.

Outlook

Over the last decades, Six Sigma went through a couple of cycles to adjust to evolving needs and to accommodate all the learning experience made by thousands of people using it every day in a lot of companies worldwide. After gaining confidence in the approach and after forming an impressive success in many organizations, it has been moved from production processes to transactional processes in manufacturing companies, later it has been applied in service companies and even in nonprofit organizations. By adding design, creativity, and innovation tools to the "standard" toolbox, a new methodology, called Design for Six Sigma, has been developed and used in all kind of design processes.

General Electric brought it to the customer in different aspects and call it ACFC – "At-the-customer-for-the-customer." Johnson & Johnson developed an approach to bring it to their sales force in order to increase incremental revenue. They call it "Sales Force Effectiveness." Pfizer is heavily focusing on customer satisfaction by zero-defect products and call it "Right the First Time." Other companies bring the variation reducing power of Six Sigma into the supply chain and apply it as a combined toolset called "Lean Six Sigma."

All this leads to the conclusion that there is no end of Six Sigma in sight. The name may change, the toolset may be enriched, the methodology may be adjusted but the goal remains the same: Quality products and services for customers through constantly improving and profitable processes driven by knowledgeable and motivated people.

References

General electric: what is Six Sigma – the roadmap to customer impact; 2002.

Kaufmann UH. Andreas Bieschke: Six Sigma meets ISO 9000. http://www.iSixSigmaEurope.com

Kaufmann UH. Six Sigma is in the bloodstream when.... Quality Digest; 2000.

Matt Barney, Motorola Inc. Motorola's second generation. http://www.motorola.com/mot/doc/0/819_MotDoc.pdf

Small and Medium Enterprises

▶ SME Growth and Influence of Internal and External Environmental Factors

Small Businesses - Value, Transmission, and Recovery

Marc Muller
International University Institute,
Munsbach, Luxembourg

Synonyms

Distressed finance; Entrepreneurship; Family business; Ownership succession; Planning; Valuation

Key Concepts and Definition of Terms

Small- and Medium-Sized Enterprises: Size Specificity

Size specificity for small- and medium-sized enterprises (SMEs) comes all naturally since it is etymologically rooted in its name. It delimitates a homogeneous business sector, relative to its constituent's size. In 1996, the European Commission defined SMEs mainly via the quantitative thresholds of staff headcount, annual turnover, and annual balance sheet. This approach was enlarged in 1996, stating that a small- and medium-sized enterprise (SME), given its size, may be "any entity engaged in an economic activity, irrespective of its legal form." Thus, the self-employed, family firms, partnerships, and associations regularly engaged in an economic activity may be considered as enterprises, irrelevant of the legal form under which the enterprise is acting. In addition, the new definition takes into account the various types of relationships between enterprises, introducing an additional criteria based on the relationship that an enterprise might have with another. Such affiliation concept distinguishes between autonomous, partner, and linked enterprises, where an autonomous enterprise means that it is not a partner or linked to another enterprise.

In the United States, the Small Business Administration (SBA) issued a definition based on the North American Industry Classification System (NAICS), according to which three generic qualitative rules and one quantitative requirement linked to the industry type are used to identify small business entities.

Managerial Specificity

Parallel to such formal developments, researches in the small business field were forging on conceptual developments, granting the SME managerial specificities, such as the dominant preponderance of the owner-manager, the adoption of intuitive and emotional strategies and tactics, or its geographical and financial limits. Their purpose was to answer the question if an SME might be a miniature large firm and if no, to give rise to a specific nature of small business management.

Such theses became established as the dominant doctrine and have become increasingly general (Bygrave 1989; Stevenson and Jarillo 1990; Gartner et al. 1992; Filion 1997), ignoring the fact that in reality, SMEs may considerably contrast one from the other (Dandridge 1979; Welsh and White 1981; Hertz 1982; Curran and Blackburn 1993, 2001) and that the sector is hardly homogeneous.

Such heterogeneity among SMEs was mostly pinpointed on differences in ownership structures, ranging from ownership in the hand of a single person who created or bought the business to more complex ownership structures represented by cofounders, purchaser(s), family members, and heirs. In latter cases, enterprises are commonly described as family businesses, whereas such definition mainly based on ownership structure challenges the quantitative criteria of the size of the enterprises.

Derived from the heterogeneous ownership structures, SMEs often differ through the preeminent role of the owner(s)/manager(s) acting either as a person or a small group of persons, the founder(s), or the founder's family. Such specificity usually is considered as positive in the sense of clear management identification, especially compared to the large company where ownership and, to a lesser extent, management might be more diffuse.

SME Values

Albeit values are far from being the exclusive attribute of SMEs, it is commonly accepted that SMEs have particular values, which basically derive from their specific ownership structures. Their list may be long, especially if one considers particular examples. Nonetheless, it is commonly accepted that core values such as courage, self-sacrifice, short decision-making process, moderation, sense of vision, self-responsibility, and passion depict SMEs. More, pragmatism, problem-solving focus, and adaptability stand for the manifestation of SME entrepreneurship. Curiosity, interest in innovation, creativity, specialization, and risk eagerness are usually the cutting edges, which empower the SME to stand up against its larger competitors. The symptomatic visionary approach of the archetypal paramount SME entrepreneur, the multigenerational concern of family-owned enterprises, the local engagement and rooting of many of them, and, finally, their endeavors to build and preserve a responsible reputation are considered among the drivers for the SME's concern for economically, ecologically, and socially responsible behavior.

Such values typically circulate among the enterprise thanks to informal understandings and shared expectations between the entrepreneur and the workforce. Values and ethical principles are consequently implicit rather than formally expressed through ethics policies, codes, and programs that are familiar in large companies. If SME entrepreneurs often resist standards and formal codes, large family businesses often face family conflicts, which call for a more formalized attitude regarding the issuing and the perpetuation of values. Latter are set in a "family codex" and aspire to preserve the family values, attitudes, and responsibilities toward business, stakeholders, heritage, and family-business assets.

As helpful all these values may be, they also bear drawbacks regarding the risk of competence limitation, vision myopia, financial constraints, and adverse consequences deriving from conflicts among the owners (family or not). Furthermore, the owner's desire for personal independence may have the effect of inhibiting cooperation with other firms, profitable use of external support and appropriate delegation of responsibilities to subordinates. The smallest firms often show to be generally growth averse and resistant to training, staff development, and other support initiatives.

Business Values and Valuation

SME Valuation

Under the assumption of purely financial objectives, the value of a business is based on the present value of net cash flows from the business to the owner. Such calculations of the business value can be based on capitalized earnings methodology or discounted cash flow techniques and demonstrate that the value of the business is based solely on its ability to earn business profits for the owner. As this definition of the value of a business does not depend on the size of the business to be valued, the general principles for valuation of SMEs do not differ from those for the valuation of larger enterprises.

Nevertheless, in valuing SMEs, specific matters may arise, not from the techniques as such but from possible deficiencies in the owner's management. Apart exceptions, it is a regrettable fact that SME owners often insufficiently cultivate the financial functions and structuring further than classical functions such as processing of payables, customer invoicing, payroll administration, financial reporting, etc. They hardly push the financial management systematically toward value-based management like performance measurement, risk management, forecasting, strategic planning, investment analysis, competitive intelligence, or financial restructuring by means of spin-offs, stock buy backs, slashing payrolls, selling off underperforming assets, etc.

Since these management actions stand for genuine firm's financial value boosters, the omission for not or hardly implementing them is liable to hinder the maximization of the SME's value.

Distinctive features may also adversely influence SMEs valuations, i.e., specific risks connected to the owner's management structure (dependence on a single or small group of persons, family issues, vision myopia, management and/or financial resources scarcity, etc.), the reliability of sources of information, the cut-off between business and private assets, etc.

But SMEs may also outrank bigger firms in growth. Such rapidly growing businesses excel by product and output innovation, high expenditures on human and physical capital, considerable upfront investments in development, production and sales, growing capital requirements and the use of risk capital, rapid changes in its organization, and related rapidly increasing revenues. For these entities, which appear considerably exposed to significant uncertainties and fluctuations connected with a high sensitivity of the forecast parameters, past results may indeed be inappropriate for the projection of future developments.

Hence, additional analysis is required notably in the fields of the products competitive abilities, the availability of resources in particular in finance and management skills, and finally in the fields of the keenness for implementing structural and organizational changes consequently to the rapid growth.

The result of these assessments might negatively influence valuation by means of risk premium and growth rates modulations.

On the opposite, many SMEs do not follow profit maximization objectives or are facing a downturn and may thus find themselves with poor earnings and return on equity lower than the discount rate.

If endured over a longer period of time, this can lead to the failure to pay creditors and to a state of overindebtedness, possibly leading ultimately to insolvency. In such scenario, alternative valuations should be applied, particularly the breakup concept under which the firm is not any more considered to continue functioning as a business entity (loss of going concern status), and is split up with all assets and liabilities listed at net realization values.

Start-up Companies Valuation

Recent well-known cases occurred where start-up companies were valuated at prices, which utterly disproved the classic valuation methods. Such skyrocketing start-up's share price is not a question of coincidental windfall but results from propensities a start-up shows up in the fields of market power, based on the potential to cast a remarkable footprint in an often new and expanding market; the mastery of a sustainable and sufficiently differentiated product/service; appropriate management skills; and openness and flexibility for entering into a satisfactory deal with potential investors.

If part or all of such prerequisites are met, the real business value for a big competitor originates from the chance to either eliminate an annoying challenger or catch up a missed market trend.

Likewise, venture capital investors' interest in such business comes from their strategy to join such a start-up in an early stage, lead up value enhancing stepping-stones in terms of financial and management structuring and finally negotiate an exit deal, awarded with substantial capital gains.

SME Recovery

In the United States, seven out of ten new employer firms last at least 2 years, and about half survive 5 years. More specifically, according to the U.S. Dept. of Commerce, Bureau of the Census, Business Dynamics Statistics data, 69% of new employer establishments born to new firms in 2000 survived at least 2 years, and 51% survived 5 or more years.

Recovering and regaining the former condition after a business misfortune is the hope of each manager-owner of a SME, although the better alternative is the avoidance and prevention of the hardship. This leads to the question if SMEs are more doomed to failure than larger entities.

There are key factors that – if not prevented – will certainly weigh down a business and possibly lead to its downfall.

The most obvious failure factor is the belonging to the wrong business. Michael E. Porter of Harvard Business School in 1979 formed a framework for business strategy development analysis enabling to derive the so-called five forces which depict the competitive intensity and henceforth the attractiveness of a particular market: threat of new entrants, threat of substitute products, bargaining power of customers, and bargaining power of suppliers. The more a firm is adversely exposed to these Five Forces, the more it is considered operating in an unattractive market.

The second key factor is poor management. Sometimes small business owners lack appropriate business and management expertise external to their specific knowledge related to their business idea.

Another key factor is the insufficient capital. In the United States, the share of small business using commercial banks declined in the past, while the share using finance companies increased. But such external funds cannot substitute for the critical need for internal funds on which SMEs depend overproportionally more than publicly traded firms. Paradoxically, fast-growing companies, whose needs for financial resources are higher, appear the more threatened by financial shortages, and many confront bankruptcy in spite of encouraging growth rates.

In case financial distress happens nevertheless and the entrepreneur has the resources to counteract, specific recovery management will include operational and financial restructuring, crisis and stakeholder management, corporate liability negotiating, and, if possible and/or appropriate, implementation of exit strategy via sale or M&A.

Transmission

Definition

Transmission is understood in the meaning of ownership succession, which embraces sale and inheritance processes.

Issues in Succession

Reasons of Successions

Inevitable changes in SMEs ownership take place for a variety of reasons, some planned and others not, like the sudden death of an owner. The reasons for particular ownership changes can indeed relate to aging and lifestyle issues, changes in owners' personal circumstances, and the managerial demands of the ownership role or the dynamics of particular ownership situations. Common specific reasons for ownership change include retirement, owner needs to realize capital from their businesses, a poor trading outlook, or, conversely, the business's development potential.

Importance

Worldwide a substantial number of family businesses are facing succession, considering that an estimated 65–80 % of all firms worldwide are family-owned businesses (Neubauer 2003).

Succession Issues

Ownership succession is a complex field because of the numerous elements influencing the transaction: the seller's status, motivation and management capabilities, the buyer's status, the target's structure and transferability, and the target's business condition. In addition, a special emphasis lies on the successful transfer of the old owner's knowledge since latter often represents the key element of the SME's human capital.

Resistance often comes from owner-managers of SMEs who do not acknowledge succession as an issue and simply ignore the yet critical succession planning. The way in which management is regularly rotating especially in larger organizations is indeed mostly inexperienced in SMEs and family businesses where it is not uncommon that owner-managers live a lifelong career. Although if this might positively influence management continuity, the excessive stretching of such status quo harms, nevertheless, definitely the management renewing process and enhances the firm's transmission pressures.

In family business, the most delicate transition commonly occurs between the founder and the second-generation founder's heir. While there is agreement in the family business literature that succession planning is highly relevant for long-term firm performance, there is no agreement regarding the best kind of succession in terms of the decision if a family member or an outsider is best to take over the firm.

Researches (Fox et al. 1996) view ownership succession in family businesses in terms of a next-generation family member taking over the chief executive officer (CEO) role. They contrast the ownership change process in a publicly owned company with that in a family business. In a public company, CEO changes take place regularly and are usually planned well in advance. By contrast in a family business, succession is an infrequently occurring process linked to generations and life spans. The number of possible successors is often limited and may be contentious. Successful change, Fox et al. (1996) argue, depends upon the effective management of the succession process.

Conclusion and Future Directions

Value, transmission, and recovery are inextricably linked by the predominance of value creation, which triggers profitability, thereby facilitating the transmission process and rendering recovery superfluous.

Cross-References

- ▶ Business Emergence
- ▶ Business Model
- ▶ Corporate Entrepreneurship
- ▶ Creative Personality
- ▶ Entrepreneur
- ▶ Entrepreneurial Capability and Leadership

▶ Entrepreneurship and Business Growth
▶ Entrepreneurship and Small Business Agility
▶ Entrepreneurship Policy
▶ Financing Entrepreneurship
▶ Health of Entrepreneurs
▶ Innovation and Entrepreneurship
▶ Knowledge Capital and Small Businesses
▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)
▶ Psychological Aspects of Entrepreneurial Dynamics
▶ Risk, Uncertainty, and Business Creation
▶ Schumpeterian Entrepreneur
▶ Small Business
▶ Small Businesses and Sustainable Development
▶ Social Responsibility
▶ Spin-off

References

Bygrave WD. The entrepreneurship paradigm (I): a philosophical look and its research methodologies. Entrep Theory Pract. 1989;13(3):7–26.
Curran J, Blackburn RA. Researching the small enterprise. London: Sage; 2001.
Dandridge TC. Children are not “little grown-ups”: small business needs its own organizational theory. J Small Bus Manag. 1979;17(2):53–7.
Filion LJ. Le champ de l’entrepreneuriat: historique, évolution, tendances (History, evolution and tendencies in the field of entrepreneurship). Revue Internationale PME. 1997;10(2):129–72.
Fox M, Nilakant V, Hamilton RT. Managing succession in family owned businesses. Int Small Bus J. 1996;15(1):15–26.
Gartner WB, Bird BJ, Starr JA. Acting as if: differentiating entrepreneurial from organizational behavior. Entrep Theory Pract. 1992;16(1):13–31.
Hertz L. In search of a small business definition; an exploration of the small-business definitions of U.S, the U.K., Israel and the People’s Republic of China. Washington: University Press of America; 1982.
Neubauer H. The dynamics of succession in family businesses in western European countries. Family Bus Rev. 2003;16(4):269–81.
Porter M. Competition in global industries. Boston: Harvard Business School Press; 1986.
Stevenson HH, Jarillo C. A paradigm of entrepreneurship: entrepreneurial management. Strat Manag J. 1990; 11:17–38. Special issue.
Welsh JA, White JF. A small business is not a little big business. Harv Bus Rev. 1981;59(4):18–32.

Small Business

Pascale Brenet
IAE, Université de Franche-Comté, Besançon, France

Synonyms

Individual enterprise; Medium-size business; Microenterprise; Small enterprise

Small is Beautiful

A small business is usually defined by its size, its independence from a large firm, and its organizational form, which is based on the key role of the entrepreneur. There is no single definition of small business: legal definitions vary by country and industry when it comes to the question of the size; there is a consensus about its qualitative properties, but this subject is extremely complex.

Employment and contribution to job creation explain why SMEs have received close attention for many years and in many countries. The economic and social contribution of SMEs is also based on their impact on territorial development, their presence in niche markets and proximity markets, and their high degree of flexibility. This flexibility is particularly useful when markets and productive systems are changing at a rapid pace. The SMEs sector is very heterogeneous but small businesses have some common characteristics: centralized management, informal information systems, low-task decomposition, short-term and implicit strategy, and close relationship with customers. The entrepreneur seizes opportunities, assumes risks, coordinates limited resources, and manages a firm. He contributes to value and job creation. Due to their economic and social impact, small business and entrepreneur are a topic of interest for nations. Since the creation of the Small Business Act in the USA in 1953, many countries have set up SMEs policies to encourage entrepreneurship and small firms’ growth. In 1979, David

Birch's study about the job-generation process in the USA was a key step both for public policies and academic research.

The small firm is not only a topic of interest for public policies. Scholars have explored this subject since the eighteenth century. Their interest has grown during the twentieth century (Landström 2005), and in one way, we can consider that the small business has become a crucial matter after large firms have grown. Research associates small business and entrepreneurship, and this field of research has gradually changed, being a topic within economic science, behavioral science, and management science.

The small business is an organizational model with an important place inside the business sector. As an agent of change, adjustment variable, or active part of a network, its specificities are of great interest for business strategy.

Small Business and Employment

Most of the time, a small business is defined by size criteria. Small- and medium-sized enterprises (SMEs) are defined officially by the EU as those with fewer than 250 employees and which are independent from larger companies. Furthermore, their annual turnover may not exceed €50 million or their annual balance sheet exceed €43 million. This definition is critical in establishing which companies may benefit from EU programs aimed at SMEs and from certain policies such as SME-specific competition rules. SMEs may be divided into three categories according to their size: microenterprises have fewer than 10 employees, small enterprises have between 10 and 49 employees, and medium-sized enterprises have between 50 and 249 employees.

Among size criteria, the number of employees is the most common due to its simplicity and accessibility. With this perspective, SMEs are considered in almost every country as firms with fewer than 250 employees, except in the United States where the threshold is 500 people and 300 in Japan. The US Small Business Administration defines a size standard eligibility depending on the industry and based on the average number of employees for the preceding 12 months or on sales volume averaged over a 3-year period.

Behind the figures is a very heterogeneous enterprise base, in which we can find a Californian high-tech start-up, a Canadian "gazelle," an Italian small firm producing ceramic within a local and traditional network, a Japanese automotive supplier, and a microenterprise created in India using microcredit facility. This diversity can be explained by many factors: business sector, level of innovation, market size, entrepreneur's qualification and skills, etc.

In 1971, the Bolton Report defined a small business using two major characteristics: independence from a large firm and the entrepreneur is the owner and the manager. The US Small Business Administration defines a small business concern as one that is independently owned and operated, is organized for profit, and is not dominant in its field. Julien (1998) considers that small business specificity is based on five features: centralized management, informal information systems both internal and external, low task decomposition, short-term and implicit strategy, and close relationship with customers.

From an employment perspective, SMEs are key actors in most countries. Some 20.9 million SMEs represent the overwhelming majority (99.8%) of enterprises active within the EU-27's nonfinancial business economy. They account for two out of every three jobs (66.7%) and for 58.6% of value added. Small businesses also make a very large contribution to job creation. SMEs and microenterprises are also the core of informal economy. This increases their relative weight in developing countries. In Europe, for instance, 92% of enterprises are microenterprises; their relative share of the nonfinancial business economy is 29% for workforce and 22% for value added.

It is not only their contribution to employment but also their contribution to job creation which explain why SMEs have received close attention for many years and in many countries. Job creation occurs when a new firm is created or when an existing firm is able to grow and develop its staff. That is why SMEs are a crucial issue in entrepreneurship, both for new firm creation and growth potential of young existing small firms.

David Birch focused on job creation in the USA in two major studies published in 1979 and 1987. He highlighted the role played by independent small firms in job creation by demonstrating that the younger and the smaller is a company, the higher is its job-generating power. He considers that small businesses are the "engine of the economy" because they create more jobs than giant companies, grow more rapidly, run greater risks of failure, and show more adaptability. In the most recent period, figures published by the Small Business Administration underlines that between 2000 and 2008, small firms (employing less than 500 employees) have created more than nine million jobs, while large firms (more than 500 employees) destroyed more than two million of jobs in the whole USA. These figures are the summary of four different phenomena: jobs created by firm births, jobs created by existing firm expansions, jobs destroyed by firm deaths, and jobs destroyed by existing firm contractions. David Birch has pointed out that the aggregate growth is built on massive continual failures.

SMEs economic and social contribution is also based on their impact on local development, their presence in niche markets and proximity markets, and their high degree of flexibility. This flexibility is particularly useful when markets and productive systems are changing at a rapid pace.

Small is beautiful as far as employment and flexibility are concerned, but due to their small size, they suffer from a number of handicaps that can slow their development and even lead to business failure. Their access to bank loan is difficult and access to investors and financial market even more; they often have little financial resources and are undercapitalized; they suffer from financial weakness that causes lack of investment, less effort in research and development, and limited commercial effort; they have difficulties in gaining access to international markets and public or complex markets; and they suffer from weak negotiating in relation to their large customers and suppliers, leading to low margins, constraints on just in time delivery, and long delays in receiving payments, despite recent European legislation. They are often poorly diversified and exposed to business risks. They can have difficulty in recruitment of qualified employees.

Since the creation of the Small Business Act in the USA in 1953, many countries have set up SMEs policies. The main kinds of measures on which these policies are based are easing the tax burden; developing public funding for research, job creation, investment, and exportation in order to facilitate risk-taking; accompanying small firms who intend to extend their markets, developing access to venture and development capital funds, facilitating access to public procurement contracts; promoting entrepreneurship by making an effort in entrepreneurial training in schools and in the university system.

Beyond this, most nations have set up a variety of public funding and support services to encourage new firm creation. These measures are very wide in order to cover a large spectrum of creations, from a local traditional microfirm to a technological knowledge intensive start-up. For the latter, a good example is the French 1999 law on innovation which combines different measures: definition of conditions for enabling researchers to set up companies to apply the results of their research, creation of seed capital funds with a mix of public and private capital, and creation of incubators for innovative businesses, national competition for innovative company creation, and research tax credit.

An Entrepreneurial Organizational Model

The small firm is not only a topic of interest for countries and public policies. It is also an organizational model with an important place inside the business sector. Small is beautiful . . .but sometimes big is plentiful; for many years, large firms have been considered as the only kind of firm able to perform financially due to economies of scale and range economies. In this perspective, small firms are suboptimal, particularly in industry.

But in some activities and some conditions, there can be scale diseconomy. Big size emphasizes organizational problems and creates rigidity and bureaucracy.

Mintzberg (1989) describes the main characteristics of entrepreneurial organization: its structure is simple, its organization resists any form of organization, communication is informal, and decision-making depends on the entrepreneur. Definition of strategy is based on intuition of the leader who reacts quickly.

Further, the transaction cost theory points out that a firm's creation is based on a choice between market and hierarchy, between organizational costs and transaction costs. In order to avoid both transaction costs and internal organization costs, some firms use hybrid organizational modes consisting of partnership, vertical partnership and company network.

Frery (1996) has focused on firms' boundary and defined the transactional firm. The transactional firm (or network firm) can come from a large firm disintegration, a network of small companies operating in the same district, or a central firm dealing with peripheral entities. The network firm is a hybrid organizational model, which is based on cooperation and coordination that neither market nor hierarchy can provide. This kind of network firm is neither a centralized large firm nor a completely autonomous small firm. Porous borders between small and specialized units characterize it.

Due to their size, SMEs are active in proximity and niche markets and often choose a strategy of focusing. They occupy specific places in markets and value chains and insure a complementarity with large firms. Audretsch considers they are agents of change because of their flexibility and reactivity. They are able to seize opportunities neglected by large firms and play a key role in knowledge circulation. For instance, small biotechnology firms are very innovative and often develop partnerships with "Big Pharma." In this case, they share financing, risks, and intellectual property. Small companies focus on research and development when large companies deal with large-scale production and marketing. Entrepreneurs in biotechnology always come from private or public research. They play a key role in innovation as mediators between science and market.

In some cases, large firms try to develop their entrepreneurial ability by using corporate venturing: intrapreneurship, spin-off, capital-venture, joint venture. Corporate venturing is a good way to set up entrepreneurial organization inside or close to the large firm. It enables large firms to explore external opportunities or develop new ventures that are risky or noncored businesses. In short, it is a good way for a large firm to act as a little one.

Conclusion and Future Directions

Entrepreneurial ability of small business is of great interest for nations because of its social and economic impacts. It is also an important matter for existing large firms looking for growth and innovation opportunities. The evidence suggests "small is beautiful."

But the small business is not a unique organization model. Job and value creation can be seen as an aggregated phenomenon, while it is based on a turbulent and chaotic collection of companies that are constantly changing, going from success to failure. David Birch considers that a pulsation model characterizes small firms. Part of the small firm sector is extremely volatile and unstable.

Many issues are still unresolved and represent a challenge both for scholars and public policies. Two of them can be underlined and concern the smaller and the bigger of what is commonly called "small business." The first question is about how to encourage firms' creation, especially when entrepreneurial intention is low. This question deals with education and entrepreneurial culture. It is a very important question in schools and universities that have to play a key role to encourage entrepreneurship as a way to professional insertion. The second question is about the mid-sized companies that are far too rare in some countries, whereas a majority of young firms never create jobs. Encouraging growth of microenterprises and reinforcing skills of individual entrepreneurs are two major challenges for many countries.

Cross-References

- ▶ Business Climate and Entrepreneurship
- ▶ Business Emergence
- ▶ Business Start-Up: From Emergence to Development
- ▶ Entrepreneur
- ▶ Entrepreneurial Opportunities
- ▶ Entrepreneurship
- ▶ Extrapreneurship
- ▶ Innovation and Entrepreneurship
- ▶ Microfirms
- ▶ Venture Capital and Small Business

References

Audretsch DB. The dynamic role of small firms: evidence from the US. Small Bus Econ. 2002;18(1–3):13–40.

Audretsch DB. The knowledge spillover, theory of entrepreneurship and economic growth. In: Vinig GT, Van Der Voort RCW, editors. The emergence of entrepreneurial economics, Research on technological innovation, management and policy, vol. 9. Burlington: Emerald Group; 2005.

Birch D. The job generation process. Cambridge: MIT Program on Neighborhood and Regional Change; 1979.

Birch D. Job creation in America. Fress Press: New York; 1987.

Fréry F. L'entreprise transactionnelle, Gérer et Comprendre, Annales des Mines, n°45; 1996.

Julien PA. PME: bilan et perspectives. Paris: Economica; 1998.

Landström H. Pionneers in entrepreneurship. New York: Springer Science; 2005.

Mintzberg H. Mintzberg on management. Inside our strange world of organization. New York: The Free Press; 1989.

Putting small businesses first, European Commission, Enterprise and Industry, 2008 http://ec.europa.eu/enterprise/newsroom/cf/_getdocument.cfm?doc_id=806.

Small Business Firms

- ▶ Microfirms

Small Business Operation

- ▶ Start-Up and Small Business Life

Small Businesses and Sustainable Development

Leïla Temri
Montpellier SupAgro, Montpellier, France

Synonyms

CSR; Environmental management; SME

Introduction

If, in light of their numbers, small businesses currently seem less sensitive to the stakes of sustainable development than large firms, they could nevertheless play an important role in expanding the practices. More and more tools, specific devices, and policies are becoming available to them. Their behavior differs somewhat from that of large firms, and at present, there is not a common theoretical approach concerning the commitment of small business in sustainable development.

Corporate Social Responsibility, the "Contribution of Business to Sustainable Development"

Sustainable Development

The story of the concept of sustainable development is now rather well known. Many authors suggest that it began with the Meadows report for the Club of Rome's book "Limits to Growth," published in 1972, which put forward the idea that natural resources are not inexhaustible and illustrated the interdependence between the economic and ecological dimensions of development in a systemic approach. That same year, the first

United Nations Conference on the Human Environment was held in Stockholm. It was the first United Nations international conference displaying environmental concerns. At the time, the expression "sustainable development" was defined as "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" in the Brundtland Report (1987), written under the aegis of the World Commission on Environment and Development and adopting a political and economic outlook while also introducing the social dimension. Later, numerous developments were presented during the United Nations Conference on Environment and Development, also called the Rio Conference or Earth Summit, organized in 1992. A document was produced called the Rio Declaration on Environment and Development, consisting of 27 principles intended to guide future sustainable development. Another outcome was an action plan referred to as Agenda 21, an agenda for the twenty-first century. Two other conferences were held under the aegis of United Nations: the Johannesburg World Summit on Sustainable Development in 2002 and the Climate Change Conference held in Copenhagen in 2009. A new conference, known as Rio + 20, is scheduled to be held in Rio in 2012. Through this short history, it is clear that the concept of sustainable development is closely associated with the United Nations from both a political and economic standpoint and that the environmental dimension is of the utmost importance.

In the Firms: CSR

Corporate social responsibility, or CSR, is an older concept than sustainable development. According to Aggeri et al. (2005), the concept of CSR emerged at the same time as large firms at the end of the nineteenth century and continued to develop throughout the 1920s, focusing on the question of the relations between firms and society. The debate was formalized by H. Bowen in an academic book entitled *Social Responsibilities of the Businessman* (1953). He presented social responsibility as a voluntary initiative on the part of businessmen and founded on ethical considerations. In the 1960s, the "business and society" outlook developed, sometimes taking account of the environmental dimension and involving numerous debates. Then in the 1970s, firms made CSR a more operational consideration through social audits and social reporting with a view to providing answers to social and stakeholders' demands. The notion of stakeholder has continued to develop since the end of the 1970s, especially with the publication of E. Freeman's book entitled *Strategic Management, A Stakeholder Approach* (1984). Aggeri et al. (2005) note that the "business society" approach does not refer to sustainable development. Consultants and international organizations made the link between the two concepts.

CSR, "A Business Contribution to Sustainable Development"

According to Aggeri et al. (2005), the main figure in uniting the theoretical concepts developed in the field of CSR and the notion of sustainable development is a British consultant, John Elkington (Commission of the European Communities 2002). Through his office, SustainAbility, founded in 1987, he developed the strategic council to the companies in the field of sustainable development. He also coined the term "triple bottom line" (TBL), based on the three acknowledged pillars of economic, social, and environmental considerations (people, planet, profit). The World Business Council for Sustainable Development – an association of companies – was founded in 1995, while in 2001, the Commission of the European Communities published a green paper on CSR entitled *Promoting a European framework for Corporate Social Responsibility* paying particular attention to the relations between CSR and sustainable development. However, it was in a communication published in 2002 that CSR was most clearly presented as "a business contribution to sustainable development." CSR was defined as a "concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis" (Commission of the European Communities 2002, p. 5). The document stresses the need for businesses to integrate CSR as a strategic point in corporate management. The environment is one of the dimensions of CSR. In the recently launched international standard ISO 26000, the fruit of negotiations between six categories of stakeholders from 93 countries and 42 international organizations, the environment is one of the seven "core subjects" included in the standard. It should be noted that sustainability deals generally with the environmental dimension. It is the view used in this entry.

SMEs

Small and medium enterprises are now considered to be important players in the economic game. This was not always the case. While the earliest firms to be established were small, larger firms became the norm in the wake of the industrial revolution. However, since 1975 and the oil crisis, the limits of large firms have been revealed, and small businesses once again began to attract more attention, as they generally represent more than 90% of all firms. Nowadays, many public policies are dedicated to small firms, be it at international, national, or regional level. The European definition of an SME is first based on staff, but other criteria are also taken into account. According to the European Commission, an SME is first and foremost "any entity engaged in an economic activity, irrespective of its legal form." An SME employs fewer than 250 people and has either an annual turnover not exceeding 50 million euros or an annual balance sheet total not exceeding 43 million euros. Three categories can be distinguished: microenterprises (fewer than 10 employees with neither the annual turnover nor annual balance sheet total exceeding 2 million euros); small enterprises (fewer than 50 employees with neither the annual turnover nor annual balance sheet total exceeding 10 million euros); and finally medium-sized enterprises (fewer than 250 employees with an annual turnover of less than 50 million euros or an annual balance sheet total not exceeding 43 million euros). SMEs benefit from numerous policies designed to support their development by creating a favorable business environment either at national or international level. In the field of sustainable development, many recommendations have been put forward. For instance, the European Expert Group on Corporate Social Responsibility and Small and Medium-sized Enterprises conducted work aimed at helping "small businesses to integrate social and environmental issues into what they do." There are also publications about SMEs and the environment. Along with other international institutions, the OECD (Organization for Economic Co-operation and Development) promotes policies favorable to SMEs on the one hand and policies in support of sustainable development on the other, although the latter are primarily intended for large companies. UNIDO (United Nations Industrial Development Organization) has also developed a program called REAP (Responsible Entrepreneurs Achievement Program) for small firms, based on the triple bottom line.

SMEs and Environmental Management

Environmental Management

Environment management is one dimension of CSR. It is difficult to find a precise definition. ISO 14000 is the standard used for environmental concerns. The first version was drafted in 1996, at about the same time as the EMAS. Today, ISO 14001:2004 and 14004:2004 are in use. According to ISO 14000, environmental management means:

– Identifying the environmental impact of the activities of the organization and what to do to minimize the harmful effects of these activities on the environment
– Establishing how to constantly improve its environmental performance

It can also lead to the implementation of a systematic approach with environmental objectives, targets, and indicators to demonstrate that the objectives have been reached.

The EMAS (European Eco-Management and Audit Scheme) is a voluntary environmental management tool available since 1995. Its aim is to implement "continual improvements in the environmental performance of companies and others organizations" by means of "tools allowing organizations to measure, evaluate, report and improve environmental performance." Initially restricted to industrial companies, it was opened to all economic sectors in 2001 and revised in 2009. Environmental management is defined as "the management of a company's activities that have an impact on the environment," but SMEs do not make great use of these systems. Recently, ISO has produced both a handbook and a CD specially designed for SMEs to make it easier for them to implement environmental management systems in accordance with ISO 14001. A new standard, ISO 14005:2010, has also been developed for them, while EMAS has developed a toolkit for small organizations. According to ADEME, the French Environment and Energy Management Agency, there are two aspects to environmental management: an "organizational approach" developed at production sites and subject to EMAS or ISO 14001 and a "product approach" aimed at designing or improving products with a view to minimizing their environmental impact throughout their life cycle. In the case of SMEs, it would therefore appear that there is no precise definition of environmental management, but just a collection of actions aimed at minimizing the environmental impact of the products and their production or of all the organizations' activities. These actions can be designed as part of a systemic approach.

SMEs' Behavior

Most of the literature in the field of environmental management and SMEs claims that small enterprises do not adopt the same behavior as larger firms. Generally, there is a discrepancy between the attitude of SMEs toward the environment and their behavior. Most of the owner-managers have a positive attitude toward sustainable development or environment, but there is a discrepancy between this attitude and the practices observed. Many SMEs are not aware of the negative externalities they may produce. A recent study published under the auspices of the European Commission measured the environmental impact of European SMEs (Constantinos et al. 2010). According to the authors, it was the first such detailed study in Europe. The study estimates that SMEs account for approximately 64% of industrial pollution in Europe. Differences can be observed between sectors, but the results must be qualified by taking the number of small firms in the different sectors into account. There is a positive relation between the size of the firm and the actions implemented to reduce their environmental impact. This result is consistent with that of several other studies. A very small proportion of SMEs uses environmental management systems such as EMAS, ISO 14 001, or national systems (about 0.4% in the European study). However, in the "Ile-de-France" region in France, an investigation has shown that, of all the different dimensions of CSR, it is the environmental aspect which has given rise to the most actions.

Many studies have tried to identify the reasons for this behavior and the rationales that might push them in this direction.

Barriers to the Integration of Environmental Actions in SMEs

Several publications mention first the owner-managers' lack of awareness of their environmental impact. Even if they are aware of this impact, they either perceive it as being too small for measures to be required or they feel that it is not their responsibility.

Other barriers are mentioned. The typical characteristics of SMEs are generally mentioned, including a lack of financial and human resources, time, skills, expertise, or "ecoliteracy" concerning environmental matters. This is why they do not correctly perceive the potential advantages of environmental management. Reducing their environmental impact is seen as a cost burden which cannot be transferred to customers rather than as a potential competitive advantage similar to cost reduction or reputation enhancement. Furthermore, product or process differentiation founded on environmental best practices could easily be copied by competitors and cannot, therefore, be defended in the long term. Familiarity with environmental legislation may also be weak, as it is considered too complex or costly to implement.

Many authors also cite external barriers such as the lack of public infrastructure in terms of transport or collection systems and waste treatment, the lack of financial support, and inadequate institutional structure and business support services in the environmental sector. The lack of adequate tools is also a factor, as those available are generally designed for larger firms, while the role of external pressures can also be cited. Many studies mention the lack of demand from stakeholders, customers, or the supply chain. This will be discussed later. Finally, the lack of information on environmental matters also contributes to explaining the discrepancy between SME attitudes and behavior in the field of environmental management, as SMEs do not adopt proactive behavior by actively seeking information. It should nevertheless be noted that this behavior is changing as a result of awareness campaigns.

More generally, it should be noted that all these barriers gradually decrease as environmental issues become “institutionalized,” which means that the more practices develop, the more they tend to become established as implicit standards. Owner-managers are now less likely to underplay their environmental impact and now demonstrate much more positive attitudes toward implementing environmental actions. They are also more positive about the relative costs and benefits of these environmental actions and are able to see potential business opportunities arising from their implementation, even if they are not convinced that environmental measures could actually increase profits. Nevertheless, size is an important contingency factor. Among SMEs, larger firms are more committed to environmental actions because they are better able to identify the benefits of these actions.

Drivers of the Implementation of Environmental Management Actions

Many factors also are considered to be drivers of SME commitment to environmental actions. Compliance with regulations is an important driver, both directly and indirectly, by increasing the awareness of the environmental impact of SMEs. According to managers, facing the same environmental constraints is also a means of ensuring equality between firms.

The entrepreneur/owner’s personal interest in sustainable development is also an important driver of the SMEs’ commitment to environmental actions, as the manager plays a dominant role within his firm. Many studies suggest that altruism, or moral imperatives, are among the most important drivers of environmental action, even if SMEs, especially the smallest ones, do not see any significant economic benefits. SMEs perceive the benefits of their environmental commitment in terms of an improvement in product/process quality, an increased market share, or the opportunity to enter new markets, but the smallest SMEs do not benefit from these advantages except for a small number enjoying cost reductions.

The role of stakeholders is not yet clear, as mentioned previously. Some recent surveys have shown that the main benefits to SMEs of addressing environmental issues are a reduced risk of prosecution, improved customer relations, and greater customer appeal. Pressure from customers, suppliers, or other stakeholders does not, however, seem to be significant. The improvement observed in employees motivation and performance has been mentioned recently as the major reason for SMEs to invest in environmental measures. Other works mention the influence of supply chains, especially in highly concentrated industries, where larger firms tend to transmit the pressure exerted on them by their stakeholders to SMEs through the value chain.

Theoretical Approaches

Most works in the field of small businesses and sustainable development are devoted to the environmental practices, the drivers of and barriers to the commitment of small firms to these actions, and contingency factors. For the most part, however, the theoretical basis is neither clear nor explicit. In some cases, stakeholder theory is mentioned but generally to state that it is not relevant. To ensure a better understanding of the theoretical frameworks that can be used, it is necessary to explain those used for CSR.

According to Gendron (2000), CSR is generally analyzed using three approaches:

- The business ethics approach, which focuses on the moral and ethical dimension of business activity. In this approach, CSR is seen as the application of morality in business and focuses on values and normative judgments.
- The business and society approach, a school of thought which is concerned with the relationship between society and business through social contracts. The firm has to prove the legitimacy of its activity to society; otherwise, society could react and compromise its future.
- The social issue management approach is referred to as being utilitarian or strategic. It holds that social issues have to be treated as parameters that must be taken into consideration in the strategic management of the firm.

Capron and Quairel-Lanoizelée (2007) position the different approaches to CSR on a continuum between two extremes:

- On the one hand, neoclassical theories, illustrated by Milton Friedman, claim that a company has no other social responsibility than to generate profits for its shareholders. According to this school of thought, it is the main condition underpinning an optimally functioning economy. The incorporation of societal goals by a firm hinges on its financial performance. In this context, agency theory attempts to define the relationship between shareholders and managers and how they influence each other in aligning their interests. In the case of small businesses, this theory does not apply because the manager is generally also the owner. Stakeholder theory is something of an extension of agency theory. It takes account of all stakeholders, i.e., all the categories of actors who have a direct or indirect interest in the activities of the firm, not only the shareholders and the managers. However, these relations can be seen from two points of view. In a view similar to that of neoclassical theory, taking the expectations and requirements of stakeholders into account is considered a prerequisite for the profitability of the company because its future depends on these stakeholders who contribute to developing its competitive advantage. According to Capron and Quairel-Lanoizelée (2007), this approach supports most CSR instruments and frames of reference. The other point of view is closer to the other extreme.
- The other extreme – the business ethics approach – considers that companies have a moral duty to operate in a socially responsible way, especially toward their stakeholders. This approach is diametrically opposite to the neoclassical vision, where morality is observed outside the firm and is established by the market or governments (Gendron 2000). In the field of business ethics, the firm has a moral obligation toward its stakeholders resulting from its moral necessity to contribute to the general welfare of society.
- Between these two opposing schools of thought lies the third vision – the business and society approach – founded on the notion of a contract between society and business, which are seen as interrelated entities. This approach is generally based on neo-institutional sociological theories (Di Maggio and Powell 1983). Firms cannot operate independent of the context in which they exist. They must ensure their legitimacy by sending positive signals showing compliance with the values of society.

In the field of environmental management, the different frameworks are mobilized, often not explicitly. Several contributions deal with competitive advantages garnered by environmental commitment. The role of the stakeholders is also discussed in many papers, sometimes from a moral standpoint and sometimes from a profit-seeking perspective, or even simply with regard to the relationship between the firm and other actors in society.

Other approaches are also adopted, including the entrepreneurship theory, founded on the characteristics of the entrepreneur, or the theory of social capital, which is similar to the business and society approach. From a psychological standpoint, the theory of planned action

(Fishbein and Ajzen 1975) attempts to explain the transition from a positive attitude toward a behavior to the intention of implementing this behavior. Finally, some approaches may deal with innovation.

Conclusion and Future Directions

Environmental management is the environmental dimension of CSR, the application of the concept of sustainable development to business. While the practices are now well developed in large firms, at least according to what they say, a discrepancy can still be observed in small firms between the attitudes of the owners/managers and their behavior. Many studies have been devoted to analyzing these practices as well as the incentives and barriers to implementing environmental practices in small firms. Nevertheless, there are still many areas to be explored. First, there is still no consistent theoretical framework for this analysis, as stakeholder theory does not appear to be suitable. Two lines of investigation could be developed: neo-institutional sociological theories and innovation theories. In particular, very few process-oriented approaches have been put forward, except for the commitment stage. Another aspect of this process needs to be explored: the use of adequate tools to help SMEs to implement actions in the field of sustainable development.

Cross-References

▶ Entrepreneur
▶ Green Business and Entrepreneurship
▶ Small Business
▶ Social Responsibility

References

Aggeri F, Pezet E, Abrassart C, Acquier A. Organiser le développement durable. Paris: Vuibert; 2005.

Bowen HR. Social responsibilities of the businessman. New York: Harper & Row; 1953.

Brundtland GH. Our common future. Report of the World Commission on Environment and Development. United Nations; 1987.

Calogirou C, Sørensen SY, Larsen PB, Alexopoulou S, et al. SMEs and the environment in the European Union, PLANET SA and Danish Technological Institute. European Commission, DG Enterprise and Industry; 2010.

Capron M, Quairel-Lanoizelée F. La responsabilité sociale d'entreprise. Paris: La Découverte; 2007 (Repères no 477).

Commission of the European Communities (2002). Corporate social responsibility: a business contribution to sustainable development. COM(2002) 347 final, 24 p.

Di Maggio PJ, Powell WW. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. American Sociological Review. 1983;48:147–60.

Fishbein MA, Ajzen I. Belief, attitude, intention and behaviour: an introduction to theory and research. Reading: Addison Wesley; 1975.

Freeman RE. Strategic management: a stakeholder approach. Boston: Pitman; 1984.

Gendron C. Enjeux sociaux et représentations de l'entreprise. Revue du MAUSS. 2000;15:320–6.

Small Enterprise

▶ Small Business

Smaller Firms

▶ Microfirms

Smart Specialization Strategies

▶ Epidemiology of Innovation: Concepts and Constructs

SME

▶ Small Businesses and Sustainable Development

SME Growth and Influence of Internal and External Environmental Factors

Priya Dhamija Gupta[1], Samapti Guha[2] and K. S. Subramanian[2]
[1]Symbiosis Centre for Management and Human Resource Management, Pune, Maharashtra, India
[2]Tata Institute of Social Sciences, Mumbai, Maharashtra, India

Synonyms

Business environment; Enterprise life cycle; Small and medium enterprises

Introduction

Enterprise growth has been an area of study for many researchers. The study of literature on small and medium enterprises (SMEs) suggests that all SMEs go through different stages of growth also commonly called as life cycles. Though the terms used by different authors may vary, the events through which each enterprise passes remain more or less the same. Most of the researchers suggest that each enterprise has to start, then grow while facing various challenges and crises, and finally mature and decline. There are many factors which will contribute to an enterprise's success. There are many precursors also, which will allow an enterprise to move from one stage to another. History of the enterprise, entrepreneur's characteristics, different agencies like market and government, and geography are some of the factors influencing enterprise's growth. There are two sets of thoughts prevailing among researchers; some suggest that the growth path followed by the enterprise is linear or predictable, and others suggest that the growth is fairly opportunistic term or unpredictable. Growth-oriented firms are a significant contributor in nation's economic gain, but the concept of growth is different for different entrepreneurs. Growth can be defined in terms of revenue generation, value addition, and expansion in terms of volume of the business. It can also be measured in the form of qualitative features like market position, quality of product, and goodwill within the customers. While studying the growth of a firm, it is essential to understand the concept of "the firm" also. The understanding of the growth of an enterprise depends on the definition of what the firm is, how much it has grown, what it offers to the market, what assets it controls, and what its legal form is.

It is critical to study how an enterprise manages its growth transitions and what pattern they follow. Most widely used framework for studying growth of an enterprise has been the life cycle analysis. In life cycle models, an enterprise's growth is considered as organic, and these are assumed to grow over a period of time in a linear phase. However, there are many researches suggesting that it may not be the case with every enterprise. Many firms do not take the linear path because it is not possible for each of those to progress through each stage. They can grow, stagnate, and decline in any order and also these things can happen more than once and there is a possibility to reverse their steps.

Enterprise growth can be identified in four theoretical perspectives: the resource-based perspective, the motivation perspective, the strategic adaptation perspective, and the configuration perspective. Resource-based perspective focuses on its resources like expansion of business activities, financial resources, and educated staff. Resource-based theory holds that there are unlimited source of opportunities in the marketplace. It is essential to manage transition (i.e., the point at which the resources are being reconfigured) by deploying firms' resources for identifying and exploiting the next growth opportunity. Hence, to determine successive phases of growth and development, resources need to be reconfigured during the transitions between stages. To conclude there are limited studies on the growth path of SMEs. During the literature review, it has been observed that study on enterprise growth has still not covered many prominent sectors like handicraft and handloom, which constitutes large number of SMEs. This entry encompasses literature review on various theories of enterprise growth. It highlights that though there are many studies on the stages of enterprise development, there is a dearth of literature to find patterns of growth followed by the small and medium enterprises. Also there is lack of literature on effect of environmental factors in determining growth path. This entry suggests a need for a framework which can be empirically tested by researchers to study enterprise growth patterns under different conditions. This entry is organized as follows. Section "Entrepreneurship and Enterprise Growth" presents the state of work done in the area of small and medium enterprises, entrepreneurship, and enterprise growth based on the literature reviewed for this study. Section "Theoretical Frame Work to Study the Growth Path of Enterprises" introduces the conceptual framework. Next, section "Research Gaps", outlines the gaps identified in research so far.

Literature Review

Entrepreneurship and Enterprise Growth

Entrepreneurship is all about identification of an opportunity, creation of new organization, and pursuing new ventures (Carton et al. 1998). There are many studies done on entrepreneurship like external skills required in entrepreneurs, e.g., Schumpeter (1934) has stated that entrepreneurs need to be innovative, creative, and should be able to take risk. Wickham (2006) has also supported his views. Pajarinen et al. (2006) have said that entrepreneurs with higher academic background are more innovative and they will use modern techniques and models to do business. Barringer and Bluedorn (1999) have described entrepreneurs as individuals who can explore the environment, discover the opportunities, and exploit them after proper evaluation. Kuratko (2009), in his book, distinguishes between entrepreneurs and small-business owners. He highlights that these two terms are often used interchangeably, but both have a lot of differences in their reaction under certain situations. An entrepreneur aggressively focuses on innovation profit and growth of the enterprise. On the other hand, a small-business owner's objective and focus is mostly on managing stable growth, sales, and profits.

An entrepreneurial venture is successful if it is growing. Growth has various connotations. It can be defined in terms of revenue generation, value addition, and expansion in terms of volume of the business. It can also be measured in the form of qualitative features like market position, quality of product, and goodwill with in the customers (Kruger 2004).

As stated earlier, growth is a vital indicator of a flourishing enterprise. There are many factors like characteristics of the entrepreneur, access to resources like finance, and manpower which affect the growth of the enterprise and differentiate it from a nongrowing enterprise. Gilbert et al. (2006) suggested how and where questions are important in the context of the growth of the enterprise. It has been highlighted that growth is a function of the decisions an entrepreneur makes, like how to grow internally or externally and where to grow in domestic market or international market. There are many different theories to identify the main factors underlying the growth of the enterprise. One set of theories addressed the influence of enterprise size and age on growth (Evans 1987; Heshmati 2001; Morone and Testa 2008), and the second set deals with the influence of variables such as strategy, organization, and the characteristics of the enterprise's owners (Fazzari et al. 1988; Lumpkin and Dess 1996; Freel and Robson 2004) on growth of the enterprise. Mateev and Anastasov (2010) have found that enterprise's growth is related to size as well as other specific characteristics like financial structure and productivity. They further added that the total assets which are one of the measures of the enterprise size have a direct impact on the sales revenue, but the number of employees, investment in R&D, and other intangible assets has not much influence on the enterprises growth prospects. Lorunka et al. (2011) have found that the gender of the founder, the amount of capital required at the time of starting the business, and growth strategy of the enterprise are very important factors in predicting growth in a small enterprise.

They have further highlighted that apart from human capital resources, the growth of an enterprise can be predicted on the basis of commitment of the person starting a new enterprise.

SMEs, Innovation, and Economic Development

Small and medium enterprises (SMEs) are considered as the backbone of the economy. SMEs sector is well recognized worldwide due to its significant contribution in socioeconomic development. This sector has contributed significantly in higher growth of employment, output, promotion of exports, and fostering entrepreneurship. Many countries have given sufficient emphasis to micro, small, and medium enterprises and have identified them as a building block for their economic development. Market conditions have changed for SMEs after economic reforms; organizations are in constant pressure to perform well, deliver quality, and also keep their operational cost low. To sustain in today's market and meet customers' requirements, it has become important for organizations to differentiate themselves on the basis of capabilities and competencies. They need to compete on different dimensions such as design and development of products, manufacturing, cost, distribution, communication, and innovative ways of marketing. These challenges call for reorientation of SMEs so that the demand for high dynamism, flexibility, and innovativeness can be met. For economic development it is critical for SMEs to create, apply, and introduce innovation (Curran and Blackburn 1994). It has been found that in the previous century, 60 % of the innovations were in the SME sector but many of them were not successful due to lack of professionalism and inability to collaborate with other enterprises (Rothwell 1986; Noteboom 1991; e.g., Bougrain and Haudeville 2002).

There is no universal definition of SMEs. Countries have used various criterions for defining SMEs. Some countries use turnover of the company to determine the size of an enterprise, whereas some use fixed investment or the number of employees (Lokhande 2011), sales volume, and worth of assets (Raman 2001). In India, as per the Micro, Small, and Medium Enterprises Development Act, 2006, micro, small, and medium enterprises are classified in two classes: manufacturing enterprises and service enterprises. The enterprises engaged in the manufacturing or production of goods are defined in terms of investment in plant and machinery:

- A small scale industry is defined on the basis of limit of value of investment in plant and machinery, which is more than 25,00,000 rupees and does not exceed five crore rupees.
- A medium-scale industry is defined on the basis of the value of investment in plant and machinery, which is more than five crores rupees, but does not exceed ten crore rupees.

In India the focus is more on the investment amount, whereas most of the other countries define small and medium enterprises (SMEs) in terms of number of employees and turnover. According to the SME White Book 2009–2010, "In Malaysia, small enterprises have a turnover between rupees two lakhs fifty thousand to one million and medium enterprises have a turnover between one million and twenty five million. Also, the average employee strength for SMEs is fifty employees and one hundred fifty employees respectively. In Hong Kong, the definition of SME is given by the Government of Hong Kong Special Administrative Regions (HKSAR). According to the KHSAR, a manufacturing business that employs fewer than hundred persons...." Further, "In China, small enterprises are defined as those that employ fifty to hundred people and medium enterprises employ hundred one to one hundred fifty people. In the European Union (EU), a business with a headcount of fewer than two hundred fifty is classified as medium sized, a business with a headcount of fewer that fifty is classified as small. In United Kingdom (UK), a small enterprise as a unit has a turnover of £5.6 million, and employs around fifty people. A medium sized enterprise has a turnover of £22.8 million and has two hundred fifty employees. Canada defines a small business as one that has around fifty to hundred employees depending on service and manufacturing respectively. A firm that has around five hundred employees is classified as a medium sized business. In Japan, for the manufacturing sector, SMEs are those that employ less than three hundred people or have an invested capital of less than hundred million yen. In the United States of America, an SME means a unit consisting of one thousand five hundred employees and has a turnover of around $0.75 to 29 million, depending upon the type of business. In the US a government department called small-business administration (SBA) sets the definition of small businesses."

Significance of Growth in SMEs

SMEs are considered as a major source of employment generation also. It has the advantage of cheap labor and flexibility of operations along with indigenizing technology (Mitra and Pingali 1999). There are a large number of studies suggesting that small businesses play a major role in job creation (Smallbone and Wyer 2000). Though there are many arguments on the overall contribution of small businesses in the new employment, it is considered as important source for employment creation (Curran 2000; Davidsson and Delmar 1997; Gibb 2000; Hamilton and Dana 2003; Robbins et al. 2000; Tonge et al. 2000; Westhead and Birley 1995). Baumol (2004) suggests that small entrepreneurial organizations and entrepreneurs will always be considered important for growth of developing economies. Hence, it is critical to pay attention on the overall growth of this sector. There are different views on the growth of SMEs. The existing body of knowledge covers different factors influencing the growth of small firms. Some of the work is being discussed in this section to highlight different views on SMEs and growth.

Chaston and Mangles (1997) suggest that if an enterprise adopts multi-strategy transformation initiatives, the probability of achieving growth objective increases. They further point that in planning a performance improvement program, different capabilities must be given priority depending upon the development stage of the firm. Kolvereid and Bullvag (1996), in their study, found that almost 40 % of the respondents do not want to grow. Further they found that there is significant relation between education, industry, past growth turnover, past growth in employees, and entrepreneur's aspiration to grow. Aspirations are also significantly related to many factors like experience, sex, location, and size of the firm. They concluded that entrepreneurs who want their firm to grow will have higher level of education and will tend to have manufacturing firms rather than service firms. Government has included many promotional policies for the promotion of this sector like product reservation, infrastructure support, directed and concessional credit, tax concession, special assessment in procurement of equipment, facility of duty drawback, quality control, and providing market network. Small-scale companies provide support to large-scale companies by supplying goods and services in small quantities, which in turn help them to achieve competitive advantage (Majumdar 2007). Muthiah and Venkatesh (2012) suggest that many factors contribute in the SME growth; similarly there are many barriers to growth. For small businesses, barriers can be of two types: institutional and financial. An institutional barrier includes enterprise's interaction with government, issues related to legalization, taxation, and government support. Financial barriers will involve lack of financial resources (Davidsson 1989). Further the author notices that SMEs can also face external and internal barriers along with social barriers which would cover aspects of market position of an enterprise, access to right kind of human resources, and access to network (Bartlett and Bukvic 2001). Studies have shown that there are many other factors that contribute to failure of a small firm/business; small businesses are dependent on the owner's insight, managerial skills, training, education, and the background of company's leader. Often lack of these characteristics is the cause of small-business failure (Gaskill et al. 1993).

Theoretical FrameWork to Study the Growth Path of Enterprises

To study the growth path of the enterprises, several scholars have suggested different theoretical framework. In this section, a brief review on the framework for studying the growth path of the enterprises is provided.

SME Growth and Influence of Internal and External Environmental Factors, Fig. 1 Pictorial representation of phases and crises of growth (Masurel and Montfort 2006)

SME Growth and Influence of Internal and External Environmental Factors, Fig. 2 Pictorial representation of stages of enterprise growth (Churchill and Lewis 1983)

Penrose (1959) has suggested that enterprises are a bundle of internal and external resources, which helps an enterprise to achieve competitive advantage. She further adds that in the long run, there can be a limit to the growth of an enterprise, but not to the size. Growth of an enterprise is determined by the rate at which experienced managerial staff can plan and implement this plan. She has further explained that the external environment of an enterprise is an image in the mind of the entrepreneur. Enterprise activities are governed by their productive opportunities which are actually a dynamic interaction between the internal and the external environment. This interaction includes all the productive possibilities that the entrepreneur can see and take advantage of. The author also mentioned that growth often has a connotation of natural and normal – a process that will occur whenever conditions are favorable. Size of the enterprise is incidental to the growth process and "an enterprise is a coherent administrative unit that provides administration coordination and authoritative communication" (Penrose 1959: Xi, 20). She has proposed that the growth of the enterprise is limited by the scope of managerial resources, specially the ability to coordinate capabilities and introduce new people into the enterprise.

Greiner (1972) has done the foundational work on the theory of enterprise development. Based on his theoretical review of growing enterprises, he has concluded that enterprises move through five distinguishable stages of growth. Each phase contains a relatively calm period of growth that ends with a management crisis (see Masurel and Montfort 2006). These five phases and crises of the growth are through creativity, direction, delegation, coordination, and collaboration (Fig. 1).

He suggests that an enterprise goes through evolution and revolution crises. These crises can be solved by introducing new structures and programs that will help employees to revitalize them. Greiner's phenomena of evolution and revolution became the base for many studies on enterprise life cycle. Another significant contributor in this field is Adizes (1979), who argues that the attitude and style of a manager has a lot of influence on the life and effectiveness of an enterprise (see Masurel and Montfort 2006). Adizes has also pointed out that reinforcement skills, self-commitment, risk-taking capacity, vision, and administrative mastery are required in the first few stages of an enterprise development. Once an enterprise reaches its prime stage, the manager needs to be result oriented and should show proper planning and coordination skills. At the maturity stage, enterprise should be backed by systems to achieve the target.

Applying the findings of Greiner to the small entrepreneurial business situation, Churchill and Lewis (1983) have developed a model. As defined by them, an enterprise can have five stages of growth depicted below (Fig. 2).

Existence is the first of the entrepreneurial venture. In this stage the enterprise struggles to establish its processes and works without a formal structure in place. The owner of the enterprise takes close supervision of each and every business activity.

At the second stage, which is survival, the business grows and the entrepreneur feels the need to have additional capital to expand the business. Since the business activity is growing, he/she prefers to add family members or known people as partners to expand the business. The main aim of the enterprise is to reach the break-even point, so that adequate cash flow can be maintained to meet day-to-day requirements of repair and replacements.

At the third stage of success, the enterprise begins to earn profits. They have enough capital to either invest in further business opportunity or continue with the same pace of growth. At this stage enterprise may take up team building and people development as one of their focus areas; however, these initiatives are driven by personal values and vision of the entrepreneur.

At the takeoff stage, focus is on further growth and expansion, seeking new opportunities. The organization becomes more formal in nature, and work is properly defined and delegated. Finally at the resource maturity stage, the enterprise is no more called a small enterprise. Company gives more emphasis on quality control, financial control, and creating a niche in the market.

Bridge et al. (2003) suggest that it is not necessary that an enterprise develops in discrete phases with clear boundaries between them. They further highlighted that "separating the development process into stages is rather like dividing the spectrum of visible light into colors." The authors argue that while broad stages of development of an enterprise can be indicted, it is very difficult to say when the business moves from one stage to another. Enterprises do not necessarily follow the linear models. It is not possible for an enterprise to progress through each stage. They can grow, stagnate, and decline in any order and also these things can happen more than once and there is a possibility to reverse their steps. Authors suggest that growth of an organization is a result of many discrete efforts. As also suggested by Blundel and Hingley (2001), growth may be achieved quickly, slowly, or not at all. It depends on the strength of the growth aspirations and growth-enabling factors of an enterprise. Hence, it is not possible to consider growth as a norm or an even progression of an enterprise.

Levie and Lichtenstein (2010) have suggested that the stage model and life cycle theories of entrepreneurial growth do not provide ample evidences of the enterprise growth and development. In their review of literature of the last 40 years, they have found that there is no agreement on defining the stages of enterprise growth. Further they have pointed out that previous researches lack proper evidences on what is the path of progress from one stage to another and the reasons behind the shift. They have suggested a new dynamic stage theory which argues that organizations are not like organisms and their growth can be co-created with the help of shifting of internal as well as external environment. Dynamic states offer that an enterprise can survive and maintain itself by being flexible and by adopting continuous changes in the environment. The author highlights the need to have a sustainable growth approach instead of growing on the basis of number of stages. Though the authors strongly recommend the use of dynamic stage theory, they conclude that an empirical research is required to find out what makes a dynamic state sustainable and when and where dynamic states change, also which contextual variables are important for the processes. Leitch et al. (2010) also suggest that there is need to understand the growth phenomenon and its importance to conceptualize the phenomenon properly. There is a lack of shared understanding on the causes, effects, and the process of growth. In the above paragraph, it was mentioned that growth is a social construct (Majumdar 2008); hence, there is lot of diversity in it. The heterogeneity of the enterprise, entrepreneur's context, adds further challenges to the study and understanding of growth. Leitch et al. (2010) also observe that three questions related to growth have been addressed at least to some extent: why, how, and how much. They further suggest that there is still lot of scope of exploration on growth as "internal process of development" (Penrose 1959).

SME Growth and Influence of Internal and External Environmental Factors, Fig. 3 Pictorial representation of chasms of growth by Chaston 2010

Chaston (2010), in their book, has suggested that under the life cycle concept of an enterprise, a new chasm has to be crossed before the next stage of growth can be commenced. Chasms are of five types: launch capacity, expansion, organizational formalization, succession, and long-term growth (Fig. 3).

Crossing each chasm will require the entrepreneur to acquire new skills and also prioritize managerial task inside the organization. The author further suggests that some of the entrepreneurs may take more time to move from one chasm to another, while for some it may be a fast progression. Financial backing, nonviable means to new technology may be the reasons for not able to cross Chasm 1 (Dunn and Cheatham 1993). To be able to cross Chasm 2, the entrepreneur should be able to generate demand and increase sales. For crossing Chasm 3, there is a need for capacity expansion. One needs to match the demand with appropriate supply. Failure to implement a formal organization structure, with professional manpower will pose challenges to cross Chasm 4 (Anon 1984). A well-established business will require a competent successor. The entrepreneur may decide to appoint an internal person or can bring new chief executive from outside of the company. An ineffective replacement for the founder may cause the business to fail to cross Chasm 5 (Ip and Jacobs 2006)

To summarize there are two theoretical frameworks of enterprise growth.

The predictable framework defines that the growth path can be linear, sequential, deterministic, and invariant (Churchill and Lewis 1983; Greiner 1972; Adizes 1979; Kimberly 1979; Hanks et.al 1993). There are different thoughts on defining the growth path of an enterprise in a predictable way starting from existence, survival, success, and takeoff and culminating with maturity then reinvention or death (Churchill and Lewis 1983; Casson 1982). The enterprise competitiveness continuously increases from the start-up stage to mature stage. At the decline stage, the competitiveness of the enterprise weakens and signals that in case the enterprise does not upgrade itself, it will fall. Chen et al. (2008) suggest that the enterprise at different life cycle stages should focus on strengthening capabilities.

The other school of thoughts suggests that there can be abrupt changes in the growth path especially in small enterprises. Recent researches have shown that due to unpredictable intervening factors like knowledge and technology, absorption capabilities, the appropriateness of founder's judgment, and competitive environment, the sequences of stages may be heterogeneous in small enterprises. Phelps et al. (2007), Aislabie (1992), Levie and Hay (1998), Rutherford et al. (2003), Stubbart and Smalley (1999), have argued that the life cycle models and the deterministic approach to growth are not relevant to all organizations. The authors point out that describing an enterprise growth through a series of stages is equivalent to assuming an organization growth as organism metaphor. Majumdar (2008) has suggested that enterprise growth depends upon entrepreneurial vision and standpoint. He has further suggested that entrepreneurship is not only maintaining a status quo but it is very critical that enterprise grows.

Enterprise growth depends on the vision and motivation of entrepreneur. The growth parameters vary from one entrepreneur to another.

The environment in which the enterprise is operating, such as social setting, formal and informal structure of organization, country of origin and its culture, and family, has different implications on the enterprise growth. Summaries of models have been done by Quinn and Cameron (1983), Phelps et al. (2007), and Levie and Lichtenstein (2010). This provides the evidences on the common propositions about organization growth, but there is a lack of integration among these studies and one cannot draw any conclusion out of it.

Business environment can perceive through four theoretical frameworks (see Davidsson and Wiklund 2000). When the focus of the enterprise is on its resources like expansion of business activities, financial resources, and educated staff, the growth is to be studied from the resource-based perspective. Growth studies applying strategic adaptation as a perspective would focus more on power distribution, structural complexities, and control mechanisms. The third theoretical perspective of an enterprise growth will be motivation perspective which focuses on the individual and their actions. Lastly, configuration perspective deals with the growth process focusing on managerial problems and how it can be dealt with, at various stages of growth. The scope of this study will cover the first perspective of enterprise growth, i.e., resources based.

Research Gaps

Literature review suggests that entrepreneurial growth has been an area of interest for policy makers, practitioners, and researchers. Many aspects of enterprise growth have been studied in the last 50 years, but there are very few studies conducted on the growth path followed by SMEs in different context. Majority of literature emphasizes growth of an enterprise through a predetermined path (Greiner 1972; Adizes 1979; Kimberly 1979; Churchill and Lewis 1983; Hanks et al. 1993). However, in the last couple of decades, there are some researches suggesting that sequence of stages of growth can be heterogeneous (Aislabie 1992; Levie and Hay 1998; Rutherford et al. 2003; Stubbart and Smalley 1999; Phelps et al. 2007) due to intervening external and internal factors. The availability of literature on alternative growth path like Jumps (Aislabie 1992), skipping stages (Masurel and Montfort 2006), and other developmental paths taken by SME's are not profound.

Growth process of an enterprise may vary from country to country, though there are many studies on the stage of an enterprise growth. The study on growth pattern of an enterprise influenced by the internal and external environmental factors is limited. There is a need to develop a conceptual framework to study the growth of SMEs as influenced by the various environmental factors.

Suggested Framework

Ardishvili et al. (1998) classified empirical growth research as either factors of growth studies or growth process studies. Environmental factors effecting the growth of enterprise can broadly be classified into two categories, i.e., internal and external factors ("Business Environment," 2001). Environment is defined as an "aggregate of all conditions events and influences that surround and affect it." It can be divided into external and internal components for better understanding:

- The internal factors are those which are controllable and comprise of the enterprises personnel, its strategy, and its functional, operational, marketing, financial, and technical capabilities.
- The external factors are beyond the control of the enterprise and comprise of economic, sociocultural, regulatory and legal, political, financial, trade, technological, demographics, geophysical factors, etc.

In order to choose an appropriate unit of analysis, the factors (internal and external) connected with growth of an enterprise ("Business Environment") are briefly given below:

External Factors

All the factors that provide opportunities or threats to an organization make up the external environment of the organization. In a broader sense, it encompasses a variety of factors discussed below.

Demographic environment includes factors like size, growth rate, age composition, and sex compositions of the population. The heterogeneity of demographics in terms of varied tastes, preferences, beliefs, temperaments, etc., affects the demand patterns of populations, and the enterprises need to make different strategies accordingly. Social environment factors include human relationships and its effects on the society and hence growth of an organization. Cultural environment and its understanding are important to understand the business environment in its totality. Understanding a particular culture and its proper analysis provides opportunities for establishing and running a business. The term political environment refers to factors related to management of public affairs and their impact on the growth of an organization. Economic environment encompasses economic planning like five-year plans, budgets, and monetary, fiscal, and industrial policies. Thus, economic system is a very important determinant of the scope of enterprises and therefore a very important external factor influencing business growth.

Business enterprises are closely associated with financial environment. To reduce the uncertainty arising out of the dynamic nature of financial environment, it is important to understand the pulse of money market and capital market. In pursuance of the broad objective, World Trade Organization (WTO) has been established and under its preview, General Agreement on Trade in Services (GATS). The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs) and the Agreement on Trade-Related Investment Measures (TRIMs) have been brought. This has made trade environment one of the deciding factors affecting the future of a business. The technological environment has a huge impact on the growth of a business. It comprises factors related to applied knowledge and the materials and machines used in the production of goods and services. Enterprises are corporate entities and have to abide by the law of the land; every country has its own system of law. Each country has its different legal systems with varied complexity and dimension. Hence, it is essential that an enterprise operating in global environment understands and copes with the global laws. The regulatory factors comprise the factors related to the planning, promotion, and regulation, by the government. Some of the factors which influence the regulatory environment include the constitutional framework, directive principles of state policy, fundamental rights, and division of legislative power between central and state governments. It also includes policies related to import/export, distribution, pricing, public sector, small-scale industries, and sick industries development. Other external factors effecting business environment would include tax environment and ethical environment.

Internal Factors

The internal environment comprises of resources, synergy, and distinctive competencies of a firm. All these together determine organizational capability in terms of its strengths and weaknesses existing in different functional areas: marketing, operations, personnel, financial, technical, etc. Business managers need to monitor the business opportunities and threats that have or likely to have an impact on their organization. However, the internal environment is constantly influenced by the external environment.

Strategy of an organization indicates the course of action to achieve the set objectives. This involves an analysis of the organizational factors (internal and external) with the environmental factors (opportunities and threats). Organization structure of an enterprise is affected by a number of factors like size of the business, the nature of the business, the diversity of the business, the characteristics of the market, the characteristics of the strategy, and the future plans of the organizations. A flexible organization structure enables the organization to quickly and effectively respond to the changes in the market. Marketing capability factors are those related to the pricing, promotion, and distribution of products or services. Operation capability factors are those that are directly related to productions. It involves factors like capacity, location, layout, product or service design, degree of automation, and extent of vertical integration. Personnel capability is one of the most important factors influencing business environment. These factors are related to the existence and use of human resources and skills in the enterprise. It has significant bearing on the capacity and ability of an organization to implement its strategy. Personnel capability would involve factors related to acquiring, maintaining, developing, and training people. It will also take care of factors related to industrial relations and organizational and employees' characteristics such as corporate image and working conditions. Financial capability factors include all those factors which are related to the availability, usage, and management of funds. To keep pace with the changing business scenario, organizations are giving a lot of importance to its technical capabilities. It is important to improve productivity and quality in this fierce competitive era. This objective can be met through continuous improvement in the work structure, procedure, and technologies. Technical people of an enterprise may bring this competitive advantage.

Conclusion and Future Direction of Research

It is important to understand the growth path of an enterprise. Study of growth prepares the owners/ manger to take strategic decisions and lay out expansion plans. The above-mentioned literature review suggests that there are many studies on identifying stage of an enterprise growth, but there is a dearth of data on how these enterprises grow and what the influencing factors are. In each geography the characteristics of enterprises differ. They are unique and operate in unique social economic conditions. There is a need to study how the internal and external environmental factor affects the growth path followed by the enterprises. Under specific conditions subset of the factors can also be taken for more intensive study. Further scope of the study could be in how growth of the SMEs can be integrated with sustainable development and innovation. There have been recent studies on how innovation can stimulate sustainable development, but there is no significant work done covering SMEs. There should be empirical research on how internal and external factors contribute in sustainable innovativeness in SMEs. In the same regard, as pointed by Carayannis et al. (2012), innovation can be described by "quintuple helix model" which has five helixes, i.e., the education system, economic system, natural environment, and media-based and culture-based public and the political system; all these helixes have critical role to play in determining enterprise growth path as well. However, future researchers can study how these helixes individually as well as collectively can facilitate or impede growth of enterprises.

Cross-References

▶ Entrepreneurship and Business Growth
▶ Entrepreneurship and Small Business Agility
▶ Entrepreneurship in Creative Economy
▶ Entrepreneurship in Developing Countries

References

Adizes I. Organizational passages diagnosing and treating lifecycle problems of organizations. Organ Dyn. 1979;(Summer):3–25.

Aislabie C. Sudden changes in a model of small firm growth. Small Bus Econ. 1992;4(4):307–14.

Anon. Problems tracked in transition from owner to professional management. J Accountancy. 1984;158(4):38–41.

Ardishvili A, Cardozo S, Harmon S, Vadakath S. Towards a theory of new venture growth. Paper presented at the 1998 Babson Entrepreneurship Research Conference, Ghent, Belgium; 1998.

Barringer BR, Bluedorn AC. The relationship between corporate entrepreneurship and strategic management. Strat Manag J. 1999;20(5):421–44.

Bartlett W, Bukvic V. Barriers to SME growth in Slovenia. MOCT-MOST: Econ Pol Transitional Economies. 2001;11:177–95.

Baumol WJ. Entrepreneurial enterprises, large established firms and other components of the free–market growth machine. Small Business Econ. 2004;23(1):9–21.

Blundel RK, Hingley M. Exploring growth in vertical inter-firm relationships: small-medium firms supplying multiple food retailers. J Small Bus Enterprise Dev. 2001;8(3):245–65.

Bougrain F, Haudeville B. Innovation, collaboration and SMEs internal research capacities. Res Pol. 2002;31: 735–47.
Bridge S, O'Neill K, Martin F. Understanding enterprises, entrepreneurship and small business. New York: Palgrave Macmillian; 2003, p. 179–227.
Business environment and introduction in business environment, the ICFAI Centre for Management Research; 2001. p. 3–20.
Carayannis EG, Barth TD, Campbell DFJ. The Quintuple Helix innovation model: global warming as a challenge and driver for innovation. J Innov Entrepreneurship. 2012;1:2.
Carton RB, Hofer CW, Meeks MD. The entrepreneur and entrepreneurship: operational definitions of their role in society. Paper presented at the annual International Council for Small Business conference, Singapore, 1998. Retrieved 23 Oct 2005 from http://www.sbaer.uca.edu/research/icsb/1998/pdf/32.pdf
Casson M. The entrepreneur: an economic theory. Oxford: Martin Robertson; 1982.
Chaston I, Entrepreneurial management in small firms. London: Sage; 2010, p. 53–72.
Chaston I, Mangles T. Core capabilities as predictors of growth potential in small manufacturing firms. J Small Bus Manage. 1997;35(1):47–57.
Chen M, Cao Y, Ma Y. An empirical research on the evolution model of competitiveness between different life cycle stages in Chinese enterprises. J Syst Sci Info. 2008;6(4):351–70.
Churchill NC, Lewis VL. The five stages of small business growth. Harv Bus Rev. 1983;61(3):30–50.
Curran J. What is small business policy in the UK for? Evaluation assessing small business policies. Int Small Bus J. 2000;18(3):36–51.
Curran J, Blackburn RA. Small firms and local economic networks: the death of the local economy. London: Paul Chapman Publishing; 1994.
Davidsson P, Delmar F. High-growth firms: characteristics, job contribution and method observations. Paper presented at the RENT XI conference, Mannhiem, November; 1997
Davidsson P. Entrepreneurship – and after? A study of growth willingness in small firms. J Bus Ventur. 1989;4:211–26.
Davidsson P, Wiklund J. Conceptual and empirical challenges in the study of firm growth. In: Sexton D, Landström H, editors. The Blackwell handbook of entrepreneurship. Oxford, MA: Blackwell Business; 2000. p. 26–44.
Development Commissioner, Ministry of MSME (MSMED Act 2006). http://www.msme.gov.in/Annual%20Report Msme2011-12_Eng.pdf. Accessed 17 Aug 2012.
Dunn P, Cheatham L. Fundamentals of small business financial management for startup, survival, growth and changing economic circumstances. Manag Finance. 1993;19(8):1–14. http://planningcommission.nic.in/plans/planrel/fiveyr/welcome.html. Viewed on 21 Aug 2012.
Evans DS. The relationship between firm growth, size and age: estimates for 100 manufacturing industries. J Ind Econ. 1987;35(4):567–81.
Fazzari SM, Hubbard RG, Petersen BC. Financing constraints and corporate investment. Brookings Pap Econ Act. 1988;1:141–95.
Freel MS, Robson PJA. Small firm innovation, growth and performance. Int Small Bus J. 2004;22(6):561–75.
Gaskill LR, Van Auken HE, Manning RA. A factor analytic study of the perceived causes of small business failure. J Small Bus Manag. 1993;31(4):18–31.
Gibb AA. SME policy, academic research and the growth of ignorance, mythical concepts, myths, assumptions, rituals and confusions. Int Small Bus J. 2000;18(3):13–36.
Gilbert BA, McDougall PP, Audretsch DB. New venture growth: a review and extension. J Manage. 2006;32:926.
Greiner L. Evolution and revolution as organizations grow. Harv Bus Rev 472. J Small Busi Manag. 1972;(July–August):37–46.
Hamilton RT, Dana LP. An increasing role for small business in New Zealand. J Small Bus Manag. 2003;41(4):402–8.
Hanks S, Watson C, Jansen E, Chandler G. Tightening the life-cycle construct: a taxonomic study of growth stage configurations in high-technology organizations. Entrepreneurship Theory Pract. 1993;18:5–29.
Heshmati A. On the growth of micro and small firms: evidence from Sweden. Small Bus Econ. 2001;17(3):213–28.
Ip B, Jacobs G. Business succession planning: a review of the evidence. J Small Bus Enterprise Dev. 2006;13(3):326–38.
Kimberly JR. Issues in the creation of organizations: initiation, innovation, and institutionalization. Acad Manag J. 1979;22:437–57.
Kolvereid L, Bullvag E. Growth intentions and actual growth: the impact of entrepreneurial choice. J Enterpris Cult. 1996;4(01):1–17.
Kruger ME. Entrepreneurial theory and creativity (chapter 2); 2004. Retrieved from http://upetd.up.ac.za/thesis/available/etd-08242004-145802/unrestricted/02chapter2.pdf. Accessed 23 Aug 2012.
Kuratko DF. Entrepreneurship, theory, process and practice. Mason: South Western Publication, 8e; 2009. p. 1–22.
Leitch C, Hill F, Neergaard H. Entrepreneurial and business growth and the quest for a 'comprehensive theory': tilting at windmills? Entrepreneurship Theory Pract. 2010;34(2):249–60.
Levie J, Hay M. Progress or just proliferation? A historical review of stages models of early corporate growth. London Business School working paper, FEM 98.5; 1998.
Levie J, Lichtenstein B. A terminal assessment of stages theory: introducing a dynamic states approach to entrepreneurship. Entrepreneurship Theory Pract. 2010;34(2):317–50.
Lokhande M. Financial inclusion: options for micro, small and medium enterprises. Synergy. 2011;IX(II):39–50.

Lorunka C, Kessler A, Frank H, Lueger M. Conditions for growth in one-person startups: a longitudinal study spanning eight years. Psicothema. 2011;23(3):446–52.
Lumpkin GT, Dess GG. Clarifying the entrepreneurial orientation construct and linking it to performance. Acad Manag Rev. 1996;21(1):135–72.
Majumdar S. Developmental aspects of entrepreneurship. Bhargava S, editor. New Delhi: Sage; 2007. p. 112–157.
Majumdar S. Modeling growth strategy in small entrepreneurial business organizations. J Entrepreneurship. 2008;17:157.
Masurel E, Montfort KV. Life cycle characteristics of small professional service firms. J Small Bus Manag. 2006;44(3):461–73.
Mateev M, Anastasov Y. Determinants of small and medium sized fast growing enterprises in central and eastern Europe: a panel data analysis. Financial Theory Pract. 2010;34(3):269–95.
MSME. (2010–11). Ministry of Micro, Small and Medium Enterprises, Government of India, Annual Report 2010–11, Chapter II. http://www.msme.gov.in/MSME-Annual-Report-2010-11-English.pdf. Accessed 28 Dec 2012.
MSME. (2011–12). Ministry of Micro, Small and Medium Enterprises, Government of India, Annual Report 2011-12, Chapter II. http://www.msme.gov.in/MSME-Annual-Report-2011-12-English.pdf. Accessed 28 Dec 2012.
Mitra R, Pingali V. Analysis of growth stages in small firms: a case study of automobile ancillaries in India. J Small Bus Manag. 1999;37(3):62–76.
Morone P, Testa G. Firms' growth, size and innovation – an investigation into the Italian manufacturing sector. Econ Innov New Technol. 2008;17(4):311–29.
Muthaih K, Venkatesh S. A study on the barriers affecting the growth of small and medium enterprises in India. Int J Res Comput Appl Manag. 2012;02(1):77–81.
Noteboom B. Strengths and weaknesses of small businesses in innovation and diffusion. Paper presented at TIMS/SOBRAPO conference, Rio de Janeiro, July, 1991.
Pajarinen M, Rouvinen P, Ylä-Anttila P. Uusyrittä jien kasvuhakuisuus, KTM julkaisuja 29/2006, Ministry of Employment and the Economy, Helsinki, 2006.
Penrose ET. A theory of the growth of the firm. Oxford: Oxford University Press; 1959. p. ix–xlix.
Penrose ET. A theory of the growth of the firm. Oxford: Oxford University Press; 1959, p. 1–57.
Phelps R, Admas R, Bessant J. Life cycle of growing organizations: a review with implications for knowledge and learning. Int J Manag Rev. 2007;9(1):1–30.
Quinn R, Cameron K. Organizational life cycles and shifting criteria of effectiveness: some preliminary evidence. Manag Sci. 1983;29(1):33–51.
Rahman S. A comparative study of TQM practice and organizational performance of SMEs with and without ISO 9000 certification. Int J Qual Reliab Manag. 2001;18(1):35–49.
Robbins DK, Pantuosco LJ, Parker DF, Fuller BK. An empirical assessment of the contribution of small business employment to US state economic performance. Small Bus Econ. 2000;15(4):293–302.
Rothwell R. The role of small firms in technological innovation. In: Curran J, editor. The survival of the small firm. Aldershot: Gower; 1986.
Rutherford MW, Buller PF, Mcmullen PR. Human resource management problems over the life-cycle of small to medium-sized firms. Hum Res Manag. 2003;42:321–35.
Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard University Press; 1934.
Sexton DL, Landstrom H, editors. The Blackwell handbook of entrepreneurship. Oxford: Blackwell Publishing; 2000, p. 1–44.
Smallbone D, Wyer P. Growth and development in the small firm. In: Carter S, James-Evans D, editors. Enterprise and small business. Harlow: Prentice Hall; 2000.
Stubbart CI, Smalley RD. The deceptive allure of stage models of strategic processes. J Manag Inquiry. 1999;8:273–87.
The SME White Book 2009–2010. Essential handbook for small and medium enterprise. Business World, p. 29–48.
Tonge R, Larsen P, Roberts M. Information systems investment within high-growth medium-sized enterprises. Manag Decis. 2000;38(7):489–502.
Westhead P, Birley S. Employment growth in new independent owner-managed Great Britain. Int Small Bus J. 1995;13(3):1–29.
Wickham P. Strategic entrepreneurship. 4th ed. London: Financial Times Prentice-Hall; 2006.

Social Capital

▶ Creativity: Cultural Capital in Mathematics
▶ Social Networks and Entrepreneurship

Social Capital of the Entrepreneur

Sophie Boutillier
Research Unit on Industry and Innovation/CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Decision; Entrepreneur; Rationality; Social networks

Introduction

The main characteristic of the concept of social capital is its wide theoretical origin. Marxist, neoclassical, and Keynesian sociologists (and economists) have all shown interest in this subject. The idea of social capital was developed at the beginning of the 1980s by the French sociologist P. Bourdieu. But, the story of this concept is longer. At the end of the 1980s, two American sociologists, R. Putman and J. Coleman, developed this concept in two different ways. For Putman, social capital is the key to democracy, a link between people and government. The analysis of Coleman is microeconomic; social capital is a resource for the individual, a resource for action. The concept of "embeddedness" of Granovetter exists in this context, to explain the social process for making decisions within an economic structure based on market mechanisms. To summarize, social capital is a (relatively) new concept to explain a commonplace sociological phenomenon.

This concept (with a wide range of definitions) has very quickly become one of the most important socioeconomic concepts. Today, for sociologists and economists, social capital has become a kind of magic formula to explain complex social phenomena. Social capital can be defined easily as a set of social networks, but many questions can be formulated. How can the process of decision-making be explained? What is the nature of social links between individuals? How can social cohesion be explained? The questions are numerous, but the concept of social capital can provide an answer to explain these phenomena, when definitions of social capital are so numerous. For example, what is a social network? Who owns social capital? What is the level of the analysis? At the individual level? Of a community? Of a country?

So economists cannot analyze the concept of social capital without studying the historical context of this arrival. The beginning of the 1980s was characterized by the neoliberal revolution. The market and the individual initiatives were considered as the engine of a new economic dynamic. The welfare state (for education, health, social security, and so on) began to assume less importance in the lives of many people. In an economic context where unemployment is increasing very quickly, individuals look for a solution, not thanks to public aids but in their own capacity, increasing their social capital.

The objective of this entry is not to present all the theories of social capital. For the demonstration, only four authors are selected: Bourdieu, Coleman, Putman, and Granovetter. These authors are considered as the four key authors of this concept. The objective is to analyze the origins and the historical context to the genesis of the social capital concept. Subsequently, this text presents some of the usual analyses of social capital, as promulgated by these four well-known sociologists. This concept appears as an answer for understanding the process of decision-making and as social means to improve social life in a society which has to face new challenges, for example, the creation of innovative enterprises.

Social Capital, Origin and Historical Context

Origins of Social Capital

The process of decision-making in neoclassical theory is based on the concept of economic rationality. In the marginalist context of competition, individuals take decisions in an environment of uncertainty. They know prices and quantities, like the other individuals in the market. Individuals have to maximize their utility (or their profit) according to their own resources (e.g., their income). In the Walras' model, there is no uncertainty, no risk (so the entrepreneur does not exist). After the Second World War, H. Simon built the concept of limited rationality. This means that individuals take decisions is a context of uncertainty. Each individual has his (or her) information and resources, because they function in a given societal context. This aspect of the analysis was presented in the Menger's model, according to which individuals operate in a context of uncertainty.

During the 1960s, G. Beker developed the concept of human capital. But human capital was not invented by Becker. Adam Smith in 1776 developed the first definition of human capital in his analysis of the division of labor (manufacturing of pings). He considered that the simplification of tasks can stop the increase of labor productivity. So, for Smith, there was a complex relationship between the division of labor and human capital.

Usually, human capital is a stock of competencies, knowledge, and personality embodied in the ability to perform labor so as to produce economic value. It is the sum total of the attributes gained by a worker though education and experience. It is similar to the "physical means of production," that is, one can invest one's human capital (education, training, medical treatment) to find a good (or a better) job. So investment in human capital (like physical capital) is a way to improve someone's capacity for labor. So, in a general sense, capital (physical or human) can produce greater value than it costs. Capital is a means to create new values in economic theory. Human capital, as a factor of production, is substitutable. Can economists develop the same analysis for social capital? Is social capital a factor of production? And what kind of value can social capital produce? Why have sociologists built the concept of social capital? But then, on the other hand, it is necessary to underline that for Coleman, for example, there is a strong link between social and human capital. The individual builds his human capital in a defined social place (family, education, experience, and so on).

Historical Context

The development of the concept of social capital takes place in a particular historical context. This new context is characterized by the emergence of the entrepreneurial society (according to D. B. Audretsch), in which the entrepreneur takes a new role and a new place. The entrepreneur has to innovate and to create jobs. He has to take initiatives in a competitive environment contrary to the salaried society where places and economic roles are more stable.

So for this reason, the concept of social capital is important to analyze entrepreneurial behavior. And, at the end of this entry, there is a presentation of the concept of the resource potential of the entrepreneur which is a synthesis of different elements of these four analyses. The objective is to develop a dialectical analysis between methodological individualism and the global analysis of social mechanisms.

The beginning of the 1980s was characterized by important economic and social changes in developed countries: decline of economic growth, increase of unemployment, development of entrepreneurship, and market regulations. So, the Keynesian regulation of the 1950s–1970s was replaced by liberal regulation. Governments were looking to promote entrepreneurship so as to create new jobs and technological and social innovations. The objective was to promote a new market and social regulatory system that could be measured. The World Bank program, "Doing Business," defined 10 topics (e.g., starting a business) to comparing the business regulatory environment across economies and over time and competing toward more efficient regulation.

Bourdieu, Putman, Coleman, and Granovetter, or Four Key Definitions of Social Capital

The Concept of Capital in Social Sciences: A Resource or an Economic Organization

During the 1980s, sociologists took an interest in the economic process of decision-making and tried to improve their own understanding of social mechanisms. They built the concept of social capital to try and understand this phenomenon. But, the word "capital," which is common in economics, is not neutral. "Capital" in economic theories has different definitions, even if, in a general sense, capital is only a factor of production. Capital is an ancient economic concept. In classical theory, capital is a factor of production, both with labor and land. In Marxist analysis, Capital (with a "capital C") is not only a means of production; capital is also a social form of economic organization. Capital is the essence of capitalism. Capital in Marx's theory is also "dead labor" (or "passed labor"), because capital (as an engine or a factory and so on) is the result of the process of labor. Sociologists use the concept of capital in different ways, but whatever their definition, they analyze capital as a source of value.

Bourdieu, Social Capital, Economic Capital, Cultural Capital, and Symbolic Capital

The French sociologist P. Bourdieu built the concept of social capital to improve not the neoclassical model but the Marxist theory of social classes. The ambition of Bourdieu was to develop a new social theory to understand the social mechanism of reproduction of inequalities between individuals and classes. Bourdieu defined social capital as a network of social relations belonging to individuals. It takes its place in his analysis along with other, different kinds of capital: economic, cultural, and symbolic. The economic capital is the stock of income and patrimony of the individual. The cultural capital is composed of three kinds of resources: incorporated (by knowledge, competencies, etc.), concretized (by the ownership of items), and institutionalized (by diplomas). The symbolic capital is composed of all the kinds of capital recognized by society.

Bourdieu uses the concept of social capital like the other types of capital as a basic element of the reproduction of social inequalities. Unlike Granovetter, Bourdieu does not use the word "embodied," but he argues that individuals have a social role which is determined by the place they occupy in society. In this way, the objective of Bourdieu is to explain the mechanisms of reproduction of social inequalities and also that inequality is not confined to economic issues but also cultural, social, and symbolic ones.

At the end of the 1980s, two American sociologists, R. Putman and J. Coleman, developed the concept of social capital in two different ways. Putman built the concept of social capital to analyze democratically imposed regulation in developed countries (especially in the United States), while Coleman developed a similar concept to analyze the process of individual decision-making. But this was not the only difference.

Putman or the Decline of Social Capital in the United States

For R. Putman, social networks existing between individuals change their behavior. The experience that an individual acquires in a community transforms his (or her) behavior. So, there is an interaction between individual and social behavior. Putman measures the decline of social capital in the United States by the decline of social, traditional, civic, and fraternal organizations which are a link between people and government. Putman distinguishes two types of social capital to understand the mechanism of social cohesion: "bonding capital" and "bridging capital." The first one occurs when you are socializing with people who are like you (same age, race, religion, and so on). The second one occurs when you make friends with people who are not like you. He explains that the "institutional performance" is based on social capital. It operates on trust, norms of reciprocity, and networks of civic engagement. In a long article published in 1995, "Bowling Alone: America's Declining Social Capital," he developed the theses of the decline of social capital in the United States: between 1980 and 1993, membership of bowling clubs declined by 40 %, while the number of players increased by 10 %. The solitude of the bowling player has become a symbol of the division of American society. He observes also the decline in electoral participation, in religious practice, and in the influence of trade unions. Putman explains that this is the reason for the economic decline of the United States, because the vitality of this society was based on powerful local associations.

Coleman, Social Capital or a Social Resource for Action

The analysis of Coleman (1986) is based on relationships of confidence between individuals in small communities. He defines three kinds of social capital: "obligations and expectations," "information channels," and "social forms." In the neoclassical tradition, Coleman considers that social capital has the same properties as other forms of capital: it is productive. Like physical and human capital, social capital does not consist entirely of fungibles. Unlike other forms of capital, social capital inheres in the structure of relations between actors and among actors. "*Obligations and expectations*": this form of social capital depends on two elements: "trustworthiness of the social environment, which means that obligations will be repaid, and the actual extent of obligations held." "*Information channels*": information is important in providing a basis for action. But acquisition of information is costly. Social capital provides information that facilitates action. "*Norms and effective sanctions*": when a norm exists and is effective, it constitutes a powerful form of social capital. For example, "effective norms that inhibit crime make it possible to walk freely outside at night in a city (. . .)." In all these cases, social capital is a resource to improve individual situation.

Granovetter, Market Society Embodied in Social Links

Since the 1980s, the concept of social capital has taken a considerable importance in economic and sociological analysis. A wide range of studies have been developed at different levels, particularly to explain the entrepreneurial process. During the same period, M. Granovetter developed the concept of "embeddedness" which launched the new socioeconomic theory to explain that individuals or firms are points of embeddedness in social networks, even in an actual market economy. According to Granovetter, it is impossible to explain economic phenomena based only on economic analysis. Economic phenomena are based on social networks. The roots of his analysis are based on a far deeper philosophical study (with numerous references to Thomas Hobbes) and also to Karl Polanyi (whose famous book *The great transformation* was published in 1944) and to Oliver Williamson (with his famous book *Markets and Hierarchies*, published in 1975). Polanyi argues that the construction of a "self-regulating" market necessitates the separation of society into economic and political realms. So the development of a market society causes massive social dislocation. According to Granovetter, market regulation is based on social networks. From the analysis of Williamson, Granovetter extracts the concept of "opportunism" – "self-interest seeking with guile; agents who are skilled at dissembling realize transactional advantages. Economic man. . . is thus a more subtle and devious creature than the usual self interest-seeking assumption reveals" (Williamson 1975, p. 255, cited by Granovetter 1985, p. 487). In this context, Williamson argues that the creation of a firm is an answer to increasing transaction costs. According to Granovetter, markets can be organized by different types of social networks existing between enterprises and managers. Granovetter underlines that economic transactions and social relationships are linked: "I argue that the anonymous market of neoclassical models is virtually nonexistent in economic life and that transactions of all kinds are rife with the social connections described" (Granovetter 1985, p. 495) (see Table 1). So, according to Granovetter, there are two types of social networks: informal and institutional. Informal networks are based on interpersonal social networks (family, friends, neighborhoods, colleagues, and so on). Institutional networks are based on impersonal social relations.

The Resource Potential of the Entrepreneur

Resource Potential, Elements for a Definition

The concept of resource potential is developed to analyze the process of social action in a particular case: entrepreneurship. This concept is useful in order to assess the role played by the social origin, the education background, the professional experience, and the financing of entrants. Each individual owns a set of resources and uses his (or her) potential to improve their economic situation (to find a job with a good salary, to create an enterprise, to find another professional activity, and so on), and their choices also depend on their own resources. The resource potential is not a natural gift, but it is the product of a social process, of the opportunities and constraints implied by this process. The resource potential can be analyzed in three respects: (1) knowledge (schooling, secondary education, higher education, further education, and professional

Social Capital of the Entrepreneur, Table 1 The four key authors and definitions of social capital

Authors	Definition of social capital	Place of social capital for understanding society
Pierre Bourdieu	A network of social relations owned by individuals	The Bourdieu analysis is founded on the Marxist theory of social classes
	Social capital takes place in the analysis of Bourdieu with different kinds of capital: economic, cultural, and symbolic capital	
James Coleman	Social capital is a resource devoted to finding other resources for action	Coleman's analysis is founded on methodological individualism
	There are three forms of social capital:	
	obligations and expectations, information channels, and norms	
	Social capital also forms a link between individuals	
Robert Putman	Social capital is the key to democracy to develop civic, social, associational, and political life	The objective of Putman's analysis is to explain the social mechanism of social reproduction
	There are two forms of social capital:	
	Bonding capital: occurs when you are socializing with people who are like you (same age, race, religion, and so on)	
	Bridging capital: occurs when you make friends with people who are not like you	
Mark Granovetter	The power of the connections between actors in dense social networks	"Strength of weak ties" and "strength of strong ties" (1973)
	The mechanism of the market is embedded in social networks (a response to Karl Polany's book, *The Great transformation* – 1944)	The concept of "embeddedness": economic relations between individuals and firms are embedded in social networks

Source: From the references

experience), (2) financial resources (personal savings, bank loans, venture capital, and different forms of public supports), (3) social relationships (family, personal, professional, institutional relations, etc.) (see Table 2). These three aspects are interdependent. For example, the knowledge of an individual depends on his education and/or professional experience. And the family context influences the educational choices positively or negatively. Many entrepreneurs were born to families of entrepreneurs. While studying, the individual meets others who can become partners and bring knowledge, money, and relationships.

Links with Bourdieu, Putman, Coleman, and Granovetter

Like Coleman, socioeconomic theories argue that social capital is a resource for action. But, like Granovetter and Bourdieu, these theories also consider that individuals are embedded in a social context, that economic activities are supported by social links. Individuals are an element of social dynamics in an interdependent relation between individuals and society. Following Granovetter, theories argue that two types of social networks exist: one based on interpersonal links and the second based on impersonal links. Personal and interpersonal links are interdependent in a socialized context.

Conclusions and Future Readings

Social capital has become one of the most active areas of analysis and debate in social science over the two last decades (and before). Social capital is an interesting concept to explain social dynamics. The social capital literature represents a wide range of definitions supported by different ways of thinking: neoclassical, Keynesian, and Marxist. But more generally, social capital represents a critical aspect of the marginalist economical approach. According to Granovetter or Coleman and the others, economical phenomena are

Social Capital of the Entrepreneur, Table 2 Resource potential of the entrepreneur, elements of definition

Resources	Main characteristics
Knowledge	Tacit knowledge obtained from the family
	Scientific and technical knowledge learned at school
	Knowledge obtained through social relations
	Knowledge obtained through professional experience
Financial resources	Personal savings
	Friendly money: parents, friends, and so on
	Bank loans
	Financial aid from institutions (e.g., public aid)
	Seed money from another individual
Social relationships	Informal relations (family, friends, neighborhood, colleagues, etc.)
	Formal relations (state, banks, other enterprises, institutions in general, etc.)

Source: The authors

embedded in the social context. In this way, social capital can be considered as a tool of sociological analysis in an interdisciplinary perspective, even if it is impossible to arrive at a consensus about its definition.

Cross-References

▶ Business Climate and Entrepreneurship
▶ Innovation and Entrepreneurship
▶ Knowledge Capital and Small Businesses
▶ Network and Entrepreneurship

References

Bourdieu P. La distinction. Critique sociale du jugement. Paris: Editions de Minuit; 1979.

Coleman J. Social theory, social research and a theory of action. Am J Sociol. 1986;91:1309–35.

Granovetter M. Economic action and social structure: the problem of embeddedness. Am J Sociol. 1985;91(3):481–510.

Putman R. Bowling alone: America's declining social capital, published in 2000 under the following title: Bowling alone, the collapse and revival of american community, Simon & Schuster, 1985.

Williamson O. Markets and hierarchies. Cambridge: Free Press; 1975.

Social Change

▶ Social Innovation

Social Controversy

▶ Antitechnology Movements: Technological Versus Social Innovation

Social Design

▶ Applied Design Thinking Lab and Creative Empowering of Interdisciplinary Teams
▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy

Social Ecology

▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice

Social Entrepreneurship

Nadine Richez-Battesti and Francesca Petrella
Lest CNRS, Aix-Marseille Université,
Aix-enprovence, France

Synonyms

Entrepreneur; Social networks

Introduction

Social entrepreneurship is commonly used to qualify all economic initiatives that serve social and/or environmental mission and that reinvest a large part of their surpluses in support of their mission. Although this definition is not yet stabilized and its boundaries remain unclear, it focuses on the aim to achieve both economic efficiency and social innovation. It takes place within a context of great uncertainty about the future of welfare states and their capacity to meet new societal needs, of financial and budgetary constraints that force public authorities to develop new forms of interaction between public and private sectors, and therefore, of need to build new responses to societal challenges that are sustainable socially, economically, and environmentally. Within this context, all sorts of initiatives that can be qualified as social innovations are gaining interest.

Although interest of social entrepreneurship seems to be recent, as far as its capacity to reconcile private and social value creation is concerned, the first works on social entrepreneurship have to be found in the 1980s. Social entrepreneurship appears as a phenomenon not well recognized that has gained interest both in the USA and in Europe, given its capacity to overcome the opposition between profit and social value creation.

Social Entrepreneurship, Social Entrepreneur, and Social Enterprise: Is There Any Difference?

These three notions are used quite indistinctively in most of the Anglo-Saxon literature, although the choice of one term out of another is not neutral.

Rooted in Entrepreneurship

These three notions have in common to share the same roots in the term "entrepreneur," which is associated with creating value and change in the economy. As explained by Dees (1998, p. 1), the origins of the word entrepreneur have to be found in the seventeenth and eighteenth centuries. For Say, in the early nineteenth century, the entrepreneur "shifts economic resources out of an area of lower productivity and into an area of higher productivity and greater yield" (Dees 1998, p. 1). One century later, Schumpeter considers that entrepreneurs are the "change agents in the economy" and create value in the sense that, "by serving new markets or creating new ways of doing things, they move the economy forward" (Dees 1998, p. 1). More recently, as described by Dees (1998), Drucker added a dimension of "opportunity": "An entrepreneur always searches for change, respond to it, and exploits it as an opportunity." A last dimension can be added to the definition of "entrepreneur." According to Stevenson, entrepreneurs pursue "the opportunity without regard to resources currently controlled." In other words, the entrepreneur is able to mobilize new resources or to find new combinations of resources to achieve his objective.

Putting together all these dimensions of the notion of entrepreneur, Dees (1998) proposes to consider social entrepreneurs as entrepreneurs with a social mission. However, the value created by the pursuit of this social mission, which is designed as a social value, cannot be easily measured by the market mechanism (that measures the private value created). Based on these dimensions, Dees (1998, p. 4) proposes the following definition:

> Social entrepreneurs are "playing the role of change agents in the social sector by adopting a mission to create and sustain social value, recognizing and relentlessly pursuing new opportunities to serve that mission, engaging in a process of continuous innovation, adaptation and learning, acting boldly without being limited by resources currently in hand, and finally exhibiting a heightened sense of accountability to the constituencies served and for the outcomes created." For Martin and Osberg (2007 p. 34), the difference between entrepreneurship and social entrepreneurship lies "in the value proposition itself." The entrepreneur anticipates and organizes his value proposition to serve the markets and create financial profit, while the social entrepreneur anticipates and organizes his action in order to create "large-scale" benefits for society. The value proposition of a social entrepreneur does

not need a market to pay for this proposition but targets excluded, marginalized, or neglected parts of the population. In their proposition, the notion of opportunity is also a central one. The social entrepreneur identifies an opportunity to improve the situation of the marginalized group of the population. In that sense, the social entrepreneur, through direct action, aims to create and sustain a new equilibrium.

Social Entrepreneurship or Social Entrepreneur?

The notions of social entrepreneurship and social entrepreneur have gained popularity since the 1990s, in the USA as well as in Europe. Today, these terms recover a wide range of organizations, since it is used to qualify nonprofit organizations that start for-profit or earned income ventures, social purpose business ventures, *social businesses*, or social enterprises.

For Martin and Osberg (2007, p. 30), this increasing popularity leads to the inclusion of various activities that create a social benefit in this notion, which can be confusing. They consider that "the definition of social entrepreneurship today is anything but clear" and argue in favor of a more "rigorous" definition. They propose to distinguish social entrepreneurship from social service provision and from social activism (Martin and Osberg 2007, p. 36). The critical distinction from social services ventures lies in the fact that the latter does not "break out of their limited frame." They do not change the system and build a new equilibrium, less unfair for the underserved groups of the population. Considering social activism, the main difference comes from the fact that the social entrepreneur implements a direct action, while social activists try to bring some change through indirect action, by militant missions toward governments for instance.

Some distinctions are however made in the literature. As suggested by Mair and Marti (2006), the notion of "social entrepreneur" focuses on the individual characteristics of the entrepreneur and his behavior. As stated by Drayton (2002), social entrepreneurs have special traits and a strong ethical fiber. Social entrepreneurs have a vision of the social change they want to achieve, do take risks to do so, are creative, and have leadership skills. By contrast, the notion of "social entrepreneurship" is a way to put more emphasis on the process, on the organizational and collective dimensions of the entrepreneurship. The notion of "social enterprise" refers to the "tangible outcome of social entrepreneurship."

Different Schools of Social Enterprise

Social enterprise emerged, approximatively, at the same period of time in both sides of the Atlantic, although without any connection between them until the mid-2000s (Defourny and Nyssens 2010). In the USA, the Social Enterprise Initiative has been launched in 1993 by the Harvard Business School, followed by large universities and foundations that develop support programs to social entrepreneurs. Different entrepreneurial initiatives with a social mission emerged in the USA in the 1980s, mainly within the nonprofit sector, but it was not until the 1990s that they were put together within the concept of "social entrepreneurship." In Europe, its emergence is associated with the development of social cooperatives in Italy, recognized by a specific law in 1991, and with the work of the EMES (EMergence des Entreprises Sociales) European Research Network during the 1990s.

Since then, the notion of social enterprise has been developed by different schools that are usually separated in two groups, although not all the works on social entrepreneurship can fit exclusively within one of the schools (Borzaga and Defourny 2001; Dees and Anderson 2006; Defourny and Nyssens 2010).

The "Earned Income" School of Thought

The "earned income" school of thought defines social enterprises as nonprofit organizations that search for alternative funding strategies. Developing commercial activities was a way to solve their funding problems since they had to face important cutbacks in public grants and encountered increasing difficulties to mobilize private donations from individuals or foundations. These organizations therefore develop market-oriented economic activities that generate fees that will be reinvested for their social purpose. This earlier approach has then been enlarged to consider as social enterprise all types of organizations, nonprofit as well as for-profit ones, that develop market-oriented economic activities serving a social purpose.

For Defourny and Nyssens (2010, p. 20), the notion of *social business* developed by Muhammad Yunus (2007) falls within this approach. For Yunus, a *social business is a non-dividend company* that does not distribute all its profits and a *no loss* company. A company that is not able to cover its production costs and reimburse its investors while serving its mission is not a *social business*. Social businesses differ from charities since they do not depend on donations nor on public subsidies to develop their activity. However, the notion of social business is now used to qualify a wide spectrum of organizations that allow for a limited redistribution of profit. The organization can therefore be "for-profit" or not-for-profit. The notion of *social business* also characterizes the new organizational models of multinational firms aimed at helping the poor to access to market, as in the *bottom of the pyramid* approach (Richez-Battesti 2010).

The "Social Innovation" School of Thought

The social innovation school gives a central role to the social innovation dynamic that is most of the time driven by a social entrepreneur, who possesses crucial personal characteristics to pursue his social mission, such as dynamism, creativity, and leadership. Social innovation is here personalized and reflects the priority given to the individual instead of to the organization. The definition of Dees (1998), mentioned above, illustrates this line of thought. The social entrepreneur is a change maker; he possesses the classical characteristics of an entrepreneur but is motivated by a social mission. This view of social innovation has been supported by foundations such as Schwab and Ashoka from the beginning of the 1980s that still encourage the development and the professionalization of social entrepreneurs, in particular with a nonprofit status. This conception is also at the heart of training program developed by higher schools in France, such as the program implemented by the Social Entrepreneurship Chair of the ESSEC school.

Social entrepreneurship can therefore be considered as a social innovation or as an opportunity to create social innovation. For Phills et al. (2008), however, both notions, social entrepreneurship and social enterprise, are not appropriate to analyze all forms of creating social change, because they have their roots in the nonprofit sector. These authors argue that the notion of social innovation is more accurate since it allows including all kinds of organizations that produce social change, such as public, for-profit, or nonprofit organizations. "Innovation can emerge in places and from people outside the scope of social entrepreneurship and social enterprise" (Phills et al. 2008, p. 37). These authors consider social innovation both as a process and as a result and focus on the analysis of the processes that lead to the emergence of social innovation.

For instance, social innovation could emerge from a collective process organized by multiple actors at the territorial level in order to create social value to solve social problems (Klein and Harrisson 2010). From this perspective, social innovation is the result of cooperation processes between local actors that coordinate to meet unsolved social problems. Such processes rely on participative dynamics and on the combination of different types of resources (market, public, and voluntary ones). This leads these authors to characterize social innovation as inclusive and participative.

Beyond the diversity of these two schools of thought, Defourny and Nyssens (2010, p. 21) mention, however, that there exists an effort toward the emergence of a common vision of a social enterprise in the USA that would include the following criteria (cf. Emerson 2006): the search for social value creation/impact, social innovation, the use of market resources and the use of managerial practices, whatever the statute of the organization, nonprofit or for-profit, public or private.

Social Enterprise in Europe

The European model of social enterprise emerged in the 1990s with the work of the EMES European Research Network, in relationship with the development of new forms of enterprises coming from the third sector, such as social cooperatives in Italy (1995), social purpose companies in Belgium (1995), or social solidarity cooperative in Portugal (1998) (Gardin 2010). The EMES Network proposed a conceptual definition of social enterprises, characterized by a set of nine criteria classified within three groups:

– The first set of criteria deals with the economic dimension of their activity (a continuous activity producing goods and/or selling services, a significant level of economic risk, a minimum amount of paid work).
– The second set of criteria concerns their social and inclusive dimension (an explicit aim to benefit the community, an initiative launched by a group of citizens, a limited profit distribution).
– And the last set of criteria characterizes their governance structure (a high degree of autonomy, a decision-making power not based on capital ownership, and a participatory nature, which involves various parties affected by the activity).

These criteria contribute to build an “ideal type” in Weber’s terms, i.e., an abstract construction that enables researchers to position themselves within the “galaxy” of social enterprises and to draw the boundaries of what can be considered as a social enterprise (Defourny and Nyssens 2006). This ideal type characterizes social enterprises by a complex mixture of goals (Evers 2001); a resource mix that combine market, public, and voluntary resources; and a multi-stakeholder organization. Such a definition of social enterprise is not that different from the definition of the social economy and builds a bridge between different components of the third sector, such as cooperatives and nonprofit organizations (Defourny and Nyssens 2006, p. 7).

A Largely Debated Notion

Social entrepreneurship, social entrepreneur, and social enterprise are similar notions that hide some elements of controversy, in particular if we compare the European approach with the American schools of thought.

As pointed by many authors, such as Young and Salamon (2002), the European vision gives more emphasis to the governance model adopted by the social entrepreneur. Participation and democratic organization are highlighted in the EMES ideal type of social entrepreneur.

Note also that the resource mix is larger in the European model since it emphasizes the necessity to combine not only market-related resources but also public subsidies and private donations (Nyssens 2006).

Lastly, the European model explicitly allows for a limited redistribution of the surpluses generated by the activity, which is not always the case in the American schools of thought. Within this perspective, mutual organizations, work integration organizations, and cooperatives can be considered as social enterprises.

We therefore propose to locate the demarcation line between the American models and the European ones in the recognition – or not – of the existence of a third economic model, at the crossroads of market, public policy, and civil society (Nyssens 2006).

For the first, social entrepreneurship relies on the characteristics and on the vision of an individual within the frame of a “new kind of capitalism that serves humanity’s most pressing needs” (Yunus 2010).

This conception can be related to the increasing recognition of the corporate social responsibility of any type of enterprises. However, if the contribution to social welfare improvement is only associated to socially and environmentally sustainable practices, these firms do not fall into our definition of social enterprises. The contribution to social value creation has to be direct and central to the aim of the firm in order to consider it as social enterprises. Nevertheless, in some cases, the boundaries with the corporate social responsibility can be permeable. Social enterprises indeed use earned income strategies to pursue a double or triple bottom line. Some therefore propose to debate on the emergence of the "welfare enterprise" (Salmon 2011).

For the European models, the social enterprise is the result of a collective process, to be found in the origin of the project as well as in the governance structure of the organization, leading to the constitution of multi-stakeholder organizations (Borzaga and Mittone 1997; Pestoff 1998; Petrella 2008). The collective dimension of social enterprises also emerges in the collective benefits that they are aimed to create. Social enterprises are therefore part of a third sector, separated from the private capitalist and the public sectors.

From this perspective, it is important to stress that social enterprises, in the European model, develop their activities in a complementary interaction with the public action. The European approach recognizes a larger diversity of organizations that interact within a more complex and diversified environment than in the American approach (Ghezali and Sibille 2011). In the USA, there is a tendency to consider social enterprises as substitutes for public action in order overcome its shortages. Social entrepreneurship is often presented as a way to develop entrepreneurial approaches to meet social problems, since governmental and philanthropic initiatives are not able to solve all the social problems (Dees 1998). Social entrepreneurs will try to develop more efficient ways of solving social problems and are seen as an opportunity to substitute social entrepreneurship to direct public intervention, through the development of markets – or quasi-markets – of welfare. By contrast, one could consider social entrepreneurship initiatives as an opportunity to redesign public policy, in particular through the adoption of more participative processes of public action (Nyssens 2006).

An institutional support to social entrepreneurship at the international level governments of different countries, along with international organizations such as the OECD and more recently the European Union, has contributed to the recognition, the legitimacy, and the development of social entrepreneurship or social enterprise around the world.

In countries such as Italy, the emergence of social cooperatives contributed to the thinking on social enterprises from the beginning of the 1990s and the works of the EMES Network in particular. In France, the agency of valorization of socioeconomic initiatives (AVISE) helped to spread the notion of social enterprise, in connection with the EMES definition on the one hand and the creation of a new legal status of collective interest cooperative in 2001.

In 2002, the British government launched a national strategy in favor of social entrepreneurship. The definition proposed in the document called "Social Enterprise: A Strategy for Success" published in 2002 (p. 13) has become the most exhaustive and used definition of social entrepreneurship: "A social enterprise is a business with primarily social objectives whose surpluses are principally reinvested or that purpose in the business or in the community, rather than being driven by the need to maximise profit for shareholders and owners." The Danish government also started to work on a national strategy to support social innovation within the same period of time.

The Skoll World Forum on social entrepreneurship, in relationship with the Oxford University, facilitated the discussions, debates, and critical issues around the question of "Social Entrepreneurship: Shifting Power Dynamics," by exploring how social entrepreneurs find their way through and can influence the power dynamics within their approach that searches for change. Nearly 800 delegates coming from more than 60 countries took part in the first meeting of the most important social entrepreneurs. Discussions, debates, and seminar sessions were organized during three days and three nights by famous personalities coming from social sectors, universities, financial organizations, and political representatives with the aim to foster innovative solutions to the most urgent social needs at the world level. The Skoll World Forum also puts into the discussion the fact that the narrowing of credit opportunities highlights the need to increase the financial sustainability of innovative initiatives and reinforce the search processes toward charities and social enterprises.

At the international level, the OECD proposed a definition of social enterprise that built upon various examples analyzed in its member countries (North America, Europe, Japan, Australia, Mexico, etc.): "Social enterprises are organisations that take different legal forms across OECD countries to pursue both social and economic goals with an entrepreneurial spirit. Social enterprises typically engage in delivery of social services and work integration services for disadvantaged groups and communities, whether in urban or rural area. In addition, social enterprises are also emerging in the provision of community services, including in the educational, cultural and environmental fields. The social enterprise refers to any type of private activity."

Since the financial crisis of 2008, the European Commission launched a package of actions to encourage a growth process that is more inclusive, emphasizing the role of social innovation and social entrepreneurship. For instance, the social business initiative falls within this set of actions (social business initiative*, COM (2011) 682 final)*. It defines a social e as follows: "A social enterprise is an operator in the social economy whose main objective is to have a social impact rather than make a profit for their owners or shareholders. It operates by providing goods and services for the market in an entrepreneurial and innovative fashion and uses its profits primarily to achieve social objectives. It is managed in an open and responsible manner and, in particular, involve employees, consumers and stakeholders affected by its commercial activities." It is interesting to note that the governance structure reflects, in one way or another, the general interest objective. Within this initiative, an action plan to support social entrepreneurship has been elaborated with the identification of key actions aimed at improving the access to funding, increasing the visibility of social entrepreneurship, and improving the legal environment.

Conclusion and Future Directions

Social entrepreneurship is a different kind of entrepreneurship aimed at creating social value, i.e., large-scale benefits for society. Everyone seems to agree on the fact that social entrepreneurs identify opportunities to foster change in society in order to solve new social problems, by providing new ideas and new types of services and by searching for more efficient – or new – combinations of resources. Social entrepreneurship is therefore generally associated to social innovation. Nevertheless, social entrepreneurship is still a controversial notion. Current debates are focusing, on the one hand, on the boundaries of these notions, between market, public policy, and civil society. On the other hand, debates concern the organizational form that social entrepreneurship will take, being led by an individual or being the result of a collective process, issue that will be determinant for the governance structure adopted by social enterprises.

Cross-References

▶ Diversity and Entrepreneurship
▶ Entrepreneur
▶ Entrepreneur in Utopian Thinking
▶ Entrepreneurship and Social Inclusion
▶ Microfirms
▶ Proximity Relationships and Entrepreneurship
▶ Social Capital
▶ Social Innovation
▶ Social Networks and Entrepreneurship
▶ Socialized Entrepreneur, Theories

References

Barthélémy A, Slitine R. Entrepreneuriat social, innover au service de l'intérêt général, Vuibert, 2011.

Borzaga C, Defourny J, editors. The emergence of social enterprise. Londres: Routledge; 2001. 386 p.

Borzaga C, Mittone L. The multistakeholders versus the non-profit organization, Università degli Studi di Trento, *Draft paper n° 7*, 1997.

Dees JG. (revise en 2001), The meaning of "social entrepreneurship", working paper, Stanford University – Graduate School of Business, Stanford, California, 1998.

Dees JG, Anderson B. Framing a theory of social entrepreneurship : building on two schools of practice and

thought, research on social entrepreneurship, ARNOVA Occasional Paper Series, vol. 1, n°3, p. 39–66, 2006.
Defourny J, Nyssens M. Defining social enterprise. In: Nyssens M, editor. Social enterprise: between market. London/New York/Routledge: Public Policies and Civil Society; 2006. p. 3–26.
Defourny J, Nyssens M. Conceptions of social enterprises and social entrepreneurship in Europe and in the United States; convergences and divergences. J Soc Entrepreneurship. 2010;1(1):32–53.
Defourny, J., Nyssens, M. (2011). Approches européennes et américaines de l'entreprise sociale : une perspective comparative, *RECMA, Revue Internationale des Etudes coopératives, mutualistes et associatives*, n°319, février 2011, p. 18–35.
Emerson, J. (2006). Moving ahead together, implications of a blended Value Framework for the future of social entrepreneurship, in A. Nicholls (dir.), *A*. social entrepreneurship. New models of sustainable social change, (pp. 391–406). New York Oxford University Press.
Evers A. The significance of social capital in the multiple goal and resource structure of social enterprises. In: Borzaga C, Defourny J, editors. The emergence of social enterprise. New York, Routledge: London; 2001. p. 296–311.
Gardin L. Les enterprises sociales, Revue du MAUSS permanente, 15 mars 2010 (en ligne). http://www.journaldumauss.net/spip.php?article664. (2010).
Ghezali T, Sibille H. Démocratiser l'économie, Grasset, (2010).
Klein J-L, Harrisson D. Innovation sociale, Emergence et effets sur la transformation des sociétés. 2nd ed. Presses de l'Université du Québec.
Mair J, Marti I. Social entrepreneurship research: a source of explanation, prediction, and delight. J World Bus. 2006;41:36–44.
Martin RL, Osberg S. Social entrepreneurship: the case for definition, Stanford Social Innovation Review, Spring, 29–39, 2007.
Nyssens M. Social enterprise. At the crossroads of market, public policies and civil society. Londres et New York: Routledge; 2006. 386 p.
Ocde. Les entreprises sociales dans les pays membres de l'OCDE, Paris, OCDE, Service du développement territorial, Rapport pour le secrétariat, 1998.
Pestoff VA. Beyond the market and state, social enterprises and civil democracy in a welfare society. Aldershot/Bookfield/Singapore/Sydney: Ashgate; 1998.
Petrella F. Organisations non lucratives et partenariat : avantages et risques dans le cas des services de développement local en Belgique. In: Enjolras B, éditor. Gouvernance et intérêt général dans les services sociaux et de santé. CIRIEC, Peter Lang; 2008. p. 107–127.
Phills J, Deiglmeier K, Miller D. Rediscovering social innovation. Stanford Soc Innov Rev. 2008;6:34–43. Fall 2008.
Richez-Battesti N. L'économie sociale et solidaire face à la crise économiqe : entre reconnaissance d'un modèle d'organisation et risque de récupération, Revue Française de Marketing; 2010. p. 49–59.
Salmon A. L'entreprise providence; espoir ou consternation, débat sur la responsabilité sociale de l'entreprise, Revue du MAUSS permanente, 15 mars 2011 (en ligne). http://www.journaldumauss.net/spip.php?article785 (2011).
Youg D, Salamon L. Commercialization, social ventures and for profit competition. In: Salamon LM, editor. The state of non profit America. Washington, DC: Brookings Institution; 2002. p. 423–46.
Yunus M. Creating a world without poverty: social business and the future of capitalism. New York: Public Affairs Books; 2007.
Yunus M. Vers un nouveau capitalisme. Paris: Le Livre de Poche; 2008.

Social Innovation

Josef Hochgerner
Centre for Social Innovation (ZSI), Vienna, Vienna, Austria

Synonyms

Innovation; Social change; Social invention

The Novel Creation, Variation or New Combination of Social Practices

For decades, industrialized countries have attributed increasing relevance to innovation as a key resource for economic growth, making it a top priority for management and research in the business sector. By comparison, social innovation long remained on the periphery even of the social sciences, and was usually neglected by policy-makers and most of the stakeholders in innovation systems. Apart from the mainstream innovation theory and innovation research, still based on the seminal work by Schumpeter (2006), only few authors referred to the topic of social innovation until the end of the twentieth century, some of whom used similar terms such as social invention. Even fewer was the number of organizations, literally just a handful, that devoted explicit efforts toward social innovation up to the year 2000.

The situation changed drastically during the first decade of the twenty-first century. The attention paid to social innovation and the resources involved in the promotion, research, and implementation of social innovation increased, most remarkably after 2008, when the concept became the subject of mainstream policies in high places. US President Obama established an "Office of Social Innovation" at the White House. In 2009, too, President Barroso of the European Commission declared social innovation a top priority (Press Release IP/09/81): "The financial and economic crisis makes creativity and innovation in general and social innovation in particular even more important to foster sustainable growth, secure jobs and boost competitiveness."

Key Concepts and Definitions

Mentioning social innovation in the same breath as the crisis of the years since 2008 is more than mere coincidence. Indeed, it is the magnitude of the societal transformations in the present that stimulates the quest for new solutions in order to gain control of socioeconomic development. What is observed and depicted as *social change* is a perpetual process which from time to time runs more smoothly than under the current pressures of globalization. Yet there are factors affecting the dynamics of change, e.g., increasing life expectancy, everyone likes and no one wants to relinquish. As a consequence, improvements in the human conditions of living turn out to be the "grand challenge" of an aging society, necessitating social innovations to cope with it. At the same time, there are dynamics of change interfering with the broadly appreciated way of life, e.g., environmental pollution, excessive wealth next to rising income disparities, conflicts, and climate change, which require changes in behavior and call for social innovation.

Though social change – the wider compass of social innovations – results to a certain extent from human activities in all walks of life, such as politics, science, industry, or culture, it does not necessarily follow targeted interventions. In sociology, referring to social change means analyzing processes of change in social structures, institutions, culture, behavioral patterns, and states of consciousness. Alterations of this kind may derive from impacts beyond societal control, e.g., from the volatile stream of social development and cultural evolution. Change sometimes remains in line with sources from previous stages of development, and sometimes change consists of major upheavals like revolutions or the collapse of political systems. Hence, change *may* be influenced by social innovations, i.e., intentional and successful attempts to modify existing social practices or to enable new ones.

As usual in discourses concerning new concepts, several definitions are proposed by researchers and practitioners. Some are rather descriptive, aiming at more or less metaphorical indications of what may be highlighted as "social" in an innovation. Other approaches aim at the analytical and scientific differentiation of social innovation from common types of innovation known as commercially successful new products, processes, marketing, and organizational novelties. The latter are clearly defined, identified, and measured according to the so-called Oslo Manual (OECD & EUROSTAT 2005), enabling reliable and accountable classification and comparison of types of innovation among enterprises and business sectors. Their economic impact on GDP, regional development, countries, EU or NAFTA etc. can be measured. Such methods have not yet been established likewise to identify and analyze social innovations with the appropriate accuracy.

A frequently chosen approach in defining social innovation is to use examples and point out the social objectives or social processes involved. Most prominent is the following one (common in European Commission reports and other publications, in exactly this form or in some variation): "Social innovations are innovations that are social in both their ends and their means – new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations. They are innovations that are not only good for society, but also enhance society's capacity to act. Social innovations take place across boundaries between the public sector, the private sector, the third sector and the household" (DG Enterprise 2012; Murray et al. 2010; cf. also BEPA 2010).

This concept of social innovation helps to promote and fund socially innovative projects. By assuming an a priori position based on the social intentions involved, it includes the relevance of social needs, their effectiveness, and interaction (relations, collaboration). However, since any innovation has some social dimension pertaining to "social needs" one way or the other, thus affecting human relations, cooperation, and collaboration, it may even become difficult to determine what is *not* a social innovation. The decisive criterion should not be a social objective ("ends") and "social means," because an innovation may be qualified as social only after implementation by the assessment of its *results* and actual impact. Moreover, using the term "social" as a specific feature calls for the definition of what is "social." In the respective literature, it seems that "social" is applied as a normative term and perceived as good for society as a whole: "The value [of social innovation] created accrues primarily to society as a whole rather than private individuals" (Phills et al. 2008, p. 36). Yet, as with any innovation, social innovations are usually targeted at serving the needs of specific individuals or groupings. Social innovations appreciated by target groups may well be met with deprecation by other groupings or entities affected in other than intended ways.

> 'Social in its ends and in its means' is a useful formula (. . .), because it conveys an idea of social as 'good for many' or 'socially desirable', as socially 'valuable'. Nevertheless, we have come to learn that not everything which is intended as good for many may eventually turn out to be considered as good from many. (. . .) In strictly scientific terms, defining 'social innovation' excludes using the terms social and innovation in the definition. Strictly speaking, the definition 'social innovations are innovations that are social both in their ends and in their means' is tautological. What we can take from this definition is that social innovation is intentional, meant to change something in what people do alone or together to the better, at least as they perceive it. The intentionality of social innovation is what distinguishes it from social change (Franz et al. 2012, p. 4).

Any innovation is socially *relevant*, be it in the process of development and implementation or when looking at social outcomes. The specificity of a "social" innovation compared with what is generally meant by "innovation" without a prefix is due to what kind of value accrues from it in first place, and how this value is owned and impropriated. In the case of what is regularly perceived as innovation, it is *economic value*, produced and owned by enterprises, and *social value* in the case of social innovation, produced and owned by manifold players across society (including the corporate sector). "Fast food," for instance, has very effectively changed behavior and relationships by meeting unmet needs in the wider realm of new lifestyles. It continues to exert enormous social impact (including the emergence of severe health problems), while meeting existing and even newly created needs. Yet it is business driven, the value it produces is clearly defined economic value in first place, and further innovations in that area are intended to augment the respective outcome, irrespective of whether they respond to new social needs. In parallel, within the same society, though in different fractions, it stimulates another set of social needs, leading to counteracting social innovations like the "slow food" movement, whereby social value is in the foreground, even if economic value is obtained as well. This example demonstrates that the understanding of what is considered "social" may not only vary, but can even include totally contradictory meanings.

It is therefore imperative neither to presume that social means and ends are always good for society, nor to perceive social innovation as something totally distinct from innovation as such. What is required instead is a concept of innovation that includes social innovation among known sorts of innovation, yet supports the determination of specific properties. In order to exclude an a priori posit of what *should* be social in an innovation, for this reason then labeled "social innovation," an *analytical* definition of social innovation must allow identify the "social" properties of an innovation based on empirical assessment. This can be established only ex post, because whether or not a social objective is achieved, and an idea or model etc. actually becomes effective is only shown posterior to implementation.

A verifiable scientific definition of social innovation requires avoiding the inclusion of the self-referential terms "social" and "innovation," on the one hand. On the other, two essential features are imperative. One is to meet the requirements of an inclusive and comprehensive paradigm of innovation to afford the possibility of measuring success and impact in *comparison* with the established concept of innovation. Another necessity in defining social innovation is to ensure a definitive *distinction* from other types of innovation, or else it would not make sense to use the specific term of social innovation at all.

1. *Comparability* with the principles of the logic of innovation in general. Theory, practice, and research concerning social innovation must follow a similar rationale regarding what is constituent of commonly defined "innovation," i.e., a "new combination of production factors" (Schumpeter 2006), leading to *commercialized* new products or processes (OECD & EUROSTAT 2005). While the decisive criterion of innovation is commercialization (success on markets), the specific type of *social* innovation similarly needs to be assessed against an appropriate criterion enabling the determination of success. Even if social innovation takes place in the business sector, it cannot be gauged by the same token as the classic innovation, which is *commercial* success on *markets*. By comparison, the success of social innovations should first be determined by analyzing the scale, pace, and range of the *adoption and use* of new solutions or social practices by *social entities*.
2. *Distinction* of what a social innovation is compared with business innovation and with what is not an innovation at all (like reform or social change). Though there is a similarity in the rationale and social innovations may also provide economic success in terms of income, employment, and related factors, measuring social impact must reach out further to the *quality of life* (e.g., diversity, stability of social relations, solidarity, and social cohesion). Thus, the second key element of what denotes the success of social innovation demands the identification of outcomes. The distinct nature of social innovations needs to be expressed by social manifestations (like products or processes in business corporations), which can be considered *social facts* (Durkheim 1982) or *social practices*. These may be standardized behavior according to norms and other rules of social control. The latter were at the core of an early, yet neglected definition of innovation – without prefix, and with no direct reference to the economic sphere – describing innovation as "changes or novelties of rites, techniques, costumes, manners and mores" (Kallen 1932, p. 58).

The following definition refrains from the tautologous circle of declaring, abridged, "social innovations are social," and enables comparability with the scientific basics of established innovation theory as well as distinguishing social innovations from business-driven ones: "Social innovations are new practices for resolving societal challenges, which are adopted and utilized by individuals, social groups and organizations concerned" (ZSI 2012, p. 2). To be very succinct and paraphrase the famous quote from Schumpeter "innovations are new combinations of production factors," social innovations may be considered "new combinations of practices to varying social settings" (possibly affecting social change). New practices can consist of modified procedures in decision making, emerging patterns of communication and collaboration, and the adoption of diverse roles and relations. Such novelties may be completely new, adapted, or imported from other fields of action and experience. Yet, wherever the major impulse comes from, social innovations are not ready-made products to be bought and applied, but *processes* which require acceptance and – usually – adaptation. The threshold to qualify as a social innovation is the improved impact of new practices on a specific social issue, compared with previous and competing practices, as well as with not taking any action at all. However, impact will show only after implementation; therefore, adoption and the factual utilization of the proposed and more or less tested innovative practices by persons, groups, and other elements in society concerned are decisive.

Theoretical Background and Issues

Innovation, referring to products, technological devices, and processes, is often perceived as clocking progress in technology and economics. But there is no static economy, waiting in equilibrium for innovations to kick-off new developments. The basic principle of innovation ever since Schumpeter has been to conceptualize innovation as a necessity responding to restless dynamics. Innovations are indispensible in order to maintain the continuity of business processes and organizations in a permanently changing environment: "The opening up of new markets, foreign or domestic, and the organizational development ... incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact of capitalism" (Schumpeter 1975, p. 82). Because of this "creative destruction" in capitalism, business enterprises, whether large or small, are forced to innovate, that is to identify and implement ever "new combinations of production factors."

By comparison, social change is continually ongoing, too, in variable dynamics just as in the economy, and influenced by it to an even greater extent. Indeed, it is not necessarily technology which changes the structure of society, as currently from the "industrial" to the "information" or "knowledge society." Though this phenomenon is still subject to scientific and public discourse, it has been demonstrated that any existing formation of society continuously creates demands for new solutions to issues it entails – either by its successes or failures (cf. Beniger 1986). Taking this approach to determine and analyze social innovations, the notion of intentionality does not arbitrarily result from pure will or sudden creativity, but rather from need and necessity in the wake of persistent social change. Nevertheless, innovation requires pioneers who take the lead as innovators or first movers, actions that may be met – from various sides – with appreciation as well as disapproval or rejection. Like every innovation, social innovations must overcome resistance, degrees of which may differ a lot depending on the areas of change as well as on the social or historical environment in which they are proposed. This is why in social innovation research and practical implementation, the composition of networks, stakeholder analysis, and comprehension of interest groups and their power – to ignore or define or "make" an issue – are of crucial relevance.

From the viewpoint of theoretical consideration, social innovation expands the traditional concept of innovation, prompting major steps toward a new paradigm of innovation to fit the dynamics of the globalized post-industrial society of the twenty-first century (cf. Howaldt and Jacobsen 2010). The emergent world society, preferably termed information society or knowledge society, needs innovations far beyond the sector of industry or business as a whole. Though business innovations and new technologies will also be necessary in the future, social innovations will become indispensible to make new products and process innovations beneficial in terms of economic, social, and environmental sustainability. In addition, the development and shaping of the public sector (public services, security, infrastructures, etc.) as well as of the civil society sector (NGOs, churches, citizens' initiatives, etc.) call for social innovations of many kinds, numerous in scope and range. Thereby, the critical challenge is to identify how social innovations contribute to the accomplishment of social objectives and to measure the *social outcome* for whom in society.

In the BEPA-Report (2010, p. 26), a differentiation is emphasized between the *process dimension* and the *output dimension* of social innovations: "The process dimension ... implies that new forms of interaction are established [whereas] . . . the output dimension . . . refers to the kind of value or output that innovation is expected to deliver: a value that is less concerned with mere profit, and including multiple dimensions of output measurement." In addition, a very valuable distinction is provided by denoting three particular dimensions of social innovations according to characteristic objectives and intended impacts:

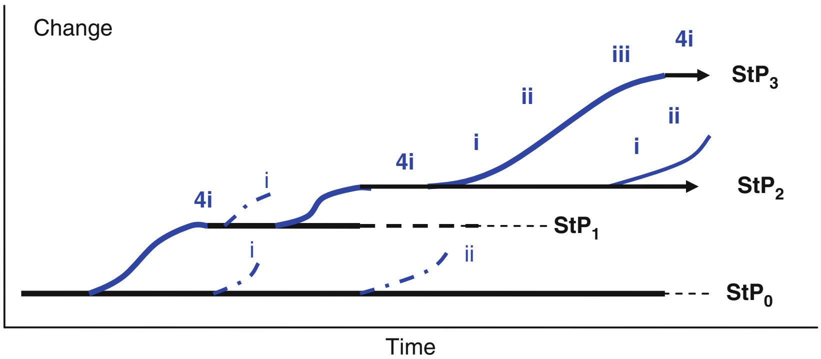
- '*The social demand perspective* . . . innovations that respond to social demands that are traditionally not addressed by the market or existing institutions and are directed towards vulnerable groups in society.' . . .
- '*The societal challenge perspective* . . . innovations that respond to those societal challenges in which the boundary between the social and the economic becomes blurred and that are directed towards society as a whole' . . ..
- '*The systemic changes perspective* . . . innovations that contribute to the reform of society in the direction of a more participative arena where empowerment and learning are both sources and outcomes of well-being.' (BEPA 2010 edition, p. 36 ff.)

Social innovations are not determined solely by the potential of ideas, but rather by the extent of realizing given potentials. These depend on whether the "invention" offers benefit to target groups, and thus, a social idea transforms into a social innovation because of utilization of the new practices and their dissemination. As mentioned earlier, social innovation should be considered a *process*, consisting of stages from the generation of an *idea ("ideation")*, on to *intervention*, *implementation*, and *impact* (a "4-*i*-process"). Ideas (inventiveness and creativity) underlie the concepts and measures proposed, which become innovations by utilization after targeted intervention and successful implementation.

If implemented successfully, social innovation entails impact, dissemination and further upscaling, and replication may take place. At best, it will be adopted and utilized to the extent of what is called "saturation of markets" in the case of business-driven innovations. Regarding social innovations, the equivalent is acceptance and usage by social groups and organizations possibly concerned. New practices may become regular practices, even standard behavior and perhaps formally institutionalized. As a result, successful social innovations then complete their *life cycle*. Once a former new practice (e.g., the people concerned adopt new roles or reshape their relations, or comply with norms, mores, or values) becomes standard and institutionalized, it ceases to stand out as an innovation. All the same, as novel practices leave previous standards behind, the new standard may become subject to new attempts to break the rule: Compulsory schooling, as well as the institutionalization of trade unions were, for instance, major systemic social innovations (actually taking very long to become standard practice). In comparison with these meanwhile established institutions, present-day ideas and intentions to accomplish new practices of schooling and of the representation of labor must appear deviant and in opposition while making their own way toward potential implementation.

Not all attempts to innovate become successful. On the one hand, innovations need to overcome resistance; on the other, the social situation, cultural and other environs like economic preconditions may change, either preventing the success of an innovation or in fact making it irrelevant. In such cases, a new idea (a) is pursued for a while, another one may lead to certain interventions (b) too, but come to a stop before actual implementation. Only if the full cycle, including implementation (c) and creation of impact (d), is completed, will the success of such a process become an innovation. It thus delivers a specific element of change in regard to either meeting a social demand or societal challenge, or stimulating systemic change. Despite the implementation of social innovations, some of which become more or less enduring standards or social institutions, previous standard behavior and rules continue to coexist until a potential decline in relevance and fading out may occur (cf. Fig. 1 for illustration).

One of the most critical issues in the theory and research of social innovation concerns the



Source: Author

StP$_0$	Standard practices concerning a specific area of the social system, existing at a certain period of time, possibly continuing next to social innovation(s), i.e. the implementation of new practices
StP$_1$	Newly established standard practice following the successful implementation of a social innovation in the area
StP$_2$	Newly established standard practice following the successful implementation of a social innovation in the area
	4i complete life cycle with impact, resulting from newly established standard practices
	i idea generated, process interrupted
	ii idea and intervention generated, process interrupted
	ii idea and intervention generated, process ongoing
- - - -	fading out of standard practices

Social Innovation, Fig. 1 The life cycle of social innovations and their contribution to change over time

tension between the economic and social effects of innovations in general, and of social innovations in particular. Business innovations create *economic value added* and are measured by parameters indicating *economic growth*. By contrast, social innovations prioritize the creation of *social facts* aimed at social change. The parameters applied should be suited to measuring *improvements in quality of life*. Neither economic growth, on the one hand, nor quality of life, on the other, is affected by just one type of innovation. This is why the broader concept of a new innovation paradigm ought to consider all innovations as socially relevant: not only those with the social intentions to alter social parameters, but also those with objectives and rationality criteria to change economic parameters.

Though innovations by definition are drivers of change, they also support the integration and continuance of social systems, since stability may be achieved by preserving the status quo *or* by adapting to new requirements and challenges. Nevertheless, excessive change creates instability, potentially leading to complete system collapse, the demolition of old systems, and the building up of new ones. Processes of change, often toward integration and disintegration in parallel, are constituent to societal development. The roles played in it by innovations in general and social innovations in particular are of great variety regarding both significance and direction.

Implications for Theory, Policy, and Practice

The *theory of social innovation* calls for further development in three major areas:

- Social innovation theory can facilitate a shift in the overall innovation paradigm, advancing it to cover innovation processes in all sectors of society. Besides companies, universities, and research facilities, citizens and customers are already considered relevant actors of innovation processes. Civil society and public institutions, however, have not yet been appropriately addressed by innovation theory and innovation research.

- Embedded in a comprehensive theory of innovation, the particular features of social innovation necessitate generic clarification of definition and conceptualization. The theoretical framework must be made compatible with scientific principles applicable to all forms of innovation, and suitable to permit analysis of the dissemination and positive as well as negative effects of social innovations in different sections of society (avoidance of normative prejudice).
- Besides theoretical refinement, methodological improvement is imperative, as there are still no reliable and established indicators and measures to identify and interpret social innovations, as is standard concerning business innovations (products, processes, etc.). Indicators should allow for measuring contributions of social innovation to increasing the quality of life, whereby theory and methods must be able to cover radical (or basic) social innovations as well as incremental ones.

A new paradigm of innovation, including social innovation, on the one hand, and addressing the social dimensions of every innovation, on the other, will support *changes in innovation policies* as well. Currently (2012/13), many national and international strategy papers express the relevance of social innovation, and research programs address topics of social development and social innovation. Moreover, an increasing number of public and private organizations are focusing on the research and promotion of social innovation. Awards for social innovation have become a frequent instrument to highlight success stories. Yet the concept of incubators for social innovation still lags far behind the massive funding of and public support for business innovation centers which has prevailed for decades. It seems that policy changes only take place after a delay following societal and scientific precursors that need to pave the way for new priorities based on modified frames of reference and value systems.

From a *practical point of view*, the increasing relevance of social innovation must not be neglected, because the most urgent and important innovations in the twenty-first century will be required in the multifaceted fields of social change and societal development. This underlines the necessity and new potentials of the social sciences in the context of transdisciplinary research. Linking science to practice may well be based on dividing topical areas of practical prominence into the categories introduced by BEPA (2010):

- Topical areas suggested under the *social demand* perspective, e.g., employment, education, social services (the UN Millennium Development Goals might be used for guidance)
- Topical areas suggested under the *societal challenges* perspective, e.g., aging societies, migration, climate change, redistribution of energy, and resources
- Topical areas suggested under the *systemic change* perspective, e.g., stopping and reversing financialization, management of abundance, strengthening solidarity and democracy

It should be noted that in practice, social innovations concerning immediate social demand, if implemented and disseminated on a large scale, may lead to systemic change as well as, of course, similarly relevant innovations, e.g., addressing climate change and energy policies. However, as systemic change is needed urgently, it will not automatically derive solely from a large number of various innovations. Systemic change reaches out beyond the usual frame of reference within which humans and societal entities act, while expecting others to behave predictably in similar ways. Thus, an imperative persists to analyze and take measures in favor of deliberate systemic change, just as individuals, organizations, and public institutions take action regarding social demands.

Conclusion and Future Directions

As outlined above, the scientific foundations of social innovation and the development, testing, and standardization of methodologies are outstanding. The results of such efforts should be compiled in a "*Handbook of Social Innovation*" to be used like the "Oslo Manual" (OECD & EUROSTAT 2005). Research and implementation is essential to build up competencies and capacities, education and training in support of social innovation, as is a specification of the professional profile of social innovators to act as enablers, evaluators, and promoters of all sorts of social innovation in practice.

Cross-References

- ▶ Antitechnology Movements: Technological Versus Social Innovation
- ▶ Business Incubator
- ▶ Collaborative Innovation and Open Innovation
- ▶ Creative Destruction
- ▶ Entrepreneurship in Creative Economy
- ▶ Ideas and Ideation
- ▶ Innovation Policies (vis-à-vis Practice and Theory)
- ▶ Innovator
- ▶ Joseph A. Schumpeter and Innovation
- ▶ Product Innovation, Process Innovation
- ▶ Social Entrepreneurship
- ▶ Techno-Globalization and Innovation
- ▶ Transdisciplinary Research (Transdisciplinarity)

References

Beniger J. The control revolution. Technological and economic origins of the information society. Cambridge, MA: Harvard University Press; 1986.

BEPA (Bureau of European Policy Advisers). Empowering people, driving change Social innovation in the European Union. Luxembourg: Publications Office of the European Union; 2010.

DG Enterprise. European social innovation competition: definition of social innovation. 2012. ec.europa.eu/enterprise/policies/innovation/policy/social-innovation/competition/index_en.htm. Nov 2012

Durkheim, É. The rules of sociological method. New York: Simon and Schuster; 1982. [1st edn: 1895]

Franz H-W, Hochgerner J, Howaldt J, editors. Challenge social innovation. Potentials for business, social entrepreneurship, welfare and civil society. Berlin/Heidelberg: Springer; 2012.

Howaldt J, Jacobsen H, editors. Soziale Innovation. Auf dem Weg zu einem postindustriellen Innovationsparadigma. Dortmunder Beiträge zur Sozialforschung. Wiesbaden: Verlag für Sozialwissenschaften; 2010.

Kallen HM. Innovation. In: Seligman ER, Johnson A, editors. Encyclopaedia of the social sciences, vol. 8. London: Macmillan; 1932. p. 58–61.

Murray R, Caulier-Grice J, Mulgan G. The open book of social innovation, Social innovation series: ways to design, develop and grow social innovation. London: The Young Foundation & NESTA; 2010.

OECD & EUROSTAT, editor. Oslo manual: guidelines for collecting and interpreting innovation data. 3rd ed. Paris: OECD; 2005.

Phills JA, Deiglmeier K, Miller DT. Rediscovering social innovation. Social Innov Rev. 2008; Fall issue:34–43

Schumpeter JA. Capitalism, socialism and democracy. New York: Harper; 1975. [1st edn: 1942]

Schumpeter JA. Theorie der wirtschaftlichen Entwicklung. Eine Untersuchung über Unternehmergewinn, Kapital, Kredit, Zins und den Konjunkturzyklus. Berlin: Duncker & Humblot; 2006. (Complete reprint of the 1st edition of 1912, including parts never contained in English editions of the book)

ZSI (Zentrum für Soziale Innovation/Centre for Social Innovation). All innovations are socially relevant. ZSI discussion paper 13. Vienna: ZSI; 2012. online: www.zsi.at/dp

Social Innovation Systems

▶ National Innovation Systems (NIS)

Social Invention

▶ Social Innovation

Social Metacognition and Micro-creativity

Ming Ming Chiu and Michael Pawlikowski
University at Buffalo, State University of New York, Buffalo, NY, USA

Synonyms

Distributed metacognition and creative ideas

Introduction

While individuals can have creative insights, groups of people often work together to create new ideas. Some group processes can help group members have creative moments in which they generate new, useful ideas (*micro-creativity*). For example, two team members disagreeing over which of their plans to implement can help a third team member recognize each of their flaws and address them by synthesizing useful elements from each into a superior plan. More generally, group members' monitoring (e.g., evaluations) and control (e.g., synthesis) of one another's knowledge, emotions, and actions (*social metacognition*) can aid group micro-creativity (Chiu and Kuo 2009). After describing micro-creativity and social metacognition, the remainder of this entry examines how social metacognition can affect micro-creativity and then discusses its implications for theory, policy, and practice.

Definitions Creativity, Metacognition, Social Metacognition

Big "C," Small "c," and Micro-creativity

Creativity is the generation of new ideas that are useful, and it can occur at different levels: for an entire society, for a single individual, or at a moment in time (Gruber and Wallace 1999). Big "C" creativity affects many people in a society (e.g., smart phones and continuous improvement process) (Gruber and Wallace 1999). In contrast, small "c" creativity may affect only a single person (e.g., buying a coffee maker to avoid the morning traffic at a local coffee shop) (Gruber and Wallace 1999). Meanwhile, *micro-creativity* occurs when a person creates a useful, new idea at a specific moment in time (e.g., combining two colleagues' suggestions to create a new idea) (Chiu 2008).

Metacognition and Social Metacognition

Individual *metacognition* is monitoring and controlling one's own knowledge, emotions, and actions (Hacker and Bol 2004). For example, Jay believes he has set his alarm clock properly for an important business meeting in the morning, but he is not sure, so he checks his alarm again. Jay monitors his knowledge of the alarm setting, recognizes his lack of confidence in his knowledge and thus, directs himself to act to collect further information about it.

Social metacognition is the social analog to individual metacognition (Chiu and Kuo 2009). For example, a chief executive officer (CEO) often distributes responsibilities among different officers, such as a chief financial operator (CFO) who oversees the firm's finances, a chief operating officer (COO) who oversees the firm's day-to-day operations, a chief technical officer (CTO) who oversees the firm's technology, and so on. After a catastrophe such as an earthquake, the CEO meets with senior staff to hear their assessments of the earthquake's impact on the firm, options for rebuilding the company, and evaluations of these options. The CEO listens to senior staff's ideas, evaluates them, and decides on which actions to take.

A Conversation Illustrating Social Metacognition's Effects on Micro-creativity

Group members' social metacognition can enhance or hinder a person's micro-creativity

(Chiu 2008), as illustrated in the following annotated scenario:

> Dave works at Will Not Compute, an onsite computer repair firm for individuals and businesses. He receives a memo to gather some colleagues and develop ideas to improve their firm's marketing. Dave asks his good friend Marc and their coworker Lisa, who often has great ideas, to work together on this initiative.

Dave uses his social metacognitive knowledge of his colleagues to select appropriate team members for this task, namely, employees who can both work together comfortably and generate interesting ideas. Working with coworkers also reduces status effects, which would otherwise hinder free exchanges of ideas and distort evaluations toward higher status colleagues.

Marc and Lisa agree to meet with Dave.

Marc: We already have our own website, isn't that enough?

Lisa: Yes, a website is essential, but we need to get people to go there. Maybe we can use some social networking to get them there?

Dave: Good idea, what if we started providing online coupons by using Group Coolpon?

Marc expresses his negative evaluation of their task goal, thereby sharing his metacognitive knowledge to aid his group members' monitoring and to influence their actions. Citing their current website, Marc criticizes their current task goal by questioning its necessity ("isn't that enough?"), thereby inviting and motivating Lisa's micro-creativity to address his criticism.

By validating Marc's idea ("yes, a website is essential") rather than immediately disagreeing with him, Lisa uses her social metacognitive understanding of his emotions and his thinking to promote his public self-image (give *face*), provide emotional support, build social rapport with him, show shared knowledge, and encourage him to continue listening to her idea. By socially positioning their task responsibility as shared ("we need to") and identifying the inadequacy of the website ("but we need to get people to go there"), Lisa's social metacognitive action validates the task goal and deters Marc's attempt to close the discussion. Furthermore, specifying the inadequacy motivates the group's need for new strategies (micro-creativity), which she addresses by sharing her new idea ("social networking"). Showing social metacognitive understanding of her colleagues' emotions, thinking, and actions, she socially positions her idea as belonging to the group ("we can") and engages Dave and Marc to consider it by asking them to evaluate its usefulness ("maybe . . .?").

By evaluating Lisa's idea positively ("good idea"), Dave gives face to Lisa, enhances their social relationship, and helps build shared knowledge. Then, he uses their shared knowledge and builds on it by suggesting a specific implementation ("providing online coupons by using Group Coolpon") and showing how micro-creativity can spark further micro-creativity. Next, Lisa asks about "Group Coolpon."

Lisa: Group Coolpon?

Dave: Group Coolpon emails people and invites them and their friends to buy online discount coupons.

Lisa: That's a great idea.

Not familiar with Dave's idea, Lisa shares her self-monitoring with the group and asks for more information ("Group Coolpon?"). Dave explains his new idea to help Lisa understand it, support it, and to build shared knowledge within the group. While Lisa supports Dave's idea, Marc does not.

Marc: Well, like most people, I am not a fan of online shopping because putting personal information online is too risky.

Lisa: Actually, there are plenty of ways consumers can shop online securely, like with PayPal.

Marc: That doesn't change my mind... I still wouldn't do it.

Lisa: I'm sure there are people that feel that way too, but we can focus on the consumers that do shop online.

Marc identifies a potential problem ("personal information online is too risky"), but shows poor social metacognitive knowledge of others by incorrectly claiming that most people share his view ("like most people, I am not a fan"). Lisa quickly and rudely rejects Marc's flawed idea as disconnected from reality ("actually"), makes a counterclaim in the form of a statement ("consumers can shop online securely"), and justifies it with evidence ("like with PayPal"). Using her social metacognitive understanding of other people, Lisa correctly evaluates Marc's incorrect claim. However, she reveals her inadequate social metacognitive knowledge and control through her rude rejection, which threatens Marc's face (*face attack*, Tracy 2008), reduces his willingness to listen to her, and reduces his micro-creativity.

After Lisa's rude rejection, Marc also responds rudely by declaring Lisa's information as inadequate ("that doesn't change my mind") and maintaining his personal position ("I still wouldn't do it"). By focusing on himself ("I") as a data point to legitimize his own ideas and position himself as a key authority, Marc separates himself from the group. By doing so, he threatens the group's shared responsibility, shared positioning and cohesion, which hinders their cooperation and the group's micro-creativity.

Rather than accelerating the spiral of rude disagreements, Lisa tries to reduce the tension by politely agreeing that some people share Marc's concern ("I'm sure there are people that feel that way too"), by reestablishing their shared positioning ("we can") and compartmentalizing the task ("focus on the consumers that do shop online"). At this point, Dave intervenes.

Dave: Let's do some research on how Group Coolpon works before making a decision. I can check on contact information.

Lisa: Great, I can look at coupon characteristics.

Dave: Marc, do you want to look at Group Coolpon reviews?

Marc: Sure, that sounds good.

Dave uses his social metacognitive understanding of the tension between Lisa and Marc to suggest collecting more information ("let's do some research on how Group Coolpon works") and postpone the decision ("before making a decision"), which adjourns the discussion and stops the argument that had stunted their micro-creativity. By having Marc and Lisa gather more information, Dave helps them become more comfortable with Group Coolpon, acquire more ideas, and develop more shared knowledge, all of which can stimulate their micro-creativity. If Dave had let Lisa and Marc's disagreement fester, it could have threatened their faces, damaged their social relationship, and hindered their micro-creativity.

Next, Dave and Lisa volunteer to gather specific information ("contact information," "coupon characteristics"). When Dave politely asks Marc to consider collecting other information ("do you want to look at Group Coolpon reviews?"), Marc agrees. As Marc's face has already been threatened by Lisa's face attack, he is more likely to agree to a request from Dave (especially a polite one) rather than Lisa.

Everyone in the group starts an internet search on their laptops for Group Coolpon in hopes to find some useful information.

Marc: I can't believe it. It's supposed to rain all weekend. Great, there go my plans.

Dave: The weather forecast is always changing. Check later and it will be mostly sunny.

Lisa: Come on, guys. Let's worry about the weekend after our meeting.

Marc gets distracted by a weather forecast ("it's supposed to rain"), which distracts Dave as well ("weather forecast is always changing"). Monitoring her coworkers' attention, Lisa refocuses their attention on the task ("let's worry about the weekend after our meeting") to reduce further distractions and enhance their micro-creativity.

Social Metacognition Effects on Micro-creativity

The above conversation illustrates how social metacognition via understanding others, evaluations, positioning, and questions, can aid micro-creativity (see Table 1). Understanding others through monitoring can aid in selecting appropriate team members who have the necessary talent and who can work together to create new ideas to accomplish a task. As a team works on a task, monitoring enables team members to recognize distractions that snare team members, tensions among them, and differences in their views. After recognizing that team member(s) are distracted, one can redirect their attention to the task to enhance micro-creativity.

Upon recognizing rising tension among team members, one can try to defuse the tension by building agreement among them or by suggesting

Social Metacognition and Micro-creativity, Table 1 Mechanisms by which social metacognition affects micro-creativity

Social metacognition	→ Mechanism → **Micro-creativity**
Understand colleagues	→ Select appropriate group members with suitable skills who work well together → **Micro-creativity**
	→ Monitor tension
	→ Reduce tension
	→ Redirect attention to task → **Micro-creativity**
	→ Monitor their attention
	→ Identify distractions
	→ Return their attention to task → **Micro-creativity**
Disagree/criticize politely	→ Detect flaws
	→ Motivate correction of flaws → **Micro-creativity**
	→ Give/save face
	→ Emotional security
	→ Explore ideas → **Micro-creativity**
Disagree/criticize rudely	→ Face attack
	→ Reduces other's openness to listen
	→ Invites retaliation
	→ Deadly spiral of face attacks –X → **Micro-creativity**
	→ More tension within group
	→ Decreases group cooperation
	→ Promotes individual positioning (I)
	→ Reduces ideas explored –X → **Micro-creativity**
Agree/support	→ Support ideas
	→ Give/save face
	→ Emotional security
	→ Explore ideas → **Micro-creativity**
	→ Support other's ideas
	→ Develop shared foundation of greater knowledge
	→ Stimulate related ideas → **Micro-creativity**
Correct evaluations	→ Support correct ideas + detect flaws
	→ Develop shared foundation of correct knowledge
	→ Stimulate related ideas → **Micro-creativity**
Incorrect evaluations	→ Discourage correct ideas + support flaws
	→ Develop shared foundation of flawed knowledge
	→ Stimulate flawed ideas –X → **Micro-creativity**
Shared positioning (we)	→ Shared responsibility
	→ Shared ideas → **Micro-creativity**
	→ Shared risk of failure
	→ Lower individual risk
	→ Less anxiety
	→ Greater motivation
	→ Explore ideas → **Micro-creativity**
Oppositional positioning (I vs. you)	→ Authority based on own experience
	→ Separate responsibility
	→ Individual risk of failure
	→ Less sharing of ideas –X → **Micro-creativity**

(*continued*)

Social Metacognition and Micro-creativity, Table 1 (continued)

Question inviting evaluation	→ Invite attention, consideration, and evaluation by others
	→ Develop shared foundation of greater knowledge
	→ Elaborate idea → **Micro-creativity**
	→ Detect flaw
	→ Motivate correction of flaw → **Micro-creativity**
Question asking for information	→ Solicit information
	→ Group member(s) fill knowledge gap
	→ Develop shared foundation of greater knowledge
	→ Stimulate related ideas → **Micro-creativity**
Command	→ Reusing old ideas –X → **Micro-creativity**
	→ Harm social relationships
	→ Exacerbate status effects
	→ Reduce ideas explored –X → **Micro-creativity**

Note: –X → indicates "hinders"

a different activity. When team members' views differ, understanding how to capitalize on their differences can aid micro-creativity, while being frustrated by them hinders micro-creativity.

Evaluations can facilitate micro-creativity through criticisms and agreements, especially correct evaluations. Criticisms identify potential flaws and motivate micro-creativity to address them (or counterarguments and justifications to reject the flaws). However, rude disagreements (such as face attacks) can escalate interpersonal conflict and hinder micro-creativity. As politeness during disagreement is the norm, lack of redress is noticeable and considered impolite (Holtgraves 1997). Hence, criticisms are often rendered polite by accompanying redress such as specifying partial agreements, highlighting shared positioning, and inviting further evaluation through questions.

Meanwhile, agreements can help build emotional and cognitive foundations for micro-creativity. Agreeing with the perceived correct parts of others' ideas gives/saves face and supports a shared, secure emotional foundation. Emotionally secure group members can listen to and explore a wider range of ideas without fearing personal rejection or embarrassment. Eventually, they can accept rejections of their weaker ideas in favor of others' stronger ideas. Group members' agreements also help build a cognitive foundation of shared understanding of greater knowledge that stimulates their exploration, development, and evaluation of new ideas.

The validity of an evaluation can also affect micro-creativity. Correct evaluations support correct ideas or identify flaws to support the group's shared, correct understandings, which can launch micro-creative elaborations. In contrast, incorrect evaluations reject correct ideas or accept flawed ideas, resulting in poorer, shared understandings that can stimulate wrong, new ideas and less micro-creativity.

Positioning (Davies and Harre 1990) task responsibilities and ideas as shared among group members is a form of social metacognitive control that helps build a social foundation for subsequent micro-creativity (Chiu and Kuo 2009). Shared positioning can share risk by distributing responsibilities among group members and aid emotional support to enhance motivation. As group members share responsibilities, they also share the risks of failure and its consequences. With less personal risk and a lower cost of failure, collaborators can feel less anxious and more motivated to create new ideas. In contrast, positioning oneself in opposition to others (I vs. you) heightens one's sense of authority based on one's own experiences, separates oneself from the group, reduces group cohesion, reduces sharing of ideas, and hinders micro-creativity.

Questions are a form of social metacognitive control that invites evaluations or solicits information to support a cognitive foundation for subsequent micro-creativity (Chiu 2008b). By framing ideas in the form of questions, a person invites group members to consider an idea, evaluate its validity and usefulness, and create new ideas that elaborate it or address its flaws. Unlike ideas expressed as definitive statements or commands, ideas in the form of questions are more polite, so they are less likely to draw a negative response and prematurely truncate the discussion or discourage identification of weaknesses. Questions that solicit information invite other group members to fill the gap in the group's shared cognitive foundation, which might otherwise hinder exploration, development, and evaluation of new ideas.

Conclusion and Future Directions

Micro-analyses of conversations can show how colleagues can influence one another, specifically how social metacognition (via understanding others, evaluations, positioning, and questions) can aid the creation of new ideas (micro-creativity). Research on social metacognition and micro-creativity is in its infancy with many unanswered theoretical and methodological questions. Theoretical issues include the relationships of micro-creativity to the small "c" creativity of individuals and groups and the Big "C" creativity of society. Furthermore, the relationships between the above social metacognitive actions and micro-creativity might differ along groups and its member characteristics (demographics, individual histories, interpersonal relationships, distribution of relevant competences), contexts (activity, institution, industry, culture), and periods of time (hours, weeks, months, years). In addition to the insights offered by case studies, methodology developments in statistical discourse analysis (Chiu 2008) are needed to systematically study many conversations by many groups. Still, social metacognition's effects on micro-creativity show how team members' interactions can affect their team creativity, and further research in this area might eventually result in interventions that enhance team creativity.

Cross-References

▶ Creative Knowledge Environments
▶ Creative Leadership
▶ Creative Problem Solving
▶ Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity
▶ Social Psychology of Creativity

References

Chiu MM. Effects of status on solutions, leadership, and evaluations during group problem solving. Sociol Educ. 2000;73(3):175–95.
Chiu MM. Flowing toward correct contributions during group problem solving: a statistical discourse analysis. J Learn Sci. 2008a;17(3):415–63.
Chiu MM. Effects of argumentation on group micro-creativity. Contemp Educ Psychol. 2008b;33: 383–402.
Chiu MM, Khoo L. Rudeness and status effects during group problem solving. J Educ Psychol. 2003;95:506–23.
Davies B, Harre R. Positioning: the discursive production of selves. J Theory Social Behav. 1990; 20(1):43–63.
Gruber HE, Wallace DB. The case study method and evolving systems approach for understanding unique creative people at work. In: Sternberg RJ, editor. Handbook of creativity. Cambridge, UK: Cambridge University Press; 1999. p. 93–115.
Hacker DJ, Bol L. Metacognitive theory: considering the social-cognitive influences. In: McInerney DM, Van Etten S, editors. Big theories revisited, vol. 4. Greenwhich: Information Age; 2004. p. 275–97.
Holtgraves T. YES, BUT... Positive politeness in conversation arguments. J Lang Social Psychol. 1997;16: 222–39.
Tracy K. Reasonable hostility. J Politeness Res. 2008;4:169–91.

Social Networks

▶ Social Capital of the Entrepreneur
▶ Social Entrepreneurship

Social Networks and Entrepreneurship

Nadine Richez-Battesti and Francesca Petrella
Lest CNRS, Aix-Marseille Université,
Aix-en-provence, France

Synonyms

Interindividual and/or Interorganizational interdependence; Social capital

Network analysis has steadily expanded over the past decades within several disciplines, such as sociology, management, and to a lesser extent economics. It has developed both in normative terms and in constructivist analyses based on empirical work. While sometimes limited to a methodological procedure based on mathematical and statistical tools as part of a structural analysis (Lazega 1998), network analysis has a broader theoretical ambition which has become increasingly pronounced.

Ranging from observation of informal ties among individuals to the network as a mode of organization, it concerns, on the one hand, the behavior of individuals or groups of individuals and, on the other, organizations. It therefore covers very varied fields of analysis, from the role of networks in access to employment to their effect on company performance or the dynamics of a territory. The term *social network* suggests connection, circulation, exchange flows, and interactions and is applied to many situations. As Bidart (2008) puts it, "a social network is a relational system." It can be defined as "a set of relationships of a specific type (e.g., collaboration, support, advice, control or influence) among a set of actors" (Lazega 1994). As a collective actor, the network can also be seen as a third way between market and hierarchy, or between macro-social approaches and individualist approaches (Mercklé 2004). The network is, finally, envisaged through the resources it makes it possible to mobilize, thus helping to associate the social network with social capital.

This entry first shows the diversity of approaches and the influence of the disciplinary starting points. Networks are then characterized in terms of indicators and methods. The interorganizational dimension of networks is more specifically characterized. Finally, the contributions and limits of network theory are discussed.

The Diversity of Approaches

Social networks are the object of a multiplicity of approaches and methodologies (Mercklé 2004). Thus, as Mercklé stresses, their history is not a linear succession of filiations but a progressive conjunction of initially quite distinct problematics, objects, and methods.

Some authors, such as Forsé (2002), trace the analysis of social networks back to the early twentieth century, pointing to the pioneering research of sociologists like Simmel (1908). Forsé thus stresses that the level of analysis chosen is neither that of the individual nor that of the collective, but an intermediate level, the meso-sociological level, where the social relations resulting from interaction among individuals can be apprehended. Others, such as Mercklé (2004), regard Barnes, in 1954, as the first anthropologist to have made use of the notion of the network. Yet others, such as Eve (2002), identify two traditions of analysis of social networks. The first, known as the Manchester School, is mainly represented by British anthropologists, from the 1950s. They aimed to characterize the configuration of a network of individuals based on an interpersonal approach. The second, social network analysis, was developed by the Harvard School within a structuralist approach. It aims to describe social groups in relational terms and analyze the nodes, whether they concern individuals, organizations, or institutions, distinguishing between formal and informal relationships.

This second school includes the sociologist Mark Granovetter (1973, 1995), who is often seen as a major theorist in network analysis. In the early 1970s, he characterized the formation of social networks and showed their importance in the structuring of contemporary social relations. Granovetter's theory of social networks makes it possible to articulate the individual and the collective by considering that the actions of actors are determined by the social organization and that the ties they form are conditioned by elements outside their own will and specific to the contexts in which they are set. This anchoring of individuals' actions in their context thus renews the analysis of individual behaviors by resituating them in the complexity of systems of social relations. Granovetter's work makes network analysis a genuine theory and not simply a specific method used in the social sciences. One of his contributions is that he characterizes the nature of ties by distinguishing between "strong" and "weak" ties. Strong ties express a high degree of resemblance between two or more persons (family, friends) who are in relationship. They link homogeneous groups and the information that circulates generally remains confined to a restricted group. By contrast, weak ties favor the circulation of individuals and groups or of information in a wider network or "from clique to clique" (Granovetter 1973). These weak ties are those richest in new information and opportunities.

The common feature of these approaches is that they privilege circulation rather than attributes (age, occupation, etc.) and identify and analyze alternative ways of functioning relative to those that are institutionalized. They also have in common the fact that they are pitched at a level of observation intermediate between individual and society (Bidart 2008) and make it possible to observe ties and intertwinings between social networks and institutions. Analyses of networks thus bring to light the mechanisms of the construction of these ties among individuals, collectives, and institutions. In particular, they show how groups are connected by common individuals, and how individuals are connected by common groups.

The Influence of Disciplinary Entry Points

However, depending on the disciplinary entry points chosen, network theory tends to privilege specific angles of observation. While the role of networks as resources for individuals and collectives is a recurrent feature, tensions can be observed between an interindividual approach to networks and a more organizational approach, again illustrating the diversity of analyses.

Structural Analysis of Social Networks as a Theory of Socialization

This approach is mainly developed by sociologists. In this structural perspective, social networks are not a particular mode of social organization but a means of analyzing social structures and examining their roles (Mercklé 2004). As Degenne and Forsé (2004) emphasize, the aim is to understand how a structure constrains individuals' behaviors and the resources they can mobilize, while resulting from the interactions among them. One therefore has to identify regularities in behavior on the basis of several criteria: connectedness (identifying groups according to the links among their members), cohesion (density of relationships), equivalence (looking for similarities among individuals), or the frequency of relationships (Forsé 2008).

Bidart (2008) makes the study of social networks a tool for understanding the processes of individual socialization. She draws up a dynamic cartography of the modes of circulation and anchoring of young people in social universes, bringing out the transversal logics and the multiple memberships. Grossetti (2004) observes the movements of embedding of individuals merging into a collective and the movements of uncoupling when individuals detach themselves from them. In particular, he characterizes the dynamics of interpersonal networks and organizations in enterprise creation.

The ambition of the sociology of social networks is thus to restore to individual behaviors the complexity of the systems of social relations in which they take on their meaning, and to which they in turn give meaning. A "social network," in this perspective, is both the set of social units and the relationships that these social units have with one another, directly or indirectly through chains of varying lengths. These social units may be individuals, informal groups of individuals, or more formal organizations, such as associations, firms, or even countries. The relationships among the elements designate forms of social interactions which can also be extremely diverse in nature: They may be monetary transactions, transfers of goods or exchange of services, transmissions of information, perceptions, or interindividual evaluations, orders, physical contacts (from handshakes to sexual relations), and more generally all kinds of verbal or gestural interactions, common participation in the same event, etc.

Social Network Theory as a Theory of Action

More recently, in the field of management, the development of social network theory within the new economic sociology, the theory of social embeddedness and the theory of social capital, have renewed the analysis of organizational dynamics and more especially of individual action, intraorganizational cooperation, and interorganizational relationships (Baret et al. 2006). Two complementary perspectives have emerged. On the one hand, Huault (1998) shows that it makes it possible to ground a theory of action by setting it in its relational context, thus relativizing the effects of the attributes specific to individuals. Network theory thus makes it possible to analyze not only individual action but also collective action. On the other hand, the network is seen as a mode of coordination of individual activities that is an alternative to the market and the hierarchy (Baret et al. 2006). It is thus a mode of organization and a mode of governance.

A third perspective completes this landscape. Actor-network theory – also known as the sociology of socio-technical networks – which is more centered on innovation, goes further into the question of cooperation. Bestriding sociology and theory of organizations, it aims to theorize the mechanisms of the production of cooperation, one successful form of which is the network (Akrich et al. 2006). These authors make *translation* a key element of their analysis. They use this term to express the need to interrelate heterogeneous activities and favor understanding among actors.

So, in this disciplinary field, social network theory makes it possible to characterize not only individual action but also collective action. Thus, some research has examined the effects of social networks on the performance of work teams (Hansen 1999), or the effects of "board interlocks" on corporate strategies (e.g., Gulati and Westphal 1999; Del Vecchio 2010). The network may be regarded instrumentally as a means of access to resources useful to action. It is also analyzed through its influence on the practices and tools of management (Lecoutre and Lièvre 2009). Finally, it is treated as an organizational model facilitating coordination among individuals or groups of individuals and organizations.

At last, the network is a mode of coordination alternative to the hierarchy, the market, and the contract, enabling flexible coordination of the resources of individuals and organizations, and in particular of knowledge resources. Social networks and the capital social they accumulate constitute a collective good for organizations: They reduce coordination costs and favor collective action based on shared values (Baret et al. 2006).

Social Network as a Theory of Social Embeddedness and as a Means of Securing Exchanges

Economics is no doubt the area in which network theory is least developed. However, as a means of coping with uncertainty, it has begun to be recognized. As Williamson (1975) observed, economic agents' efforts to reduce risk in situations of uncertainty induce transaction costs. More generally, the means used to reduce uncertainty come up against various limits – the difficulty of accessing information on products or partners, the incompleteness of contracts, and the risk of opportunist behavior by one of the parties. In such situations, the social embedding of a transaction and the interdependence of social and economic ties represent an efficient mechanism for economic coordination and offset the deficiencies of the market. Hence, it is the informational dimension of social networks that is privileged in this type of analysis (Ferrary 2010).

However, this notion of social embeddedness, derived from the works of Granovetter (2005) and the contributions of economic sociology, is not reduced to the informational dimension alone (Ferrary 2010). It makes insertion in networks a social capital that is regarded as a resource for individuals. Social embeddedness also modifies the mechanisms of social regulation that influence the behavior of economic agents and their individual decision making.

From another standpoint, in the construction of the social bond and the dynamics of networks in the writings of economists, they are often regarded as the result of the utilitarian behavior of individuals who maximize their utility by involving themselves in networks. This assumes intentionality on the part of individuals in their membership of networks, which leaves little place for other, e.g., more altruistic, behaviors.

Finally, Aoki (2010) refines the economists' distinction between social capital and social networks, considering that the notion of social capital relates primarily to individual strategies whereas social networks refer to the behaviors of individuals and result from an overall equilibrium associated with specific organizational models. In doing so, he gives the notion of the social network a more organizational dimension than that of the – more individual – social capital.

Characterizing Social Networks: Indicators and Methods

Different authors characterize networks according to different criteria, relating to their size, their density, the strength of the ties, their frequency, intensity, diversity, or multiplexity (a relationship is multiplex if it serves for several sorts of exchanges at once, as defined by Degenne and Forsé (1994)), their completeness or, on the contrary, the more personal character of networks, or the places that certain individuals or collective actors occupy in the network (more or less central), and they specify the nature of the relations among individuals and organizations (proximity, trust, reciprocity, etc.). One of the difficulties encountered by these approaches is that of defining the frontiers of the network that is observed: Is it a personal network (of friends), is it complete (in the sense of a finite network such as a work team, etc.), is it stable (having a certain permanence, etc.), is it open (with the introduction of a principle of saturation, i.e., a situation in which supplementary observation does not modify the social structure being studied)? Another difficulty lies in taking account of its dynamic evolution – how does one grasp its changes over time? And what about learning effects?

Social network analysis is also based on the study of the relations among individuals and their regularities. It is thus possible to identify subgroups of individuals and their relationships with the network as a whole. This type of procedure relies on specific models and methods and on use of mathematical tools borrowed from the theory of graphs and linear algebra.

The methods of networks analysis may be inductive. Networks are then described in order to analyze a relational structure with the aid of a graphical representation (a sociogram) representing the ties among the actors. A good knowledge of the terrain of observation is required (Lazega 1998). Some authors adopt narrative approaches, thus exhibiting the activated relationships identifying the relational chains (Grossetti and Barthe 2008). They can also be deductive. In this case, membership of a network is treated either as an explanatory variable or as a variable to be explained.

To categorize research on social networks in the field of management, Chauvet and Chollet (2010) propose two levels of characterization of networks. These two levels in themselves constitute a template for reading networks. They distinguish the units of analysis and the level of analysis. The units of analysis, i.e., the actors who represent the nodes in the social network studied, may be either individuals, or groups of individuals, or organizations. As regards the level of analysis of the effects of the network, it may either concern the benefits that the actor derives from the network or may privilege the effects of the network as a whole, observing how it is regulated or what its contributions are for the group, in a more collective perspective.

On the basis of this template, they bring to light the areas in which the contribution of network analysis to questions of management has been most significant: careers and professional development, management of innovation, corporate governance, entrepreneurship, organizational change, and team management.

Social Network and Social Capital: The Predominance of Analysis in Terms of Resources

Numerous studies use simultaneously the terms *network* and *social capital*. The proximity between social networks and social capital is expressed in the very definition of social capital in the sense in which it is used by Coleman (1990) as made up of relationships among individuals, social networks and norms of reciprocity, and the relationship of trust. It is also found in the emphasis on action found in the works of management researchers inasmuch as they regard the network as an alternative to hierarchy and the market (Baret et al. 2006). Finally, it is based on the fact that social capital helps to reduce the costs of cooperation. Bidart (2008: 44) for her part considers that "the notion of social capital... refers to the modalities of access to and use of the resources contained in social networks."

Generally, and especially in management science, authors consider that the social network constitutes a social capital for the individual. Thus, Mercklé (2004) and Baret et al. (2006) show how Burt (1992), in formulating his theory of structural holes (gaps between two nonredundant contacts), illustrates the ways in which the structure of a social network offers competitive advantages to social actors. Thus, the less the actors have redundant relations, i.e., the less the actors know one another, the more each can hope to derive from his network of resources. In this sense, social capital does not only depend on the number of contacts or the frequency of relations between the actors, but also on the non-redundancy of the relations. However, when allowance is made for power within the network, this tends to reduce the importance of the structural holes in favor of the actor's more or less central or peripheral position within the network. Consideration of informal relations also occupies an increasing place in the analysis of networks and social capital (Lazega 2006).

Social Network and Entrepreneurship: Interpersonal Networks and Firm Networks

Numerous studies have noted the role of social networks in the success of the entrepreneurial process (Hoang and Antoncic 2003). They emphasize the importance of the entrepreneur's personal connections in the success of her entrepreneurship. Personal relations as social capital for the entrepreneur is a decisive resource in entrepreneurial dynamics. The density of the enterprise creator's network does not suffice for an understanding of the effects of the network. Two complementary elements have to be taken into account. On the one hand, there are collective dynamics which may be present from the outset in the entrepreneurial project. Thus, some authors use the term *embedded individual* and point out the collective dimension of entrepreneurship (Chabaud and Condor 2006). Others start out from the nature of the relations, in particular trust, to respond to the difficulty of accessing key resources (e.g., financing). Finally, access to resources (or competences) is a key element for the entrepreneurial team.

From another standpoint, firm networks are a characteristic feature of the reconfiguration of large companies, but also of smaller ones, helping to articulate entrepreneurial strategies with managerial strategies. The aim is the pursuit of interdependence to achieve greater efficiencies for the networked organizations, while maintaining a degree of autonomy. In this sense, the question of firm networks is not limited to large companies but extends to all companies.

Finally, the organizations supporting activity creation endeavor to integrate company creators within these same social networks. They are the source of the development of the social capital that is essential in nurturing an entrepreneurial activity.

Interorganizational Networks

Networks are both interindividual and interorganizational. This second dimension will now be developed more specifically.

Interorganizational Networks, Resources, and Territories

Interorganizational networks are generally mobilized to explain the factors that lead firms to establish themselves alongside one another and to develop cooperation strategies (clusters, industrial districts, "poles of competitiveness," etc.) conducive to their development. More broadly, network theory makes it possible to understand alliances and cooperation among organizations. It leads one to privilege observation of the types of resources that circulate between firms.

These analyses in terms of networks are situated in a critical perspective relative to the arguments traditionally invoked in terms of price effects to justify economies of agglomeration. They are also based on consideration of Marshallian externalities resulting from interfirm relations. They make it possible on the one hand to analyze the spatial strategies of companies, and on the other to characterize modes of cooperation among actors and among firms that are neither of the commercial relations type, nor hierarchical, nor contractual. Networks develop in particular when contractual relationships are difficult and it is necessary to avoid opportunist behaviors and reduce organization costs.

These interorganizational networks have particular links with the territory in the context of territorial networks or globalized networks (Boschet and Rambonilaza 2010). These territorial networks are generally analyzed in relation to the local productive systems and their configuration in terms of industrial fabric, factors of attraction, and specific resources. The analyses show that cooperation among organizations is strengthened by the development of informal ties that reduce transaction costs. The different types of localized productive systems are identified through a characterization of interfirm ties and ties with the network leader (Carluer 2005) and depend to a large extent on their anchoring in the territory.

These interorganizational networks are also involved in processes of embedding (in the sense of increased interdependence among different social forms) to mobilize resources and of decoupling (in the sense of the process of autonomization of one form relative to another) to give strength to a collective actor (Grossetti and Barthe 2008).

Finally, these social networks help to facilitate and legitimize innovative processes, as soon as they are contextualized and able to develop functions of mediation (Grossetti and Barthe 2008) and translation, to make the innovations introduced by entrepreneurs intelligible to others (Akrich et al. 2006).

Interorganizational Networks and Network Firms

The theory of network firms has been developed since the 1990s within an analysis of cooperation among firms that makes it possible to move beyond the dichotomy put forward by Coase between the firm and the market. A network firm can be defined as a single productive organization among legally independent firms articulated by a focal firm. It characterizes an oblique economic integration (Baudry 2003), meaning a process of product design between clients and suppliers, without capital integration and even without real material assets. A network firm develops to access resources and create new resources.

This conception of the network firm feeds into the debate on a third way between the market and the hierarchy, extending the analysis of a hybrid institutional form put forward by Williamson (1985), and strengthens analyses in terms of cooperation.

Interorganizational Networks and Networked Governance

In the approaches that bear on interorganizational networks, public policy networks are regarded as an alternative form of governance through which resources can be allocated, control exercised, and actors coordinated in other ways than through the mechanism of the market, characterized by competition, or the hierarchy, where bureaucracy often has the upper hand (Rhodes 1996). These studies have developed in a context of a questioning of the modalities of public intervention, decentralization of competences, dissemination of the principles of New Public Management, and opening up to a plurality of public and private actors put into competition in order to improve the efficiency of public policies.

A public policy network is defined as "the result of more or less stable and non-hierarchic cooperation among organizations that exchange resources and may share norms and interests" (Le Galès and Thatcher 1995). These networks are thus constituted by a complex set of self-organizing public and private organizations which continuously interact in the framework of relations among its members based on trust, reciprocity, and mutual interdependence (Larson 1992; Rhodes 1996: 659).

As Enjolras (2008) underlines, from the standpoint of governance, the concept of the public policy network designates a plurality of concrete phenomena in which both public and private actors cooperate with a view to economic, social, or public policy ends. More precisely, he characterizes a regime of governance in terms of three constituent elements, namely, the actors involved and their characteristics; the public policy instruments used to satisfy the public interest; and the institutional modalities of coordination and interaction among actors in a public policy network (Enjolras 2008).

Conclusion and Future Directions

As has become apparent, network theory constitutes a mode of coordination beyond the market, the hierarchy, and the contract. It is situated at an intermediate level between the micro and the macro and makes it possible to avoid both the risks of over-socialization (social membership is overdeterminant) and under-socialization (individuals are regarded as unrelated atoms) (Forsé 2008) of the analysis of social and economic transformations. It facilitates a better analysis of the current transformations, as they affect either individuals or organizations, and their contextualization. It is particularly pertinent for an understanding of the strategies of firms and entrepreneurs, and in particular their anchorage in local territories.

However, as Mercklé (2004) pointed out few years ago, even today, social network theory gives rise to more modeling and deductive works than empirical and interpretative works. From this point of view, it is clear that an opposition still exists between interpretivist approaches on the one hand and positivist or causal approaches on the other.

The transversality of network analyses is an unavoidable element of research in various disciplines and in the renewal of debates. But these analyses must integrate more complex dimensions, notably that of understanding how to act on networks (Chauvet and Chollet 2010), without becoming trapped in a utilitarian or instrumentalized approach to social networks. The social embedding of economic relations and the resulting articulation between economic exchanges and social exchanges indeed opens up particularly relevant perspectives for analyzing the current transformations of individual behaviors, organizations, or territories.

Cross-References

▶ Actor-Network-Theory and Creativity Research
▶ Clusters, Networks, and Entrepreneurship
▶ Network and Entrepreneurship
▶ Networking Entrepreneurship
▶ Proximity Relationships and Entrepreneurship
▶ Social Capital of the Entrepreneur

References

Akrich M, Callon M, Latour B. Sociologie de la traduction: textes fondateurs. Paris: Presses de l'Ecole des Mines; 2006.

Aoki M. Le capital social individuel, les réseaux sociaux et leurs liens avec le jeu économique. Rev d'écon Dév. 2010;24:97–119.

Baret C, Huault I, Picq T. Management et réseaux sociaux. Jeux d'ombres et de lumières sur les organisations. Rev Fr Gest. 2006;163:93–106.
Barnes JA. Class and committees in a Norwegian Island Parish. Hum Relat. 1954;VII(1):39–59.
Baudry B. Economie de la firme. Paris: La Découverte, Collection Repères; 2003.
Bidart C. Étudier les réseaux: Apports et perspectives pour les sciences sociales. Inf soc. 2008;(147):34–45.
Boschet C, Rambonilaza T. Les mécanismes de coordination dans les réseaux sociaux: un cadre analytique de la dynamique territorial. Rev d'Écon Rég Urbaine. 2010; juin:569–93.
Burt R. Structural holes: the social structure of competition. Cambridge, MA: Havard University Press; 1992.
Carluer F. Réseaux d'entreprises et territoires: une matrice d'analyse stratégique. Manag et avenir. 2005;6:7–25.
Chabaud D, Condor R. Le rôle des reseaux sociaux dans le processus de création d'entreprises: faut-il compléter la perspective ? XVème Conférence Internationale de Management Stratégique, 13–16 June; Annecy/Geneva; 2006.
Chauvet V, Chollet B. Management et réseaux sociaux: bilan et perspectives de recherche. Rev française de Gestion. 2010;(202):79–96.
Coleman JS. Foundations of social theory. Cambridge, MA: Belknap; 1990.
Degenne A, Forsé M. Les réseaux sociaux: une approche structurale en sociologie. Paris: Armand Colin, Collection U; 1994.
Del Vecchio N. Réseaux de conseil d'administration et adoption de pratiques de gouvernance d'entreprise. Rev Fr Gest. 2010;202:145–61.
Enjolras B, editor. Gouvernance et intérêt général dans les services sociaux et de santé. Brussels: CIRIEC, Peter Lang; 2008.
Eve M. Deux traditions d'analyse des réseaux sociaux. Réseaux. 2002;115:183–212.
Ferrary M. Dynamique des réseaux sociaux et stratégies d'encastrement social. Rev d'Econ Ind. 2010; (129–130):1er et 2ème trimestre, 171–202.
Forsé M. Définir et analyser les réseaux sociaux: les enjeux de l'analyse structurale. Inf soc. 2008;147:10–9.
Granovetter M. The strength of weak ties. Am J Sociol. 1973;78(6):1360–80.
Granovetter M. The economic sociology of firms and entrepreneurs. In: Portes A, editor. The economic sociology of immigration: essays on networks, ethnicity, and entrepreneurship. New York: Russel Sage Foundation; 1995.
Grossetti M. Sociologie de l'imprévisible: dynamiques de l'activité et des formes sociales. Paris: PUF; 2004.
Grossetti M, Barthe J-F. Dynamiques des réseaux interpersonnels et des organisations dans les créations d'entreprises. Rev Fr Sociol. 2008;49:585–612.
Gulati R, Westphal JD. Cooperative or controlling? the effects of CEO-board relations and the content of interlocks on the formation of joint-ventures. Adm Sci Q. 1999;44:473–506.
Hansen M. The search transfer problem: the role of weak ties in sharing knowledge across organization subunits. Adm Sci Q. 1999;44:82–111.
Hoang H, Antoncic B. Network-based research in entrepreneurship: a critical review. J Bus Ventur. 2003; 18(2):165–87.
Huault I. Embeddedness et théorie de l'entreprise, autour des travaux de Mark Granovetter. Gérer Compr, Ann Mines. 1998;juin:73–86.
Larson A. Network dyads in entrepreneurial settings: a study of governance exchange relationships. Adm Sci Q. 1992;37:76–104.
Lazega E. Analyse des réseaux et sociologie des organisations. Rev Fr sociol. 1994;35(2):293–320.
Lazega E. Réseaux sociaux et structures relationnelles. Paris: PUF, Collection Que sais-je? 1998.
Lazega E. Le capital social de l'organisation flexibilisée. Rev Fr Gest. 2006;32:127–37.
Le Galès P, Thatcher M. Les réseaux de politique publique. Débat autour des policy networks. Paris: L'Harmattan; 1995.
Lecoutre M, Lièvre P. Réseaux sociaux: ressource pour l'action ou outil de gestion. Manag Avenir. 2009;27: 73–85.
Mercklé P. Sociologie des réseaux sociaux. Paris: La Découverte, Collection Repères; 2004.
Rhodes R. The new governance: governing without government. Pol Stud. 1996;44(4):652–67.
Simmel G. Sociology. Inquiries into the construction of social forms. Leiden/Boston: Brill; 1908/2009.
Williamson OE. The economic institutions of capitalism: firms, markets, relational contracting. New York: The Free Press; 1985.

Social Psychology of Creativity

Beth A. Hennessey[1,4], Beth Altringer[2,4] and Seana Moran[3,4]
[1]Wellesley College, Wellesley, MA, USA
[2]Harvard School of Engineering and Applied Sciences, Harvard University, Cambridge, MA, USA
[3]Singapore University of Technology and Design, Singapore, Singapore
[4]MIT International Design Center, Cambridge, MA, USA

Synonyms

Creativity and environment; Social psychology of innovation

Introduction

Implicit in much of the early theorizing and research on creativity was a focus on the internal determinants of creativity, to the exclusion of external factors such as the environmental circumstances that foster idea generation and creative behavior. In the mid-1970s, this gap in the creativity literature began to be recognized by a small group of social psychologists who came to concentrate their interest on the contexts in which creative ideas are most often generated or seemingly intractable problems are solved. This change of focus eventually led to the study of what has come to be termed "the social psychology of creativity." Explorations of the environmental factors conducive to (or detrimental to) creative performance were soon broadened to consider not only models of environmental and social contextual influences on the individual but also models of how creativity actually arises through social interaction and collaboration in teams or groups, as well as models of how creative ideas and products can ripple through and eventually transform entire social communities. For the most part, these lines of inquiry were initially pursued fairly separately from one another. Recent interest in multidisciplinary and interdisciplinary approaches coupled with exciting advances in modeling and statistical analysis techniques now make it possible for these three areas of research to inform each other and provide new possibilities for better understanding the social dimension of creativity production and dissemination.

Environmental Influences on Individuals' Creativity

Pioneers in the study of the impact of environmental factors on creative performance were Lepper, Greene, and Nisbett who, in 1973, found that, for preschoolers, working for an expected "Good Player Award" significantly decreased their interest in and enjoyment of drawing with markers. When compared with an unexpected reward group and a no-reward group, children who had made drawings in order to receive an award spent significantly less time using the markers during subsequent free play periods. Moreover, the globally assessed quality of the rewarded children's drawings was judged to be significantly lower than that of the other design groups. What was truly astounding about these findings was that *all* of the young participants in this study were specifically selected because they were passionate about drawing with markers. Yet a simple, one-time offer of a certificate was enough to undermine their task interest as well as their performance.

Over the years, experimental paradigms have become increasingly complex and results increasingly nuanced. But the basic findings remain the same. There has been observed a consistent relation between the motivational orientation brought by an individual to an open-ended problem or task and the likelihood of creative performance on that task. And it is the environment that, in large part, has been found to determine that motivational orientation. As summarized in the Intrinsic Motivation Principle of Creativity, intrinsic motivation is conducive to creativity, while extrinsic motivation is almost always detrimental (Amabile 1996). Simply stated, the expectation of reward, as well as the imposition of a variety of other extrinsic environmental constraints including expected evaluation, competition, and time limits, has been demonstrated to negatively impact the intrinsic task motivation and creativity of persons of all ages (see Amabile 1996; Hennessey 2003b).

Not only is intrinsic task motivation necessary for creative performance, it has also been shown to be an extremely delicate and fleeting state. Researchers have found it all too easy to undermine intrinsic motivation and creativity with the promise of a reward or an expected evaluation. What has not been easy is understanding why these extrinsic constraints have such a negative effect. Early theorists suggested a "discounting" or "overjustification" process. In situations where actions are overjustified, when both a plausible internal and an external cause of behavior are present, most individuals will tend to *discount* the internal cause in favor of the external explanation. The assumption will be made that task engagement or attempts to solve a problem have been driven by extrinsic rather than intrinsic reasons (see Amabile 1996; Hennessey 2003b). And without high levels of intrinsic motivation, creative performance is extremely unlikely.

Why is intrinsic motivation so necessary for creative performance? Some have proposed that one of the most important functions of task motivation is the control of attention. Studies of a phenomenon termed optimal experience or "flow," for example, point to a link between creative performance and a highly pleasurable state in which persons become so immersed in an activity or problem that they lose all sense of time and place. But when an extrinsic constraint is imposed on an individual's behavior, a portion of the cognition, concentration, and energy that should be devoted to the task or problem requiring a creative solution is instead directed toward the impending reward, deadline, or evaluation. Amabile (1996) offers a maze metaphor that is helpful in illustrating this phenomenon. She suggests that an open-ended "creativity-type" task is like a maze. There is one starting point, but there are a variety of exit points and many different paths to those exits. Most importantly, some of those exits, those solutions, are much more "elegant" or creative than others. In the face of an expected reward or evaluation, the goal is to "play it safe" and get in and out of the maze as quickly as possible. In order for a creative idea or solution to be generated, however, it is essential to become immersed in the maze itself. The artist, musician, scientist, or writer must be willing to experiment with alternative pathways and risk hitting a "dead end."

At the core of many conceptualizations of the intrinsically motivated state is the issue of control. Most contemporary theoretical models developed to explain the undermining effects of extrinsic constraints rest on the assumption that persons of all ages and backgrounds are driven by an innate need to preserve a sense of autonomy and self-determination – to feel an internal locus of control and to act as "origins" of their own behavior. This formulation has been applied equally successfully to classroom, laboratory, and workplace situations (see Amabile 1996; Hennessey 2003b) and has also helped to explain a small body of seemingly contradictory findings offered by investigators trained in the behaviorist tradition.

These researchers present the strongly contrasting view that creativity can be *easily increased* by reward and that the detrimental effects of extrinsic constraints occur only under limited conditions that can be easily avoided. A debate over these issues first surfaced in the mid-1990s, prompting the publication of a series of heated commentaries and critiques. At the core of the disagreement were important differences in the definitions of creativity driving investigations, the algorithmic or heuristic nature of the experimental tasks employed, and the instructions given to study participants. Generally speaking, this controversy has been healthy for the field, generating a number of new avenues of study including investigations into so-called "immunization" effects and a sort of motivational synergy that combines elements of intrinsic and extrinsic orientations (see Amabile 1996; Hennessey 2003b).

In sum, a complex array of factors contributes to an intrinsically motivated orientation and creativity of performance. When confronted with an open-ended task or problem, the individual feels curious and stimulated. Task engagement feels free of strong external control, and as progress is made, there emerge feelings of competence, mastery, and self-efficacy. Importantly, each of these hallmarks of intrinsic motivation focuses on an internal phenomenological state: Intrinsic motivation is assumed to be the result of an essentially individualized process. Although some theorists talk of supportive motivational milieus, corporate climate, or the complex social systems found in large organizations, the imposition of a deadline or the promise (and eventual receipt) of a reward or evaluation is seen as primarily a mechanistic process. Yet creativity is essentially a social phenomenon. Domain and technical skills are most often taught and acquired in a group setting. Creativity skills are modeled by others, and the generation of creative ideas and the process of bringing those ideas to fruition frequently come as a result of group efforts.

Many years ago, social psychologists began to move beyond a narrow consideration of the individual doing the creating toward an appreciation of the strong impact that a variety of environmental factors can have on motivation and creativity of performance. Others began to ask whether teachers or managers who impose environmental constraints or peers in a classroom or the workplace might themselves shape an individual's ideas about creativity, their motivational orientation, and their creativity of performance. It is these kinds of research questions that add a truly social component to the social psychology of creativity (see Hennessey 2003a). The sections that follow outline two especially important areas of inquiry: one with a focus on teams and the other with an emphasis on the ways in which creative ideas and products are introduced into and influence the broader social community or society.

Creativity in Teams and Groups

In recent years, researchers have moved beyond viewing teams as part of the broader organizational context (Amabile 1996) and have begun to focus more directly on team-level factors that influence creative problem solving and innovation. This shift has occurred for multiple reasons (Reiter-Palmon et al. 2012; Paulus et al. 2012). First, teams now produce more knowledge than individuals. The emergence of the knowledge economy has changed the nature of innovative work such that problems tend to be more complex and require more diverse skills than individuals are likely to possess. With this shift toward groups as the dominant form of knowledge production, new challenges arise. Teams must learn to harness the value of diverse team member skill sets, while managing conflict and other social processes associated with increased diversity. Furthermore, scholars increasingly acknowledge that team creativity is emergent and indeed represents a different phenomenon than individual or organization-level creativity.

Researchers have linked a number of team-level factors to enhanced team creativity. These factors, which are generally thought to interact to influence outcomes, can be divided into three categories: team characteristics, social processes, and cognitive processes (for a review, see Reiter-Palmon et al. 2012). The relations among these areas are multilevel and complex. For example, one process in a team interacts with and can affect other social processes, making it difficult to discern moderating factors and relative importance.

Team characteristics are often studied in the context of the effects of team member diversity or size on creative outcomes. Researchers have shown that the relation between team composition and creativity is more complex than initially thought (Reiter-Palmon et al. 2012). Demographic diversity appears to have no discernable influence on outcomes; however, functional diversity, also termed skill-related diversity, has often been positively linked to enhanced team creativity. Other sources of team member diversity, such as cognitive style, creative ability, and personality, have also been shown to affect outcomes.

Several social process variables have been identified as being linked to improved creative outcomes, including adaptation, coordination, communication and information sharing, trust, psychological safety, support, conflict, cohesion, evaluation, group stability, virtual teams, and leadership (for full review, see Reiter-Palmon et al. 2012 and Paulus et al. 2012).

Effective coordination and communication are especially important for projects that are complex, ambiguous, or require adaptation (e.g., creative problem-solving projects). Researchers tend to agree that open and constructive communication leads to better overall outcomes. Team psychological safety, a construct linked to interpersonal trust, refers to a shared belief that the team is capable and that individuals within the group will be supported when they take interpersonal or project-based risks. Team-based research coming from a variety of fields has linked these supportive behaviors to team effectiveness and adaptation, and this finding likely applies in the context of creativity and innovation, although further research is needed in this area.

The role of team conflict in influencing creativity is complex. Researchers tend to distinguish between task and relationship conflict, although at present, there is a lack sufficient evidence to delineate clear relations between these two constructs and their individual or collective influence on outcomes. Some scholars suggest a curvilinear relation between conflict and creativity, similar to the relation that has been found between diversity and creativity, although again, further research is needed.

Team cohesion, or the connectedness of team members and the view that the group is working as a collective, has been related to improved outcomes, although the relation is not straightforward. Cohesion can also serve to suppress constructive conflict, leading to "group think," which has been shown to hamper creativity.

Team-level cognitive processes leading to creativity have received comparatively less attention in the literature than have individual cognitive processes, team characteristics, and social processes, although this trend is changing (Reiter-Palmon et al. 2012). The most studied cognitive process is idea generation. This factor has often been equated with creativity, although, importantly, it is only one of several cognitive processes involved in team creativity. Research remains inconclusive as to the benefits of group, as opposed to individual, brainstorming.

Other team cognitive processes tied to creative production include additional stages of the creative problem-solving process (problem definition, information gathering, idea evaluation, idea testing or prototyping, implementation planning, execution, dissemination, and evaluation), as well as shared mental models, social cognition, team reflexivity (Reiter-Palmon et al. 2012), and task focus (Paulus et al. 2012). As with many of the aforementioned factors, more work is needed to better understand team cognitive processes, how they relate to one another, and the ways in which cognitive processes interact with team social processes and team characteristics.

Although research on team-level creativity has increased dramatically in recent years, there remain a number of methodological issues. There is a need for more objective assessments of creative outcomes at the team level. Also needed are more studies that move beyond laboratory simulations and college student populations that can be generalized to broader educational, organizational, and cultural contexts (Paulus et al. 2012). Additional investigations of this type will be particularly important as scholars endeavor to improve our understanding of how individual factors interact at the team-level, and with team-level and organizational-level factors, to influence creativity.

Creativity as a Social-Psychological Force Within and Across Groups

Expanding the investigative lens even further, some researchers have focused their attention on how creative ideas or products introduced into a social context can change the way members of a community think or behave. This approach to the study of creativity highlights how the person-context interaction is mutually influential and bidirectional. Not only can social-environmental factors or features of the work teams in which people find themselves impact creative behavior, but the creative behavior and the ideas and products generated can be a cause of social-psychological phenomena, such as opinion or behavior change, sociocultural development of groups over time, and shifts in power and knowledge among groups (Moran 2010).

Most social psychology paradigms emphasize the ways in which individuals are influenced by and come into alignment with a social context as they conform to normative influences, such as peer pressure, or informational influences, such as education. As more people believe and behave in the same way, they reinforce each other's sense that they are behaving correctly. They come to contribute to the group, be it a family, work team, organization, industry or field, social community, or even an entire society, in a way that maintains the current state of that group.

When a person, team, or organization introduces an original idea or product, variation is introduced into the larger group's ways of thinking, or its culture. Over time, some group members – or others outside the group – may deem the novelty useful. As the idea or product influences more people, it moves from "little-c" personal creativity, to "middle-c" shared creativity, and potentially to "big-C" historically transformative creativity (see Moran 2010).

Creativity can be a social-psychological force for an individual's self-expression within a group and/or a vehicle for improvement of that group as a whole (Moran 2010). Personal creativity exemplifies how individuals within a group *express* their idiosyncratic understanding of or perspective on some topic. The group provides a forum, a tool, for individuals to present variation or difference. Historical creativity, such as the creative breakthroughs of paradigm shifters like Einstein, or social transformations, such as those brought on by the civil rights movement, exemplify how the group as a whole can be *improved*. Individual contributions are tools for advancement of the group into a stronger position within the wider context. Creative ideas, products, and solutions are only creative temporarily – as they are being introduced and judged. Over time, if accepted, what was once deemed creative becomes the norm or standard for later generations.

The process by which a novel product is launched into and accepted by a community, field, or market is termed "innovation diffusion" (Rogers 1983). Because of conservative psychological biases and inertia characterizing most social groups (i.e., people tend to like things the way they are unless a novelty can be shown to be greatly beneficial over and above the perceived costs or risks), it is often difficult for new ideas or products to be adopted (Rogers 1983). Adoption stems from individuals sharing information, mimicking others' behavior, learning vicariously based on others' experiences with the innovation, and social influence exerted by powerful opinion leaders (Peres et al. 2010).

Early diffusion models considered group members to be essentially homogeneous. More recently, researchers have become increasingly concerned with the ways in which variability among characteristics of users, products, relationships, and social structures influence the adoption rates of innovations (Peres et al. 2010). Studies of the impact of user characteristics address openness to experience, risk-taking, price sensitivity, and needs. Studies of product characteristics focus on how useful, compatible, understandable, and versatile the product is for users' needs (Rogers 1983). Investigations of interpersonal variables include studies of how individuals infer the social consequences of adoption and the changing assessments of trust and reputation stemming from media (Peres et al. 2010). Finally, social-structural analyses show that weaker ties across diverse groups, and marginal players at groups' boundaries, are both important for creativity's social influence (Peres et al. 2010).

A logistic model (S-curve) depicts the stages after product introduction in which different types of people adopt (Rogers 1983). A few are "innovators," curious people who try new products even before they are reviewed or critiqued by professionals. About 10–25% of the community, "early adopters," are opinion leaders with a wide social network to generate "buzz." As more people use the idea or product, the product can become more valuable. Over time, this process termed a "network externality" (Peres et al. 2010) reduces the uncertainty and risk so that the "majority" become users. Risk-averse and strongly price-sensitive individuals, "laggards," wait for price reductions, but they may be forced to adopt the innovation because it has become the norm (Rogers 1983). For example, once a critical mass of people bought telephones or joined Facebook, many individuals felt compelled to follow suit in order to stay in communication with friends.

Much of the scholarship on this process has been done outside of social psychology – incorporating work coming from other areas of psychology as well as related disciplines including sociology, economics, business/organizational, and engineering. Contributions coming from the field of education through knowledge acquisition studies and the organizational literature on innovation and diffusion of technology have been particularly influential. This multidisciplinary perspective underscores the importance of individual contributions and how they can affect larger social entities. The spread of creative ideas is a social-psychological construct because it describes how innovations, transmitted through social interactions and influences, impact the preferences, opinions, attitudes, and behaviors of persons both individually and collectively.

Conclusion and Future Directions

Clearly, the expansion of research questions, empirical methodologies, and investigative focuses outlined in this entry has contributed significantly to an understanding of the social psychology of creativity. Yet there remains much work to be done. Like their colleagues before them, contemporary researchers have a long way to go before they fully understand the complex interplay between social-environmental factors, the generation of creative ideas or problem solutions, and the diffusion of those ideas both within and across teams and social communities and into broader societal contexts. Only by using multiple lenses simultaneously, cutting across levels, and incorporating the perspectives of social, organizational, educational, and developmental theorists will investigators be able to reach this goal. Recent work also underscores the importance of infusing a consideration of the intersection between cultural and social influences into any new models. What is needed now is an all-encompassing systems approach to the social psychology of creativity, a theory that will tie together and consolidate the growing diversity of perspectives found in the literature – from the interaction between a single individual and the immediate environment to the impact of overarching cultural norms on the creative process.

Cross-References

▶ Business Climate and Entrepreneurialism
▶ Business Creativity
▶ Creative Behavior
▶ Creative Problem Solving
▶ Creativity and Innovation: What Is the Difference?
▶ Freedom and Constraints in Creativity
▶ In Search of Cognitive Foundations of Creativity
▶ Interdisciplinarity and Innovation
▶ Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity
▶ Measurement of Creativity
▶ Psychology of Creativity
▶ Social Innovation

References

Amabile TM. Creativity in context. Boulder, CO: Westview; 1996.

Hennessey BA. Is the social psychology of creativity really social? Moving beyond a focus on the individual. In: Paulus P, Nijstad B, editors. Group creativity: innovation through collaboration. New York: Oxford University Press; 2003a. p. 181–201.

Hennessey BA. The social psychology of creativity. Scand J Educ Res. 2003b;47:253–71.

Moran S. The roles of creativity in society. In: Kaufman JC, Sternberg RJ, editors. The Cambridge handbook of creativity. New York: Cambridge University Press; 2010. p. 74–90.

Paulus PB, Dzindolet M, Kohn NW. Collaborative creativity – group creativity. In: Mumford MD, editor. Handbook of organizational creativity. London: Elsevier; 2012. p. 327–58.

Peres R, Muller E, Mahajan V. Innovation diffusion and new product growth models: a critical review and research directions. Int J Res Mark. 2010;27(2):91–106.

Reiter-Palmon R, Wigert B, de Vreede T. Team creativity: the effect of group composition, social processes and cognition. In: Mumford MD, editor. Handbook of organizational creativity. London: Elsevier; 2012. p. 295–326.

Rogers EM. Diffusion of innovations. 3rd ed. New York: Free Press; 1983.

Social Psychology of Innovation

▶ Social Psychology of Creativity

Social Responsibility

▶ Microfirms

Social Spin-Off

► Extrapreneurship

Social Ventures

► Entrepreneurship and Social Inclusion

Socialization of Entrepreneur

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Socialized Entrepreneur, Theories

Sophie Boutillier[1,2] and Dimitri Uzunidis[1,3]
[1]Research Unit on Industry and Innovation/ CLERSE–CNRS (UMR 8019), University of Lille Nord de France, Research Network on Innovation, Dunkerque, France
[2]Research Unit on Industry and Innovation, University of Littoral Côte d'Opale, Dunkerque, France
[3]Political Economy, Research Unit on Industry and Innovation University, University of Littoral Côte d'Opale, Dunkerque, France

Synonyms

Business climate and entrepreneurship; Entrepreneurship; Family and entrepreneurship; Socialization of entrepreneur

The beginning of the twentieth century is marked by growth in the size of firms, by the development of the division of work within the enterprise and between enterprises, and by the separation between property and the generation of capital, that is, managerial capital. This second period saw important progress in the socialization of the economy. The socialized entrepreneur (Boutillier and Uzunidis, 1995) devoted himself to the development of managerial capital, that is, an economy dominated by large firms and where the role of the State is preponderant both in its own functions as entrepreneur (predominantly during the period 1950–1970) and in the reduction of uncertainties (since the 1980s). In spite of the rapidly growing concentration of economic activity, entrepreneurial initiatives are far from having disappeared – contrary to the fears expressed by Schumpeter. In order to escape from the feudal economy, it was necessary to invent a new economic logic (whence, the heroic entrepreneur). In managerial capitalism dominated by powerful groups, the rules of competition are not fixed. Here, the entrepreneur assumes more than ever his part of the risk in an economic context always dominated by uncertainty – even though managerial capital has generally been considered by various economists as a situation of relative stability in terms of market positioning (thanks to its oligopolistic structure) and consequently one of comparatively weak uncertainties.

Just as it has been a question of returning to the sources, the founding economists, their neoclassical successors, whose work marked the course of the twentieth century, called back into question the hypothesis of market transparency and thereby rehabilitated the entrepreneur, using as their starting point the founding analysis of Carl Menger. The function of the entrepreneur is to channel the uncertainty inherent in the working of the market. This leads to the detection or creation of market opportunities. Hayek, Mises, Kirzner, Knight, Casson, and Audretsch describe a socialized entrepreneur whose activity occupies the ground between the strategies of large firms and aspects of public policy (whether it is a question of supporting the activities of large groups or seeking to favorize the creation of new firms to fight against unemployment or to encourage innovation).

Uncertainty, Risk, and the Entrepreneurial Function

Friedrich Von Hayek: Ignorance and Success

For Friedrich A. von Hayek (1899–1992) (2011), who declared himself a supporter of the arguments of Menger, the entrepreneur does not take decisions within a transparent economic environment.

On the contrary, since the knowledge capable of being brought to bear consciously by any one individual is only a small part of the knowledge that can contribute at any one moment to the success of his actions. Hayek explains in substance that the sum total of the knowledge of all individuals exists nowhere in an integrated manner. Moreover, to the extent that knowledge progresses, new zones of ignorance are discovered. Briefly, economic actors take decisions in a context of uncertainty (and not of transparency – putting into question one of the hypotheses of the competitive equilibrium model). It is on account of this fundamental reason that the market economy functions. F. von Hayek is, besides, highly critical of those he calls intellectuals: an understanding of business, he explains, and explanations of the determination of relative values in terms of marginal utility are crucial for a comprehension of the order on which the subsistence of millions of human lives depends. And such questions ought to be familiar to any cultivated person. Such comprehension has nevertheless been counteracted by the general mistrust with which intellectuals tend to consider the subject as a whole. For everything that has been brought up to date by marginalist theory – that is to say that the task of each individual should be to contribute, on the basis of his knowledge and his personal capacity, to satisfying the needs of the community by bringing to bear his *personally chosen* contribution – is foreign at one and the same time to the primitive spirit, to the reigning constructivism, and to explicit socialism.

Then he adds that the objections of the *fine spirits* (underlined by Hayek) of our time – the intellectuals – do not differ profoundly from the objections of members of primitive groups. What intellectuals imbued with constructivist prejudices consider as being the most reprehensible in the structure of the market, the money, and the financial institutions is that the producers, distributors, and financiers are not preoccupied with the concrete needs of people but with the abstract calculation of costs and profits. They forget in that – or they have not understood – what is at the heart of the arguments we have just set out.

The quest for profit is precisely what makes possible the more efficient use of resources. It permits the most productive utilization of the diversity of potential contributions from other firms.... The entrepreneur, if he intends to supply the means of creating still more means that may themselves serve others and particularly if he aims to serve a multiplicity of final objectives, must within the context of his activities experiment beyond currently known practices and targets. Prices and profits represent everything that most producers require so as to be able to serve effectively the needs of people they do not know. They constitute the instruments of research – in the same way as the soldier or the hunter, the mariner or the aircraft pilot, radar, or a pair of twins. The processes of the market furnish to most people the material and information resources they require to obtain *what they wish*.

Hayek reproaches intellectuals for understanding nothing, either of the economy, or of the entrepreneur, whether it is through stupidity or ignorance. As he explains it in substance, merchants have since the dawn of humanity been the motors of civilization and of progress. He insists particularly on this subject by underlining that commerce antedates in the history of mankind either the invention of agriculture or of the State. Governments have for the most part hindered whatever might promote the development of long-distance business, while business people have, on the contrary, contributed to keeping officialdom informed. Those who have offered the greatest independence and the greatest security to the business world have benefitted from the growth of information and of populations which have resulted. Those States which have aided business people to go about their activities have shared handsomely in the resultant profits.

Information is the nerve center of business; economic agents act in ignorance of the decisions of other economic agents. Hayek begins chapter 2 of "The Constitution of Freedom" (Hayek, 1994, p. 23) by the Socratic maxim: recognizing our ignorance is the beginning of wisdom. The first condition to understand society, he explains, is to take conscience of the ineluctable ignorance by men of much of what can help them to achieve their ends. The greater part of the advantages of life as part of society... rest on the fact that the individual benefits from more knowledge than he is aware of. It could be said that civilization begins when the individual, in pursuit of his aims, is able to make use of a greater sum of knowledge than he has been able to acquire himself and when he can extend beyond the boundaries of his own ignorance by making use of knowledge which he does not himself possess. The main idea here is that the individual can, paradoxically, succeed despite himself, of at least without possessing all the information necessary for the success of his business.

Hayek insists, too, on a phenomenon which we call "socialization," although he calls it "civilization." He writes that the spirit of man is the product of civilization in which he has grown up and explains that we must take into account that the knowledge that an individual spirit consciously manipulates is only a small part of the knowledge that at a given moment contributes to the success of his actions.

Ludwig Von Mises: The Entrepreneur and the Law of the Market

Mises signs up, like Hayek, to the Menger problematic. For Mises (1881–1973), entrepreneurs are the motive force of the market. He defines them as a sort of intermediary acting on the marketplace. This premise leads him to accentuate the effects of competition. Entrepreneurs are "those people who seek to obtain a profit by taking advantage of differences in prices." Faster in their comprehension and further-sighted than other men, they look around themselves for potential sources of profit. They buy where and when they consider prices are too low, and they sell where and when they consider prices have risen too high. They address themselves to the owners of production factors, and their competition leads to rises in the price of these factors until they reach the limit which corresponds to their anticipation of the price of future products. They address themselves as well to consumers, and the competition they bring to bear forces down the price of consumer goods to the point where the entire offer becomes the motive force of the market in the same way that it has become the motive force of production. The entrepreneur is a singular economic agent because each individual combines several functions, for example, consumer and worker. Moreover, a single individual can combine the functions of entrepreneur, owner, capitalist, and worker. But, what is the specific function of the entrepreneur? The specific function of the entrepreneur consists in determining how the factors of production shall be utilized. The entrepreneur is the man who dedicates them to specific functions. His objective is purely egotistical, he is there to enrich himself, but he does not dispose of a complete freedom of action since he cannot escape from the law of the market. Consumers have an important role since the entrepreneur "can only succeed by providing the best possible service to the consumer." His profit depends on the approval of his behavior stemming from the consumer. Mises also speaks of consumers as captains of the economy. The entrepreneur must obey them.

Like Schumpeter, and a good many other economists before him, the entrepreneur is not embodied in a single individual. "The economy, in speaking of entrepreneurs, has in view not necessarily men, but a particular function." In defining this function, the objective of the economist is not to define a particular group or class of men, but the entrepreneurial function is unique to each action. Seeking to incarnate the entrepreneur within an imaginary personality is to have recourse to a "methodological subterfuge." Mises underlines that every action is integrated into the flux of time and therefore involves a speculation. Capitalists, owners, and workers are speculators by necessity. It is the same with the consumer who looks to provide for his anticipated needs. Thus, all the world can be an entrepreneur (which implicitly signifies that the state of the entrepreneur is not permanent) and above all if the entrepreneur gives himself over to arbitrage on prices, which is not a behavior specific to the stated function because all economic actors are led to speculate, since "each action is integrated into the flux of time and therefore implies a speculation."

Mises pursues his process of constructing the theory of the entrepreneur in seeking to pose a question relating to a series of generally accepted ideas. Thus, the entrepreneur may not actually be a business owner because he has to borrow the funds he needs so as to have the use of them. What about profit in such a case? “If he succeeds, the profits are his, but if he fails, the loss falls on the capitalists who have lent him the funds.” From his own point of view, the capitalist who lends him the funds is also a speculator and an entrepreneur since he still runs the risk of losing his money. “There is nothing that resembles a perfectly safe investment.” Anyone can be an entrepreneur and speculate. Speculation is not a domain reserved for the entrepreneur. Does that signify that the economy is composed exclusively of entrepreneurs and that everyone acts to maximize his capital or the fruits of his labor?

Israel Kirzner: Uncertainty and Profit

In the same line of thought, Kirzner (1930–) describes entrepreneurial activity as the discovery of profit opportunities that others have not discovered previously. There flows from this the concept of “entrepreneurial vigilance.” In such conditions, the profit of the entrepreneur is the reward obtained partly by chance but also due to the ability of the entrepreneur to anticipate the way individuals will react to change. Kirzner refuses the issue of the maximization of profit. Or rather, the entrepreneur is not only a calculating agent, he is also an economic actor attentive to opportunities. The Kirznerian entrepreneur, in contrast to his Schumpeterian counterpart, creates nothing new, but is a discoverer of opportunities which exist already.

For Kirzner (1973), profit opportunities are born of imbalance rather than of equilibrium. The entrepreneur must be vigilant to detect and then to exploit the profit opportunities which may present themselves. The entrepreneur thus presents himself as the economic actor who exploits the ignorance of others and uncovers information to his advantage. He thus puts in evidence the “entrepreneurial vigilance” which is defined as a kind of particular capacity of entrepreneurs to acquire information in a spontaneous way. But evidently, according to Kirzner, we know that human beings do not operate in a world of perfect knowledge and it is that which leads us to underline the importance of the vigilance which certain individuals can manifest with regard to new information. Kirzner underlines heavily that the entrepreneur has no place in a world of perfect information. Thus, in a world of perfect knowledge, that is to say one where opportunities for unexploited gains are excluded, such a decision-maker has simply nothing to do and has no field of action to exercise his decision-making powers. Kirzner calls fundamentally into question the model of pure and perfect competition, but equally the theory of Schumpeter. Schumpeter’s theory differs from mine. The Schumpeterian entrepreneur acts so as to disturb a situation in balance. The action of his entrepreneur interrupts a continuously circulating flux. He is described as unleashing change and generating new opportunities.

Even though each new entrepreneurial innovation may lead finally to a new equilibrium, the entrepreneur is still presented as an unbalancing rather than a balancing force. For me, the changes that the entrepreneur triggers are turned more towards the hypothetical state of equilibrium; they are changes provoked in response to an existing scheme of things resulting from mistaken decisions, a scheme characterized by missed opportunities. The entrepreneur, according to Kirzner, leads us towards a mutual adjustment of these discordant elements in the market which resulted from previous ignorance of the market. My insistence on this difference between Schumpeter’s analysis and my own underlines the crucial importance of the entrepreneurial spirit in the development of the market. A treatment such as that of Schumpeter, who identifies the entrepreneurial dynamic as an exogenous force disturbing an economy in a state of equilibrium (to finally reach another such state on account of “imitators”), risks giving the impression that, to reach a state of equilibrium, entrepreneurial acts are, in principle, not called for. Differently stated, such a representation risks nourishing the completely false idea that a state of equilibrium can be established without the intervention of some kind of social instrument which deploys and assembles dispersed items of information, together comprising the unique components of such a state.

Only entrepreneurial action can lead to real balance. According to Kirzner, the entrepreneur is not a source of innovation ex nihilo but he is constantly on the lookout for opportunities which already exist and are waiting to be noticed. In economic development as well, the entrepreneur must be considered as responding to opportunities rather than creating them, as in seizing occasions that may yield profits, rather than generating them. But, while the entrepreneur according to Schumpeterian theory is an exceptional being, who by his acts causes the economy to develop in response, as accepted by the Austrian school following the work of Menger, the entrepreneur is a man like others, who has known, or who knows, better than others how to detect profit opportunities. This capacity shows in a facility to perceive opportunities offered by the market. Thanks to this quality, the entrepreneur knows how to combine the factors of production, and in what quantities, and also how to find the people holding the information he needs in order to find the sources of profit. Kirzner calls into question in his own way the myth of the self-made man in showing implicitly that entrepreneurial success is not just the consequence of the intrinsic qualities of an individual, however exceptional he may be.

From another standpoint, in discovering the profit opportunities which had previously lain unknown, the entrepreneur introduces changes that create a new situation of uncertainty, but one from which other entrepreneurs may draw profits in discovering in their turn other previously ignored opportunities. Opportunities are born of imbalance, not of balance. The existence of imbalance signifies the existence of pockets of ignorance within the market structure. In the absence of such pockets of ignorance, there are no more investment opportunities and consequently nothing for the entrepreneur. One comes back to the conclusions of Walras.

Franck Knight: Unpredictable Risks

The profit received by the entrepreneur is for Frank Knight (1885–1962) a fair remuneration because it is the product of uncertainty and of the risk taken. Uncertainty in fact occupies a large place in his analysis. The author opposes two types of society. The first is an imagined society, but he attempts to describe it as realistically as possible. This society is characterized by the absence of uncertainty. All the economic actors have available to them the same knowledge and the same information. This society changes radically with the introduction of uncertainty so as to constitute the second type of society. Two major problems flow from the introduction of uncertainty (Knight, 1965):

1. First of all, the entrepreneurs must forecast the needs of consumers; this task, along with the technological management and control of production, finds itself concentrated within one particular category of individuals: the entrepreneur.
2. Next, in this context of uncertainty, the work of conception focuses preponderantly on the two major blocks of production and organization. The entrepreneur and the hierarchical organization of the firm are the consequences of introducing uncertainty into a market economy. Add to that that in this context of uncertainty, the entrepreneur takes risks which, according to Knight, have no measure of probability by reason of the unpredictable character of market development. The profit is then the just remuneration.

Knight approaches the almost original definition of the entrepreneur, that of Cantillon, since the entrepreneur is only defined by virtue of his capacity to take risks.

The Entrepreneurial Behavior in the "Laissez-Faire" Economy

Marc Casson: The Family and the Socialization of the Entrepreneur

Mark Casson (1945–) prolongs the neoclassical analysis so as to make room for the entrepreneur by introducing noneconomic elements, first of all the family. The economic actors are thus encased within a particular social environment, before becoming economic actors ready to attack the market. This basis leads Casson to put forward two elements of fundamental analysis to explain the entrepreneurial success which results: the family (creation of a network of relations to obtain finance and locate markets) and the mastery of information (also to find funds and markets). Casson defines the entrepreneur as someone specialized who takes reasoned decisions relative to the coordination of rare resources. Then he details the different parts of his definition (2003):

1. The entrepreneur is a person. He is an individual. He is not a team nor a committee, nor an organization . . .. Only individuals are capable of taking decisions.
2. The entrepreneur is someone specialized; a specialist fulfills his function not only for his own account but also for the account of others.
3. He takes his decisions in well-reflected form; a well-reflected decision corresponds to the fact that a set of distinct individuals share the same objectives and, acting in the same context, can take opposite decisions. This results from their different perceptions of a given situation.
4. He coordinates rare resources, capital, and labor: such coordination can be defined as an advantageous reallocation of resources. An entrepreneur is therefore an agent of change. He seeks to improve the deployment of resources which are rare by virtue of the offer and of the demand.

This definition is valid, whatever the institutional framework under consideration. The entrepreneur is not a characteristic of the capitalist economy. The entrepreneur may even be the planner of a socialist economy, a priest, or a monarch in a traditional society. In reality, though, the function of the entrepreneur is closely identified with the privately owned firm in a market economy.

Entrepreneurial success is conditioned by information and by the family. Information includes profit opportunities. What are the exploitable markets available or to be created? The family constitutes a notable source of potential information. The knowledge contained within even his own family can be turned to advantage. But success is limited by the extent of the family fortune and by the extent of competences available within the family. The entrepreneur is confronted with multiple barriers to entry:

1. The personal fortune of the entrepreneur is often insufficient; informal contacts with the family, friends, and business partners are important for amassing capital or contracts with financial intermediaries.
2. Collecting information is difficult; outside of the family, clubs and associations constitute the most important nonprofit institutions, thanks to which individuals can secure contacts and assemble the information necessary to the launch of their enterprise.
3. The educational and training level of the entrepreneur plans an important part: the qualifications obtained play a very important role if he is to pass beyond the constraints imposed by the absence of a personal fortune.

Casson sets out the qualities required to be an entrepreneur; nothing new since J.-B. Say is noteworthy: capacity for negotiation, capacity for organization, capacity for management, capacity for selling, and capacity for innovation. But what then are the reasons why an individual can turn into an entrepreneur?

1. The first reason invoked that one becomes an entrepreneur because there is no job vacant. In other terms, setting up one’s own business can constitute the only way out of an unemployment situation, which is provoked, for example, by trade unions which have set a rate of pay too high to allow employers to recruit.
2. The individual can refuse to be placed under the control of a superior who may impose on him one task or another independently of his own aspirations.
3. The individual may only be seeking a part-time job, to earn some extra money, or may become an entrepreneur as a complement to a salaried activity, as a pastime.
4. The main reason that leads an individual to become an entrepreneur is that he will find thereby the autonomy he needs to exploit his talents.

Among these four arguments, the fourth is the only positive one. The first three reflect negative aspirations. The individual then acts in the quality of "employer of last resort" for himself, and there is little chance of succeeding for the following reasons:

1. An individual who considers that it is difficult to find employment in a competitive situation, or to preserve his employment once he has obtained it, will probably not have the personal qualities required to succeed in business.
2. An individual who cannot stand the idea of being employed will probably not be capable of employing other people, thus limiting very rapidly the growth prospects for his firm.
3. An individual who insists on working as he wishes will certainly not provide his customers with the quality of service they except, which will limit the chances of survival of his firm.
4. One can equally well think that an entrepreneur without salaried experience will be seriously penalized. In order to succeed, it is advisable to start out as a salaried employee. People in such position can learn the business of their employer, before branching out on their own. They can put to good use the positive or negative experience acquired in their employer's firm.

There exists consequently a very close link between the condition of the salaried employee and that of the entrepreneur, to the extent that the first can constitute a kind of springboard to becoming an entrepreneur. Even more pertinent is that Casson wrote the fundamental traits of his thoughts at the beginning of the 1980s, a period during which the liberal policies introduced in the industrial countries sought, by the promotion of the spirit of enterprise, to attenuate the harmful effects of the unemployment which burst on the scene following massive redundancies and the failure of many businesses.

To arrive at creating one's own business, the demands are numerous: the capital (personal savings); what are the legal forms in which the firm may take shape (limited liability company, partnership. . .); and what is the level of institutional qualification, the professional experience of the entrepreneur (has he been salaried before venturing into entrepreneurship). On what networks of relations, personal, family, and professional can he depend? The question of capital always poses problems. It is difficult to borrow because potential lenders do not necessarily share the enthusiasm or the anguish of the entrepreneur. To skirt round such obstacles, Casson affirms that it may be preferable either to take an executive position or to save up for the needed capital by taking on some routine work before committing oneself to a career as an entrepreneur. He adds that there exist a large number of organizations (especially the great conglomerates) which specialize in the selection of entrepreneurs. This signifies also that the creation of a firm is not only an individual decision, but it is also closely linked to the dynamism of the economy, and vice versa. The greater the number of new businesses in an economy, the more it is capable of renewing itself and consequently of developing further. This filtering of new vocations is carried out principally through qualifications obtained at university, in business schools, or professional associations. The educational system also plays an important role in the development of entrepreneurial capacities. To find the capital necessary for launching a business, the entrepreneur may have recourse to the banks, but these are not always favorable to the financing of entrepreneurial projects. According to Casson (Casson, 2003), the principal alternative to the bank remains the family. But the family such as conceived here has nothing in common with the 200 families that became shareholders in the *Banque de France* in the 1930s!

Two principal factors make the family an effective substitute for the bank or for all other forms of institutional finance in the creation of a business. First of all, a family develops over several generations. The most senior generation can thus offer finance to the youngest. Then, the lenders commit their capital with confidence because of the positive image they have of the family. But, one can also ask why today many new entrepreneurs create their firms without even looking for help from the public. It is often through ignorance but also because such entrepreneurs, coming from modest backgrounds, and which constitute a good proportion of new entrepreneurs, mobilize forces they know and which they can influence. Two networks to support the creation of new businesses exist, one institutional, the other informal. They can be complementary (as is often the case), but it can be noticed, particularly in cases of firms created by entrepreneurs with few or no qualifications, that family networks easily win the day over the institutional networks.

If the family defaults, the other solution consists for Casson for the would-be entrepreneur to work still harder and save even more. He gives up his leisure and renounces consumerism so as to get more rapidly the extra funds he needs for investment. Leisure is among the least important functions for the entrepreneur, not only on account of the very nature of his activity (it is often difficult to define the boundary between work and leisure) but also because the entrepreneur has something to prove to others, that is, that his judgment is correct.

D. B. Audretsch: The Entrepreneurial Society

At the beginning of the 1980s, D. A. Audretsch (with Z. Acs) (Acs and Audretsch, 1988) focused his attention on innovative small and medium enterprises. This represented an important segmentation in theoretical terms. Since the beginning of the nineteenth century, for many economists, only big enterprises had been innovative. During the period 1960–1970, J. K. Galbraith and A. Chandler had demonstrated the superiority of large firms in producing new technologies and knowledge. Galbraith underlines that it is not the entrepreneur who put man on the moon but a whole organization. Galbraith points his attention towards economic and technological convergences between capitalism and socialism. Both are based on large firms, and State regulation plays an important role. So, in a very famous article (published in 1988), Audretsch and Acs showed the important capacity of small enterprises to innovate in certain specific industrial sectors (e.g., microelectronics and microinformatics).

During the period 1980 up to the 1990s, Audretsch (Audretsch, 2007) centered his analysis on university spillovers. He showed that innovative small enterprises are localized in very specific geographic areas around university centers. He focused his analysis on various new technology sectors (e.g., biotechnologies). He analyzed deeper relationships between academic research and entrepreneurship. So, small and medium enterprises play an important role in developing new activities in very specific sectors (knowledge-intensive). They are not the result of the collapse of heroic capitalism. They contribute actively to producing new technologies and knowledge.

But, an important part of Audretsch's research program is concentrated on the evolution of capitalism. Political events at the end of the 1990s (fall of the Berlin wall and the end of the USSR) gave capitalism a new geographical and social area of expansion. Since the 1990s, capitalism has been the only economic and social organization. But, at the same moment, the structural organization of capitalism has changed: small enterprises are taking a new place in capitalist countries. Governments are developing new policies to support entrepreneurship. For Audretsch, a new balance has to be developed between political and economic democracies. Politically, western countries (in Europe, as in America) are democracies. But, during the 1950s–1970s, their economies were very concentrated on the economic power of a small number of big firms, especially in the United States. So, it was essential to create a real balance between political and economic democracies – in other words, between political decentralization and economic decentralization of power. In a capitalist society, the entrepreneur must to have the opportunity to develop his (or her) activities, to create new jobs and new (innovative) activities.

So progressively, the nature of capitalism has changed. Market regulation replaces state regulation (or Keynesian regulation). For Audretsch, a new society has appeared: the entrepreneurial society. It is not a society where large firms have disappeared, but a society where people have opportunities to create a business and where the governance of large firms has changed. They have adopted entrepreneurial behavior. Competition in the new context is based not on prices (like during 1950s–1970s) but on innovation. So, large firms have to be more creative.

This evolution of capitalism is taking place in an historical context. After the Second World War, the objective was to produce goods and to rebuild the economies of western countries (to face the communist threat). Since the end of the 1970s, world economic competition has changed. New economic actors (in Asia, but also in South America) have taken their place in world markets. In this context, to keep their place in world markets, developed countries must innovate. World competition is based on innovative products and services. In this context, the entrepreneur according to Audretsch is still a hero.

Conclusions and Future Directions

It is illusory to try and search in the economy for an entrepreneur labeled Schumpeterian, Hayekian, or others. The entrepreneur is not embodied in a specific personality. Since Cantillon, up to the present day, it is in terms of the function of the entrepreneur that we must speak or, still more, conceive the entrepreneur as a type of ideal, to revert to the categories of Max Weber. The function of the entrepreneur is to schematize the mechanism for change and for the introduction of innovations. The essential question is to highlight the mechanism due to which the creation of new knowledge is achieved. As an attentive observer of the economic, social, and technological world which surrounds him, the entrepreneur has the capacity to detect new investment opportunities which could prove to be sources of profit. Investment opportunities stem from situations of uncertainty, which in their turn originate from competitive movements between firms. However, to detect an investment opportunity is not a guarantee of profit. Numerous entrepreneurs, yesterday and today, have failed in the process of creating a business in an activity a priori rich in positive prospects.

Cross-References

▶ Business Cycles
▶ Entrepreneurship and Business Growth
▶ Environmental Determinants of Entrepreneurship
▶ Heroic Entrepreneur, Theories
▶ Individual Determinants of Entrepreneurship
▶ Industrial Atmosphere
▶ Schumpeterian Entrepreneur

References

Acs ZJ, Audretsch DB. Innovation in large and small firms: an empirical analysis. Am Econ Rev. 1988;78(4):678–90.

Audretsch DB. The entrepreneurial society. Oxford: Oxford University Press; 2007.

Boutillier S, Uzunidis D. L'entrepreneur. Une analyse socio-économique. Paris: Economica; 1995.

Casson M. The entrepreneur: an economic theory. 1st ed. Cheltenham: Edward Elgar; 2003.

Hayek F. The Road to Serfdom. Chicago: Chicago University Press, 1994 (first edition 1944).

Hayek F. The constitution of liberty. 1st ed. Chicago: Chicago University Press; 2011 (first edition 1960).

Kirzner I. Competition and entrepreneurship. Chicago: Chicago University Press; 1973.

Knight FR. Uncertainty, and Profit. Boston: Houghton and Mifflin; 1965.

Societal Transformation

▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy

Society and Entrepreneurship

▶ Entrepreneurship and Social Inclusion

Society-Nature Interactions

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Socio-ecological Transition

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Sociology of Innovation

▶ Actor-Network-Theory and Creativity Research

Sociology of Translation

▶ Actor-Network-Theory and Creativity Research

SOHO

▶ Microfirms

Sozidolinguistics

▶ Creative Linguistics

Sozidonics

▶ Science of Creativity

Speaking

▶ Speaking Pictures: Innovation in Fine Arts

Speaking Pictures: Innovation in Fine Arts

George S. Campbell
Vienna, Austria

Synonyms

Art; Communication; Fine art; Graphic; Intelligence; Language; Pictures; Speaking; Visual

Introduction

Quite often innovations are discovered when a researcher is developing a new theory and realizes that this theory can be applied to an innovation in another discipline. Such was this case in which a theory to categorize intelligence could be applied to graphic art. So this entry will start at the beginning with intelligence.

Although intelligence itself cannot be satisfactorily defined, it is at least possible to describe various aspects. Until recently the prevailing opinion, attributed to Freud, was that people have a consciousness, which harbors the light of intelligence and rationality, and a subconsciousness, an unfathomable dungeon which harbors the dark forces of primeval drives. But this division was artificial since most of people's daily activities are performed by their minds without troubling them with conscious mental activity (how much time does a person spend thinking about breathing, walking, not tripping, not bumping into things, keeping his heart beating, or digesting his food?); indeed, almost everything people do is without consciously thinking about it. In the section on orders of intelligence, the current opinion will be presented that, within the brain, consciousness is spatially multiple but temporally singular. This temporal singularity is called awareness, and it is the tip of a mental iceberg that shifts with the ebb and flow of consciousness. There is no sharp distinction between consciousness and subconsciousness; there is only a continuum of awareness.

There are, however, domains of intelligence for which a specific type of intelligence can be identified. The types of intelligence which will be discussed in this introduction are the lingual (language) and the sensual: visual (sight), auditory (sound), olfactory (smell), gustatory (taste), and tactile (touch). Of course intelligence can be viewed from different perspectives, which will be discussed later, but the aforementioned classification is most useful for the present considerations. It will be demonstrated that these types of intelligence generally process data independently and can even arrive at results which are conflicting. Nevertheless, by defining domains of intelligence and grouping these domains into environments, a powerful tool is obtained that enables one to define a partial ordering for intelligence which produces some rather startling results.

Types of Intelligence

Since language is the most pronounced characteristic that distinguishes humans from animals, the prevailing opinion of many scientists and philosophers has been and still is that language is the essence of intelligence; indeed, language and intelligence could somehow be considered equivalent. Especially written language, the written word was mystic. "In the beginning was the Word, and the Word was with God, and the Word was God" (the Gospel according to Saint John). Plato considered the word to be the essence of reality, the object itself being only a virtual reflection. Human ancestors even considered the word to be so powerful that words for dangerous objects were avoided. For example, the word "bear" derives from the same root as "brown," because they were afraid to call it by its original name "*árktos*" or it might hear its name and appear, and no one wants a bear in his tent. But bears, not being as clever as humans, would not realize that they were being called "brownies."

Although language often dominates our thoughts, especially when writing a book, there are other forms of nonverbal intelligence which are just as important to the entire complex of intelligence; some of these types, such as visual intelligence, are even more powerful than the lingual intelligence. The intention in this introduction will be to review types and limitations of intelligence as a preparation. For the purpose of the discussions, "intelligence" will include perception, reasoning, memory, and all associated processes.

Are animals intelligent? Anyone who has pets, particularly the ubiquitous cats and dogs, would certainly agree that they are. At least cats are not too stupid to come in out of the rain. But even the doubters must agree that the primates, especially chimpanzees, demonstrate behavior which must be considered intelligent. Yet these animals do not have languages, although they do have a limited communication consisting of grunts, whistles, and grimaces. For a long time, some scientists thought that chimpanzees must be intelligent enough to use at least a simple language, the only inhibitor being their inferior vocal cords. The results have been disappointing and inconclusive at the best. The problem is not that chimpanzees lack vocal cords, but that they lack a language center in their brains. What is apparent here is that intelligence is possible without language. In fact there are different types of intelligences, and to each of these intelligences, there is an associated art form.

Before continuing, it is necessary to do the impossible and define art, but first consider the following questions:

1. Is an alpine scene in nature art?
2. Is a photograph of this scene art?
3. If the photograph were from Ansel Adams, would it be art?
4. Would a painting of the same scene be art?

Definition: *Art is an intentional form of communication directed to one or more of a person's sensual intelligences.* Thus, music is communication to the auditory intelligence, pictures to the visual, etc. Now it is possible to answer the questions:

1. An alpine scene, however beautiful, is not a form of communication; it simply is there and thus not art.
2. If the photograph is simply a snapshot to remind the viewer of a pleasant trip, similar

to an entry in a diary, then it is also not intentional communication to a sense and is not art.

3. Ansel Adams was a talented photographer, and his published photographs were definitely an intentional communication to the visual and even emotional senses. Certainly art.
4. It is impossible for a painter to simply record a scene as a camera; he must always interpret it, thus art.

Note that art must be directed at one or more *sensual* intelligences. Thus, a communication wholly within the domain of lingual intelligence, such as a mathematical textbook, is not art. Poetry, however, which is communicated in language but directed at our sensual intelligences, is art. In the preceding only the concept art has been defined and not quality. In evaluating the quality of any work of art, three basic questions must be asked (Perrine 1987):

1. What is its central purpose?
2. How fully has this purpose been accomplished?
3. How important is this purpose?

(2) should be rephrased as:

2) How effectively has this purpose been communicated?

The first question must be asked in order to understand the work of art. Questions (2) and (3) are those by which it can be evaluated. Some critics have objected to the use of such terms as "purpose" and "intention" altogether; no one can know, they maintain, what was attempted in the work of art, only what was done.

This view is questionable. The artist must have a purpose to produce any work of art, although an outsider may not be able to determine it, which makes it more difficult to understand and evaluate the art. The results of any randomizing process may be pleasant, but they are not works of art. Since this is often not understood, especially by the undiscerning, the gates are wide open to charlatans. It is easy, maybe even fun, to dump a bucket of gore on a canvas and wallow around on it in a marijuana trance, but the result is not art (unless the purpose of the creator is to present chaos, but even this is debatable), although a clever perpetrator may sell it by the meter to enthusiastic New York matrons and then wallow in fame and riches.

It is obvious that computers, which, in spite of the advances of artificial intelligence, do not even remotely possess intelligence, cannot produce art. This is often confused because artists use computers as tools to produce art, but it is the human and not the computer who is the artist.

Can animals, which are intelligent, produce art? This is a difficult question to answer. There was a female chimpanzee at the Viennese zoo that painted pictures which were selling briskly, primarily due to their novelty, the proceeds being donated to the zoo. If you watched the chimpanzee, you noticed that she spent about as much time sucking on the paint brushes and licking the paint (which was food coloring) as she did spreading the paint nonchalantly over the paper. It appeared that she had no intentional purpose, but who knows? Eating some of her own "art work" is no criterion because, after all, cooks do it too.

The previous discussion of art was necessary in order to understand why types of art are associated with types of intelligence. The following is a brief discussion of several types of intelligence and is not intended to be rigorous, since the main purpose of this entry is to present a specific artistic innovation which is in the next section. However, this discussion will help to provide a better understanding of the prerequisites necessary for the innovation.

Visual intelligence: associated with sight
Auditory intelligence: associated with hearing
Olfactory and gustatory intelligence: associated with smell and taste
Tactile intelligence: associated with touch

Other Types of Intelligence?

In addition to the five classical senses, there are also various organic senses such as hunger, thirst, fatigue, or balance, which are also necessary for the entire complex of intelligence but which will not be covered since they have no direct influence for the further development. In order to make this distinction more exact, the following definitions must be introduced:

1. A *sensual intelligence* is a type of intelligence corresponding to one of the five classical senses.
2. A *monitoring intelligence* is a type of intelligence corresponding to one of the other organic senses.

The approach taken up to now has been reductionistic. If there were a good understanding of intelligence, a holistic approach might be better, but there is not. Thus intelligence has been reduced to types because this will make it possible to draw some very remarkable conclusions.

Of course there are other useful approaches to partitioning intelligence, one of the most influential being that of Howard Gardner.

Gardner's influential 1983 book *Frames of Mind* (Gardner 2011) was a manifesto refuting the IQ view; it proposed that there was not just one, monolithic kind of intelligence that was crucial for life success but rather a wide spectrum of intelligences, with seven key varieties. His list includes the two standard academic kinds, verbal and mathematical-logical alacrity, but it goes on to include the spatial capacity seen in, say, an outstanding artist or architect; the kinesthetic genius displayed in the physical fluidity and grace of a Martha Graham or Magic Johnson; and the musical gifts of a Mozart or Yo-Yo Ma. Rounding out the list are two faces of what Gardner calls "the personal intelligences": interpersonal skills, like those of a great therapist such as Carl Rogers or a world-class leader such as Martin Luther King, Jr., and the "intrapsychic" capacity that could emerge, on the one hand, in the brilliant insights of Sigmund Freud or, with less fanfare, in the inner contentment that arises from attuning one's life to be in keeping with one's true feelings.

The abilities related to personal intelligences can be expanded into five main types:

1. Knowing one's emotions
2. Managing emotions
3. Motivating oneself
4. Recognizing emotions in others
5. Handling relationships

These abilities then enable the four separate skills of interpersonal intelligence:

1. Organizing groups
2. Negotiating solutions
3. Personal connection
4. Social analysis

The advantage of Gardner's partitioning of intelligence is that it allows a person to recognize his own potential deficiencies for success. Indeed Gardner's concepts are being used in experimental classes in some schools to improve student performance.

In this entry, emotions and feelings are not classified as intelligences but as aspects which are necessary for intelligence, and are included with other aspects, such as drives and instincts, which are also necessary. In his book, *Descartes' Error* (Damasio 1994), Antonio Damasio demonstrates that patients with specific brain lesions that hamper their emotions also suffer loss of their reasoning ability. In fact he states that "Reduction in emotion may constitute an equally important source of irrational behavior" (p. 539). The reason for this is that persons usually do not have sufficient information to make logically "correct" decisions but must rely on gut feelings to come to a conclusion. Patients who have brain lesions that diminish the processing of emotions may remain intelligent, as far as IQ tests are concerned, and knowledgeable, but incapable of making decisions because they cannot include emotions and feelings in the process.

An emotion is a psychical reaction to a specific situation or experience, whereas a feeling is the mental awareness of a bodily state. Although there are many emotions, the primary feelings are happiness, sadness, anger, fear, and disgust. It should be remembered that the brain and body communicate not only electrically through neurons but also chemically (hormonally) through the blood and that this communication is a feedback process, actually a cybernetic regulation. It is from this feedback that a person's brain becomes aware of his bodily state and feelings arise. For example, a person may experience the emotion of love, but whether he feels happy or sad depends on the reaction of the loved one to his emotion and the resulting bodily state. In artificial intelligence it would be easy to program emotions but impossible to program feelings with the current state of the art.

The important fact here is that reasoning does not just depend on an abstract process called logic, but also on human characteristics of emotions and feelings, characteristics that are generally considered animal as compared to the spiritual of thought.

Lingual Intelligence

Lingual intelligence is one of the most important types of intelligence for humans, especially if someone is writing a book. Indeed, some researchers have considered lingual intelligence to be the essence of intelligence, i.e., only if something can be verbally formulated as a concept can it be processed with intelligence. This idea that language and intelligence are somehow equivalent dates back to ancient Greece. Plato philosophized that one can only discover reality through reasoning (intelligence) in which one conceptualizes ideals that represent an a priori true reality which is eternal, as opposed to the world of our senses which is fleeting. This type of philosophy is called idealism.

Aristotle is also called the father of logic because he was the first person to formalize language to abstract the process of intelligence. This type of logic is called syllogistic logic (to draw a conclusion) and is used to deduce a conclusion from premises.

Since language seems to be such an essential element of our formal thought process, does this mean that one cannot have thoughts that cannot be verbalized (formulated in language)? The answer is yes if restricted to lingual intelligence, but no if the other types of intelligence are included. Because the other types of intelligence are neglected in schools and not generally recognized, this is why most people are so restricted in their thoughts by their own language and probably why creativity, which requires the other types of intelligence, is so rare. For an interesting theory on the origin of language, see *The Semi-Aquatic Theory* (Campbell and Campbell 2011).

Fortunately, this problem can be avoided by not defining intelligence but by defining the domains of each type of intelligence and then ordering these domains.

Definition: The *domain* for each type of intelligence of a specific individual (human or animal) is the range of phenomena which that type of intelligence can perceive and process. Specifically for each individual:

1. The domain of visual intelligence is the spectrum of visible light.
2. The domain of auditory intelligence is the range of audible sound.
3. The domain of olfactory intelligence is the set of odorous substances (according to Henning a mixture of the six qualities: fragrant, spicy, ethereal, resinous, putrid, and burned).
4. The domain of gustatory intelligence is the set of substances capable of being tasted (a mixture of the qualities: bitter, sour, salt, and sweet).
5. The domain of tactile intelligence is the physical state of the individual's immediate environment (the cutaneous qualities: pressure, pain, warmth, and cold).
6. The domain of lingual intelligence is the passive vocabulary of the individual. (This domain only exists for humans.)

Aspects of the Physical vs. the Conceptual Environment

Obviously there is a basic difference between the physical and conceptual environments. The physical environment exists in the physical world and is perceived by our respective types of intelligences through the interface of the corresponding senses. The conceptual environment, on the other hand, exists only in our minds and is perceived directly by our lingual intelligence without any interface to the outside world. This means that in order to communicate (or interact with the external environment) with lingual intelligence, a person must employ one or more sensory intelligences. This communication will be explored in detail because it will open new areas of artistic expression. The following is a list of the current types of sensory communication with examples:

1. Sight: only digital communication; e.g., alphabets, hieroglyphs, Chinese characters, sign language (ASL), heliographs, smoke signals, and signal flags
2. Sound: both analog, such as speech, and digital, such as Morse code
3. Smell: none
4. Taste: none
5. Touch: digital, such as Braille

The senses of smell and taste are too cumbersome to be used for viable lingual communication. The sense of touch is probably too inert for analog signals.

It is obvious that the only sensory signal which a human can produce, that has a high enough frequency to be suitably modulated, is sound (voice). This is the reason why the original lingual communication was speech. Nonetheless, light is also suitable for analog communication since the wave frequencies are even higher than those of sound. Now that the technical means exist, it would be possible to convert speech into a light spectrum and either project it into a room or display it on a screen. With practice one could understand this visual speech, although perhaps only a child would have the mental adaptability to master it. In any case this would open up a whole new range of graphical art, an art in which a person not only sees the forms and shapes but also sees them "speaking" to him through a modulation of the colors.

In the beginning probably abstract art with few objects would be the most convenient for such a speaking picture so that it would not be too confusing for the viewer. At first a blank screen with only a few words would be the easiest to learn, but then the pictures and language could be more complicated.

What is the point in all this, you might ask. This question is not relevant because one could ask what the point is in all art. Art communicates to the senses, and if it is possible to communicate to several senses in one picture, a major breakthrough has been achieved.

Quite often there are variations in existing art forms, but this represents a completely new artistic development. Truly a useful and challenging artistic innovation.

Conclusion and Future Directions

For more than 19,000 years, since the wonderful Paleolithic cave paintings of Lascaux, humans have been representing the world of their senses in graphical form, for esthetic, religious, and simply enjoyable reasons. There is no reason to doubt that graphic art will exist as long as humans do. However, since the cave paintings, there have been frequent changes in style (not always positive), but the results have always been basically similar: graphic art has remained a two-dimensional art form that has only been directed to a person's visual intelligence. Of course some graphic art contains written text, but this has always remained static. This entry presents a method of expanding graphic art to a means of addressing both the visual and lingual intelligences in a dynamic mode and should open up a whole new area of artistic representations and add a new facet to the developing knowledge society.

Of course the question arises whether this addition to graphic art is simply a novelty or is actually meaningful. A few decades ago, the answer would have been that it is only a novelty, but with the rapid advances in technology, it certainly has a future. It has been seriously predicted that within a few years, new dwellings will be constructed with an entire wall as a display, either LED or newer technology. This display wall will be used for TV and various types of information. When the wall is not in use, it has been suggested that it can be used to display pictures. Such a wall would be ideal for speaking pictures which are not intrusive such as sound is but can be enjoyed in pensive moments. The future looks bright for speaking pictures.

Cross-References

▶ Artistic Research
▶ Creativity and Emotion

S

- ▶ Creativity and Innovation: What Is the Difference?
- ▶ Creativity, Experiential Theories
- ▶ Linguistic Dimension of Creativity, Invention, Innovation, and Entrepreneurship
- ▶ Preparing a "Creative Revolution" – Arts and Universities of the Arts in the Creative Knowledge Economy
- ▶ Science of Creativity

References

Campbell GS, Campbell DFJ. The semi-aquatic theory: semi-aquatic evolutionary phase and environment, language development of modern humans. With a short epilog on conceptualized evolution, social ecology and the qintuple helix. Int J Soc Ecol Sustain Dev. 2011;2(1):15–30. IGI Publishing.

Damasio A. Descartes' error. New York: G.P. Putnam's Sons; 1994.

Gardner H. Frames of mind. 3rd ed. New York: Basic Books; 2011.

Perrine L. Sound and sense. San Diego: Harcourt Brace Jovanovich Publishers; 1987. p. 224.

Special Situation

▶ Entrepreneurship and Financial Markets

Spin-off

Pierre Barbaroux
French Air Force Research Center,
BA 701-EOAA/CReA, Salon Air-France, France

Synonyms

Carve-out; Leveraged buyouts; Sell-off; Split-offs; Split-ups

Definition

There exists a variety of definitions of what constitutes a spin-off organization (Pirnay et al. 2003). According to Carayannis et al. (1998), for example, a spin-off organization designates "a new company that is formed by individuals who were former employees of a parent organization (. . .) around a core technology that originated at a parent organization and that was transferred to the new company" (Carayannis et al. 1998: 1). Zhara et al. (2007) further suggested that a spin-off organization is "a separate legal entity that is set up to commercialize new technology that was originally developed by a university or an established corporation" (Zhara et al. 2007: 572). One should therefore discriminate between two types of spin-off organizations depending on the legal status and activity of their parent organizations: (1) corporate spin-offs and (2) academic spin-offs (e.g., university spin-offs).

Corporate Spin-Offs

Corporate spin-offs (CSOs) involve companies that encourage their managers and employees to establish dedicated organizations so as to commercialize new technologies (Chesbrough and Rosenbloom 2002; Jong 2006). CSOs are often based on the "separation of a subsidiary or division from its parent company by creating an independent company where the parent shareholders retain proportionate equity interest" (Uddin 2010: 43). More specifically, Zhara et al. (2007: 573) explained that corporate spin-offs "result from managers and employees' initiatives aimed at creating momentum for a new business or technology that falls outside the parent firm's skill base" (Zhara et al. 2007: 573). Spinning-off, therefore, enables the parent corporation to create value from the commercial exploitation of in-house knowledge and technologies not belonging to its core business portfolio. Incidentally, large corporations might be tempted to "reduce their size by spinning-off one or more division" (Veld and Veld-Merkoulova 2009: 407), considering spinning-off as a divestiture instrument that is likely to improve returns and create value for shareholders (Cusatis et al. 1993; Johnson et al. 1996). As Veld and Veld-Merkoulova (2009) argued, "in a spin-off, the shares of a firm's subsidiary are distributed pro-rata among shareholders of the company. No cash transaction takes place. After the spin-off, the shareholders of the parent company hold shares in both the parent company and the subsidiary" (Veld and Veld-Merkoulova 2009: 407). This might contribute to explain why corporate spin-offs are "viewed by the market as value-increasing" (Veld and Veld-Merkoulova 2009: 417), particularly when they (1) involve assets outside the core business of the parent firm and (2) are nontaxable.

CSOs should be distinguished from alternative methods of divesting assets, including sell-offs, leveraged buyouts, split-ups, split-offs, and carve-out. The main differences between the above divesting strategies can be stated as follows. With sell-offs, "the parent firm divests assets to a third party. The assets typically are exchanged for cash and/or other securities" (Nixon et al. 2000: 278). The foregoing transaction does not alter the size of the selling company but convert real assets into liquid assets, generating discretionary cash for shareholders. A leveraged buyout "is the purchase of the stocks or assets of a company, or a subsidiary of a company by an investor group that normally includes the management of the organization which is being 'bought'" (Woo et al. 1992: 433). With a split-up, "the shares of all the subsidiaries that comprise the firm are distributed," while in a split-off, "the parent's shareholders have to exchange the shares of the parent to obtain the shares of the subsidiaries" (Veld and Veld-Merkoulova 2009: 418, note 3). Consequently, in a split-up as well as in a split-off, the parent company disappears. Finally, in an equity carve-out, a cash transaction is realized between the public and the parent company since "shares of subsidiary are sold to the public" (Veld and Veld-Merkoulova 2009: 418, note 3).

Academic Spin-Offs

Contrary to corporate spin-offs, academic spin-offs (ASOs) never result from a divestiture strategy adopted by universities to reduce their size and improve their market-value. They represent "new entrepreneurial activities (...) set up by professors, young researchers, PhD students" (Chiesa and Piccaluga 2000: 331) who aim at translating scientific knowledge into innovative products, services, or technologies (Van Burg et al. 2008; Clarysse et al. 2007). Hence, academic spin-offs are necessarily "generated within academic contexts or private and State-owned research labs" (Chiesa and Piccaluga 2000: 331), their activities being oriented toward developing technical ideas or technology. Therefore, academic spin-offs are necessarily founded by – at least – one faculty member, staff member, student, or researcher who left the university to establish an entrepreneurial firm and exploit a discovery or technology he/she developed within the university (McQueen and Wallmark 1982; Smilor et al. 1990). As indicated by Zhara et al. (2007), "university spin-offs are created by academic entrepreneurs, faculty and graduate students to commercialize their discoveries. These firms are founded by one or more academic inventors (faculty or student or staff), who may (or may not) be currently affiliated with the academic institution and/or the firm, and is created based on a license or other agreement with an academic institution to transfer a core technology" (Zhara et al. 2007: 572).

Elaborating a typology of science-based entrepreneurial firms originated from a university, Pirnay et al. (2003) discriminated between four types of university spin-offs depending (1) on the status of individuals involved in the newly created science-based entrepreneurial firm (i.e., researcher or student) and (2) the tacit or codified nature of the knowledge transferred from university to the new venture (Pirnay et al., 2003: 358). Scholars also distinguish public research spin-offs established by universities from private research and technology (R&T) organization spin-offs. As Davenport et al. (2002: 241) argued, "it is relatively rare to find case studies of spin-offs from research and technology institutes (RTIs) that are not universities." Although both types of organizations produce scientific knowledge, the main differences between universities and RTIs reside in their respective research processes and objectives which, in turn, are determinative for the particular strategy adopted by researchers for transferring technology (e.g., spin-offs versus licensing) or raising funds (e.g., public money versus venture capital).

Basically, private science-based organizations, alike corporations, "aim especially at exploitation and application, are much more focused in trying, and appropriate research results (through patents, secrecy, etc.) as much as possible; very rarely (. . .) they produce knowledge *just* for the purpose of diffusing it" (Chiesa and Piccaluga 2000: 329). Subsequently, in contrast with public research labs at universities, private R&T organizations are likely to focus on short- and medium-term research associated with direct economic applications and returns. However, the foregoing distinction between private and public research-oriented organizations tends to disappear since public research laboratories are more and more involved in valorization and commercialization of scientific knowledge, adopting profit-oriented, short and medium terms, strategies (Chiesa and Piccaluga 2000; Pirnay et al. 2003).

Research Questions

There exists a vast literature on spin-off companies. Scholars focus on three sub-themes: (1) the motives and objectives attached to the creation of a spin-off company, (2) the performance of spinning-off a business unit or a technology for the parent organization as well as the new company, and (3) the implications of spin-offs for public policy (financial support, fiscal policy, innovation policy, etc.).

Motives

Spin-offs occur for a variety of reasons. By and large, scholars discriminate between two types of motives and/or objectives driving spin-offs' creation: (1) knowledge-oriented and (2) value-oriented. Regarding the first set of motives and objectives, it has been demonstrated that spin-offs facilitate the transfer and exploitation of knowledge by enabling universities and corporations to create separate organizational forms dedicated to the production and commercialization of new products and/or technology. Therefore, spin-offs are considered as an effective strategy for exploiting in-house knowledge and technology, providing their parent organizations with additional sources of revenue. Regarding the second type of motives, a corporation is likely to spin-off a business unit or a technology if it expects such divesture strategy will "have a positive effect on the shareholders value due to removal of diseconomies, increase in efficiency, and paying more attention to core business" (Uddin 2010: 43). Krishnaswami and Subramaniam (1999: 74) further argued that spin-offs generate "abnormal returns" even in the long run. Among the causes of the positive impacts attached to spin-offs, the authors mentioned "improvement in focus and the elimination of negative synergies, transfer of wealth from bondholders to shareholders, tax and regulatory advantages, and recontracting benefits after the spin-off" (Krishnaswami and Subramaniam 1999: 74).

Performance

Performance is a central research question addressed by scholars and students of university and corporate spin-offs. The question revolves around the identification of its *sources* and the definition of *performance indicators* attached to spin-offs which could be applied to evaluate the impact of spinning-off a technology, a business unit, or a division for the parent organization and/or the newly formed entrepreneurial firm.

By and large, performance measures are computed by using public information revealed by firms and/or available on stock markets. Investigating the long-run performance of a sample of parent firms identified from the stock distribution by firms trading on the NYSE, Amex, and NASDAQ, Hollowell (2009) demonstrated that, in the long run (4-year period), "spin-offs outperformed the market" (Hollowell 2009: 120). To arrive at this conclusion, the author used the following indicators: cumulative average adjusted returns calculated in excess of the market benchmark and buy-and-hold returns calculated for sample firms and market index. In the same vein, Klein and Rosenfeld (2010) compared the respective performance of conventional versus sponsored spin-offs. Contrary to conventional spin-offs, sponsored spin-offs need to raise external capital and receive cash flows from outside investors. Focusing on profitability measures (ROA), the authors indicated that "sponsored spin-offs are underperformers over the postevent periods" (Zhara et al. 2007: 243).

Early research on spin-off performance, however, tended to focus exclusively on parent organizations. Woo et al. (1992: 434) pointed out that few studies focus "on the performance of the divested units, rather than that of the divesting firms." Investigating divested units' performance, Woo et al. (1992) assumed "that *relatedness* between the divested unit and the prior parent firm" is likely to influence "post-spin-off performance" (Woo et al. 1992: 346). The definition of the concept of relatedness is based on "joint activities, resource sharing or cross-market coordination established upon a high degree of similarity along both supply and demand dimensions between the spin-off unit and the rest of the parent firm" (Woo et al. 1992: 346). Within this framework, the authors demonstrated that related subsidiaries exhibit better performance than unrelated ones. To reach such a conclusion, the authors adopted the following performance measures (Woo et al. 1992: 439): return on assets (i.e., net earning on total assets ratio), market-to-book ratio (i.e., market value/share on stockholders' equity/share ratio), and inflation-adjusted sales (i.e., annual compounded rate of growth of inflation-adjusted sales). Adopting a knowledge-based perspective, Zhara et al. (2007): 584 developed a comparative study of the performance of university spin-offs and corporate spin-offs using three performance measures: productivity (overall sales/full-time employees), profitability (i.e., return on assets), and revenue growth (i.e., year-to-year changes in a spin-off revenue multiplied by 100). Within this framework, the authors shed light on the role played by internal factors (e.g., resources, capabilities, network, and inheritance from parent organizations) in significantly shaping spin-offs' performance. In particular, Zhara et al. (2007: 594) demonstrated that CSOs outperformed ASOs since they "benefit from the skills transferred through their founders and employees who had worked for their parent corporations and maintained contacts with their friends and associates there." The foregoing enables CSOs' founders to mobilize prior experiences, networks, and connections (social capital) so as to access and absorb knowledge and fully realize commercial opportunities. De Cleyn et al. (2009: 53) confirmed that university spin-offs exhibit poorer performance merely because their founders "often lack industry experience (. . .) their managerial skills for leading a venture (which are different from those needed to lead a research group) (being) mostly underdeveloped." In addition, the authors explained that the publication-oriented culture, which characterizes researchers' mindset, "contrasts with a commercial attitude where trade secrets and hidden agendas sometimes play an important role" (De Cleyn et al. 2009: 53).

Public Policy

The implications of spin-offs for public policy have been documented by scholars and can be summarized as follows. First, policy-makers should lessen the barriers to technology transfer and commercialization by implementing a legal and fiscal environment (e.g., intellectual property protection, Bayh-Doyle Act) which encourages public and private investments in basic research and research and development (R&D). In many countries, "national policy has been changed to provide universities with intellectual property rights (IPR) ownership and a formal responsibility for the commercialization of patentable technologies" (Rasmussen and Borch 2010: 611). This has fostered innovation and growth in many different industries. Second, policy-makers aim at providing financial and relational supports for public research, and small-firms' R&D, which are expected to have (positive) impacts across industries (Cohen et al. 2002). In this way, policy-makers often provide individuals and companies with fiscal incentives (e.g., tax reductions) to support both ASOs and CSOs. They also facilitate the establishment of relationships between public agencies, industry funding, and venture capitalists so as to enable spin-offs' founders to access resources needed to face those complex problems occurring "at a point along a new high-tech venture's expansion path preventing it from achieving the transition from one development phase to the next" (Vohora et al., 2004: 159).

Empirical Evidence

Empirical examples of spin-offs are widespread in the literature (Klepper 2001; Veld and Veld-Merkoulova 2009). A few examples are presented here. Chesbrough (2003) documented 24 spin-off companies created by former researchers at Xerox's Palo Alto Research Center (PARC) from 1979 to 1998, some of which becoming leaders in their respective industry (e.g., Adobe, 3Com). Chiesa and Piccaluga (2000) also reported many examples of academic and corporate spin-off companies created in France, Sweden, Scotland, the Netherlands, the USA, and Italy over the last three decades. Debroux (2008) illustrated how university spin-offs emerge as an effective entrepreneurial strategy for developing and commercializing technology within the Japanese Innovation System, the latter being dominated by large corporations' laboratories and R&D facilities. Addressing the relationship between public research and industrial development, Feldman and Desrochers (2003) and Jong (2006) examined how the Johns Hopkins University (Hopkins), and the University of California (Berkeley), Stanford University (Stanford), and the University of California San Francisco (UCSF) promoted the formation of spin-off companies. While Hopkins had limited impact on regional development (Feldman and Desrochers 2003: 20), it has been demonstrated that UCSF played a critical role in the formation of the San Francisco biotech industry, while Stanford greatly influenced the emergence and development of the Silicon Valley high-tech electronics industry (Jong 2006: 277).

Conclusions and Future Directions

Fostering the creation, diffusion, and exploitation of knowledge raises critical challenges for policy-makers, corporate firms, and universities. Future research on spin-offs should be directed toward investigating how it integrates with other organizational forms facilitating knowledge transfer, innovation, and value creation. The development of effective organizational forms to exploit internal and external knowledge is likely to involve organizational changes at various levels. As Veld and Veld-Merkoulova (2009): 418 argued, an "interesting topic for future research relates to the fact that there are still many large conglomerates that combine many unrelated divisions (. . .) this raises the question of why these conglomerates are still in one piece." The divesture of a corporation's subsidiary or the creation of an academic entrepreneurial company, therefore, could be investigated from a design-oriented perspective. The foregoing would provide a framework for dealing with the various dimensions attached to the creation of spin-offs (e.g., public policies, fiscal incentives, funding issues, public-private partnerships). Considering the implications of the spin-off phenomena from an organization-design perspective would deepen our knowledge of the organizational and relational architecture supporting interactions between firms, universities, public agencies, and investors. In addition, special efforts could be dedicated to the identification of "good practices" associated with the creation of spin-off companies. The identification of good practices for both academics and corporations would enlarge our understanding of the factors influencing the performance of spin-off companies. Finally, most research efforts focus on technology-driven spin-offs. It would be interesting to go beyond technology-based and investigate service-based spin-off companies as a mean for academics and corporations to create value and generate additional revenue.

Cross-References

► Academic Firm
► Corporate Entrepreneurship
► Extrapreneurship
► Innovation Opportunities and Business Start-up

References

Carayannis E, Rogers E, Kurihara K, Allbritton M. High technology spin-offs from government, R&D laboratories and research universities. Technovation. 1998;18(1):1–11.

Chesbrough H. Open innovation. The new imperative for creating and profiting from technology. Boston: Harvard Business School Press; 2003.

Chesbrough H, Rosenbloom RS. The role of the business model in capturing value from innovation: evidence from xerox corporation's technology spin-off companies. Ind Corp Change. 2002;11(3):529–55.

Chiesa V, Piccaluga A. Exploitation and diffusion of public research: the case of academic spin-off companies in Italy. R&D Manag. 2000;30(4):329–39.

Clarysse B, Wright M, Lockett A, Mustar P, Knockaert M. Academic spin-offs, formal technology transfer and capital raising. Ind Corp Change. 2007;16(4):609–40.

Cohen WM, Nelson RR, Walsh JP. Links and impacts: the influence of public research on industrial R&D. Manag Sci. 2002;48(1):1–23.

Cusatis P, Miles J, Woodridge JR. Restructuring through spin-offs: the stock market evidence. J Financial Econ. 1993;33:293–311.

Davenport S, Carr A, Bibby D. Leveraging talent: spin-off strategy at industrial research. R&D Manag. 2002;32(3):241–54.

De Cleyn SH, Jacoby A, Braet J. Success factors in new product development: how do they apply to company characteristics of academic spin-offs? J Priv Equ, Winter; 2009. pp. 51–61.

Debroux P. Innovation in Japan: what role for university spin-offs? Asia Pacific Bus Rev. 2008;14(3): 443–60.

Feldman M, Desrochers P. Research universities and local economic development: lessons from the history of the John Hopkins university. Ind Innov. 2003;10(1):5–24.

Hollowell BJ. The long-term performance of parent firms and their spin-offs. The International Journal of Business and Finance Research. 2009;3(1):119–29.

Johnson SA, Klein DP, Thibodeaux VL. The effects of spin-offs on corporate investment and performance. J Financial Res. 1996;19(2):293–307.

Jong S. How organizational structures in science shape spin-off firms: the biochemistry departments of Berkeley, Stanford, and UCSF and the birth of biotech industry. Ind Corp Change. 2006;15(2):251–83.

Klein A, Rosenfeld J. The long-run perfomance of sponsored and conventional spin-offs. Financ Manage. 2010:227–47.

Klepper S. Employee startups in high-tech industries. Ind Corp Change. 2001;10(3):639–74.

Krishnaswami S, Subramaniam V. Information asymmetry, valuation and the corporate spin-off decision. J Financial Econ. 1999;53:73–112.

McQueen DH, Wallmark JT. Spin-off companies from Chalmers University of technology. Technovation. 1982;1:305–15.

Nixon TD, Roenfeldt RL, Sicherman NW. The choice between spin-offs and sell-offs. Rev Quant FinanceAcc. 2000;14:277–88.

Pirnay F, Surlemont B, Nlemvo F. Toward a typology of university spin-offs. Small Bus Econ. 2003;21:355–69.

Rasmussen E, Borch OJ. University capabilities in facilitating entrepreneurship: a longitudinal study of spin-off ventures at mid-range universities. Res Policy. 2010;39(5):602–12.

Smilor RW, Gibson DV, Dietrich GB. Spin-out companies: technology start-ups from UT-Austin. J Bus Ventur. 1990;5(1):63–76.

Uddin H. Corporate spin-offs and shareholders' value: evidence from Singapore. The Int J Bus Finance Res. 2010;4(4):43–58.

Van Burg E, Romme G, Gilsing VA, Reymen IMM. Creating university spin-offs: a science-based design perspective. J Prod Innov Manag. 2008;25:114–28.

Veld C, Veld-Merkoulova YV. Value creation through spin-offs: a review of the empirical evidence. Int J Manag Rev. 2009;11(4):407–20.

Vohora A, Wright M, Lockett A. Critical junctures in the development of university high-tech spinout companies. Res Policy. 2004;33(1):147–75.

Woo CY, Willard GE, Daellenbach US. Spin-off performance: a case of overstated expectations? Strateg Manag J. 1992;13:433–47.

Zhara SA, Van de Velde E, Larraneta B. Knowledge conversion capability and the performance of corporate and university spin-offs. Ind Corp Change. 2007;16(4):569–608.

Split-Offs

▶ Spin-off

Split-Ups

▶ Spin-off

Startup

Marian Wielezynski
Université du Littoral (RRI Dunkerque),
Consulting-European Union, Beauvais, France

Synonyms

Age zero firm; Dotcoms; Gazelle

A startup company is a company that is in the first stage of its operations, mainly in the fields of information technology. The products, systems, or services (PSS) involved in those operations aim at satisfying needs in consumption as well as in production goods sectors. In the late 1970s, the most common type of startup company is producing electronic devices such as microprocessors and digitalized circuits (hardware). Then, in the late 1980s, appear startup companies producing standardized programs and operating systems (software). In the late 1990s, hardware and software converge through the Internet into a specific pattern of companies known as "dotcom" companies. From then on, the concept of startup company becomes widely used to name those specific structures.

Particularly, the financing is rather innovative. Special money named seed capital is the capital used for financing projects during their startup phase, before production commences (research, market studies, etc.). It is provided by specialized funds, business angels, etc. What the financiers take into account are:

– An opportunity of investment, identified by some entrepreneur(s)
– A product, a system, or a service (PSS), designed to satisfy the identified need
– Ownership of the main features of this PSS by the entrepreneur (patent, copyright, skills)
– Advantages of the investment linked to specific technological features
– Benefits for customers and clients in terms of safety, health, communication, time optimizing, and money saving
– Reliable elements from the market research on this PSS showing it will sell well

The business plan gathers all this information to convince investors. A venture capital investor or investment pool will provide funds to an enterprise on the basis of this business plan detailing the product, system, and service (PSS) and the background of the management group. At this very moment, the earliest stage at which a plan becomes operational, a startup is born. It is an "age zero firm." Then, some projects reach the critical size and develop by themselves, others do not and fail. Why? The answer must be found in the conditions of what is called now the "business model" (Chesbrough and Rosenbloom 2001).

Startup entrepreneurs do not come out from nowhere. They were incubated in some place and territory where they decided to do it their way. The transition from startup inspiration to creative incubation, before hatching out, deserves some reflection. Moreover, the consequences on job net creation by startups should catch more attention from the observers.

Startup Incubation: From Conventional Business Plan to Alternative Business Model

Enhancing entrepreneurship through public institutions in numerous fields appears as a new practice in the USA in the years 1960s, taking the shape of "business incubators." In the USA, there are currently 1,200 of those centers, usually managed by universities, hosting 41,000 startup companies (NBIA 2011). The methods of "incubators" are now being benchmarked. Incubated companies know how to take advantage of finding in those institutions professional assistance and service providers to fulfill their business needs.

Institutional incubators help all kinds of projects to emerge in many sectors, not only in the Internet. The concept of startup companies appears later than the "incubators," surprisingly enough heading for "accelerators," nowadays. Among the incubated projects sustained by the institutions, some of them are featured for new technologies of information and communication, linked with electronic devices. Those PSS show intense responsiveness to customer's wants. They give birth to the burgeoning home and desktop computer industry. By the end of the twentieth century, startup and "dotcoms" surge as new categories of economic phenomenon. The very places of their birth happen to be not necessarily in the "business incubators" which were set up through the USA, inside the universities and their campuses. The first shelter of startup companies would be well homes and garages. But modern economic history shows also many examples of successful existing companies giving birth themselves to "spin-off" enterprises. Some significant startups appeared indeed in large privately owned enterprises. New entrepreneurs inside those companies define themselves against the dominant internal culture, by opposing current beliefs, expectations, and governance. These ambitious executives have new ideas for technological and economic alternatives but are getting frustrated with the lack of incentive felt in their professional environment. At the same time, they know – and even participate in – the building of a successful and well-established business model, thus acquiring experience. Hence, innovation comes as the result of applying well-known features issued from a successful model whose methods and forces are assimilated by the startup entrepreneur to a new venture of his own. The startup enterprise appears in an environment where some changes are to be introduced, according to the entrepreneur. If this is impossible, creating a startup with a new business plan, and soon a new business model, becomes the contradictory alternative solution. Most successful startups pivot to new decisions at least once from the ongoing business plan.

A good business incubator can be a firm rather than a public state-owned institution, that is, a place where the cold winds of competition stimulate instinct for survival of the securely employed executive, on one hand, and, on the other hand, stimulate as well appetite for fame and fortune of the nascent entrepreneur. Which of the contenders will come out on top in the struggle for innovation? Large companies tend to inhibit pivoting for their "internal startups." An exception to the rule is presented with Xerox and the features of their governance.

Xerox 914: The Stem Cell of Startups Odyssey

The model 914 has no future in the office-copying-equipment market. It is too costly. This is a unanimous opinion shared by consultants (Arthur D. Little) and big companies (General Electric).

But on September 26, 1959, Xerox (ex-Haloid) brings the 914 to market by itself, surmounting the obstacles of high cost by using an innovative business model. Instead of selling the equipment, Xerox offers customers a lease. A customer needs only to pay $95.00 per month to lease the machine, promising to pay 4 cents per copy beyond the first 2,000 copies each month. Xerox would provide all required service and support, and the lease could be cancelled on only 15 days notice.

It is successful. The actual consumption reaches rapidly 2,000 copies a day (not a month). The technology of electrophotography allows very high speed, and new models appear increasing faster and faster the number of photocopies swallowed by contemporary societies and paying fees to Xerox. Xerox' revenue grows at an astonishing compound 41% rate for a dozen years, turning $30 million Haloid Corporation (now Xerox) into a global enterprise with $2.5 billion in revenues by 1972.

Meanwhile, in 1968, C. Peter McColough (1922–2006), who had led sales and marketing of the 914 against winds and tides at the beginning, is appointed chief executive of Xerox. As the growth of copier revenues begin to flatten at the end of the 1960s, McColough sets a new direction toward "the architecture of information." His first steps toward realizing this vision is to enter the computer business in 1969 by establishing the Palo Alto Research Center (PARC) in 1970 to lead the way technologically for the future of desktop computing and startups Odyssey.

Three Business Models and a Failure

In the 1970s, many startups are created for the purpose of commercializing one or more technologies developed within the corporate research laboratories. Xerox is then acting willy-nilly as an incubator. Chesbrough and Rosenbloom (2001) identify 35 spin-off companies between 1979 and 2000 emanating from the corporate research laboratories of Xerox.

Three of those startups create significant economic value, and they do it mainly in opposition with the business entity they stem from, thus pivoting to an innovative business model.

3Com: Large Scale Sales Versus Selective Distribution

Robert Metcalfe (1946–) is hired in 1973 by PARC to promote a technology to link Xerox printers and workstations to DEC minicomputers. Spurred by Metcalfe's efforts, Digital, Intel, and Xerox form an alliance (DIX) to define a standard for Ethernet LAN communication and to promote its widespread adoption as an "open standard" by the computer industry. Armed with the DIX alliance, 3COM starts up seeking venture capital in order to begin developing hardware products in October 1980. The search pays off in February 1981, with first round funding of a million dollars from investors who look beyond the business plan and are attracted by Metcalfe's vision and charisma.

By 1982, the minicomputer market for Ethernet begins to take off.

3Com realizes much greater success in the IBM PC marketplace, selling Ethernet adapter cards to be installed in corporate networks running Novell's operating system. The core value proposition becomes the ability to share files and printers via an Ethernet also compatible with the nascent IBM PC standard.

Yet, Metcalfe continues to focus on the emerging desktop market, but Xerox does not follow him. He quits.

Metcalfe had originally expected 3COM to follow the Xerox-like business model of an integrated manufacturer with its own direct sales force, which is then the prevalent pattern in the industry. After leaving Xerox, however, he has compiled with his wife a directory of independent vendors of local area computer networks across the USA. From now on, 3Com distributes its products through independent resellers, giving up the idea of direct sales force distributing the products, systems, and services (PSS) to selected consumers.

Thus, the key ingredients in what emerged as the working definition of 3COM's business model stood in sharp contrast to the Xerox model of exploiting unique proprietary technologies through a direct sales system to a group of known customers. The latent value in the Ethernet technology really did not materialize until the technology was targeted at a different market, offering a different value proposition and utilizing an open technology platform, and sold through a new set of distribution channels.

Adobe: From Postscript to PDF

The spin-off of Adobe from Xerox follows a path similar to that of 3Com. Adobe's founders, Charles Geshke (1939–) and John Warnock (1940–), left PARC in 1983, after an argument with Robert Adams, then the head of Xerox's printing division, in order to commercialize a page description language that becomes their first product, PostScript. PostScript allows printers to use digital fonts to reproduce a wide variety of characters generated from a PC. Adobe Systems, Inc. went on to become a public company 4 years later and continues to operate as an independent company with a valuation exceeding $12 billion in 2011.

The technology embodied in PostScript came from Interpress, a page description software developed at Xerox PARC. Interpress was an internal, proprietary protocol used to print fonts generated from Xerox workstations on Xerox printers. Warnock and Geschke argued with Adams over whether to make Interpress into an open standard, as Ethernet was then becoming. As Geschke remembers it, "Certainly, within Xerox, none of this was going to happen. They wanted to have an industry standard, but they wanted to control everything at the same time."

Adobe's initial business plan contains many elements that were similar to the model then dominant at Xerox, but subsequent events forced the founders to change it. As Geschke recalls:

> Our original business plan was different. We were going to supply a turnkey systems solution including hardware, printers, software, etc. With this in hand, we were then going to build a turnkey publishing system. It turns out other people were trying

> to do this at the same time – there would have been a lot of competition if we had gone this route. . ..
>
> In many respects Steve Jobs (1955–2011) was key ingredient in getting things going the way they did. Steve came to us and said, "we don't want your hardware, just sell us the software". We said, "No!" Later Steve came back and said, "OK, then just license it to me". That's how the business plan formed. It wasn't there in the beginning.

Then, selling font libraries to computer and printer office equipment manufacturers (OEM) like Apple and Hewlett-Packard requires very different resources to execute. Computer makers like Apple and IBM and printer makers like Canon and HP enter into a new value network. Together, they effectively create a new value proposition that enables the output of rich document types via desktop publishing and WYSIWYG graphics. They focus on supplying just the digital font libraries to laser printer and software manufacturers, which are made increasingly valuable by the impressive improvements in PCs, printers, and software. They compete through establishing PostScript as a de facto standard. As with 3Com, the business model that eventually creates significant economic value out of PostScript for Adobe differs greatly from the Xerox business model.

SynOptics: From Fiber to Copper

Andy Ludwick and Ron Schmidt leave PARC in 1985 to form a startup to commercialize PARC technology. SynOptics seeks to enable Ethernet technology to run over fiber optic cabling. The founders intend to develop the capability to deliver a complete network system: fiber optic cabling requires to run Ethernet over that faster medium. Their original business plan involves the creation of an extensive field installation and service organization, along with a direct sales force, like Xerox. But what gets the company off the ground, though, is discovery of the ability to run Ethernet communications at high speeds over already installed IBM token ring copper wires. Ron Schmidt has been experimenting with this capability just prior to leaving PARC, but it isn't until after SynOptics is formed that its importance becomes evident. SynOptics soon abandons the fiber optic approach implied in its name and focuses instead on running networks using its protocols and software on copper wiring already installed for IBM networks.

This allows SynOptics to avoid providing installation, field service, and support in its own part of the value chain (Xerox business model). Instead, they are relying on a network of resellers to distribute, service, and support the product. SynOptics makes customers' copper wire more valuable and enables faster network transmissions. They save a great deal on installation costs. Despite intense competition that drives down prices, SynOptics' annual revenue grows to a high of $700 million in 1993. Thus, SynOptics' eventual business model differed completely from Ludwick and Schmidt's initial Xerox-like business plan.

Metaphor: An Unsuccessful Xerox Business Model

Metaphor is created by David Liddle and Donald Massaro in 1982. It develops a series of technologies that allow nontechnical users to create sophisticated queries of large data bases. This enables a new group of users to mine corporate data for a variety of new purposes, such as market research, pricing analyses, or analyzing possible new product features. Metaphor would let workers construct their own database queries to access corporate data directly in an intuitive fashion.

This is what Google does nowadays.

Metaphor's ambitious technical approach is accompanied by a business model that would have been familiar to Xerox. It includes developing a proprietary software product and selling that software bundled in with proprietary hardware as a turnkey solution for its customers through Metaphor's own direct sales force. Liddle defends this approach as the only viable means at the time to implement their product strategy:

> The problem wasn't one of a business model. When we started Metaphor, standards weren't available and the only choice was to do the entire system – that's the way every body did it then. It's not like today. What's more, this kind of product couldn't be sold at a retail level. The only way to sell it was with a knowledgeable sales force. . ..

Similarly to Adobe's circumstances, at the time Warnock and Geschke leave PARC (not long after Liddle and Massaro left), there are no standards for fonts or generating computer characters mathematically on laser printers either. Nor is there an obvious way to distribute such a product. And Adobe's initial plans are to develop the entire system as well. The value network has to be constructed. Warnock and Geschke believe that, in hindsight, Adobe would not have succeeded, had they continued with their initial business plan. They also felt Metaphor import this approach as a direct result of their experience in Xerox. John Warnock remarks that "Metaphor took the Xerox business model. This may have been a mistake. Metaphor is not one of the great commercial successes spun out of PARC."

The company did manage to survive from 1982 until its sale in 1991 to IBM, but its financial performance is meager, and it burned through a great deal of venture capital.

The founders of Metaphor commercialize some promising user interface and database query concepts through a business model that is quite similar to the one at Xerox. They do not pivot to something else.

On the contrary, 3COM, Adobe, and SynOptics create value from Xerox technologies only after they transform their business plans substantially from the ones that Xerox usually validate.

3COM pivot to a distributor's network, Adobe pivot to a licensing policy, and SynOptics pivot to compatible hardware.

Hence, conducting a startup within a successful established firm is likely to be more highly motivating when alternative business models can be considered. It seems notable that among these examples, while some business model is implicit from the start, a different model hatches out by the time the successful ventures demonstrate their viability. This is where innovation begins and new jobs are created.

Startups and Job Growth

To recreate the organization that can be observed in the startups, in research as well as in fund-raising, many sectors rationalize their structures by deploying small autonomous units. The takeoff of the Internet begets not only new valuable PSS but also the consciousness that without a specific business model, a "prototype" or "pilot" PSS remains issueless. Forty-five years after the creation of PARC by Xerox, the economy gives birth to startups in many sectors like pharmaceuticals, biotechnology, semiconductors, etc., offering widely diversified PSS. Particularly, there is a dynamic in firm birth that seems to be very important for understanding job creation – specifically, the unique effect of new firms, or startups: they have nothing to sell, yet, but hopes, but they do have workers to pay, not with "hopes," thus offering outlets to the markets in the meantime.

Job growth is driven, essentially entirely, by startup firms that develop organically.

Put simply, current observations in the USA show that without startups, there would be no net job growth in the US economy. This fact is true for almost all the years for which the United States has data going back to 1977 (10 years after PARC creation). By construction, the Business Dynamics Statistics (BDS), new data bank made publicly available in a variety of ways through the US government web site, defines an *existing firm* – age 1 up to age 26 and beyond – such that it can both create and lose jobs. In contrast, a *startup*, or age zero firm, only creates jobs because it experiences no gross job destruction. It could be anticipated that the net job gain also would be positive at existing firms. This would mean these ones would constantly hire more people than they would dismiss, but that is decisively not the case on the territory of the USA, during most years on record. Particularly, Table 1 below shows that, during a rather difficult year (2009), job creation at startups remains stable, while net job losses at existing firms are highly sensitive to the business cycle.

That means that all firms in a latter age group create just a fraction of jobs created by startups. For example, in 2005, startups created 3.5 million jobs, compared to the 355,000 gross jobs created that year by firms founded in 1995, which also lost 422,000 jobs that year. Indeed, existing firms

Startup, Table 1 Active establishments by firm age (USA 2009) and job creation

Age of firms	Number of firms	Share of employment	Share of job creation	Share of job destruction
Total	12,247,735	100%	100%	100%
Startups (age zero)	**814,743**	**6%**	**16%**	**0%**
1–5 years	3,025,057	23%	16%	20%
6–10 years	1,906,105	14%	9%	12%
11–20 years	2,441,063	19%	13%	17%
21 years and over	4,060,767	38%	46%	52%

Source: U.S. Census Bureau, Center for Economic Studies, "Business Dynamics Statistics" - (BDS)

in all year groups have gross job losses that are larger than gross job gains.

A closer analysis indicates net job growth in the United States comes from firms less than *one* year old, formally defined as startups (Kane 2010).

Conclusions and Further Directions

Startups, defined as less than 1 year old or zero age firms, appear to generate net job growth in the United States. Aggregating net job creation of existing firms ages beyond one shows few or no net job creation compared with job destruction. If existing firms happen to lose jobs in the territories where they operate, it seems that compensation can only be found in increasing the rate of birth of new firms. The products, systems, and services (PSS) involved in those creations develop as the needs for consumption and production goods arise, offering one another the outlets justifying job creation. As a matter of fact, startups appear now in a globalized economy, creating jobs in territories totally different from the places where existing firms used to run their activities. New opportunities are surging up in emerging sectors and territories where business plans and business models apply not only to production and sales but also to innovative research. So that job creation by startups compensates job losses by existing firms on different territories and economic areas. Seed capital used for financing projects during their startup phase, and before sales reach the break-even point, should provision against compensation adjustment delays in the field of employment.

With a specific tool of measuring this effect of new net job creation of entrepreneurship in contemporary economies, policymakers should appreciate more accurately the life cycle of job growth.

In other words, promoting employment growth must include a central consideration for startup firms and the places, territories, and areas to hatch them out.

Cross-References

▶ Business Incubator
▶ Business Model
▶ Business Start-Up: From Emergence to Development
▶ Entrepreneurship Policies
▶ Heroic Entrepreneur, Theories
▶ Partnerships and Entrepreneurship (Vol Entrepreneurship)
▶ Psychological Aspects of Entrepreneurial Dynamics
▶ Socialized Entrepreneur, Theories
▶ Spin-off

References

Boutillier S, Uzunidis D. L'entrepreneur "force vive" du capitalisme. France: Benevent; 2010.

Business Dynamics Statistics (BDS): the U.S. government Web site. http://www.ces.census.gov/index.php/bds. Accessed May 2011.

Chesbrough H, Rosenbloom R. The role of the business model in capturing value from innovation: evidence from xerox corporation's technology spinoff companies. http://www.hbs.edu/research/facpubs/workingpapers/papers2/0001/01-002.pdf (2001).

Habiby A, Coyle DM. The high-intensity entrepreneur. Harvard Business Review, Sept 2010.
Kane T. The importance of startups in job creation and job destruction. Kaufmann Foundation Research Series http://www.kauffman.org/uploadedFiles/firm_formation_importance_of_startups.pdf (2010).
National Business Incubation Association (NBIA). Benchmark your incubator management practices – and access tools for continuous improvement. http://www.nbia.org/resource_library/peer/benchmark/index.php (2011).
Var. Aut. Processus synchrones d'innovation, Innovations, Cahiers d'Economie de l'Innovation De Boeck/Cairn N°35, 2011-2, (2011).

Start-Up

▶ Innovation Opportunities and Business Start-up
▶ Microfirms

Start-Up and Proximity Relations

▶ Innovative Milieu as a Driving Force of Innovative Entrepreneurship

Start-Up and Small Business Life

Dafna Kariv
The School of Business Administration,
The College of Management Academic Studies,
Rishon Lezion, Hamerkaz, Israel

Synonyms

Entrepreneurial firm; New companies in innovative sectors; Setting up a venture; Small business operation

Key Concepts and Definition of Terms

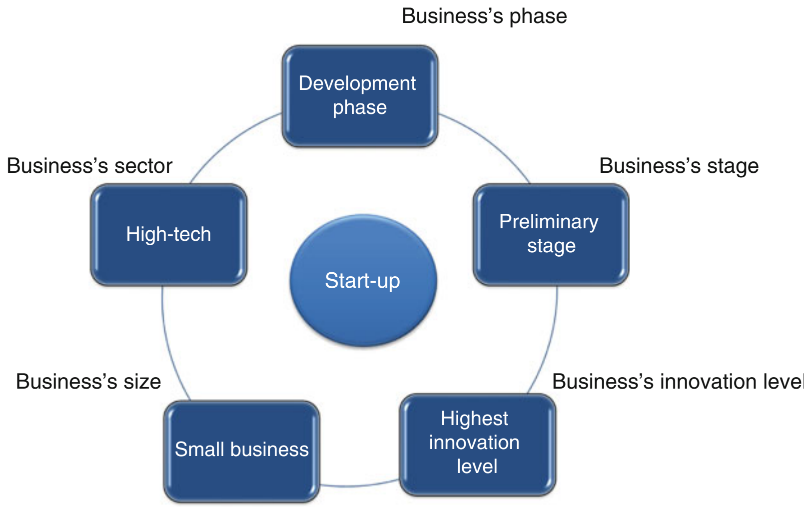
Start-ups refer to a specific form of entrepreneurial business: these are new, small ventures in their early stages operating mainly in sectors with the highest level of cutting-edge innovation and technology. They generate a competitive advantage by carrying out their operation with small, highly specialized, creative teams. Start-ups are regarded as possessing the "genome" that accelerates innovation, inventions, and risk-taking. Consequently, start-ups are viewed as highly dynamic, growth-oriented, profit-driven, and determined to introduce value.

Start-ups are regarded in the entrepreneurship research as a multifaceted but vague concept, consisting of an interaction of sequential measures (e.g., introducing innovative ideas, exploiting opportunities, using cutting-edge technologies for implementation, gathering highly expert teams) that are embedded in the external and internal environments' culture, technology, and infrastructures. These measures are then echoed in the start-up's structure, processes, and daily life, as presented in Fig. 1.

Small start-ups (SSUs) are deemed a promising track to personal financial success and thus have become a buzzword in public debate and research. At the macro level, SSUs have been recognized as a major vehicle for regional and economic growth via their introduction of innovation, originality, and a higher number of patents into the region. Consequently, they create new jobs for professionals and experts, as well as jobs that stimulate innovation and use of advanced technology; they are facilitators of upward social mobility, and they foster innovation in the region. At the micro level, SSUs are considered primary enablers of wealth generation and promotion of one's expertise and a platform for "born-global" companies. Thus start-ups are sound and highly regarded. Concurrently, SSUs are known to experience higher rates of discontinuation and failure.

The constant churning activity of SSU setups and closures, recognized in most countries in terms of start-ups' stimulating success stories (e.g., Apple, Google, Facebook), creates an atmosphere in which setting up a SSU seems risky and uncertain, yet at the same time promising and thrilling. Research consistently shows that youth aspire to establishing start-ups in the future.

Start-Up and Small Business Life, Fig. 1 Distinctive components of SSUs



The probability of SSU success relies on a number of entrepreneurial pillars, e.g., the entrepreneur's personal competencies, the presence of lucrative opportunities, generation of resources, and partnerships, coupled with a higher degree of innovation, newness, and expertise compared to traditional industry.

However, the SSU's dependence on the highest levels of innovation may yield two different situations: lacking the levels of resources, experience, networks, recognition, and legitimacy in the marketplace enjoyed by more established and larger firms is a critical disadvantage for SSUs in generating the required resources to best fit the customers' needs and in building new assets on an ongoing basis to produce a sustainable competitive advantage. As such, their preliminary advantage, i.e., developing innovation, may eventually be counterproductive and even result in their own discontinuation. The second situation involves the SSU's flexible and adjustable internal structures and processes, which are the outcome of its size, business phase, and stage. Thus, relative to established and larger firms, SSUs are less constrained by internal routines and may use more adaptive capabilities and may therefore more rapidly adapt to new conditions. This leads to the use of strategies and practices that can more easily engender innovation and competitive advantages (Reynolds 2000).

Theoretical Background and Open-Ended Issues

The theories and models that have been most widely used in explaining the scientific principles of SSUs are based mainly on human capital (Becker 1993), capabilities models: the resource-based view (Barney 1991) and the dynamic capabilities model (Eisenhardt and Martin 2000), and knowledge-based models (Eisenhardt and Santos 2002; Teece 2000).

Human Capital

According to the human capital (HC) theory, factors such as education, prior entrepreneurial experience, training, managerial know-how, and some other attainable factors are relevant to the emergence and success of SSUs; entrepreneurs possessing a higher quality of human capital will have a superior ability to successfully exploit opportunities, be better able to judge, or even create, potential opportunities, and be better networked, informed, and more proficient in using their teams' knowledge to more effectively manage their ventures.

The HC theory asserts that the quality of the human capital blend in the business delivers both *functional* capabilities that assist in commercializing the products/services and *adjustment* capabilities that enable altering internal capabilities in accordance with environmental changes, e.g., technological advances, introduction of cutting-edge knowledge, and the constant emergence of sophisticated competitors. Thus, SSUs can only succeed by employing a range of expertise and a high quality of professional human capital, hinged around knowledge and embedded within the business teams, processes, and structures.

SSU entrepreneurs often find it difficult to enact the full range of managerial and organizational capabilities necessary to lead a new business toward success due to their specific expertise which is mostly in professional-technological areas; this, coupled with the demand for businesses to continually innovate, requires a range of up-to-date human capital characteristics that are readily available or embodied in the teams, e.g., management, marketing, strategic collaboration, and funding. Because such characteristics may be lacking in SSU entrepreneurs, they should be appropriated and integrated from the outside in order to sustain the business (Shaver et al. 2001).

Resource-Based View

The resource-based view (RBV) is regarded as a robust theoretical framework that enables determining a venture's performance by exploring and understanding its business resources and subsequently, its value. The RBV was initially promoted by Penrose and later expanded by other scholars. The RBV stresses that new ventures accrue their internal resources in order to generate a competitive advantage in the market, hence will look for resources that can either provide the business with a competitive advantage (e.g., SSUs that recruit well-known scientists, receiving a prestigious grant) or produce outcomes that can provide a competitive advantage (e.g., a developed technology that enables creating a new product/service, approved investment endowments that enable upscaling). Resources are regarded by the RBV as objective, heterogeneous entities. Accordingly, the venture's stock of resources may include financial, human, physical, and technological resources, which may be either tangible (e.g., machinery, employees, remedies) or intangible (e.g., culture, social capital, expertise). The main essence of "resources" according to the RBV is that they will be exploited and used in the SSU only when identified as adding significant value to the venture. The RBV espouses the concept of VRIN, which refers to *valuable, rare, imperfectly imitable*, and *nonsubstitutable* resources, thus encompassing a significant source of competitive advantage.

In sectors that stimulate SSUs, where innovation and development are salient, the blend of resource combinations can add value to the business; VRIN resources which are strongly embedded in the business' technology, processes, and team expertise, as well as in some latent resources such as culture, robust leadership, or social capital, may be most valuable in breeding the business' competitive advantages. The relevance of the RBV to SSUs is echoed in the multitude of studies published on the relationship between Schumpeterian views of innovation and RBV.

As already mentioned, the unique context that nurtures SSUs, i.e., uncertainty, technological challenges, time to market, and a constant lack of tangible assets versus the venture's essential need to develop technology and acquire the best expertise, as well as machinery, equipment, and premises, among others, requires SSUs to identify innovation in their own businesses, export it from the outside, or create VRIN resources to sustain their competitive advantage. In this sense, the HC theory is useful, particularly when coupled with the RBV, in explaining SSU performance and success, by using high-quality and best-fitting human capital and developing it into VRIN resources that allow generating a competitive advantage.

Networks – The growth in popularity and business-related use of virtual network platforms, e.g., Facebook and Twitter, emphasizes the power of the venture's networks and social capital as VRIN resources, which can produce sustainable competitive advantages. Particularly in innovative sectors exporting the most fitting expertise, ideas, knowledge, and technologies, it is the core of potential success. Commercializing the novelty requires another specialized conduit that networks might fill via more efficient channels. Drawing upon the RBV concepts, SSU resources can deliver, mobilize, or create new key capabilities via networks and facilitate the SSU's activity and success.

Several social network theories may be relevant to understanding the successes and failures of start-ups. The notion of strong and weak information ties recognizes the premise that the value of information transmissions depends on the quality of the links, the people that the entrepreneur is linked to, and the type of information received (Adler and Kwon 2002). The implication of these theories to SSUs involves their dependence on key factors, such as the most up-to-date knowledge, information, and technological advances, which are critical to their survival and success. As these key factors are asymmetrically distributed, i.e., within laboratories, governmental bodies, academic publications, etc., virtual networks can greatly ease the search and their implementation.

Dynamic Capabilities Theory

The dynamic capabilities (DC) perspective, which emerged from the RBV, adds a vigorous, dynamic outlook on SSU strategies and success levels. The DC perspective conceives of start-ups as vigorously altering their internal resources to generate sustainable competitive advantages by reconfiguring their resources, capabilities, and expertise to adapt to the dynamic, changing environment. The RBV has been criticized by some researchers as considering competitive advantage from a static rather than dynamic approach, even though new ventures animatedly exploit opportunities and later their resources within dynamic markets. The DC perspective regards the new venture as being in a continual process of developing innovative responses to adjust to the dynamic, changing environment. Resources are viewed as asset positions that can be deployed creatively in order to shape opportunities; subsequently, innovation and technologies are deemed a "must" in developing new capabilities and avoiding the problem of "core rigidities." Such valuable asset positions depend on the entrepreneurial team's ability to identify and respond in a timely fashion to the dynamic challenges posed by the environment. The new venture's competitive advantage is thus determined by its dynamic capabilities. Here too, the relevance of the HC theory is strengthened, as human capital that is developed and blended in with the SSU's assets creates higher competitive advantages. While a blend of human capabilities is a necessity for SSU success, it may hold some risks and have unfavorable outcomes that can destroy valuable extant capabilities (Teece 2000; Zahra et al. 2000).

As the focus of the DC theory is response to changing environments, its implications for SSUs are vital: in essence, the DC perspective postulates that the venture's capabilities will be valuable only when they are constantly dynamic and adjustable to the environment's rapidly changing demands. As such, the DC perspective emphasizes the processes rather than "just" obtaining VRIN-based resources and can illustrate the dynamic changes in the SSU through its concepts.

Bricolage – Drawing on the conceptualization of bricolage: "making do by applying combinations of resources at hand to new problems and opportunities," this model may facilitate our understanding of the flexible and innovative adaptation of SSUs' available resources. The bricolage model suggests that any resource can be redefined by enacting alternative practices and routines; accordingly, SSU entrepreneurs often use and alter physical, social, or institutional resources that are disregarded by the more established firms, thus introducing creative and original resources that create a significant competitive advantage. In their endeavor to attract qualified expertise and enhance innovation, SSU entrepreneurs may draw on their experience from existing business relationships, prior employment, private networks, etc., to access information, knowledge, and opportunities and promote their dynamic capabilities and business resources (Zahra et al. 2000).

Knowledge-Based Theories

The knowledge-based view (KBV) contends that knowledge is the firm's most valuable resource, as it is a VRIN resource that can be altered and adjusted, providing a major source for sustainable competitive advantage. Traditionally, the KBV has been considered an extended perspective of the RBV, i.e., a most valuable generic VRIN resource, a most difficult asset to imitate that generates a sustainable competitive advantage. Knowledge was considered to be relatively immobile and molded through the business' stock of resources. However newer views of knowledge, reflecting the rapidly changing environment, highlight the notion that superior business performance can be reached by continuously creating temporary competitive advantages; these can be achieved by altering resources and adjusting them to the market's changes (Eisenhardt and Santos 2002; McEvily and Chakravarthy 2002; Eisenhardt and Martin 2000), thus emphasizing the dynamic nature of knowledge. As such, the KBV can be viewed as embedded in the DC perspective, as knowledge creation is a crucial dimension in forming the start-up's intellectual capital and dynamic capabilities.

The SSU's stock of knowledge is an intangible resource embedded in and mobilized across the different business processes, e.g., teams' expertise, the business' systems, the business' culture, among others, depending on the focus attributed to knowledge in the business' success. Information technologies can play an important role in the KBV of the firm in that information systems can be used to produce, enhance, and accelerate large-scale intra- and interfirm knowledge management.

Knowledge can be transferred as know-what, and know-how may therefore be replicated and combined with the SSU's existing knowledge to create superior, sophisticated knowledge of the business. Knowledge transfer is promoted by people because it is possessed by individuals, yet when transferred, it is shaped by the business' context. Accordingly, it reflects the business' use of this knowledge. While knowledge transfer is potentially risky because it can disclose the business' technologies and practices, knowledge is voluntarily shared and exported by SSUs and individuals, as the benefits are thought to outweigh the risks. Nevertheless, to deter risk, SSUs import knowledge and then recombine it with their existing knowledge and mold into their existing structure. As such, imported knowledge can contribute to SSUs without putting the businesses that exported it at risk; eventually, application of this knowledge will take on different forms. Porter (1990) pointed out that knowledge and its derivatives may engender rivalry, which is a powerful stimulus for SSUs toward enhancing the creation of new knowledge to sustain their competitive advantage, making knowledge a vibrant source for development and improvement.

SSU Characteristics

The broad dimensions of entrepreneurship and SSU research are presented in Table 1. Due to the dynamic nature of SSUs and their environments, different dimensions are constantly being identified as being associated with SSU structure, processes, and outcomes.

The environment – SSUs exist in a complex environment with a constantly accelerating pace of change and the demand for the "next promising exit" as a driving force. Drawing on Schumpeter's views, innovation, development, and technological advances are essential sources of any firm's economic growth. Accordingly, environments encompassing characteristics associated with innovation (e.g., environments that produce leapfrogging, high-tech areas, developing regions in which the first national priority is development and innovation) stimulate the emergence of new SSUs. SSUs, however, are highly vulnerable to any change in the environment, in particular advances in technology and innovation. In any environment, SSUs encounter established companies that are attempting to slow down and minimize the potential competition from the newly born SSU. SSUs react by (a) accelerating and scaling up their activity to create a competitive advantage over the existing companies; (b) proposing collaborations with the

Start-Up and Small Business Life, Table 1 Leading dimensions associated with the life of a start-up

The entrepreneur	Local environment	Global environment	Business structure and processes
Personal traits – entrepreneurial competencies and capabilities, risk-taking, proactivity	**Localized knowledge**; **dynamics of technology-intensive sectors**	**Technology development**: global technological dynamics, knowledge-based environment, emergence of cutting-edge developments, emergence and popularity of internet, e-commerce, and e-businesses	**Innovation**, embedded in the business' structure and processes
Entrepreneurial expertise and knowledge	**Knowledge stock and knowledge centrality**: innovation and expertise that originate from a region and is developed in the same region	**Lucrative opportunities**: existence and feasibility of lucrative global opportunities; collaborations and bilateral agreements	**The business demographics, business team**
Entrepreneurial intentions, aspirations, and motivations	**Knowledge diversification**: production of new knowledge from the existing regional knowledge	**Global economic state**: customers' ability to purchase innovative products/services; investors' ability to invest in cutting-edge products	**Investments and strategic collaborations**
	Lucrative regional opportunities and **regional resources**	**Contextual factors**: factors in the global arena affecting the setup of global, knowledge-based start-ups, e.g., bilateral relationships, politics, economics, international law, cultural approaches to innovation, and collaborations with academia	**Financing**: fund-raising and investment management
	Contextual factors in the local environment		**Strategies used**
	Cultural approach toward start-ups		**Networking**
	Local infrastructure and support systems		**Business growth and success**
			Business difficulties and failure

existing companies, e.g., mergers and acquisitions; or (c) accepting the balance of power in the market and discontinuing their activity. As a result, innovation can be at risk. By choosing model (a), SSUs experience rapid growth which is frequently coupled with embracing the more traditional rather than innovative routines associated with larger firms' operations; model (b) may push SSUs to become assimilated within the larger firms, hence accepting their ongoing culture, processes, and structures; model (c) refers to ending the business.

The growth rate of SSUs is systematically and positively associated with the environment: countries experiencing a greater role for entrepreneurial activity and higher rates of subsequent growth cultivate more successful start-ups and vice versa. A potential implication is that countries which have a greater share of start-ups and encourage the setting up of SSUs are rewarded in terms of economic growth (Thurik et al. 2008).

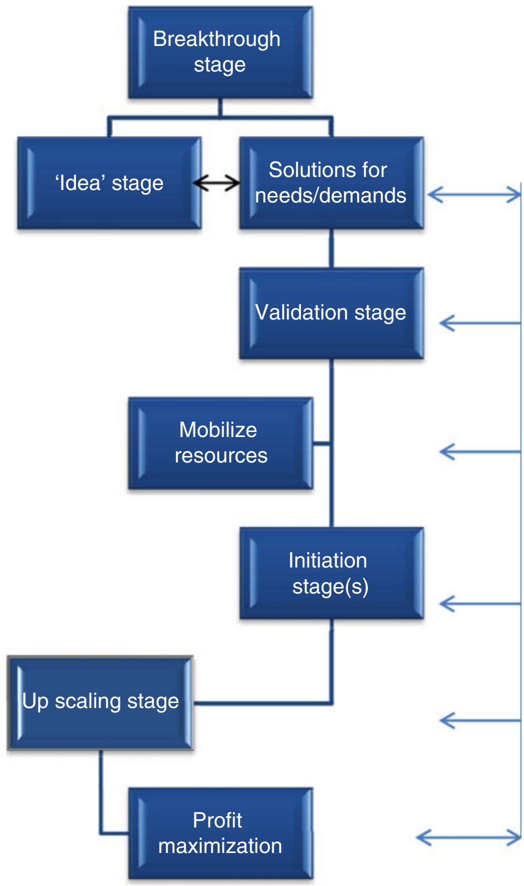
Types of start-ups – SSUs capture value by creating a competitive advantage. Many SSUs introduce innovation or innovative technology, manifested in two basic ways: (a) process-based: incorporating innovation/innovative technology within their current operation to foster efficiency, shorten research and development (R&D)

and production processes, and reduce organizational costs; (b) outcome-based: developing new products or launching new ventures that exploit the introduced innovation/innovative technology for new markets or in new arenas by introducing new products/services to the market.

Despite these differences, all SSUs consider innovation an imperative asset. They take innovation to the market through a process implicitly embodied in their overall course of action. While innovation may remain latent to the market until it is commercialized, it is a significant component that is reflected in each of the business' dimensions.

The business focus of SSUs leads to different business types, identified as: (a) laboratory SSUs, which focus on patent development and on rigorous R&D activity, such as academic spin-offs and pharmaceutical start-ups; (b) product-centric SSUs focused on self-acquisition of customers, such as Google, Dropbox, Eventbrite, and SlideShare; (c) SSUs focused on self-service customer acquisition that target critical mass and are based on new ways for people to network, e.g., Facebook, Twitter, YouTube, PayPal, Quora, and eBay; (d) SSUs that rebuild other companies' innovations for smaller enterprises, e.g., PBworks, UserVoice, Mixpanel, Dimdim, and HubSpot; (e) SSUs focused on sales with high customer dependency and lower certainty, such as Oracle, Cloudera, Splunk, Salesforce, BazaarVoice, and MySQL. Each of these types engenders specific expertise, knowledge, business structures, and processes. The levels of innovation and the consequent allocation of capital for R&D and technological advances are tightly associated with the SSU's culture and the significance it assigns to innovation.

Stages of SSU development – SSUs are regarded as evolving in unique and specific stages which reflect their innovation. Of the various models promoted in this research area, the following representative stages emerge (summarized in Fig. 2): (a) the breakthrough stage, referring to a start-up's identification of a meaningful need; (b) the idea stage, in which the entrepreneur/team provide solutions to meet the identified need; (c) the validation stage, in



Start-Up and Small Business Life, Fig. 2 Stages of SSU development

which start-ups look for early validation to ensure that the shareholders are interested in their future solutions by seeking seed funding and recruiting key experts to implement their ideas; (d) the initiation stage (this phase may involve several stages): the business model and value proposition may be refined and improved, then resources may be mobilized, a repeatable sales process and scalable customer acquisition channels may be sought, and activity may be adjusted to competitor activity; (e) the scaling stage – start-ups strive to grow and therefore seek funding and engage in more formal organizational structures while still perpetuating their team's creativity and enthusiasm; and (f) profit maximization – this stage often involves strategic collaborations, internationalization, and introduction of more sophisticated innovation. Many start-ups endeavor to combine internal mechanisms that nurture constant innovation with a more structured organizational composition that will appeal to their shareholders. Relying on their inherently higher levels of tolerance to uncertainty and ambiguity, start-ups pursue knowledge-based, competitive environments, as well as enabling their creation.

Linking academia and practice – The demand imposed on academic institutions to unearth innovation and technological advances, as well as to become more attractive to their shareholders, often leads to collaborations with local SSUs in which university licensing strategies and university incentives and licensing revenues are introduced. Such links benefit both sides: the SSUs may benefit by promoting their R&D and disseminating their advances through academic routes, while "star" faculty members can commercialize their laboratory inventions through SSUs.

SSU difficulties – SSUs face difficulties in both setting up and sustaining their businesses due to the rapidly changing and competitive environment, the dynamic nature of technological advances and the nature of their business' processes, which are part of their daily routine.

In the first stages, SSUs are typically resource-deficient and may tackle difficulties related to uncertainty regarding the market's acceptance of their introduced innovations, the technological feasibility of developing the planned product/service, the team's expertise and ability to meet the demanding R&D deadlines, or outcome quality. Moreover, competitors may capture the targeted customers for the same products/services; the resources which are then needed to differentiate the SSU's products/services from those introduced by the competitors or alternatively, to target the original products/services to other groups of customers, may be uneconomical and may even push SSUs to discontinuation. Governmental regulations and support (e.g., funding, technological commercialization, transfer, and investments), which are prominent factors in an SSU's survival and prospective success, can be inappropriate for some SSUs' needs.

SSUs that develop high-technology products may also be faced with particular difficulties linked with their own innovation; e.g., their applications may be unclear, the markets may not yet be prepared or mature enough for the innovation, and the innovative products may be obscure for the customers who find it difficult to link their needs and the developed product (van Gelderen et al. 2011).

Table 1 presents the dimensions that are most often discussed in research.

Conclusion and Implications

Studies on SSUs have been sweeping through the field of entrepreneurship; the last decade has witnessed widespread research into SSU life cycles, mainly due to the emergence of the internet. These trends have resulted in the prevalence of SSUs, shifting the balance of power away from established companies to the small, innovation-based businesses, which can generate cheaper innovation, are much more adaptable, and can use creativity and flexibility to adjust their offerings to the market's changing demands.

As such, SSUs have become popular, constituting an employment track that is highly aspired to in the market, as it has been associated with a successful, wealthy, and fulfilling life. Nevertheless, research has revealed that the rates of SSU failure are high and that the lives of SSUs are fueled with uncertainty and risk.

Drawing on the theoretical models introduced in this chapter, emphasizing their unique capabilities, mainly human capital and knowledge, to differentiate themselves from existing firms, and coping with the market's dynamic which tends to push new businesses out, SSUs identify and mobilize their capabilities and resources to use their size advantage and reach sustainable competitive advantages.

The main implication of this chapter is for the educational system and academic institutions: while SSUs are deemed an ideal employment track, the relevant capabilities to evolve into a successful SSU entrepreneur are outside the scope of traditional schools' and academic institutions' focus. Alternatively, educational institutions emphasize the establishment of students' professional and scientific knowledge and neglect to cover entrepreneurial know-how, such as thinking creatively and originally, taking risks, being proactive, and being able to express innovative ideas in a clear and focused presentation, among others, which can be seen as the platform for innovation and advancement. Educational and academic institutions introduce knowledge and information yet lag behind in introducing those capabilities that can promote entrepreneurship. By fostering and supporting innovation in the culture, format and processes at the school, and higher academic levels, younger generations will obtain the relevant spirit and know-how relevant to the SSU life cycle and promote SSU success levels worldwide.

Cross-References

► Business Start-Up: From Emergence to Development
► Innovation Opportunities and Business Start-Up
► Knowledge Capital and Small Businesses
► Small Business
► Small Businesses and Sustainable Development
► Start-Up
► Techno-Globalization and Innovation

References

Adler P, Kwon S. Social capital: prospects for a new concept. Acad Manage Rev. 2002;27(1):17–40.
Barney J. Firm resources and the theory of competitive advantage. J Manag. 1991;17:99–120.
Becker GS. Human capital: a theoretical and empirical analysis with special reference to education. 3rd ed. Chicago: University of Chicago Press; 1993.
Eisenhardt KM, Martin JA. Dynamic capabilities: what are they? Strat Manag J. 2000;21:1105–21.
Eisenhardt KM, Santos FM. Knowledge-based view: a new theory of strategy? In: Pettigrew A, Thomas H, Whittington R, editors. Handbook of strategy and management. 1st ed. London, UK: Sage; 2002. p. 139–64.
Hessels J, van Gelderen M, Thurik R. Entrepreneurial aspirations, motivations, and their drivers. Small Bus Econ. 2008;31(3):323–39.
McEvily KS, Chakravarthy B. The persistence of knowledge-based advantage: an empirical test for product performance and technological knowledge. Strat Manag J. 2002;23:285–305.
Reynolds PD. National panel study of U.S. business startups: background and methodology. In: Katz J, editor. Databases for the study of entrepreneurship, Advances in entrepreneurship, firm emergence and growth, vol. 4. Amsterdam: Elsevier Science; 2000.
Shaver KG, Gartner WB, Crosby E, Bakalarova K, Gatewood EJ. Attributions about entrepreneurship: a framework and process for analyzing reasons for starting a business. Entrep Theory Pract. 2001;26(2): 5–32.
Teece DJ. Managing intellectual capital: organizational, strategic, and policy dimensions. New York: Oxford University Press; 2000.
Zahra SA, Ireland RD, Hitt MA. International expansion by new venture firms: International diversity, mode of market entry, technological learning and performance. Acad Manage J. 2000;43:925–50.

Start-Ups in Services

► New Forms of Entrepreneurship in a Sustainable Knowledge-Based Service Economy

State Space

► State Space Paradox of Computational Research in Creativity

State Space Paradox

► State Space Paradox of Computational Research in Creativity

State Space Paradox of Computational Research in Creativity

Ömer Akin
School of Architecture, Carnegie Mellon University, Pittsburgh, PA, USA

Synonyms

Artificial intelligence; Case-based reasoning; Closed system; Data mining; Emergent shapes; Generative algorithms; Genotype; Open system;

Petri nets; Rule-based expert systems; Shape grammars; State space; State space paradox; Sudden mental insight

Computational Research in Creativity

It is an often used adage that humans are fundamentally curious and creative. Yet, some take issue with the implication that creativity is innate and argue that one gains power over goals through knowledge, whether they are related to creativity or not. This makes a case for a pragmatic view of how to explore, inquire, and research: "the human condition can be improved through understanding." Ultimately, all explanations of human drive to achieve novelty are based on the tautological notion that creativity and curiosity have value. Regardless of the motivations underlying it, understanding phenomenon will eventually turn out to be important. Through such understanding, humans recognize, describe, emulate, and control external (i.e., global climate) as well as internal (i.e., human psyche) phenomenon.

Sudden Mental Insight: A Form of Creativity

One of the widely recognized and studied forms of creative behavior is the one called the sudden mental insight (SMI). This phenomenon has received considerable coverage in creativity literature (Hayes 1981). SMI refers to the sudden onset of a realization that makes the solution of a very difficult problem or the creation of a remarkable result possible. Hayes (1981) argues that SMIs can be explained through already known cognitive functions. Others have shown how the creative "leap" is akin to bridge building between the problem and solution domains which are normally separated by a chasm, and described the mechanics of the SMI in the context of several design and problem solving protocols. While, to date, important issues remain unresolved and un-researched, SMI is one of the few, known, overt signs of creativity (see ► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon).

Creativity and Computation

In the age of information technology (IT), it is rare that any topic should be untouched by tools and concepts of computation. It turns out that creativity is one of the earliest IT goals addressed by techno-savvy folks of all kinds and backgrounds. It is no wonder that artist Harold Cohen has been painting with brush as well as *Aaron*, his digital counterpart, for more than three decades (Holtzman 1994). Cohen's motivation for building the digital painter *Aaron* was for the same reasons as those provided in the introduction to this essay: curiosity and the impulse to do something new, which happens to be a curiously circular explanation. In the early years, Aaron was an automaton following instructions given to it through "rules," a common device used in most artificial intelligence (AI) applications. Soon, Cohen realized that Aaron was no match for a human painter, like himself, principally because it did not learn from its experiences. Upon the urging of Edward Feigenbaum, who is considered to be one of the fathers of AI, Cohen decided to write some rules into Aaron about color theory. Then, Aaron started using color, which elicited the "wow!" or the SMI response from Cohen himself. He asks, "How did it come up with that?" providing a living example of how computer systems can behave in ways that are surprisingly human. Obviously, such personal impressions alone cannot be the measure for machine intelligence.

Alan Turing presented a test for machine intelligence through a succinct description. "I propose to consider the question, 'Can machines think?'" or "Are there imaginable digital computers which would do well in the imitation game?" (Turing 1950). Ultimately, this sort of thinking led to the following tangible proposition: *"It is not difficult to devise a paper machine which will play a not very bad game of chess. Now get three men as subjects for the experiment. A, B and C. A and C are to be rather poor chess players, B is the operator who works the paper machine. . . . Two rooms are used with some arrangement for communicating moves, and a game is played between C and either A or the paper machine. C may find it quite difficult to tell which he is playing"*

(Turing 1950). Hence, the general principle that if one is unable to distinguish between a digital agent and a human by observing only their behavior – whether playing chess or reciting poetry – then the digital agent must be considered as capable as its human counterpart. Yet, Harold Cohen, like so many other users of digital assistants in creative tasks, considers these tools inferior because they can neither act in novel ways on their own volition nor learn from their actions.

Eve Sussman created a program with the help of Jeff Garneau, called the "Serendipity Machine," that makes real-time splices of a set of video and audio recordings, based on a predefined, index-matching schema. As the permutations of audio-video pairings are spliced end-to-end, the result turns out to be quite startling if not delightful. Yet, Sussman is unwilling to call the Serendipity Machine a "creative companion." Professor Selmer Bringsjord of Rensselaer Polytechnic Institute believes that mystifying the creator of the digital system is the least a creativity system should do; otherwise, he concludes that "we will keep cloning our own intelligence."

Brigham Young University scientists have built a system called Darcy that judges art works. Darcy has elicited curiosity among humans, yet upon learning that its judgment is based solely on a preference for "red, bloody, and violent," one's enthusiasm wanes. There are many digital emulators of human activities but lack the litmus test for what is sufficiently creative or intelligent. Bringsjord brings this idea home when he remarks "Martha Stewart is credited with being creative when she recommends that we should use brown napkins with a yellow table cloth." Up to now, the Turing test is the best thing anyone has come up with; yet, even that would not be able to show that airplanes are not as capable as birds, even though they can outfly, outdistance, and out-cargo birds.

Computer Assistance in Creativity

Computer-based research on creativity, even from the beginning, has focused on a combination of the procedural and representational paradigms. Digital system models of creativity, on the other hand, build models through a singular feature, either representational or procedural, but not both. Procedural approaches include (1) rule-based expert systems, (2) case-based reasoning systems, and (3) complex generative algorithms (such as genetic, annealing, neural nets), while representational ones include (1) shape emergence, (2) object-based representation, and (3) complex recognition systems (data mining, Petri nets).

Procedural Approaches

All software, regardless of its primary functionality must operate within a representation. Expert systems tend to use the rewrite-rule formalism for this purpose. Case-based reasoning approaches match, retrieve, and adapt cases to create new solutions. Genetic algorithms rely on the representation of complex symbolic strings called *genotypes* that can map into complex objects. Mimicking the lateral inhibitions that take place between the ganglia during synaptic activity in the cerebral cortex, neural nets are representations that are built in order to create lateral relations between the nodes of a network. While representation is important, essentially, these approaches are built to provide procedurally defined approaches it machine intelligence. Representations are there merely to facilitate the procedural objectives by enabling genetic mutations, rule firings, case adaptations, or the neural-net derivations that can achieve creative solutions (Table 1).

Several researchers have explored the potential of genetic algorithms in design. Often, the design domain is represented as a collection of rules. The mutation of these rules holds great promise in effecting change in design search space. Using a search metaphor to explore the design space and their genetic metamorphosis illustrates the power of such approaches. Difficulty, however, exists in the predictability of the results based on the modifications made in the rules.

Rule-based representations have given rise to the conjecture that design can be achieved

State Space Paradox of Computational Research in Creativity, Table 1 Procedural systems for design creativity (Source: Akin et al. 2012)

Systems	Procedural schema	Representation schema
Rule-based	Apply rewrite rules that have their left-hand side match problem representation	Problem parameter variables; rewrite rules; strategy for rule application
Genetic algorithms	Use meta-rules to mutate rewrite rules; generate solutions	Problem parameter variables; rewrite rules; rule application strategy; rule mutation mechanism
Case-based	Match case; retrieve case; adapt case	Case representation; case-based

State Space Paradox of Computational Research in Creativity, Table 2 Representational systems for design creativity (Source: Akin et al. 2012)

Systems	Representation schema	Procedural schema
Shape emergence and grammars	Geometric primitives; maximal shapes	Combinatorial enumeration
Cognitive schema	Object-based representation of functional, behavioral, and physical characteristics	Formal reasoning; heuristic reasoning
Recognition algorithms – data mining, Petri nets	Large data bases; process models	Pattern recognition; heuristic search; abstraction

through the application of predetermined rules of geometric composition. The potential of the approach has been amply demonstrated by many who have created design spaces after well known, often historical sets and styles of designs: Palladian plans, Ire-Ray windows, and Queen Anne houses. A counterintuitive but promising result that has emerged from the early work in this area is that the grammar formalism often goes far beyond the original set of patterns and designs that give rise to the grammar, in the first place.

Maher's work on case-based engineering design demonstrates how precedents can be used to create paths of evolution for new designs starting from existing ones (Maher et al. 1995). Some may argue that creative solutions should not be based on precedents or cases. Others argue that all designs, novel or routine, are based on earlier examples. In the end, the adaptation functionality that transforms the case into a solution makes it possible to reach a nonroutine, if not novel, design. In summary, the creative process envisioned by these systems requires that the problem being solved be represented in terms dictated by the procedural algorithm.

Representational Approaches

Because it is versatile enough to be regarded a representational approach as well, shape grammars has been an important area of investigation in design creativity (Table 2). This is largely due to their potential to recognize *emergent* shapes (Stiny 2007). In some cases, creativity is attributed to the ability of the designer to detect patterns that are not evident but are "evolving." The quality of a design then is affected by these points of SMI that a designer recognizes as she is navigating in a *space of design solutions*.

Others argue that in order to represent the process of creativity, a more complex representational schema is needed, including functions, behaviors, and structures to be embedded in new designs (Coyn and Subrahmanian 1993). This goes back to the early schema-based linguistic representations of memory and more recent applications in object-based software engineering approaches that have also been applied in architectural design. While these approaches also have great potential in capturing nontrivial aspects of architectural design, their claim of creativity has not been demonstrated (Rosenman and Gero 1993).

In very complex design space networks, Petri nets, and colored Petri nets in particular, can abstract general patterns that are not evident to the naked eye. These applications are most useful in representing complex procedural domains, such as VLSI design or large system design problems in chemical plants. Through these applications, it is possible to control and predict overall performance in designed systems, including error detection and recovery, time of completion, and cost of delivery.

Data mining, a complex pattern recognition algorithm, is even more general in its purposes. It allows the user to discern patterns in unorganized data or data organized for purposes other than the ones currently at hand. Through this it is possible to identify relevant design requirements or select among many alternative solutions the ones that are most likely to yield creative solutions.

Environments for Integrating Representations and Procedures

Computational environments created to support mixing and matching of representation with procedure formalisms can provide support for design creativity. The ingredients necessary for such integration are extremely demanding. Table 3 shows an illustrative scenario in which many representations and procedures can be used in tandem to reach creative solutions to a design problem. In such a scenario, the designer starts with an object-based representation, which allows her to reason about the overall behavior of the object to be designed, its functional characteristics, and its structure. The design proposal emerging from this can be used to search a case-base of legacy designs to see if similar solutions have been developed in the past and if the present solution can be improved using their features. Here, the designer may observe that a shape-grammatical order is evident. In that case, the shape grammar formalism can be used to detect pattern emergence, and genetic algorithms can be used to realize a design mutation suggested by the emergent patterns. Finally, the designer performs data mining to discern the dominant features of the solutions generated and represents these using the original schemata consisting of functions, behaviors, and structures.

The final design is represented using rendering and visualization applications. This process is repeated in response to the feedback obtained from the client, each time combining a new set of procedures and representations to serve the purposes of creativity. Clearly, the realization of such a scenario would require standardization and interoperability between current digital platforms and applications. If the requisite support in the form of building information modeling, integrated with data exchange standards, is available (Akin et al. 2012), such a process promises to create environments within which human creative behavior can be enhanced and extended.

State Space Paradox of Computational Research in Creativity, Table 3 An illustrative scenario for creativity support (Source: Akin et al. 2012)

Creative search scenario based on a hybrid assistance system driven by sudden mental insights (SMIs)		
Problem state	Example of problem reformulations driven by SMIs	Representation or procedural system
T0 – initial state	Cognitive schema-based initial problem formulation	Cognitive schema
T1 – first SMI	Case-based solutions	Case-based system
T2 – second SMI	Shape formalism rule-based solutions	Rule-based system
T3 – third SMI	Emergent shape-based solutions	Shape grammar formalism
T4 – fourth SMI	Generative rule-based transformation of solutions	Genetic algorithm
T5 – fifth SMI	Data mining-based selection of solutions	Data mining algorithm

The Paradox of Creativity Research

The State Space of Creativity

All digital systems of creativity, whether intended for assistance or emulation of the process, exist within an implicit or explicit *state space* (Newell and Simon 1972). The state space represents any finite slice of time in the digital system's functionality through *entities*, *operations*, *goals*, *heuristics,* and *predicates* that apply to that moment in time. This is a powerful concept because it makes talking about the digitally modeled process of creativity possible, or any formalized process, in discrete terms.

At any time-slice, the digital application works with representational and procedural applications toward satisfying a goal (Tables 1, 2, 3). This goal may be to determine if a given object is creative (i.e., Darcy), or to create an object that emulates features it may be considered creative (i.e., Aaron, Serendipity Machine). In either case, the details of the outcomes are computable from the specifics of the state space. All that goes into the computation, whether it is a set of criteria to interpret patterns and colors on a painting, rules of color theory, a generative algorithm to transform a given *genotype*, an emergent pattern, or the requirement specification for a layout generator, all is subsumed in the state space representation. In other words, these systems like all other computer programs are *closed systems*. Because their input parameters and possible outcomes are predefined, they cannot behave in any manner that is not preprogrammed through these definitions.

A human agent, on the other hand, is an *open system* and functions in an evolving state space. She changes the initial state, the methods of operation that transform states, and the scope of acceptable solutions, at will (Simon 1973). In other words, depending on the circumstance she may prefer *blue, sad*, and *subdued* over *red, bloody*, and *violent*; as well as to shift the criteria of selection to a voting mechanism by onlookers. The permutations are as endless as concepts carried in one's head, including those that are not possible to express in words or represent in symbolic notation.

The State Space Paradox

There have been attempts to emulate the kind of behavior seen in open systems. Genetic algorithms, for example, that produce transformations on given genotypes are limited by the range and complexity of these symbol strings. In response to this limitation, new variations of genetic algorithms have been developed in which an algorithm permutes the symbol string, thus making the outcomes they induce less predictable. However, far from escaping the limitations of a closed system, this approach simply embeds one closed system (i.e., permutation of the genotypes) inside another one (i.e., generation of designs based on the genotypes). In the end, all that such a digital application can do is subsumed in its state space. This is the essence of the State Space Paradox (SSP) of computational research on creativity.

The SSP arises when an attempt is made to replicate some aspects of creative behavior by means of automated or computational closed systems. The typical argument made in systems that claim to have automated creativity is on the basis that the digital application alters the initial state space of the problem by modifying or shifting it onto another structure. For instance, Rosenman et al. state: "In creative design the state space has to be [re]-formulated. This may include extending the state space of possible solutions or creating a new state space" (Rosenman and Gero 1993, pp. 114).

This implies that achieving a creative solution involves the definition or redefinition of a problem space as distinct from the one(s) that were given at the outset of the digital systems operations. In other words, a closed computer system, in order to be creative, must redefine its own state space. Newell and Simon (1972, pp. 76) define a state space representation of *search* as the set of three indispensable components: initial state (I), conditions on the admissible transformations from one state to the next (C), and characteristics of a terminal state (T). Thus, the search space in a given state space of problem i can be defined as $S_i = \{I_i, C_i, T_i\}$.

The creative computer system, foreseen in Rosenman and Gero (1993), and other statements that have followed its lead, then, have to be either capable of defining a new state space, say S_j, or be able to modify the original space, S_i, into a new space, $S_{i'}$. In the former case, the computer program would generate the set $\{I_j, C_j, T_j\}$, and in the latter case, it would generate $\{I_{i'}, C_{i'}, T_{i'}\}$ based on the original set $\{I_i, C_i, T_i\}$. In either case, the new space is generated by the closed computer system which can only be achieved by applying C_i, the only operator set it has, to I_i, or its descendants generated by earlier applications of C_i. Therefore, $\{I_j, C_j, T_j\} \subseteq Si$; $\{I_{i'}, C_{i'}, T_{i'}\} \subseteq Si$.

Thus, anything that is generated by a closed system is by definition a proper subset of its state space.

The Consequences of the Paradox

The SSP has a serious implication for how humans regard creativity-related computer systems. Tautologically, they are incapable of exhibiting the creativity that open systems possess, in a human or otherwise. This does not negate the possibility that digital creativity applications can and will invoke the SMI response in a human observer. However, they do not have the capacity to break out of their state space boundaries, regardless of the ingenuity the programmers may have built into them.

SMI inducing creative computer systems do not get a break when they are considered in the context of their cultural milieu. A principal reason why creativity is sought after is because it is scarce. Creativity is basically a rare human act. There are very few individuals who are considered truly creative and their lives are finite. This is a tautological outcome. If there was an overabundance of creative acts, one would no longer be willing to call them creative – or the word creative would have an entirely different meaning.

If automated systems could produce things that resemble creative ones that humans produce, there would be an overabundance of so-called creative objects. This would, without a doubt, make humans value them less, and the target of creativity would shift. Creativity is not an absolute thing. It defies static definition and criteria of recognition. Different cultural contexts, time, place, collective agreement among individuals, and evolution of human taste and choice significantly influence what they call creative. Thus, attaining it through well-defined and rational means will inevitably run into some form of the State Space Paradox.

Conclusion and Future Directions

While the going has been tough up to now, given the State Space Paradox, creativity inducing or emulating digital systems have an even tougher road ahead of them. They will neither impress their creators, or anyone else for that matter, beyond the first SMI impression, nor will go beyond what is culturally consider a gimmick. This does not preclude the occasional digital application that is so smart that it will become the artist's, or creator's, reliable companion with its superior interface design and time-saving functions. However, in the end, a thorough analysis, beyond the SMI, will show that the human collaborator of the digital assistant will determine a product's creativity. This is not so much a perspective of a Luddite, as it is one of a cultural determinism. What one considers creative is a product of all of the traits that humans possess. For a machine to match that would require the machine to have all traits of humans.

Cross-References

▶ Creativity Across Cultures
▶ Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon
▶ Creativity Machine® Paradigm
▶ Creativity, Experiential Theories
▶ In Search of Cognitive Foundations of Creativity
▶ Psychology of Creativity
▶ Research on Creativity
▶ University Research and Innovation

References

Akin O, et al. Embedded commissioning of building systems. Guernsey: Artech House; 2012.

Coyn RF, Subrahmanian E. Computer supported creative design: a paradigmatic approach. In: Gero JS, Maher ML, editors. Modeling creativity and knowledge-based creative design. Hillsdale: Lawrence Erlbaum; 1993. p. 295–328.

Hayes JR. The complete problem solver. Philadelphia: The Franklin Institute Press; 1981.

Holtzman S. Digital mantras. Cambridge, MA: The MIT Press; 1994.

Maher ML, Balachandran MB, Zhang DM. Case-based reasoning in design. New York: Psychology Press/Taylor and Francis Group; 1995.

Newell A, Simon HA. Human information processing. Englewood Cliffs: Prentice hall; 1972.
Rosenman MA, Gero JS. Creativity in design using a design prototype approach. In: Gero JS, Maher ML, editors. Modeling creativity and knowledge-based creative design. Hillsdale: Lawrence Erlbaum; 1993. p. 111–38.
Simon HA. The structure of ill structured problems. Artif Intell. 1973;4(3–4):181–201.
Stiny G. Shape: talking about seeing and doing. Cambridge, MA: The MIT Press; 2007.
Turing AM. Computing machinery and intelligence. Mind. 1950;59:433–60.

Statistics

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

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Strategic Scanning of SME

Michel Marchesnay
ERFI, Université de Montpellier,
Montpelier, France

Synonyms

Observation; Planning; Survey; Vision

Introduction

The words “strategic” and “scanning” have to be redefined when applied to SME. Indeed, the specific nature of the medium-sized business firms, and even more, of the smaller ones, require challenging usual definitions commonly given in handbooks of management (Aguilar 1967; Albright 2004). SME specificity is based, firstly, on the “opening” of the organization (Gilad and Gilad 2003) and, secondly, on the “closing” links between the “economic” and “social” sides of business (Hansen and Hamilton 2011). Dealing with four logics of action (Marchesnay 1998), four ideal types of entrepreneurs are described, each one working with different sorts and levels of scanning activities (Marchesnay 2011). Ultimately, the risk impacts (dependency, vulnerability), linked to competitive structures and conducts, are classified (7).

The Very Nature of Scanning the SME Environment

Scanning will be defined as the management activity comprising the following stages and tasks: (1) defining the scope to be scanned; (2) choosing the accurate (pertinent) information to be scanned; (3) translating it into feasible data; (4) settling critical values; (5) forecasting feedback decisions, in order to react and adapt to collected or perceived changes.

The scanning activity, in the managerial world, is mostly based on procedures. It is achieved by overspecialized functional units, in charge of preparing and controlling operational divisions. Executives periodically report on the "state of affairs," by stressing the most remarkable changes detected inside surveyed scopes. They may also alert, in case of emergency, "just in time," ever the business units or top management. Referring to the IMC pattern (Intelligence – Modeling – Choice) designed by H.A. Simon, the Intelligence stage is limited to the choice of the selected "facts" reduced to computable data. The Modeling stage applies the procedures designed to collect and process data. The Choice (decision) stage is logically deduced from the previous ones.

With regard to SME, scanning is jointly taken in charge, formally or not, ever by the boss (including associates, family members), and/or by employees. Indeed, many SME entrepreneurs are reluctant to grow beyond 250 people, arguing that they would be "unable to know the first name of each employee." It means that "information" is mostly collected by informal ways, and even by chance, including highly confidential ("strategic") data. Then, the intrinsic nature of both collected and required information changes. In place of "formatted" data, the SME entrepreneur is searching for "raw" data. The entrepreneurial cognitive process is intuitive and systemic, conversely to the managerial one, which is analytic and systematic. Empirical research reveals that, most often, the "small entrepreneur" modifies the IMC sequence and practices "heuristics": He/she intuitively feels the "right" (satisfying) decision (Choice), just after he/she searches for a justifying model (Modeling) and, ultimately, the accurate information (I).

Mr X planed to buy out a bakery. The "procedural" way would have implied to collect information relative to the local bakery trade market (I), to apply a marketing research model (M), and, consequently, to deduce logically the best place. In fact, Mr X was intimately convinced that one targeted bakery was the best deal. He decided to park early in front of the bakery (M) and to observe, all day, who entered in the shop, what they bought, and so on (I). By doing so, he was convinced of the achievement of his project.

The Very Nature of the Strategic Decision Process of SME Entrepreneurs

Management specialists are firmly convinced that "SME entrepreneurs have no strategy," due to lack of formal reporting, planning, and forecasting. The prevailing images of SME are that of reluctance to innovation or export, of short-term vision, of refusal to grow, and so on. Those critics are obviously reinforced concerning the smallest units. However, the specific and efficient nature of the strategic process of SME is increasingly acknowledged. For instance, the biggest firms try to "break" their giant and bureaucratic structures and replace them by smaller (more "adhocratic," according to the classification of organizations by Mintzberg) project units, limited to 250 people.

Strategic management studies confused for a long time corporate strategy with business policy. In 1965, Igor Ansof defined more precisely corporate strategy as the whole set of decisions relative to the "environment." During the early 1970s, he extended the environment beyond the market and industrial structures, by inclusion of every disruptive events or steady trends (social, technological, financial, political, and so on) underlying strategic impacts on firm conducts.

As assumed by the so-called process approach (vs the "content one") of strategy, the environment is currently perceived as turbulent, always changing, so that it needs to be carefully and extensively surveyed. Each entrepreneur has primarily to scan his own "specified environment," comprising the whole set of both individual stakeholders and social institutions. But he/she has nowadays to scan information at a larger, even worldwide, level.

Mr P. started up a business based on motor GPL process (Liquefied Petroleum Gas : use of gas, usually combined with a "classical" oil motor). But the technique revealed to be highly unstable, not entirely mastered, so that it entailed accidents. Thus, after each trouble, the European Community sharply changed security rules and norms, in such a way that the entrepreneur was unable to scan "just in time" the data and quickly adapt. He resigned himself to close his workshop.

An Organization Without Frontiers

The frontier between "in" and "out" of the small-sized organization is highly porous. It first means that the entrepreneur has to scan also his/her own employees. In the "harvest" of indoor strategic information, the "accurate" data are often the most spontaneous, due to the fact that the written (formal, reported) information distorts the message and excludes the most part of perceived signals.

Mr P., a pork butcher entrepreneur, compelled his delivery man, as soon as he returned to the factory, to enter in his office. He charged with relating spontaneously, "higgledy-piggledy," everything he had seen, heard, smelled, etc., in the warehouse, or been told with the receiving agent. In this way, the entrepreneur collected current ("fresh") information concerning new products or packaging, prices, margins of competitors, consumers reactions, and so on. Of course, the employee would have been unable to write a fruitful formal report.

Inside small organizations, scanning information relative to the human climate is unavoidable. Every entrepreneur has his own "sensors," based on experience, intuition, and knowledge of each employee. But human scanning is incomparably harder than the technical one, namely, the relationships between people or departments. So, the entrepreneur has to adapt his/her behavior in accordance with the scanned (perceived or reported) information, in order to reduce conflicts. He/she may use arguments based on affect ("Please, be kind, come on Saturday to finish the job"), effect ("The job was promised for Friday"), or intellect ("If the job is not finished, we lose future orders").

He/she has to similarly adapt with the external stakeholders. So, the SME entrepreneur must together pay attention to three targets:

– Firstly, efficacy (rate of attainment of the forecasted goals)
– Secondly, efficiency (use rate of available resources)
– Thirdly, effectiveness (rate of individual and collective satisfactions)

Related with the perceived rate of involvement, a high level of effectiveness (human and social performance) is assumed to have a positive impact on the two other targeted performances. However, too many SME primarily focus on efficacy and, above all, efficiency, at the expense of the human side.

A Mix of Economic and Social Incentives

Similarly, the frontier between "economic" and "social" environments is porous. The visionary process of the entrepreneur must include the two sides. For instance, besides the "classical" human resources management, the entrepreneur must scan the main trends concerning demography, education, new habits, and aspirations, and evaluate their impact on his own business. Even in his/her close neighborhood, he/she has to adapt the level and the nature of the required competences and jobs, due to technical and economic changes. Concerning the business strategy, relative to the choice of technologies, products, and markets, the vision must also merge social and economic evolutions. Nowadays, every entrepreneur is faced with a so-called new or hyper modernity, comprising a mix of globalization and localization, new ethical values, new competitors, tastes, and habits, and so on.

The visionary process, namely, the entrepreneurial perception of the future events and decisions, is bi-dimensional, comprising "length" and "width." It has been observed four typical cases:

– Some entrepreneurs have both "long-term" and "large extent" visions, coping with highly turbulent environments, and requiring a strong scanning activity.
– Entrepreneurs preferably working in stable environments or mature businesses have a "shortsighted" vision, needing a weak scanning activity.
– Entrepreneurs focusing on their own business and skill try to exclusively foresee future changes (technology-push or market-pull) linked to the life cycle of their own specialty. They scan the surrounding and present facts and events.
– But most of SME entrepreneurs focus exclusively on their nearby "milieu." As evidenced by searchers on entrepreneurship, the exceedingly embedded entrepreneurs reveal some propensity to avoid changes. They appear as somewhat shortsighted and narrow minded businessmen.

Mr M., a medium-sized entrepreneur, located in a rural area, manufactured all sorts of lights and lamps, and traded them with specialized shops and big retailers. But new competitors, originated from emergent countries, sharply invaded the European market, offering lower prices and standardized goods. Mr P., until then conservative in matters of marketing and product management, was forced to change his mind. A visionary scanning of the future of the lamp industry convinced him to specialize in designing, manufacturing, and installation of ceiling lights for commercial areas, well suited to each case. He recruited designers, reinforced the sale force, and sharply reduced the manufacturing capacity, by outsourcing. Since this strategic change, his firm has got the European leadership of that niche.

"Scanning" the Logic of Action of Each Entrepreneur

Both content and importance of scanning are primarily linked to the identity of each entrepreneur: who he/she is, what he/she does, and why. That identity determines his/her "logic of action." Entrepreneurship researches point up four dominant logics, each one being defined by the hierarchy between several aspirations (what is called a "lexicographic function"):

– The "survival" logic prioritizes the income maximization, as observed among a great part of the smallest and one people enterprises. As a second best, the entrepreneur may search for the "survival" of his/her business, until his/her retirement or his/her recruitment as a salaried worker.
– The "patrimonial" logic focuses on the accumulation and reinforcement of the family or personal tangible assets (the patrimony), in order to perpetuate the enterprise. As a second best, and by way of consequence, it attempts to maintain the independence of the capital, in order to preserve the personal or family governance. Growth and expansion contribute to enhance perpetuation and independence.
– The "managerial" logic focuses on the growth of mature markets, viewed as the best way to get more profits. Profits are targeted as a way to both pay the shareholders and self-finance expansion and efficiency costs.
– The "entrepreneurial" logic is based on innovative practices. It firstly implies the search of a rapid growth in highly expanding and risky markets. As a second best, the innovator is willing to be free, to hold his/her autonomy of decision, and searches for various financial supports. In the first stage of the growth of a nascent business, he/she does not focus on perpetuation, maybe hoping to sell patents or maybe the entire enterprise.

Linking the Type of Entrepreneur and the Scanning Intensity

The SME entrepreneur may be typified, concerning their scanning practice, by crossing the two dimensions mentioned above, namely, the logic of action and the environmental embeddedness. Four "ideal types" are suggested.

The "Isolated" Entrepreneurs

They have no stable and dense relationships with their nearby environment, including stakeholders. For instance, their reluctance to take in charge the commercial side, preferring to "stay in the workshop," has been observed. Consequently, their scanning activity is poor, "waiting for the client," weakly opened to innovative facts, habits evolution, fashionable products, etc. They are viewed as almost short sighted and short minded. However, they succeed, for instance, in markets based on craft skills, tradition, and, nowadays, ecology. This also comprises a lot of activities with low (financial) value creation, so they are outsourced by bigger firms.

This entrepreneur has owned, for several years, a small factory, working with local wood workers, located in a National Park, a wooded country. He manufactures outdoor furniture, for picnic or camping sites with facilities, managed by private owners or public agencies. He has no relations with the surrounding villages and farms, except for wood deliveries. He mentioned that he called the Craft Chamber of the neighboring town in order to get labor support, but "they were unskilled," so that he did not use them. The furniture is well made, and robust, but his firm suffers from no advertising and market policy, from a lack of designing and novelties, from remoteness from the main clients, located near the Mediterranean Sea, and, above all, from cutthroat competition by Eastern Europe manufacturers. He intends to close his workshop and to start again near the sea coast. But he does not intend to change his practices…

The "Notable" Entrepreneurs

They primarily aspire to be socially recognized as influential people, especially when they are of humble origin. Besides their image of successful businessman, they are in search of some "notability," as "eminent" members of local Society. For instance, they want to be elected to political councils or professional institutions. They usually sponsor or preside over local sports clubs, and support humanitarian (religious, philosophical, artistic) institutions or events. That social activity is however closely linked to the professional one, above all when those entrepreneurs work in markets dominated by public bids – for instance, building, roads, public works, and so on.

"Notable" entrepreneurs take great care with human relationships. Inside their enterprise, they try to quickly perceive any troublesome signs or incidents, and behave as *pater familias* – as is usual in craft manufacturing. Outside, they are always scanning their various networks, in order to detect confidential information, such as "intruders," new public projects and bids, and so on. Moreover, they prioritize the family patrimony, searching for physical assets ("stone and land"), preferably to immaterial ones (patents, brands). They try to maintain the family governance (no associates, no leverage).

Mr N., of modest origin, got leadership in the regional public market of garbage disposal and cleaning. Deeply embedded in social networks, he supports or presides over the main professional clubs (football, rugby, handball…) of regional cities, as well as "smaller clubs" of "smaller towns." He recruits a great part of his workers from among the players. He is an influential member of the regional chamber of commerce and of a lot of official committees. He is used to assert in media that he takes great care to "not put all his eggs in the same basket." He seizes the opportunity of league matches to invite "notables" (elected representative, influential people) and stakeholders (clients, suppliers, bankers, etc.), so enhancing the opportunity to collect first hand strategic information. His wife and son are deeply involved in other units of the group. He bought lands and farms in the Natural Park of Camargue (near the Mediterranean Sea), as both a profitable investment (around tourism and entertainments) and a perennial patrimony for the family.

The "Nomad" Entrepreneurs

They may be defined as "profit seekers" and "managerial minded." They are well educated, skilled in management or engineering. A lot of them were executives before creating their own business. They work on mature, yet expanding markets, so that they primarily aim at improving efficacy and efficiency, profitability, and productivity. They preferably plan changes in business strategy (technologies, markets, and products). Their reluctance to incrementally react to scanned events may be explained by the fact that a lot of "nomads" are subcontractors or suppliers for bigger firms. They may even appear as "quasi-firms," actually governed by financial investors or big concerns.

"Nomads" avoid being "stuck in the milieu," to be irreversibly embedded in a local network. Being averse to proximity, they maintain distance from local institutions. Moreover, they can easily close their business, as soon as they find a more munificent place (free tax, activity parks, or more attractive market), including settling in a foreign country. Consequently, effectiveness problems and local legitimacy being none of their business, they give preference to worker flexibility.

The scanning tasks are primarily centered on facts and events concerning the business: innovations, competitors' decisions or "ploys," public rules (laws and norms, tax incentives, financial). An executive may be in charge of formally deal with and classifying that factual information. On the other hand, the boss has to search for all sorts of "informal" information, "harvested," for instance, during meetings, congresses, and so on.

Mr X. resigned his job of engineer in a big concern to settle in business on his own one's account. He was located in an activity park, where he benefited from free taxes and financial incentives by the regional council, especially given for job creations. He manufactured all sorts of wooden furniture for wineries and wine estates (barrels, display shelves, and so on). His business worked well, but being a "nomad" he worried about two things: the lack of involvement of the employees, reluctant to increase their productivity or work on Saturdays; the distance to the "core market," which was in "Bordelais" (Bordeaux wines, on the Atlantic coast), and not in "Languedoc" (Mediterranean vineyards). He was searching for another place, and did not intend to pay back the regional subsidies. His scanning activity was focused on information concerning the wine industry, underlying opportunities for profit and sales increases, cut-off costs, or financial supports.

The "Enterprising" Entrepreneurs

They are the most involved in scanning tasks. Firstly, they work in turbulent markets, needing high reactivity. Secondly, they are "open minded," and so benefit from a high propensity to seize opportunities in their environment. Thirdly, they are "networkers," including both "institutional" and "spontaneous" networks.

Thus, "enterprising" entrepreneurs cultivate their social relationships. They actively participate in the local (regional) life, as ever actors or sponsors. They thereby improve effectiveness (social climate, individual involvement) inside their enterprise. Otherwise, the various social ("weak" or "strong") links underlie a "bundle" of information. Some of them are perceived as a strategic opportunity by the "enterprising"; they are seen as a "scarce resource" and so are included in "core capacities" inside the organization. Moreover, the "enterprising" entrepreneurs try to forecast the best innovative decisions and investment budgets. Thus, they use formal procedures in order to systematically collect formal or published information, concerning laws and rules, technological innovations, social and political facts impacting their own business. The "enterprising entrepreneurs," working in risky businesses, hope for a high return on investment, based on high rates of innovation and demand. Their high locus of control gives incentive to take advantage of any "undiscovered" information, or to make productive use of "available" information. They are typically opportunistic.

The O. family (two brothers and their sister) run their family business, located since several generations in a small rural town. They are deeply embedded: Their grandfather was the mayor, and he gave his name to the main street. They manufacture door and window frames, by using, until recent years, wood from nearby forests. Faced with the declining demand of craft wood frames, they decided to scan their business *area more deeply, in order to detect emerging needs and tastes, and new technologies (processes and raw materials). They concluded that, firstly, the demand for building and restoring houses inspired by the regional style was booming, particularly by retired or urban clients. Secondly, there were new materials, other than wooden made, more resistant and esthetic. Thirdly, the red pine tree of Finland did not rot, in contrast to the local wood. Thus, they renewed their business strategy, by improving the design of their frames, adapting each project to the desires of the client and the wishes of the architect. The "O. Enterprise" won several prizes, at both regional and national levels, due in part to the protection of the local architectural patrimony.*

The Very Nature of Competitive Risks for SME Entrepreneurs

Whatever the type of entrepreneur, they all have to primarily face with two main strategic troubles on their market – a risk of dependency and of high vulnerability. Thus, the SME entrepreneur must currently survey their positioning inside their competitive environment. Several criteria may be practiced.

Avoiding Excessive Dependency

The rate of dependency may be practically scanned by using the following criteria:

– First, detect the key transactions where (1) the number of actual suppliers or clients for a given transaction is weak, even unique, (2) the amount of potential (substitutable) stakeholders is weak, even zero, (3) that transaction is essential to the working, and even the survival of the business.
– Second, in case of high dependency, make a guess about the intent of the other people, and evaluate consequences in matter of exchange costs, pricing, and margins.
– Third, try to make the relationship more secure and stable.
– Fourth, if unsuccessful, try to find a substitute transaction by strategic changes, as, for instance, new raw materials or machines, new clients and delivery channel, new products.

As sportsmen usually say "the best defense is attack." Troubles due to dependency are weakened, even destroyed, when the entrepreneur improves his/her competitive advantage, by seizing opportunities for some distinctive competence, or by mastering idiosyncratic resources. Entrepreneurs may cooperate with other colleagues in the same state of dependency vis-à-vis big retailers or suppliers – what is called a "coopetitive" strategy (combining competition and cooperation). In any case, a high dependency rate would may increase the scanning activity by the entrepreneur.

Reducing Market Vulnerability

Vulnerability may be defined and evaluated as the firm's sensibility to any hostile event. Firms or market are usually impacted by very precise features, as, for instance, in the tourism industry, the impact of climatic (lack or excess of rain), or politic (riots) troubles. The main topics of vulnerability are the following ones:

– The market complexity is defined by the number of competitors and the reciprocal impact of individual or collective strategies (for instance, price cut-offs, advertising campaigns, new ventures, new products, etc.). Some markets, in spite of comprising numerous competitors, are highly segmented; others are highly sensitive to "battles," but the competitors are few (big retailers for instance). But the SME works usually on "market of great number," according to the theoretical model of "monopolistic competition." Thus, the entrepreneur has to scan, sometimes day by day, all events, made of threats and opportunities.
– The market accessibility is defined by the ease of entry, but also of exit. The height of entry and exit barriers is made up of entry investment (partly irrecoverable), reputation and skill to acquire, legal rules, and so on. Low barriers increase a priori vulnerability, but the best protection may be to "build a niche," for instance, by acquiring patents, by signing long-term contracts (a way to reduce

dependency risks), by taking advantage of "singular" skills, and so on.

– The competitor's aggressiveness is evaluated by the intensity and frequency of disruptive actions. The more the competitors are aggressive, the more the entrepreneur has to survey events: experience, intuition, embeddedness in local institutions and networks reveal to be scanning tools and skills of the greatest importance.

Conclusion and Future Directions

To conclude, SME entrepreneurs would of course prefer to be independent from upstream or downstream activities, to be well protected from intruders, and to peacefully work. However, this case is so infrequent that scanning the environment appears as a crucial task.

Mr B. was a munificent entrepreneur producing traditional pastries in his craft workshop, located in a small town near from an expanding city. He delivered them, at a good price, to bakeries and delicatessens. Born in the village, he enjoyed buying the vineyard where his father was a modest worker and making it profitable. Hoping to be elected as mayor, or even more, his network comprised his main clients, whom he invited to big game hunting in Africa. But he decided to grow, and to work primarily with big retailers. The competition was aggressive, with firms practicing low costs and weak margins, while constantly changing. He became increasingly dependent on sales to big retailing. Unable to payback bank credits, he ultimately closed his workshop, and stayed in wine production.

Entrepreneurship research must deepen knowledge concerning various traits of the scanning activity, as related with a lot of contingent variables. It namely includes the enlarged nearby environment, the new relations between the social and professional life (for instance, lifestyle entrepreneurs), the renewed content of the information system (for instance, the meaning of opportunity), and the increasing role of cognition (for instance, the intuition and perception) in the creative and adaptive processes.

At a more practical level, small entrepreneurs and supporting institutions need more suitable tools to scan the environment. It implies prospecting and developing the networks of stakeholders and installing cognitive signals to rapidly detect innovative opportunities and adaptive reactions.

Cross-References

▶ Business Emergence
▶ Business Start-Up: From Emergence to Development
▶ Craftsman
▶ Creative Styles
▶ Entrepreneurial Opportunity
▶ Entrepreneurship and Small Business Agility
▶ Entrepreneurship and Social Inclusion
▶ Environmental Determinants of Entrepreneurship
▶ Firm Failure and Exit
▶ Individual Determinants of Entrepreneurship
▶ Information Monitoring and Business Creation
▶ Innovation Opportunities and Business Start-up
▶ Network and Entrepreneurship
▶ Networking Entrepreneurship
▶ Proximity Relationships and Entrepreneurship
▶ Risk, Uncertainty, and Business Creation
▶ Small Business
▶ Start-up and Small Business Life
▶ Territory and Entrepreneurship

References

Aguilar J. Scanning the business environment. New York: Mac Millan; 1967.

Albright KS. Environmental scanning: radar for success. Info Manag J. 2004;38(3):38–45.

Gilad T, Gilad B. Early warning: using competitive intelligence to anticipate market shifts, control risk, and create powerful strategies. New York: Amacom; 2003.

Hansen B, Hamilton RT. Factors distinguishing small firms growers and non-growers. Int Small Bus J. 2011;29(n°3):278–98.

Marchesnay M. Strategic management. In: Julien PA, editor. The state of the art in small business and entrepreneurship. Brookefield: Ashgate; 1998. p. 150–79.

Marchesnay M. Small business and sustainable development. In: Lesca N, editor. Environmental scanning and sustainable development. Hoboken: Wiley; 2011. p. 77–100.

Strategic System

► Business Model

Strategic Thinking and Creative Invention

Andrea Gaggioli and Alessandro Antonietti
Department of Psychology, Catholic University of the Sacred Heart, Milan, Italy

Synonyms

Creativity techniques; Heuristics; Metacognition; Self-regulation

Strategic Thinking and Creativity

Creativity and invention are often conceived as underlying mental processes which are far from strategic thinking. Creative and innovative ideas are sometimes interpreted as outcomes of unconscious processes which cannot be predicted and, least of all, controlled by the individual. It seems that creative invention is the result of a sudden insight which cannot be prepared, prompted, and driven by means of deliberate thinking strategies. However, on the other hand, a variety of thinking strategies aimed at facilitating or inducing the emergence of original ideas have been devised and are currently proposed as productive ways to solve problems, lead to discoveries, improve existing artifacts, and build new entities. This implies that creative inventions can be achieved, thanks to specific cognitive processes, which can be activated and orientated according to precise mental plans and can be taught so that people can apply them intentionally.

These conflicting views can be reconciled by distinguishing two possible meanings of "strategic." In the first case, a behavior or a thinking process is strategic in the sense that it is not erratic, but it has its own regularity, namely, it follows a systematic and/or recurrent path. This explains why theorists and practitioners suggested specific cognitive strategies, usually consisting of series of mental operations and steps to be followed, which have been proved (on the basis of speculations or empirical tests) to be effective in fostering creative invention. In the second case, "strategic" means that what occurs in the individual's mind is consciously programmed and monitored by the individual himself, who, before and during the inventive process, exerts a control over such a process. Thus, a process can be strategic according to the first meaning but not to the second one. It is the case of a person who implements a certain reasoning rule spontaneously, without being aware of what he is doing. It is also the case of a person who has been trained to apply a given procedure and now he is induced to apply it automatically. Hence, thinking is strategic in a "weak" sense if a creative outcome is reached through a systematic path, irrespectively of the fact that this happens or does not happen under the deliberate control of the person. Instead, in order to be "strategic" in the strong sense, the thinking process has to be consciously driven so to follow a programmed series of steps intentionally.

Methods for Individual Creative Invention

In order to lead people to be strategic in the first, weak sense, a large number of procedures, techniques, and methods have been devised, all aimed at inducing people to apply specific thinking strategies. Methods which can be applied individually are first reported; in the next section, methods aimed at fostering group creativity are described.

Various strategies aim to facilitate the processes of discovery or invention by the juxtaposition of two or more elements. These strategies are based on the assumption that the combination of disparate elements can lead at insights. The precursor of this kind of techniques was Raimundo Lulio (1235–1316), who designed a "machine for ideas" consisting of several concentric disks on the edges of which some words were written. By rotating the disks in different positions, you could read the resulting combination of the terms which were aligned: such combination should inspire new concepts. More recently, other procedures have been developed based on the random combination of elements. One of these is to juxtapose the situation needing for improvements or innovation with a word chosen at random from the dictionary so that the combination will produce some useful ideas. For example, given the need of finding a way to reduce noise pollution, the randomly chosen word from the vocabulary was "anthracite," which triggered the following ideas; the charcoal comes from underground and so one might drive traffic in tunnels or can build the places that need silence (libraries, leisure centers, etc.) undergrounds; anthracite is dark and this reminds the idea that there are tools which protect eyes from strong light, thus suggesting that similar devices protecting ears from loud noises can be invented (e.g., plugs activated by disturbing acoustic stimuli). Another method based on random combinations of items was proposed by Buzan (1974): according to the *combination of symbols* method, a conventional symbol (letter, number, picture) must be associated to each relevant aspect of the situation. These symbols must be grouped in a completely random way as long as new combinations of elements emerge so to prompt to novel ideas. A third technique, called *forced relations*, consists in connecting two elements (objects or ideas) in order to make a third element emerge. For example, if the goal is to help a person lying in bed to read, the two terms ("reading" and "bed") are put in relation. Reading is done usually with the trunk of the body in the upright position, while in bed you stay in a horizontal plane. It is therefore necessary to reduce the gap between the two positions. One can thus think of a device which projects the page of the book you are reading onto a horizontal plane, or a periscope that allows reading the book placed perpendicular to the bed, or a particular bookstand suspended above your head.

A systematic use of the combination of the elements occurs in the *morphological synthesis*, due to the astronomer Fritz Zwicky. The procedure requires first to describe the various aspects of an object or concept and identify the main features of what has to be invented. Then you need to envisage the possible values of those aspects (different materials, different uses, etc.). In the last phase, values and features are combined in order to produce associations that may not previously considered be particularly useful. For instance, if you are asked to invent a new type of vehicle, you may decide to operate on two aspects: the mode of vehicle power and the medium along which it must travel. Possible features of the first aspect are force of gravity, fuel, etc. Possible features of the second aspect are tube, air, etc. Then you examine all the possible combinations (vehicle driven by the force of gravity and traveling in a tube, vehicle driven by the force of gravity and traveling in the air, etc.). You discard those combinations that correspond to vehicle types that already exist and those definitely impossible; the rest may suggest some useful idea.

The *analysis of the characteristics*, also known as *attribute listing* or *constituent element* method, consists of two phases. In the first phase, the elements, attributes, or properties of an object or situation are listed in a comprehensive manner. In the second phase, all the elements listed are taken into consideration one by one and one wonders if they cannot be transformed in order to enhance their effectiveness. The method was developed especially in relation to the invention of mechanical devices which can be broken down into parts. For example, if you are asked to invent a new piece of chalk to write on the board, you must list the most important attributes of the object in question: shape, size, color, etc. Then you devise possible changes of these attributes: colors other than white, increased size of the piece of chalk, etc. Finally, you apply attributes possessed by other objects to the piece of chalk, for example, the way a cigarette is held in the hand. This might suggest you to invent a new type of pieces of chalk which can be handled, thanks to a mouthpiece, so to prevent your hand to get dirty. Or if you are asked to devise a new model of screwdriver, you have to list the attributes of the tool (blade, handle, end to insert into the screw, etc.). Changes of each attribute can lead to a more user-friendly instrument: the shaft of the screwdriver can be hexagonal instead of round, the tip can be made adaptable to various forms of screws, etc.

The *fractionation* strategy requires breaking the situation into parts so that implicit assumptions related to the whole fail to bias reasoning. For example, if the problem is, again, to reduce noise pollution, you will examine the different components, such as the various causes (transportation, etc.) or the means through which the sound propagates (air, walls of the buildings, etc.). For each component, you will try to devise measures that avoid the inconveniences complained (e.g., silent tires or insulating building materials).

Another procedure, devised by De Bono (1969), is the *impossible intermediate*. Faced with an obstacle, think of a solution seemingly impossible. Then let your mind free to elaborate this solution, until you reach a new and feasible way out. For example, given the request of making the process of unloading cargo from ships more efficient, you can think about this impossible solution: unloading the ship while it is still at sea. How to make this feasible? Ships could be designed to allow to anticipate some of unloading procedures: workers could be carried, with helicopters, on the ship approaching the harbor in order to start the stevedores unloading, so that, once the ship arrives to the port, they will only transfer the cargo on trucks.

Finally, it is worth mentioning the method suggested by Finke (Smith et al. 1992), consisting in showing individuals some simple geometric shapes and then ask them to mentally combine them with the objective to achieve an overall form with a final meaning or a final object that has some useful features. In this strategy, people are presented three geometric figures that are either two- or three-dimensional. They observe the figures for some time and then close their eyes for 2 min trying to mentally combine the figures into a composite image with a sense, which they must then draw. Individuals are told that they cannot bend, stretch, or compress the given figures, but they can change the size, orientation, position, and the material of the stimulus figures. The synthesis of mental images has been extensively investigated in recent times because of its functional properties. This synthesis leads to the possibility that a global image resulting from the combination of several partial images can have more meaning than their constituent parts. This is a property closely related to creativity because it often involves the ability to go beyond the immediate meaning of things and to find these hidden or discounted properties. The outcome of the mental synthesis is in fact a new mental picture that could help, by means of an intuition, to better understand the original meaning. Some people who have applied this technique have reported to be surprised by their imaginative creation.

Strategic Thinking and Creative Collaboration

The relationship between strategic thinking and creative invention can be examined not just at the individual but also at group level. The potential of groups for creativity can be better understood looking at the history of inventions, which shows that most significant innovations involved various forms of joint efforts. These famous collaborations include Albert Einstein and Niels Bohr, Pablo Picasso and Simone de Beauvoir, and George Bateson and Margaret Mead, just to list a few. Furthermore, nowadays, companies are increasingly recognizing the added value of collaboration in the development of innovative products and services and the key role played by the diversity of skills and knowledge in this process.

Several features of collaboration might explain why it is so beneficial to creativity and innovation. Firstly, collaboration allows breaking down complex problems and specialized division of labor. Secondly, collaboration fosters divergent thinking, supports synergistic coordination, and allows members to share knowledge and information. Considering the importance of creative teamwork for innovation, the definition of strategies to support collective idea generation has become an important challenge of creativity research.

Historically, *brainstorming* has arguably become the most widely known and used technique to enhance creative synergy. This method was popularized by Alex Osborn in the 1940s and 1950s and described in his book *Applied Imagination*. Essentially, brainstorming consists of a group of people collaborating in a noncritical environment to generate a high number of ideas and is characterized by four basic rules:

(a) Withhold criticisms: the disapproval or rejection of the ideas should be postponed to a second stage; averse judgments of ideas – such as "it won't work," "it is not feasible," or "it is too expensive" – are not allowed.
(b) Encourage the generation of audacious, exaggerated ideas: team members should be pushed to free their imagination and propose provocative or even bizarre ideas.
(c) Focus on the quantity of ideas and not their quality: the greater is the number of ideas generated, the more likely it is that useful ideas will result.
(d) Build upon and elaborate each other ideas (*hitchhiking*): in addition to contribute with their own ideas, participants should try to suggest how ideas proposed by other group members could be improved or combined into new ones.

The technique typically involves gathering a group of 5–6 participants (including both novices and experts, from a wide variety of background). Regardless of the number of participants, group members should be well briefed about the rules, the problem, and its main implications. The brainstorming panel also includes a leader (also called facilitator or panel chairman) and an idea recorder (who can be the same person of the facilitator). The leader should be well trained in the technique and has several tasks, which include ensuring that participants are adequately briefed on the objectives of the meeting and on the characteristics of the problem, maintaining the rapid flow of ideas, keeping the group focused, preventing participants from getting discouraged, and favoring a positive group climate. The leader also contributes to the generation of ideas. Most authors agree about the importance to have a comfortable setting, where coworkers can interact without distractions and enjoy a relaxing atmosphere. During a brainstorming session, the generation of ideas can be solicited in different ways, depending on the characteristics of the group: in the so-called round-robin method, members take turns, in order, offering a single idea, and therefore each member is given a chance to speak; in the alternative, "freewheeling" brainstorm, participants express their ideas spontaneously and the facilitator records the ideas as they are suggested. At the end of the brainstorming session, after a large set of ideas have been generated, they are evaluated and selected. The evaluation of the ideas is kept separated from the generation phases and occurs after a short interval of time. The screening can be done by the group itself, by a subgroup of its members, or by third people and consists in the aggregation, classification, and identification of useful ideas, according to explicit criteria that are coherent with the organization's objectives.

In the course of the years, several variations of the original brainstorming technique have been introduced. For example, in the *brain-writing* technique, each participant generates a number of ideas, then records them individually (i.e., using post-it notes or small cards) and pass them on to the next person, who uses them as a trigger for his own thoughts. The *nominal group* technique is another variant of brainstorming that encourages all group members to participate, preventing the monopolization of the discussion by a single person. It is considered particularly useful when the group needs to prioritize a large number of options, within a structure that supports inclusion and consensus-building. The technique consists in having participants write their ideas on a piece of paper, and then the moderator collects the ideas, which are ranked by the group independently. After that, the list of ideas is rewritten in priority order. Finally, it is worth mentioning that in recent years, computerized versions of the manual brainstorming technique have been proposed. *Electronic brainstorming* systems can be supported by different types of informatics tools (spanning from e-mail to peer-to-peer software) and allow participants to display and share a list of ideas using a computer console.

The increasing popularity achieved by brainstorming over the years has led researchers to investigate the effectiveness of this technique in enhancing group creative performance. Unfortunately, the bulk of empirical evidence indicates that group brainstorming is not more effective than individual brainstorming (Paulus and Nijstad 2003). In a typical experiment of this kind, the creative performance by a group of participants ("real groups") is compared to that of the same number of participants working individually ("nominal groups"). In most cases, the result of the comparison has found that real groups tend to generate less ideas than nominal groups. This reduced productivity might be explained by both social and cognitive influence processes. The first category may include the effects of social comparison among members, such as evaluation apprehension (i.e., fear negative evaluations from others), social loafing (individuals give less effort in a group because responsibility is diffused), and social matching (the tendency to conform to peers, who lead group members to adapt their proposals to be similar to others). Cognitive influence processes include the so-called production-blocking effect (in the course of idea generation, one person speaks while the others listen, and this results in a cognitive interference that hinders the generation of ideas), excessive demands on cognitive resources and working memory (due to the dual tasks of paying attention to others' ideas and generating one's own ideas), distractions and fixation (being exposed to others' ideas, members tend to focus on those and block other types of ideas from taking hold). Paulus and Brown (2007) have proposed a cognitive-social-motivational perspective on brainstorming, which provides a basis for understanding group creative processes for ideational tasks. They argued that the creative process occurring in groups has two key dimensions: a social dimension, since it results from the interaction with other individuals, and a cognitive dimension, because group members share each other's ideas, views, and information. The model posits that in order to achieve high levels of creativity, group members need to focus their attention deeply on the activities of the other participants. By focusing on others' ideas, new insights can be stimulated, new knowledge accessed, and more elaborated combinations generated. However, allocating attention and avoiding distractions is only the first step: the shared ideas must be further processed and elaborated by participants, and this involves the ability to understand, remember, evaluate and integrate the shared information. These abilities, in turn, can be affected by group context factors, such as the structure and the motivation of the task.

In sum, group members' interactions and processes play a mediating role in determining how the individual ideas and products are integrated and developed into group-level creativity outcomes. From this perspective, a significant role is played by behaviors that are able to positively influence group functioning, such as inspiring group members to elevate their goals, providing feedback and individualized consideration, asking for and recognizing different ideas (Taggar 2002). For instance, Sawyer (2007) analyzed in detail the behavior of several improvisational teams in various creative areas (jazz, theater) and concluded that the majority of successful teams were distinguished by their ability to reach a state of *group flow*, a peak experience where a group is performing at its top level of ability. Flow is a psychological state characterized by global positivity and a high level of complexity, in which the perception of a higher-than-average opportunities for action (challenges) is coupled with the perception of appropriate skills. Other peculiar characteristics of this experience include high levels of concentration and involvement in the task at hand, enjoyment, a positive affective state, and intrinsic motivation. Sawyer (2007) identified several conditions which facilitate the occurrence of this optimal state at group level, such as close listening, complete concentration, feelings of autonomy, competence, mutual connection, and equal participation in the creation of the final performance. According to Sawyer, the achievement of group flow involves a balance between the extrinsic/intrinsic nature of the goal and preexisting structures shared by the team members (e.g., know-how, instructions, repertory of cultural symbols, and set of tacit practices).

Conclusions and Future Directions

Once one or more techniques or methods, such as those mentioned in the previous sections, have been acquired by an individual or a group, what does lead people to apply them in a proper manner? A strategic, in the second sense highlighted at the beginning of this entry, attitude seems to be relevant. In fact, persons should realize that the situation they are facing needs to be approached through the creative technique they were taught. Moreover, if they know more than one technique, they have to decide which technique is better according to the situation in question (Antonietti et al. 2000). In addition, they should perceive if they are applying the chosen technique in the right way and if they are achieving the expected outcomes; otherwise, they should shift to another technique. In other words, a metacognitive attitude and self-regulatory skills are requested to monitor and control the application of strategies and methods aimed at supporting the generation of original and innovative ideas. However, such a metacognitive competence has been poorly investigated in the field of creativity (Jaušovec 1994; De Stobbeleir et al. 2011). A task for future research is to understand to what extent metacognition and self-regulation are actually beneficial to the creative and inventive process.

Cross-References

- ▶ Analogies and Analogical Reasoning in Invention
- ▶ Brainstorming and Invention
- ▶ Co-conception and Entrepreneurial Strategies
- ▶ Corporate Creativity
- ▶ Creative Problem Solving
- ▶ Creative Thinking Training
- ▶ Creativity Techniques
- ▶ Interaction, Simulation, and Invention
- ▶ Thinking Skills, Development

References

Antonietti A, Ignazi S, Perego P. Metacognitive knowledge about problem-solving methods. Br J Educ Psychol. 2000;70:1–16.

Buzan T. Use your head. London: BBC; 1974.

De Bono E. The mechanism of mind. London: Cape; 1969.

De Stobbeleir KEM, Ashford SJ, Buyens D. Self-regulation of creativity at work: the role of feedback-seeking behavior in creative performance. Acad Manage J. 2011;54:811–31.

Jaušovec N. Metacognition in creative problem solving. In: Runco MA, editor. Problem finding, problem solving, and creativity. Westport, CT: Alex; 1994. p. 77–95.

Paulus PB, Brown VR. Toward more creative and innovative group idea generation: a cognitive-social-motivational perspective of brainstorming. Soc Personal Compass. 2007;1:248–65.

Paulus PB, Nijstad BA. Group creativity: innovation through collaboration. New York: Oxford University Press; 2003.

Sawyer KR. Group genius: the creative power of collaboration. New York: Basic Books; 2007.

Smith SM, Finke RA, Ward TB. Creative cognition. Theory, research, and applications. Cambridge, MA: MIT Press; 1992.

Taggar S. Individual creativity and group ability to utilize individual creative resources: a multilevel model. Acad Manage J. 2002;45:315–30.

Strategy

▶ Model for Managing Intangibility of Organizational Creativity: Management Innovation Index

Structural Cognition

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Superachiever

▶ Genius

Superior Creative Power

▶ Genius

Superior Intellectual Power

▶ Genius

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▶ Scientific Inventive Thinking Skills in Children

Supposition

▶ Imagination

Survey

▶ Strategic Scanning of SME

Sustainable Development

▶ Green Business and Entrepreneurship
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Systems Theory and Innovation

Cinzia Colapinto[1] and Colin Porlezza[2]
[1]Department of Management, Ca' Foscari University Venice, Venice, Italy
[2]Institute of Media and Journalism, University of Lugano, Lugano, Switzerland

Synonyms

Creativity; Ecosystems; Systems of innovation

Creativity and Innovation

Creativity and innovation are attributes of individual people but also features of organizations like firms, cultural institutions, and social networks. In the knowledge economy, they are of increasing value for developing emergent and advanced countries. In the last years, "systems of innovation" have emerged as a new research topic, in which the analysis has been broadened from artifacts to systems, from firms to clusters and networks.

Literature provides different definitions of "innovation." Joseph Schumpeter is often considered the first economist to draw attention to the importance of innovation. Innovation is closely related to development in Schumpeter's theory: indeed, economic development is driven by the discontinuous emergence of new combinations (innovations) that are economically more viable than the old way of doing things (Schumpeter 1934). Drawing from Schumpeter's theory, researchers have also been pointing out the importance of the succession of innovation and stability phases for the firm development.

Most of the innovation definitions have focused on similar points with different perspectives, as they imply change and renewal for a better situation. The Oslo Manual, by the Organization for Economic Cooperation and Development (OECD 1997), defines innovation by linking it to technological change, while the European Union gives a broader definition (1995) introducing the change in workforce talent, working conditions, and managerial and organizational jobs.

Creativity and innovation are overlapping concepts: indeed, creativity is about the origination of new ideas. The creation of ideas, images, symbols, design, and cultural expression should be considered a national asset in multiple ways. As developed countries are moving from economies based on tangible assets to ones based on commercialization of intellectual property and other intangible assets (such as research and development, computer software, design, brand, human capital, and organizational systems), creativity and innovation are crucial drivers.

However, concepts like creativity and innovation are not bound to certain assets or institutions. Especially nowadays, they benefit from evolving and overlapping relationships between different institutions: innovation is a more systemic process with tangible implications for the whole society. Hence, systems theory can be a fruitful approach in order to understand innovation and creativity not only from an institutional perspective but how it has been produced within society.

Moreover, culture and society can be no longer understood in isolation from the media: media should be defined as "molding forces." In this sense "mediatization" has evolved as a key concept to describe a fundamental transformation of the relationship between the media, culture, and society. The term "mediatization" captures the interrelation between media-communicative change, on the one hand, and sociocultural change, on the other. Thus, (science) journalism plays a crucial role in spreading creative and innovative ideas, which in turn become the starting point for further innovation processes.

The Development of Innovation Concept

Innovation is considered as a catalyst for economic growth, which does not rely anymore only on the traditional production's factors (land, labor, and capital). In particular, Romer (1990) highlighted the weight of technological progress and ideas as the relevant engine of growth. In the last decade, a paradigm shift has occurred introducing new ways of collaboration between different actors (co-opetition, co-creation, and extension of the value chain) and the integration of commercialization, empirical knowledge, and the public good in order to sustain economic growth at national level.

Traditionally, innovation was conceived in linear terms, that is, the elite science universities or the laboratories in the large corporations would generate a flow of inventions that in turn would be commercialized. Both the traditional Schumpeterian and the linear models have been found inadequate to define innovation. Researchers regard innovation as an evolutionary, complex, nonlinear, and interactive process. Many actors and factors, both inside and outside a firm, play a crucial role: in the ages of customer empowerment, customers are included in the firm value chain which turns into a real-value constellation. Nowadays innovation and research benefit from evolving and overlapping relationships between academia, government, and industry: innovation is a more systemic process, with an accent on effective coordination of a system in which high skills are widely diffused in different areas.

Another way to depict the evolution of the innovation concept is to consider the shift from mode 1 to mode 3. "Mode 1" of knowledge production refers primarily to basic research performed by universities. "Mode 2" focuses on knowledge application and a knowledge-based problem-solving. Expanding and extending the "mode 1" and "mode 2" knowledge production systems, today the "mode 3" is at the heart of a multilateral system, encompassing mutually complementary and reinforcing innovation networks consisting of human and intellectual capital, shaped by social capital and underpinned by financial capital (Carayannis and Campbell 2012).

Since innovation is seen as a systemic process, the use of an alternative approach such as the theory of social systems can lead to new insights. Systems theory is widespread in social sciences, particularly within media and journalism studies, but only fairly used in the area of creativity and innovation. As Willke (1996) has been arguing, modern systems theory has become one of the main paradigms within social sciences because the highly organized society can only be analyzed through theories with a sufficient self-complexity. One of the major advantages of a system theoretical approach is that it sensitizes the scientific observer to be careful with normative prescriptions or determinism.

As Baecker (2001) argues, systems have never really had a good press, because they seem to suggest that there is more order in society than there really is. This is particularly the case if dealing with concepts such as innovation and creativity, which always bear a slightly muddled connotation. However, systems are not given objects within society. They constitute themselves according to a differentiation based on meaning. Thus, every system comes up with specific internal structures in order to solve a certain kind of complexity that surrounds it in the environment. In other words, every system carries out a certain function within society. Systems theory raises questions about how society is organized on a macro-level in different functional systems such as politics, economy, media, or science and which relationships are upheld between them.

Innovation is a process that occurs in and between various systems and is characterized by cross-sectorial linkages and interdependencies between creative industries, cultural institutions, content and applications production, government, and other industries as well. Since systems theory allows to distinguish and observe different areas within society, one can indeed grasp all these mutual implications with the advantage of dealing with the issue from each system's distinct point of view.

Theoretical Background and Open-Ended Issues

The Triple Helix theory was devised in the 1990s by professors Henry Etzkowitz and Loet Leydesdorff. They point out that innovation moves outside of a single organization (e.g., Universities are no more ivory towers); thus lateral relationships across boundaries, rather than hierarchical bureaucratic structures, become more important. Their model refers to a spiral (versus traditional linear) model of innovation that captures multiple reciprocal relationships among institutional settings (government, industry, and university) at different stages in the capitalization of knowledge. These three institutional spheres which formerly operated at arms' length in liberal capitalist societies are increasingly working together with a spiral pattern of linkages emerging at various stages of the innovation process. The "Triple Helix" system of relationships between university, industry, and government can also enhance the effectiveness of universities in developing countries as agents of innovation, industrialization, and sustainable development.

The Triple Helix model has been extended bringing media, "civil society," or "the public" back into the model as a fourth helix: a broader and better understanding of knowledge production and innovation application requires that also the public becomes more integrated into advanced innovation systems. Arguing that the Triple Helix model is not a sufficient condition for long-term growth, the Quadruple Helix Innovation theory associates knowledge production and knowledge use with media, public discourses, creative industries, culture, values, lifestyles, and art. In other words, creative industries, arts, and art universities represent crucial assets for the evolution and advancement of knowledge economies (Carayannis and Campbell 2009). Observing some technology clusters (e.g., Silicon Valley, Route 128, and Waterloo Region), it is also evident the driving and relevant role played by financing organizations (Carayannis and Campbell 2012) or venture capital companies in fostering revenue growth and commercialization (Colapinto and Porlezza 2012). According to Carayannis and Campbell (2009), innovation ecosystems are systems in which different organizations and institutions in public and private sectors (such as governments, universities, research institutions, business communities, and financing organizations) collaborate and compete between each other, thus creating an environment prolific for innovation. At the higher degree of complexity and dimensionality is associated the Quintuple Helix model which brings in the perspective of the natural environments of society, also for the knowledge production and innovation. This latter interdisciplinary and transdisciplinary framework of analysis relates knowledge, innovation, and natural environments to each other, and it fits the transdisciplinary analysis of sustainable development and social ecology.

Recent theoretical debate concerning social systems leads the readers to the existence of the exchange between actors belonging to different social systems which has a positive influence on firms' innovativeness. Kaufmann and Tödtling (2001, p. 795) observe the interactions among three different social systems (business, science, and policy) with different modes of interpretation, decision rules, objectives, and specific communicative standards. Crossing the border to another system increases the diversity of an organization's innovation partners and fosters innovation. Linking different systems stimulates innovativeness and can increase effectiveness more than remaining within the same set of routines. This approach obviously recalls the Triple Helix model. Knowledge is no longer produced only in universities, but people can observe a diversification of the sites of knowledge production which takes place in different settings, from university to government laboratories, industries, and think tanks. However, this diversification has further stimulated university research through inter-sectorial collaboration and has created a wider system.

An alternative but at the same time integrative approach to the Helix model is offered by the theory of social systems. Whereas the Helix model is a strategy of development based on the collaboration among different institutions, systems theory raises questions about how innovation is being accomplished within society and which relationships are upheld between all the different social systems. Systems theory embodies therefore some remarkable potential to relate innovation production and transfer and thus analyze the interdependencies between different systems on a larger, social scale.

Moreover, it allows to examine the concrete liaisons between science and society and the distinctive role played by the media and (science) journalism.

From a systemic perspective, the different helices are autonomous systems. In other words, industry corresponds to the economic system, government corresponds to the political system, universities to the scientific system, and media to the media system. However, every social system observes its environment on its own. But often the instruments to observe the environment are not complex enough in order to take into consideration other systems (cf. Görke and Scholl 2006). The same aspect occurs within the Helix model: how can the interactions between different helices assure knowledge or creativity growth if every helix has a different perspective on why information is regarded as relevant?

That is the point where the media journalism become relevant. Journalism is asked to observe, construct, and reduce complexity within society and integrates information and knowledge about innovation throughout the existing systems. By doing so, journalism creates its own reality and conveys information not in a passive way but produces an actively modeled orientation for society. Journalism becomes a crucial player in today's knowledge societies, though.

Implications for Theory, Policy, and Practice

Theory has to take into account these new forms of knowledge production and the existence of hybrid actors. The complexity of the phenomenon requires a multi-perspective and multidisciplinary approach in defining and explaining the innovation and creativity processes. As industrial and political interests have been integrated into the evaluation, organization, and performance of university research, a change in policy and funding regulations is needed. This means, for instance, that funding agencies contribute to constructing, reproducing, and changing the institutional order of academic research. Indeed, academic research nowadays has to be pursued with openness toward practical applications and commercial exploitation.

University moved from the "ivory tower" to a common entrepreneurial format in the late twentieth century. Many researchers explain the emergence of this new model as a response to the increasing importance of knowledge in innovation systems and the recognition that the university is a relevant player and broker of both knowledge and technology. The entrepreneurial university is required to engage and negotiate with other institutional spheres. Interface specialists appear, especially at centralized level (e.g., technology transfer or university spin-off offices). Most universities have set a press or media relations office which acts as the first point of contact for local, national, and international media. Many communication offices serve to develop communication both inside and outside the university.

It seems therefore that the Helix model, which associates knowledge production and knowledge use with media, is of particular importance in order to understand knowledge production and innovation in modern societies. Particularly scientific journalism observes and describes the interdependencies between science and society. Usually, scientific events chosen for news coverage are such events that are of great interest in the social context of science, that is, in other social systems, such as those news events considered to have medical, political, legal, economic, or moral implications.

As Peters et al. (2008) argue, this systemic notion of science journalism has particular implications for the knowledge production within society: "One of the consequences of this conceptualization of journalism is that journalism is seen not as a transmitter of knowledge but as a producer of knowledge. Observation of society results in media constructs, which represent a specific type of knowledge about the world that is influenced by the media logic." This is also true for innovation: journalism not only conveys information about innovation but acts also as a starting point for new innovation processes.

However, it seems that the role of media and journalism throughout the process of innovation and creativity is underrated and should be more thoroughly unpacked in terms of its (social) implications.

Conclusion and Future Directions

As innovation is a complex concept, different perspectives have to be considered in its definition. This contribution proposes to merge two different approaches to have a better understanding of innovation. As the barriers blocking cooperation between institutions belonging to different systems are reducing, a broader framework able to "bridge" the different systems is necessary. The crucial role of commercialization, collaborations, and communications leads toward systems theory as a good partner of and theoretical framework for the Helix models. Future research directions involve empirical tests to verify some of the trends suggested in the literature.

However, the existing scholarship presents shortcomings when it comes to the application of combined theoretical approaches such as the one presented in this entry. In order to overcome such limitations, the findings in this entry suggest that academia should broaden its scope of research to other fields. The combination of systems theory and the Helix models could contribute to rethinking some aspects of the process of "medialization" with respect to science. An increase in the orientation of science to the media, due to the close relationship of science to its social context, could be a very interesting avenue for future studies. Moreover, since medialization in science is often seen as a consequence of medialization in politics, research should also be extended to other areas such as politics or economy. Either way, more empirical research is needed – not only to "test" the theoretical implications stated in the article but to gain more detailed insights in the ongoing process of continuously overlapping and interpenetrating systems.

Cross-References

▶ Creative Collaboration
▶ Creative Knowledge Environments
▶ Creativity and Innovation: What Is the Difference?
▶ Higher Education and Innovation
▶ University Research and Innovation

References

Baecker D. Why systems? Theor Cult Soc. 2001;18(1):59–74.

Carayannis EG, Campbell DFJ. Knowledge creation, diffusion, and use in innovation networks and knowledge clusters: a comparative systems approach across the United States, Europe and Asia. Westport: Praeger; 2009.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems, Springer briefs in business, vol. 7. New York: Springer; 2012.

Colapinto C, Porlezza C. Innovation in creative industries: from the Quadruple-helix model to the systems theory. Journal of the Knowledge Economy 2012; 3(4):343–353.

European Commission. Green paper on innovation, COM (1995) 688. Brussels: European Commission; 1995.

Görke A, Scholl A. Niklas Luhmann's theory of social systems and journalism research. J Stud. 2006; 7(4):644–55.

Kaufmann A, Tödtling F. Science–industry interaction in the process of innovation: the importance of boundary-crossing between systems. Res Policy. 2001; 30(5):791–804.

OECD. Proposed guidelines for collecting and interpreting technological innovation data: The Oslo manual. Paris: OECD; 1997.

Peters HP, Heinrichs H, Jung A, Kallfall M, Petersen I. Medialization of science as a prerequisite of its legitimization and political relevance. In: Cheng D et al., editors. Communicating science in social contexts. New models, new practices. Amsterdam: Springer; 2008.

Romer PM. Endogenous technological change. J Polit Econ. 1990;98(5):S71–102.

Schumpeter JA. The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle. Cambridge, MA: Harvard University Press; 1934.

Willke H. Systemtheorie II: Grundzüge einer Theorie der Intervention in komplexe Systeme. Stuttgart: UTB; 1996.

T

Tacit Knowledge

► Role of Intuition in Creativity

Teaching and Research/ Teaching-Research Nexus

► Higher Education and Innovation

Teaching as Invention

Ulrike Hanke
Department of Educational Science,
Albert-Ludwigs-University of Freiburg,
Freiburg, Germany

Synonyms

Instructional design; Lesson design; Planning lessons

Introduction

The knowledge as well as the beliefs of a teacher influence the way teaching takes place and the results of the teaching process (Pajares 1992; Neuweg 2011). But knowledge and beliefs are not the only factors influencing the teaching process. Since under certain conditions teaching can be described as a problem-solving process, i.e., as an invention process, it seems probable that the creative disposition of the teacher may be another factor that influences the teaching process (Hanke et al. 2011). This contribution describes teaching as a decision process and explains under which conditions it takes place as an invention process which is influenced by the creative disposition of the teacher. As one of these conditions is that enough time is available for processing, it will be shown that above all, designing lessons can take place as a creative problem-solving process, i.e., as an invention process.

Key Concepts and Definition of Terms

Teaching

In order to describe how a creative disposition may influence teaching, it is important to have a look at the process which takes place before a teacher acts, independent whether it is an act of designing lessons or an act of interacting in class. In both cases, this process preceding action is a decision process that results in the decision on how to act. In order to describe this process in more detail, it can to be divided into three subprocesses (Hanke 2011): (1) the subprocess of perceiving the environment, (2) the subprocess of activating possibilities of how to act, and (3) the subprocess of choosing one of these possibilities (see Fig. 1).

E.G. Carayannis (ed.), *Encyclopedia of Creativity, Invention, Innovation, and Entrepreneurship*,
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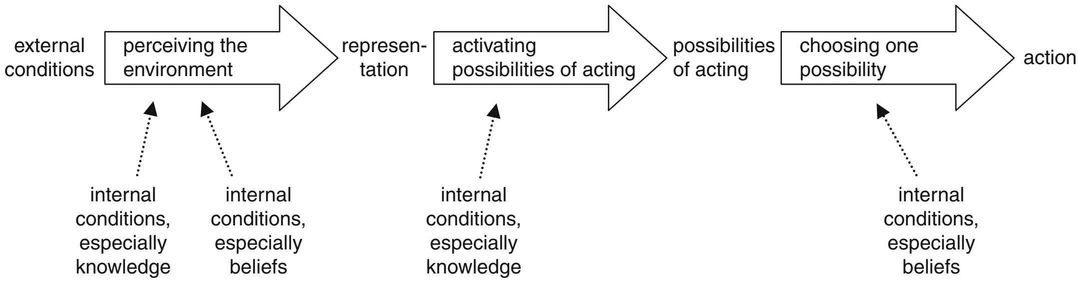


Teaching as Invention, Fig. 1 Subprocesses of the decision process

The starting point of the decision process is to perceive the environment and represent it mentally (subprocess 1). Based on this representation, the teachers realize different possibilities of how they can act (subprocess 2) and finally choose one of them to implement (subprocess 3).

Each of these three subprocesses is influenced by internal and external conditions (see Fig. 1). External conditions are those aspects of the environment that teachers perceive, e.g., location, media available, number of pupils, etc. Internal conditions are the teachers' knowledge (Neuweg 2011), their beliefs (Pajares 1992), their experiences, their emotions (Hascher and Krapp 2009) and motivation (Krapp and Hascher 2009), their skills, etc., and perhaps their creative disposition as well (Hanke et al. 2011).

External conditions are perceived and represented differently by different teachers, depending on their internal conditions. Thus, subprocess 1 is influenced by the external conditions on the one hand and by the internal conditions on the other, which are mainly the knowledge and the beliefs of the teachers which are represented in perception schemata (Berliner and Carter 1989).

Based on how teachers represent the external conditions, they realize different possibilities of how they can act. Which possibilities they realize depends on their representation of the external conditions on the one hand and on their perception schemata on the other hand. It is evident that teachers who have more knowledge are able to activate more possibilities of how to act than those who have less knowledge.

The last subprocess is, in contrast, mainly driven by the teachers' beliefs. Depending on these beliefs, they evaluate the effectiveness and adequacy of the different possibilities and therefore choose different possibilities of how to act.

The decision process described above can take place based on schemata, i.e., based on already existing knowledge and beliefs, as well as a process of mental model construction. In most cases, it is a schema-based process because this way of processing is less exhausting. A mental model is only constructed if the schema-based processing fails (Seel 1991) because of a resistance to process based on an existing schema, i.e., because of a resistance to assimilation as discussed by Piaget (1976). This resistance provokes a mental disequilibrium, which makes a person feel the necessity to accommodate, i.e., to construct a mental model.

As assimilation and accommodation are the basic processes of information processing and therefore take place in every situation, they are also assumed to be the basic processes in the decision process of teaching described above.

A schema-based decision process in teaching is characterized by activation of schemata in the second subprocess and an evaluation based on schemata, i.e., on existing knowledge and experiences in the third subprocess. On the other hand, a decision process that results in a mental model can be characterized as a problem-solving or invention process. In this case, knowledge is activated, but it has to be restructured in order to construct a mental model and with it find a solution for the problem/task. Thus, the second subprocess is not a process of activating schemata, but one of restructuring knowledge and constructing a mental model: it is an invention process.

Based on these assumptions, the decision process in teaching is assumed to be schema-based as long as there is no resistance to processing based on schemata. But a closer look at the different processes of teaching shows the specifics of that act:

The basic assumption is that the decision process described above takes place during the preactive phase of teaching, i.e., while designing lessons, as well as during the interactive phase of teaching, i.e., in class. There is, however, one big difference concerning the external conditions of these decision processes during the two phases of teaching: during lesson design, there is less time pressure than during the interactive phase, where teachers have to act almost immediately, as the learners are waiting for their reactions. For this reason, the decision process during the interactive phase is assumed to be mainly schema-based, i.e., is based on already existing schemata that represent the individual teachers' knowledge and beliefs. Because of time pressure, it is not possible for them to generate new solutions in a problem-solving or an invention process based on the construction of a mental model. They are forced to act based on a schema, even if this schema does not meet the requirements of the situation very well.

On the other hand, there is less time pressure during lesson design. It could therefore be assumed that the decision process during the preactive phase of teaching is schema-based, but turns into a problem-solving process as soon as a resistance to schema-based processing is met. Taking into account that the lessons which teachers have to design are almost never truly identical (at least the conditions of the target audience vary), it seems plausible to assume that the task to design a lesson often provokes a resistance to process based on schemata and therefore turns lesson design into a process of invention. However, findings about scripts and schemata in the lesson designs of the teachers and the way they act in class (Seidel 2011) do not give evidence for this. These findings seem to be an indicator of mainly schema-based processing, even while designing lessons.

For this reason, it is assumed that a task to design a new lesson does, in many cases, not cause a resistance to schema-based processing.

The only condition that may cause the construction of a mental model in designing lessons therefore seems to be a high commitment or dedication to act in an extraordinary way. When teachers have the time and are motivated to put effort into teaching, this may provoke them to construct a mental model instead of designing a lesson based on schemata. In this case, the process of designing a lesson can be characterized as a problem-solving process or an invention process.

It can be summed up that the decision process in teaching in the pre- as well as in the interactive phase is primarily schema-based. Only in cases where enough time is available, i.e., mainly during the preactive phase, and when teachers meet a resistance or are sufficiently motivated, may schema-based processing be inhibited and a mental model will be constructed. In this case, the decision process can be described as a problem-solving or invention process. As is to be shown later, the problem-solving process is the place where creativity comes into play. But beforehand, the concept of creativity has to be defined.

Creativity

Creativity is normally discussed in the context of the characterizations of creative products, creative processes, and creative persons (Funke 2000). Creative products are developed by creative persons in a creative process and are normally (Linneweh 1978; Schlicksupp 1999; Sternberg and Lubart 2002) characterized as new, i.e., different from already existing products and as useful and practical at the same time. As the result of a creative process is a new product, this creative process cannot be based on schemata, but can be characterized as a process of mental model construction, i.e., as an invention or a problem-solving process (Landau 1974), during which the creative person has to solve the problem to create a new but nevertheless practical product (Linneweh 1978). In this sense, the creative process is not an unusual process, but an act of thinking that takes place every day. Nevertheless, it is not the primary way of thinking: as has been described above, there are certain conditions that have to be met in order to inhibit schema-based processing.

As schema-based processing does not result in new products, it is not supposed to be a creative process and is not supposed to be influenced by a creative disposition of a person. On the other hand, a problem-solving process which is supposed to result in a creative product may depend on a creative disposition, as will be shown in the following section.

Theoretical Background and Open-Ended Issues

Creative Teaching

Concerning teaching, a creative disposition may influence the way that teachers act because creativity influences the decision process that precedes action. It can be assumed that creative persons are able to perceive (subprocess 1) their environment differently because they do not rely only on their schemata. Additionally, they will also be able to create new but nevertheless useful possibilities of how to act and do not only activate their existing schemata (subprocess 2). Concerning the third subprocess of the decision process, it is assumed that a creative disposition may lead to a different evaluation of the possibilities and therefore to a different choice of how to act.

The decision process can therefore have the form of a creative process, but nevertheless not every decision process while teaching is creative in nature: as was explained before, in most cases, this decision process takes place as a schema-driven process that is carried out automatically. In this case, the decision process cannot be described as a creative process in the sense of a problem-solving process, because activating schemata is not supposed to be influenced by a creative disposition.

On the other hand, the construction of a mental model as a problem-solving or invention process may be influenced by a creative disposition.

But as elaborated above, certain conditions have to be met before a decision process in teaching makes the construction of a mental model probable: there has to be enough time and there has to be a resistance to perform schema-based processing, or the motivation to put extra effort into teaching. As teachers have to decide under time pressure during the interactive phase of teaching, creative processing is supposed to take place only during the preactive phase of teaching. Thus, teaching as an invention process is always a process of designing lessons.

It may be astonishing that not every process of designing lessons is a creative problem-solving process, because the task to plan a new lesson may seem to provoke a resistance to process based on schemata. But as has been shown, the analysis of lesson designs gives evidence for mainly schema-based processing, even during lesson design (Seidel 2003, 2011; Seidel and Prenzel 2004). Therefore, the task of constructing a new lesson design does not always provoke a resistance to assimilate and therefore does not automatically inhibit processing based on schemata.

For this reason, it is believed that creative processing in designing lessons is met when teachers are willing and motivated to put effort into it.

This is the reason why the subjects in one of the rarely existent studies about creativity and teaching (Hanke et al. 2011) were explicitly asked to design creative lessons. In order to investigate the effect of a creative disposition in lesson designs, this was necessary to make sure that the subjects constructed mental models and did not activate schemata, because schema-based processing does not even have the potential to be influenced by a creative disposition. In this study, the subjects (students enrolled in the "Instructional Design" Bachelor program at the University of Freiburg, Germany) had to create two lesson designs with different specifications. Their resulting lesson designs were then rated by their degree of novelty and practicability. In addition, the lesson designs of each person were compared, in order to investigate if more creative persons create more structurally varied lesson designs. The results of this quite small study ($N = 44$) showed no clear evidence for an effect of a creative disposition measured by the V-K-T (verbaler Kreativitätstest/verbal creativity test, Schoppe 1975) on the lesson designs. But an in-depth analysis gives first evidence that participants with a creative disposition create more structurally varied lesson designs (Hanke et al. 2011).

Conclusion and Future Directions

The explanations above show that teaching processes can usually not be characterized as invention processes because creativity does not show up under time pressure. For this reason, creative processing in teaching can only take place during the preactive phase in the process of designing lessons. But as the less exhausting and therefore "usual" way of processing is schema-based, and the task to design a new lesson does not cause the necessary resistance, even the process of designing lessons does not usually take the form of a creative invention process. The only situation when designing lessons becomes an invention process seems to be when the teachers are motivated enough to put extra effort into designing a lesson. However, since there are almost no studies about the role of creativity in teaching, the explanations above can only be treated as tentative hypotheses. There is a need for significant additional research in order to be able to describe the relation between processes of teaching and creativity.

Cross-References

► Creative Behavior
► Creative Pedagogy
► Creativity Training in Design Education
► Divergent Thinking
► Divergent Versus Convergent Thinking
► Teaching Creativity

References

Berliner DC, Carter KJ. Differences in processing classroom information by expert and novice teachers. In: Clark CM, Lowyck J, editors. Teacher thinking and professional action. Leuven: Leuven University Press; 1989.

Funke J. Psychologie der Kreativität. In: Holm-Hadulla RM, editor. Kreativität. Heidelberg: Springer; 2000. p. 283–300.

Hanke U. Möglichkeiten der Realisierung von Fallarbeit in Blended Learning Lernumgebungen. Seminar. 2011;3(11):46–59.

Hanke U, Ifenthaler D, Seel NM. Effects of creative dispositions on the design of lessons. Open Educ J. 2011;4(Suppl 1: M10):113–9.

Hascher T, Krapp A. Emotionale Voraussetzungen der Entwicklung der Professionalität von Lehrenden. In: Zlatkin-Troitschanskaia O, Beck K, Sembill D, Nickolaus R, Mulder R, editors. Lehrprofessionalität: Bedingungen, Genese, Wirkungen und ihre Messung. Weinheim & Basel: Beltz; 2009. p. 365–75.

Krapp A, Hascher T. Motivationale Voraussetzungen der Entwicklung der Professionalität von Lehrenden. In: Zlatkin-Troitschanskaia O, Beck K, Sembill D, Nickolaus R, Mulder R, editors. Lehrprofessionalität: Bedingungen, Genese, Wirkungen und ihre Messung. Weinheim & Basel: Beltz; 2009. p. 377–87.

Landau E. *Psychologie der Kreativitaet*. Psychologie und Person (Bd. 17). München: Reinhardt; 1974.

Linneweh K. Kreatives Denken. Effektive Werbung (Bd. 4). Karlsruhe: Gitzel; 1978.

Neuweg GH. Das Wissen der Wissensvermittler. In: Terhart E, Bennewitz H, Rothland M, editors. Handbuch der Forschung zum Lehrerberuf. Münster: Waxmann; 2011. p. 451–77.

Pajares MF. Teachers' beliefs and educational research: cleaning up a messy construct. Rev Educ Res. 1992; 62(3):307–32.

Piaget J. Die Äquilibration der kognitiven Strukturen. Stuttgart: Ernst Klett; 1976.

Schlicksupp H. Innovation, Kreativität und Ideenfindung. Würzburg: Vogel; 1999.

Schoppe KJ. Verbaler Kreativitäts-Test. Ein Verfahren zur Erfassung verbal-produktiver Kreativitätsmerkmale. Göttingen: Verlag für Psychologie; 1975.

Seel N. Weltwissen und mentale Modelle. Göttingen: Hogrefe; 1991.

Seidel T. Lehr-Lernskripts im Unterricht: Freiräume und Einschränkungen für kognitive und motivationale Lernprozesse - eine Videostudie im Physikunterricht. Muenster; New York; Muenchen; Berlin: Waxmann; 2003.

Seidel T. Lehrerhandeln im Unterricht. In: Terhart E, Bennewitz H, Rothland M, editors. Handbuch der Forschung zum Lehrerberuf. Münster: Waxmann; 2011. p. 605–29.

Seidel T, Prenzel M. Muster unterrichtlicher Aktivitäten im Physik-Unterricht. In: Doll J, Prenzel M, editors.

Bildungsqualität von Schule: Lehrerprofessionalisierung, Unterrichtsentwicklung und Schülerförderung als Strategien der Qualitätsentwicklung. Muenster; New York; Muenchen; Berlin: Waxmann; 2004. pp. 177–94.
Sternberg JR, Lubart TI. The concept of creativity: prospects and paradigms. In: Sternberg RJ, editor. Handbook of creativity. Cambridge: Cambridge University Press; 2002. p. 3–15.

Teaching Creativity

▶ Promoting Student Creativity and Inventiveness in Science and Engineering

Teaching Problem Solving

▶ Inventive Thinking Skills, Development

Teaching Thinking

▶ Inventive Thinking Skills, Development

Techno-Globalization and Innovation

Klaus Schuch
Centre for Social Innovation (ZSI), Vienna, Austria

Synonyms

Innovation internationalization; Research; Technology

Techno-globalization denotes a global pervasion in generating technological knowledge and exploiting innovations with a technological content. It also claims that globalization has been shaped and advanced with the help of technology. With regard to research and development (here *R&D*) and innovation, the term in its most modest use is shorthand for the fact that generation, transmission, and diffusion of technologies is increasingly international in scope. A fundamental typology of Archibugi and Michie (1995) differentiates between global technology exploitation, global technological cooperation, and global generation of technology. Techno-globalization subsumes different internationalization aspects: firstly, the international exploitation of domestically generated new technological knowledge on foreign markets, either embedded in innovative products or process technologies (exploited by trade or offshore production) or nonembedded (by license agreements); secondly, the internationalization of sourcing new technological knowledge by founding or buying R&D facilities abroad or through international R&D subcontracting and outsourcing (and, conversely, the selling of R&D services to foreign customers); and, thirdly, international R&D cooperation in generating new technological knowledge through joint R&D ventures, cooperative agreements, or alliances and collaborative R&D projects, where each participating partner typically retains its formal independence. The main actors of techno-globalization are commercial companies looking for business opportunities and technological competition head start at an increasingly global scale. Industrial and technological standards play a major role in favoring or preventing entrepreneurial activities in creating or penetrating specific markets. Increasingly public research organizations engage themselves in the field of international R&D pushing international R&D *cooperation* as a sub-phenomenon of R&D internationalization to become a distinct field of science and technology (*here S&T*) policy. Research about techno-globalization, however, is still confronted with methodological shortcomings, insufficient data, and data comparability.

Background and Drivers of Techno-Globalization

Techno-globalization is both a result and a driver of new forms of economic organization and division of labor, fortified by sociopolitical (e.g., integration of the European Union, *here* EU) and sociocultural (e.g., "global village" and web2.0) changes. Among its main characteristics are:

- A wide application of new technologies to organize global transactions (information and communication technologies; logistics, packaging, and transport technologies)
- Multinational enterprises (*here* MNEs) as major agents and promoters, which – next to technology trade and technology exploitation – increasingly undertake R&D at locations outside their home countries and which are implementing new management practices to (out)source R&D internationally (e.g., open innovation)
- A worldwide tendency toward market deregulation, diffusing from the triadic countries (the USA, Japan, the European Union) to emerging economies and beyond, accompanied by global and sub-global diffusion of standards and norms
- An increasing mobility of production factors, especially capital, but also of (codified) knowledge, accompanied by an emergence of efficiency-oriented education systems, capable to produce human resources to manage the global exchange of goods, services, capital, information, and knowledge, not only in economically advanced post-industrialized countries but also in emerging economies with considerably cheaper labor costs
- Rising public awareness on global challenges, which do not stop in front of national borders

Economic growth and technological change, defined as the extension of knowledge in way of new products, production, and organization technologies, are increasingly relying on innovation relevant knowledge. The competition for new innovation relevant knowledge has reached a global level. Technological progress has both an endogenous as well as an exogenous dimension. Positive exogenous spillover (e.g., by means of technology transfer) can only develop if the knowledge-receiving company (or institution) has the ability to make use of it and to enhance it through own contributions. For the development of absorptive capacities, the quality of educational institutions (e.g., universities) and science and technology policy (through an efficient allocation of resources) play a major role. National economies which do not invest in knowledge production might in the long term not be able to master the speed of progress of knowledge-based economies (and societies).

Internationalization of Business R&D

Techno-globalization is not a new phenomenon. Although it might reach back decades, it became widely recognized in the academic discourse end of the 1980s and early 1990s. This was caused by a strong growth in the 1980s by companies' propensities to trade and to exploit their inventions and innovations internationally. Also, global technological cooperation of companies experienced a major boost during that time (Mowery 1992), however, confined to few, but crucial fields (e.g., information and telecommunication technologies), and with a very selective regional focus on the "classical" triadic countries (Japan, but especially on the USA and Europe). A more recent development is that companies increasingly also undertake R&D at locations outside their home countries. The location of R&D production has always been regarded as most "sticky" among all business processes, in a sense, that it was perceived as least transferable to other locations or countries. Only 20 years ago, Patel and Pavitt (1991) concluded that R&D is an important case of non-globalization. Today, a vast amount of evidence draws a different picture. Internationalization of R&D has become an important trend that shapes the national innovation system of all OECD countries. Foreign-owned firms already account for around 20% of total business R&D in France, Germany, and Spain; between 30% and 50% in Canada, Hungary, Portugal, the Slovak Republic, Sweden, and the UK; and more than 50% in especially smaller countries such as Austria, Belgium, the Czech Republic, or Ireland (Dachs et al. 2012).

Howells (2008) contextualizes the new wave of R&D globalization as an ongoing process of increasing spatial division of R&D where, besides the geographical widening, a deepening of R&D activities is occurring too. Business R&D is widely considered a production-related activity as input into the innovation process and a knowledge-generating activity as input into the transformation of manufacturing-based economies into knowledge-based economies. In more general words, *"R&D either follows production"* or *"R&D follows excellence*." In the first mode, the so-called adaptation mode, companies need to perform some R&D in foreign markets to adapt to local tastes and requirements and/or to take advantage of cost arbitrations in the global division of scientific labor. In the second mode, the augmentation mode, companies are driven by the search for excellent R&D conditions, particularly access to quality and scale of human resources and to a developed public research base.

Especially the first of these two modes was decisive for the emergence of the so-called BRICS countries (i.e., Brazil, Russia, India, China, and South Africa) as R&D locations of foreign companies. In part, the BRICS are also emerging as hotspots for R&D excellence, but the notion of "R&D following excellence" is still predominately a core issue of intra-triadic exchange with a few new smaller high- or post-industrialized countries catching up, such as Israel or Singapore. According to Dachs et al. (2012), foreign-owned firms in the USA spent around EUR 30 billion on R&D in 2007. The corresponding amount for Germany is EUR 11 billion and EUR 9 billion for the UK. The R&D expenditure of US firms in the EU (considered as one entity, not taking intra-EU relationships into account) and of EU firms in the USA taken together account for two-third of R&D expenditure of foreign-owned firms in manufacturing worldwide. In absolute terms, overseas R&D expenditure of US firms in the EU more than doubled between 1994 and 2008, but in relative terms, the rise of Asian countries as R&D locations for US firms has led to a dramatically declining share of US overseas expenditure in the EU (from around 75% in 1994 to around 60% in 2008). Brazil, Russia, India, and China are not only host countries for R&D activities of foreign-owned firms, but a few of their companies are also increasingly setting up R&D activities in the EU and the USA.

R&D expenditure of foreign-owned firms concentrates on R&D intensive, high-technology or medium-high-technology sectors. Thus, techno-globalization predominantly takes primarily place in pharmaceuticals, machinery and equipment, electrical and optical equipment, information and telecommunications (here *ICT*), motor vehicles, and other transport equipment. Some sectors offer better preconditions for a decentralized organization of R&D because their knowledge base is less cumulative with fewer size advantages in R&D or allow also an easier exchange of knowledge. This is the case for ICT, but also for business services as important non-manufacturing sector for instance in Israel or the UK. The lowest degrees of internationalization of R&D are found in low- and medium-low-technology sectors such as textiles and clothing, wood, paper, rubber and plastics, or basic metals and metal products. Though data is scarce, the existing evidence suggests that service industries tend to be characterized by lower levels of R&D internationalization compared to manufacturing industries (paragraph based on Dachs et al. 2012).

Major motives for firms to locate R&D activities abroad are:

- The size of the host economy, which promises superior market potentials and sales prospects conducive to R&D efforts of foreign-owned affiliates, especially in light of specific market and customer preferences and requirements
- Rising costs of R&D in knowledge intensive industries, which lead to international R&D allicances, mergers and acquisitions
- The accessibility and quality of a developed public research base (including technological infrastructure)
- The quality, cost, and size of skilled workforce, which is important for any research endeavors
- Subsidies incentives

However, R&D internationalization is still heavily influenced by geographic proximity and low cultural barriers, that is, factors which are conducive to reduce transaction costs.

From a country's inward perspective, R&D expenditure and labor productivity of foreign-owned affiliates seems to be positively related to labor productivity of domestic suppliers, especially if incentives for spillover and competition effects are promoted by the host country's industrial and innovation policy (Edler 2008). Sometimes, local content measures, including funding of collaborative R&D projects, are in use to enforce a connection of the MNEs' R&D with domestic partners to avoid a Janus-shaped industrial organization, where productive MNEs are not integrated in domestic chains of economic value added and where local companies, thus, do not benefit from productivity spillovers and remain less efficient and profitable. From an outward perspective, home countries may benefit from the global expansion and from reverse knowledge spillovers and reverse technology transfer. Although hollowing-out effects are possible, today's empirical evidence still suggests that overseas R&D activities are usually not (yet) a substitution for similar domestic activities.

Internationalization of Science and Technology Policy

The role of S&T policy for R&D internationalization has long been regarded primarily as an accompanying "enabling" or – at least – "preventing" framework. Although academic science has been international in scope almost since its inception, public R&D expenditure remained rooted in the national context. The enabling function of internationally oriented S&T policy comprises the development of stimulating incentives or support programs, while its preventing function primarily concerns the protection of intellectual property at international scale. Above all, however, the main task of national S&T policy toward internationalization of R&D is to keep the own house clean, that is, to be an attractive place for conducting R&D and, thus, for attracting R&D inflows from abroad.

In the last couple of years, S&T policies actively started to deal with internationalization of R&D, not just to let it happen but to support it and even to direct it. Examples for this proactive understanding are incentives to attract inward corporate and institutional R&D; to establish and to participate in cross-border research programs; to invest in joint R&D labs abroad; to support the mobility of researchers; and to promote political cooperation, dialogue, and trust eventually leading to coordination of R&D internationalization policies toward third countries.

Basically, two different sets of S&T internationalization objectives can be distinguished: an intrinsic dimension, which puts goals into the center of public S&T policy that directly aim to substantiate S&T (e.g., through enabling R&D cooperation among the best researchers globally or to find joint solutions for large-scale R&D infrastructures which cannot be financed by a country at its own) and an extrinsic dimension, which puts goals into the center that are meant to support other policies (e.g., facilitation of access to foreign markets through standard settings or research for development to assist technical development cooperation). The main addressees of interventionist approaches of S&T policy toward R&D internationalization are public R&D organizations and agencies.

The major motives of public R&D organizations to participate in international R&D cooperation are to access and to utilize excellent and complementary knowledge available abroad, to secure international funding, and to build up reputation through international visibility. For universities, further motives are to gain solvent students, to branch out colleges to commercialize their educational activities, and also to bolster their prestige in international rankings. Branch campus offshoring is a rather new phenomenon, connected particularly to American universities, with an initial concentration on the Middle East and a very recent shift to the Far East.

The main objectives (Sonnenburg et al. 2008) that drive R&D internationalization from an S&T policy perspective are:

- The quality acceleration and excellence objective
- The market and competition objective
- The resource acquisition objective
- The cost optimization objective
- The global or regional development objective
- The science diplomacy objective

Different rationales are guiding these objectives: the rationale behind the *quality acceleration and excellence objective* is primarily an intrinsic one that assumes that international R&D cooperation improves the domestic science base, leads to faster and improved scientific progress as well as enhanced, or even superior, scientific productivity, and is also supportive for the professional advancement of the involved researchers (e.g., trough joint publications in acknowledged international journals). The rationale behind the extrinsic *market and competition objective* is to support the market entry of domestically produced technologies/innovations abroad as well as to support the access to and a quick uptake of technologies produced abroad within the domestic economy. The rationale behind the *resource acquisition objective* overlaps partly with the two major objectives mentioned before. The access to information, knowledge, technology, and expertise as well as to singular equipment/facilities and materials is in the focus. But resource acquisition is not limited to different codified and tacit dimensions of technology transfer but extends to brain gain, gaining of solvent students, and increasingly also gaining research funds from abroad or from multilateral or international sources. The *cost optimization objective* from a public S&T policy focus does not primarily mean to use cost arbitrages of other countries (e.g., lower wages abroad) as might be an argument of the business sector but rather focuses on cost-sharing approaches to create critical mass in a certain S&T arena, for example, to establish large-scale research infrastructures, and it also includes the rationale of risk sharing. The assumption behind the *global or regional development objective* is the comprehension that many risks have no frontiers (e.g., infectious diseases or climate change) or cannot be solved without international cooperation and solidarity (e.g., Millennium Development Goals) and, thus, have to be tackled through international R&D collaboration (e.g., research for development). The main rationales underlying the *science diplomacy objective*, which often refers to global challenges and to development cooperation agendas, are to support other policies through R&D cooperation (e.g., nonproliferation of mass destruction weapons through keeping former weapon researchers busy with civilian R&D projects) and, secondly, to promote the national science base abroad in support of other objectives already mentioned above (e.g., to attract "brains" or to promote a general quality trademark like "made in Germany").

Public S&T policies toward R&D internationalization have both a strong "inward" dimension, which is to reinforce the domestic S&T base through attraction of and connection establishment to foreign resources (e.g., human resources, knowledge, or foreign funds), as well as a strong "outward" dimension in linking domestic actors to foreign markets and to knowledge produced abroad (Boekholt et al. 2009). An important channel for absorption, extensively taken up by the European Commission, is to integrate foreign actors into cooperation programs. The most recent communication of the European Commission (here *EC*) on internationalization puts the issue of excellence through competition (or better *co-opetition*) in the forefront: "*Excellence in research stems from competition between researchers and from getting the best to compete and co-operate with each other. A crucial way to achieve this is [. . .] to work together across borders"* (European Commission 2008, p. 4). This stems from the belief that the EU does not claim to be a self-sufficient entity in the realm of S&T and innovation, but that both Europe's knowledge resource (e.g., human capital) and its role in the global economy will be increasingly shaped by its ability to source knowledge internationally and to adapt it for its own use.

Further Aspects: Sub-Global S&T Integration, Technological, and Industrial Standards and R&D Internationalization Indicators

This integrative approach, which cumulated in a general opening of the 7th European Framework Programme for Research and Technology Development (2007–2013), the world's largest single R&D program, toward third countries, is a further aspect of the most ambitious international S&T policy integration process ever experienced sub-globally, namely, the creation of a single European research area (here *ERA*). With ERA, a harmonized, mutually open intra-European R&D arena of free movement of knowledge, researchers, and technology, with the aim of increasing cooperation, stimulating competition, and achieving an optimized allocation of resources, should be created by 2013. Less advanced subcontinental integration policies in the field of S&T can be witnessed in other important regions of the world too, such as in MERCOSUR, the Common Southern Latin American Market, here especially between Argentina and Brazil, or in ASEAN, the Association of Southeast Asian Nations. Regarding the latter, the ASEAN Committee on Science and Technology has been established back in 1971 with the objective to increase the competitiveness of S&T in the ASEAN region by supporting intra-regional R&D cooperation, partly supported by the ASEAN Science Fund established in 1989.

A further important aspect of integration policies is to reduce regulative barriers preventing a diffusion of economically relevant technological activities, including knowledge generation and innovation exploitation, across national borders. After technology, regulation and standard-setting has played an important role in making globalization a reality. In order to facilitate global communication, telecommunication technology – for instance – depends strongly on industrial and technological standardizations. Also, environmental standards and codes with more or less technological implications (e.g., passive energy buildings and 3-l motors) can be either encouraging or discouraging to global transactions. Typically, the standard setter has both an accumulative and first-mover advantage against the standard adopter. Triadic industries, and contemporarily also increasingly China and Russia as well as other emerging economies, have a long history in competing standards for the sake of promoting own industries globally, respectively, of preventing the intrusion of foreign companies at domestic markets. Early set standards can help to focus investments, but they can also subvert vivid innovation competition and might result in technological trajectories with too early dead end. Industrial and S&T policy increasingly aims to push international standard setting by establishing lead markets or pre-commercial innovation procurement, but often industrial standards are settled by market forces. A classical example of a standard war was that of the Video Home System VHS (developed by JVC) versus Betamax (developed by Sony) about video cassettes.

Compared to economically wasteful standard wars, open technical standards developed under appropriate patent policies can generate significant public benefits. Competition within an open technical standards framework, however, depends crucially on the proper functioning of industry standards setting organizations. An often citied example is that of GSM, the global system for mobile communications, which is in use in 200 countries, covering around four-fifth of all mobile communication clients. In order to avoid a similar fragmented situation as the one referring to analogous mobile communications in Europe, the *Groupe Spécial Mobile* was established in 1982 to develop a uniform intra-European standard for digital mobile communications, which later pushed other standards, for example, in the USA, aside and became a global industrial standard. In 2000, next generation GSM standard activities have been transferred into the "3GPP" consortium, which includes relevant authorities from the EU, the USA; Japan, Korea, and China as partners.

The measurement of techno-globalization differs significantly with respect to the observed phenomenon. Indicators are usually well developed at the level of supranational and international organizations, but poor when it comes to binational or multinational programs or the participation of foreign companies or research organizations in national programs. Patent statistics can provide a number of meaningful throughput indicators for approximating business-relevant knowledge interactions at global and international level, while academic publication databases, such as Scopus or Thomson Reuters Web of Science, enable insights in international co-publication activities which are globally on the rise. Although there are a series of reports on international R&D flows, published data is frequently neither complete nor fully comparable. Among other issues, published data on sources and origins of R&D expenditures reveal methodological differences, data gaps (especially concerning specific regions), timeliness in reporting, and high levels of aggregation, preventing in-depth analysis to observe the often subtle changes in the character and content of internationalized R&D. The situation is even worse when it comes to R&D activities of public funding organizations and research organizations. Governments do often not precisely know themselves what share of national budget is spent for foreign actors or how money allocated to domestic actors is spent abroad or in international cooperation (Verbeek et al. 2009).

Conclusions and Future Directions

Since the industrial revolution the importance of technological change for economic development has not been questioned. Access to scientific and technological knowledge can be seen as what divides the "haves" and the "have-nots." One of the highest-value business functions in terms of its value-added contribution is R&D. For this reason, internationalization in general, and in particular of high value-added activities such as R&D, is an issue of political debate. There are first signs that in contrast to the early years of foreign direct investments in R&D in emerging economies, an investment in those countries could be more likely to be accompanied by a disinvestment in the triadic core regions. This shift in R&D locations might be amplified by a larger supply of skilled and more cost-efficient S&T workforce in emerging economies, which will shape the global R&D landscape in the future. While a lot about empirical trends and motives of firms is known and the measurement of internationalization of research organizations has just begun, there is still considerable lack of knowledge as regards the effects of techno-globalization on home and host countries, not only in terms of economy but also in terms of impact on the social fabric and cohesion as well as on the individual experience in the everyday world.

In fact, under techno-globalization, more can be understood than only different aspects of R&D internationalization or the diffusion of technology for the sake of economic activity or academic progress. Future research on techno-globalization will have to take also noneconomic and non-R&D processes into account. The globalized impact of basic technical infrastructures, such as the internet on political developments (e.g., the Arab revolution in 2011), or the presumably borderless use of "social" software on the design and diffusion of sociocultural trends and social innovations will probably broaden the focus of research about techno-globalization in the future. Furthermore, global sustainability, justice and governance aspects of technology, its unequal distribution, and use in view of its contribution to induce global problems but also to mitigate global challenges will have to be readdressed. Effects of technologies induced in region "A" might have intended or unintended impact on region "B" (e.g., spatially differentiated effects of the emission of chlorofluorocarbons [*CFCs*] on the planet's protective ozone layer) and can even create global dependencies (e.g., the use of genetically manipulated seeds in Africa). This calls for more effective international cooperation and appropriate sharing of burdens and benefits in order to protect the global "commons" and the world's public goods, but what constitutes effective governance of international cooperation in STI to meet global challenges is not yet clear (OECD 2012).

Finally, the question about winners and losers needs to be reassessed. While globalization in general seems to have created a system which has benefitted the more developed countries, it also seems that globalization trough technology, as a whole, has not only brought preponderant negative impact on the developing countries. In fact, while some developing countries have profited enormously through techno-globalization, others lack certain factors preventing them to take active part and to gain benefits.

Cross-References

► Knowledge Society, Knowledge-Based Economy, and Innovation
► Multi-level Systems of Innovation

References

Archibugi D, Michie J. The globalisation of technology: a new taxonomy. Camb J Econ. 1995;19:121–40.
Boekholt P, Cunningham P, Edler J, Flanagan K. Drivers of international collaboration in research. Synthesis report to the EU Commission. Technopolis and Manchester Institute of Innovation Research, 2009.
Dachs B, Hanzl-Weiss D, Hunya G, Foster N, Kampik F et al. Internationalisation of business investments in R&D and analysis of their economic impact. Final report to DG industry. Brussels: European Commission; 2012.
Edler J. Creative internationalization: widening the perspectives on analysis and policy regarding beneficial international R&D activities. J Technol Trans. 2008;4:337–52.
European Commission. A strategic European framework for international science and technology cooperation. Communication from the commission to the council and the European parliament. Brussels: European Commission; 2008.
Howells J. New directions of R&D: current and prospective challenges. R&D Manag. 2008;38(3):2341–252.
Mowery D. International collaborative ventures and US firm'technology strategy. In: Granstrand O, Hakanson L, Sjölander S, editors. Technology management and international business. Internationalization of R&D and technology. Chichester: Wiley; 1992.
OECD. International co-operation in science, technology and innovation: meeting global challenges through better governance. Steering group on governance of international co-operation in science, technology and innovation for global challenges through better governance. DSTI/STP/STIG(2012)1. Paris: OECD; 2012
Patel P, Pavitt K. Large firms in the production of the world's technology: an important case of non-globalization. J Int Bus Stud. 1991;22(1):1–22.
Sonnenburg J, Nill J, Schuch K, Schwaag-Serger S, Teirlinck P, Van der Zwan A. Policy approaches towards S&T cooperation with third countries. Analytical report on behalf of the CREST Working Group on R&D Internationalisation, Brussels, 2008.
Verbeek A, Shapira P, Elder J, Knell M, Gagliardi D, Lykogianni E. Analysis of R&D international funding flows and their impact on the research system in selected member states. Final study report by idea consult, University of Manchester and NIFU STEP, Brussels, 2009.

Technological Entrepreneurship and Asymmetries

Florin Paun
ONERA – The French Aerospace Lab, Palaiseau Cedex, France

Synonyms

Actors management; Technological innovation management

The concept of asymmetries is adapted to the technological innovation, process aimed to create a new sustainable business based on a new couple of technology related to a targeted (created) market. The entrepreneurial team which leads this process is facing an important challenge while developing the technology up to the ninth Technology Readiness Level (TRL) corresponding to the market certification. Asymmetries, between the entrepreneurial team and the other actors among the different stages corresponding at the various levels of the TRL scale while progressing on it, are identified and described in this contribution (first sales and market issues are not addressed hereby). Newly identified asymmetries (Paun 2011) in the innovation process occurring on different risk, cultures, and time scales are introduced together with the classic one (information asymmetry) (Stiglitz and Weiss 1992), occurring from different possessed information (particularly related to the technology gap in this described case). These asymmetries could induce barriers to the technological development process. Finally, examples of collaborative tools developed to compensate or reduce these asymmetries are proposed (Paun 2011).

Notion of "Technological Entrepreneurship"

This contribution identifies the eventual barriers occurring between the entrepreneurial team (or individuals) and the other actors while carrying technology-based innovation projects.

Technological Entrepreneurship

Regardless of the new idea sourcing approach, provided by a promising new emerging technology (technology push) or by the identification of an existing expressed need in the market (market pull), the successful exploitation of such a new idea will be possible only when the technological development chain will take end by the introduction in the market of a new product or service. The technology development process, by creating new technologies or by adapting existing ones up to a new product or service, is thus a fundamental process related to any technology-based innovation. The commonly used tool for measuring the progression of the technology development process is the Technology Readiness Level – TRL scale (first definition by Mankins 1995). This scale is proposing nine levels, starting from level 1, meaning fundamental research, and finishing at level 9 related to the market certification and sales authorization, passing through TRL levels 3–4 related to laboratory demonstration or proof of concept and through TRL levels 6–7 related to operational conditions demonstration or industrial prototype.

The success of such a development process is partially given by the ability of the entrepreneurial team (or individuals) to define, identify, obtain, and manage the appropriate capabilities able to provide technology progression relative to the TRL scale, and this regardless of their socioeconomic environment (individuals, company employees, state agents. . .).

At each level, the actors are changing and their characteristics too. Up to the level of TRL 3–4, the work will be carried by scientists; between TRL 3–4 and TRL 6–7, by industrial R&D offices competencies types; and beyond, by industrial process designers. The decisions will be made on thinking patterns adopted by R&D directors, then by design offices, marketing directors, and production and supply chain managers. The investments will be driven from business angel to venture capital thinking patterns while progressing on the TRL scale.

All these actors are different, and the entrepreneurial team will need to understand, negotiate, and work with all of them using and being adapted to their specificities.

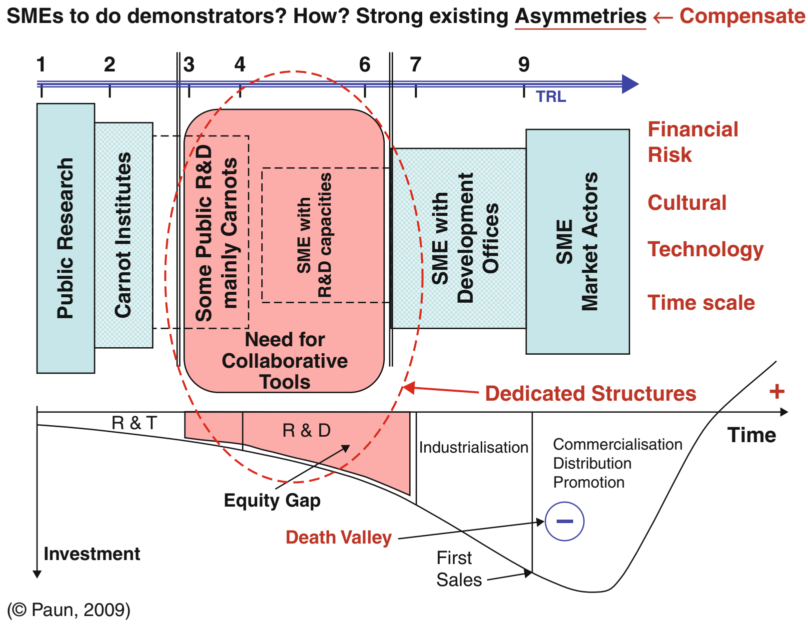
Notions of "Asymmetries"

Certain barriers for the technological entrepreneurship are mostly related to the various existing asymmetries between parties and could be reduced, for the information asymmetry, or compensated, for the risk, cultural, and time scaling of other newly identified asymmetries (Paun 2011) specific to the technological entrepreneurship, with specific collaborative tools.

Asymmetries Definition and Identification-Induced Barriers

Some of the actors involved in the technology development process (identified like a fundamental process inside the technological entrepreneurship), who will collaborate along the TRL scale stages with the entrepreneurs, will be highlighted and analyzed.

What about the characteristics of scientists, industrial researchers and developers, design engineers, industrial process executives, and marketing, financial, or supply chain managers? Or about business angels or venture capital partners, who will invest in the particular case of a technology-based venture? Are they thinking and behaving in the same way? Do they have the same type of competencies? Obviously no.



Technological Entrepreneurship and Asymmetries, Fig. 1 Information (from technology perspective) asymmetry showcased on the TRL scale between public R&D laboratories and small and media enterprises

Does the entrepreneurial team (or individuals) involved in a given technological entrepreneurship posses all these specific competencies? It is impossible and not necessary. Are all of these actors different and specific? Yes, and it is good like this because they all have complementary skills. Do the entrepreneurs need to collaborate and work with them? Yes.

The differences between the various actors are defining the existing asymmetries. These asymmetries will create value and will lead to the successful exploitation of the new idea if well coordinated and managed.

The specificity of the technological entrepreneurship is thus the one of being a highly collaborative process (Paun 2011). If it is well proposed by Stiglitz theory that the information asymmetry (Stiglitz and Weiss 1992) in a transactional relation could create value, it has to be acknowledged that, within a collaborative relation, asymmetries must be compensated (sometimes even reduced) in order to avoid barriers otherwise impeaching the agreements.

The ***information asymmetry*** related to the technological entrepreneurship could be identified as the difference existing between the scientist competencies, operating between TRL 1 and TRL 4, and the industrial process designers, operating between TRL 7 and 9 (see Fig. 1). They need "technological translation" between them, and this specific role could be assumed by developers from both sides or by appropriate training. For example, if the entrepreneur is a scientist, he will need to learn what industrial process means at least to a sufficient level to be able to understand an appropriate specialist.

A scientist is minded on a "workshipman" instinct as Veblen described it (Veblen 1914). An entrepreneur is mostly a "predator" type for Veblen. This strong ***cultural asymmetry*** could lock the process if not compensated, and it is generally acknowledged by various practitioners that working with a scientist "is not so easy." This is coming from this newly conceptualized cultural asymmetry (Paun and Richard 2009). They also need specific compensation tools (e.g., "translators") activated between them in order to be able to understand each other while the scientist will be interested by the knowledge progress and the entrepreneur by the prototype design.

Other important asymmetries are occurring while an entrepreneurial team is contracting R&D works with a laboratory. The value of the

R&D contract could represent an important percentage of the financial resources in the case of a small enterprise and very few for an important R&D laboratory.

This ***financial risk asymmetry*** (Paun 2011) has to be compensated while working together in order to guarantee for the execution of this type of contract the same importance for both parties, especially if the R&D laboratory is working with main industrials on important R&D contracts which could get a priority to the small enterprise one.

In addition to compensating for risk and technological asymmetries between the two parties, this contract has also subsequently proved to be a good tool for reducing transactional information asymmetries (Akerlof 1970; Stiglitz and Weiss 1992) between the start-up partner and its investors. Indeed, at the time of the phase of "due diligence" between the creators of the start-up partners and the business angels, the shared risk development contracts (Paun and Richard 2009) yield paramount information on both the product and the target market, and on the technological developments and their costs.

The ***time scaling asymmetry*** (Paun 2011) could occur in the same phase of contracting R&D works between an SME and an important R&D laboratory which are used to work with main industrial or state agencies. Indeed, in this case, some laboratories are programming their activities on a yearly base (eventually revised once or twice per year) while the SMEs are expecting actions and acting themselves on a monthly base (sometime even faster). This asymmetry could be accepted for eventually the negotiating stage of an agreement but will endanger the SME in the case of eventual delayed works (due to a monthly scale against a yearly one).

Example of Collaborative Tool as Asymmetries Reduction or Compensation Mechanism

To compensate and equilibrate the various described asymmetries occurring between a small enterprise (or a start-up) and an important R&D laboratory, a new type of R&D contract is being observed in practice recently (Paun 2011). Based on a negotiated business plan for the new product or service proposed for a targeted market by the entrepreneurial team, the R&D laboratory could invest in its own work to be carried for developing the needed technology. The financial risk taken by the laboratory is sufficient enough to prioritize the negotiated contract between the parties and give the same importance of succeeding the technological development to both parties. The various other asymmetries will be compensated by the strong managerial support inside the R&D laboratory provided on this type of ***risk and benefits sharing development contract***s.

Technological demonstrations that result in innovation can arise in any of the market sectors in which the SME receiving the technology can itself control the innovation process completely (until the successful introduction of the new product to the market). For example, some niche markets will be accessible, even in the aerospace sector (green aviation, small-scale drones, leisure, etc.). Once the technology is demonstrated, there are strong chances that the large aerospace groups will integrate this technology as a tested module into the systems they are designing (Mouchnino and Sautel 2007).

Conclusion and Future Directions

Succeeding the technological entrepreneurship implies to correctly identify, obtain, and manage the appropriate capabilities (Paun et al. 2012) able to provide the successful exploitation of a new technology (or a new couple of technology crossed with a market). Obtaining the capabilities will be a matter of rightly identifying and compensating (Paun 2011) through collaborative tools the various asymmetries existing between the different actors who posses these capabilities. The sum of competencies and capabilities then gives a figure for "capacity," as in building capacity both external and internal resources need to be meshed together (Paun et al. 2012).

Many authors have identified, in the various studies of the conditions and mechanisms of financial support for innovation and their impact on economic growth, that information asymmetry (Akerlof 1970; Stiglitz and Weiss 1992) is one of the major factors influencing the financial risk taken to generate innovations in our societies.

The generalization of this type of collaborative tools will no doubt mean the constitution of a better business angels culture and venture capital in France, and especially the appearance of new investors because of the reduction in financial risk as a result of the reduction of information asymmetry between the SMEs (or start-up partners) and investors.

As a transition to the macroeconomic level, an important perspective could directly impact the development policies of regionally specialized clusters, as with the national strategies for innovation. The R&D laboratories will adapt their behavior by intensively using asymmetries compensation/reduction mechanisms in their relationship with the regionally specialized SMEs, but also with other SMEs, not regional or acting in other domains.

Thus, the regionally specialized clusters (supposing there is more than one present in the same region) will be interconnected through direct collaborations occurring between some of their "provider (R&D labs)" and technology "consumer (technology adopter SMEs)" members. They will also be interconnected with other non-regional clusters. These types of interactions, driven through either market-pull or technology-push (or hybrid) approaches, will exchange technology inside and outside their related clusters, with no more monitoring by clusters authorities. To upgrade this type of a possible multiply embedded innovative system, mainly based on TT between providers and consumers of technology, the smart grid models could be an appropriate approach (Paun 2011).

Cross-References

▶ Business Angels
▶ Clusters
▶ Informal Venture Capital
▶ Innovation Systems
▶ Open Innovation
▶ Organizational Behavior
▶ SME
▶ Technology

References

Akerlof GA. The market for 'lemons': quality uncertainty and the market mechanism. Q J Econ. 1970;84(3):488–500.

Mankins JC. Technology readiness levels, a white paper, April 6, Advanced concepts office, Office of Space Access and Technology, NASA, 1995.

Mouchnino N, Sautel O. "Coordination productive et enjeux concurrentiels au sein d'une industrie modulaire: l'exemple d'Airbus" ("Productive coordination and competing stakes within a modular industry: the example of Airbus"). Innovations. 2007;2007/1(25):135–53.

Paun F, Richard P. Rôle des outils collaboratifs dans la réduction et la com- pensation des asymétries relatives au processus de transfert de technologie; étude de cas sur la nouvelle politique ONERA–PME in Le travail collaboratif. "Une innovation générique", Marché et Organisations, 2009.

Paun F. From managing information asymmetries towards a systemic asymmetries approach in technology transfer and innovation strategies: an economic analysis of the SME strategy at ONERA – The French Aerospace LabTM. IUP J Knowl Manag. 2011;9(4):27–52.

Paun F, von Tunzelmann N, Richard P. Asymmetries and dynamic interactive capabilities in technology transfer between ONERA – the French aerospace LABTM and SMEs in De Boeck Université. J Innov Econ. 2012;2012/1(9):103–37.

Stiglitz J, Weiss A. Asymmetric information in credit markets and its implications for macroeconomics. Oxf Econ Pap. 1992;44:694–724.

Veblen T. The instinct of workmanship, and the state of the industrial arts. Augustus Kelley: New York; 1914/1963.

Technological Innovation

▶ Invention and Modification of New Tool-Use Behavior

Technological Innovation Management

▶ Technological Entrepreneurship and Asymmetries

Technological Innovation Systems

► National Innovation Systems (NIS)

Technological Invention of Disease

Bjørn M. Hofmann
University College of Gjøvik, Gjøvik, Norway
University of Oslo, Oslo, Norway

Synonyms

Ailment; Discovery; Illness; Innovation; Sickness

Disease and Technology

Traditionally, diseases are considered to be entities in nature that are revealed by the health sciences. In short, diseases are discovered in nature. However, our view on nature is dependent on technology, which changes ever more rapidly. Diabetes has been a disease of the nervous system, of the liver, of the kidneys, and of the Langerhans islets of the pancreas. In 1763, Sauvage classified all 2,400 known diseases in his *Nosologia methodica*, and in the WHO's International Classification of Disease (ICD-10) of today, there are 45,000 disease codes. This development is not only a result of improved knowledge of nature but also of invention, innovation, and entrepreneurship.

There is unanimity that technology plays an important role in the development of medical theory as well as clinical practice. Technology has become the driving force of medical development. It has changed medical knowledge as well as its practice. The detection of bacteria, the development of penicillin, and the elaboration of the diagnostic and therapeutic armamentarium (as in the case of ECG, X-ray, MRI, endoscopy, genetic and pharmaceutical products) have all played an evolutionary role in medicine over the last two centuries.

There are many ways in which technology may influence health care in general and the concept of disease in particular. Firstly, according to a common account, technology has eradicated many diseases, reduced the prevalence of others, and improved the health of the human race. Technology has great potential for reducing disability and avoidable death, improving the quality of life and prolonging lives of good quality. That is, technology alters the occurrence of disease. Secondly, it has been argued that technological development alters the physical and social environment of man, creating new diseases. Life in modern urban societies causes man to develop new diseases. Thirdly, modern medicine has become dependent on and altered by the technical armamentarium it applies (Hellerstein 1983; Tymstra 1989; Jennett 1994; Mitcham 1994, 1995; Davidson 1995; Fischer and Welch 1999). It has changed the content and configuration of its knowledge. Both in theory and in practice, technology appears constitutive of medical activity and its basic concepts. As the two first perspectives are trivial, only the third perspective will be addressed here, as it represents the strongest claim: Technology provides the basic phenomena defining disease and generates and forms medical knowledge and action. Hence, there is an essential relation between technology and the concept of disease.

What Is Technology?

Before entering the detailed discussion on how technology constitutes the concept of disease, it will be important to clear what is meant by *technology*. A plausible definition of technology might be that it is the complex of devices, methods, and organizations applied in human purposive activity. Both in terms of devices, methods, and organization, technology today is integrated in modern medicine. A defibrillator (heart starter) is not just a box with wires, electrodes, and electronic components (*device*). It is a defibrillator on behalf of the *methods* of medical resuscitation applied in an *organization* of health care. This definition of technology stresses the significance of technology for different levels of health care, and accordingly, the term "technological medicine" emphasizes the constitutive role of technology in modern medicine.

What Does It Mean to *Invent* Disease?

The term invention denotes that diseases are not mere discovered in nature but that disease entities are framed by technological practices: Diseases are defined by its tools on three levels: ontologically, epistemologically, and practically (see below). This hinges on an intimate interaction between science, invention, and entrepreneurship which has been particularly visible since the British industrial revolution (Freeman 1997; Hessels and van Lente 2008).

After what has been called the empirical turn in the philosophy of science, the traditional divide between science and society has withered. Science does not live an isolated life in laboratories delivering results to society, but science and society continuously interact in negotiating and renegotiating the phenomena, the methodologies, and the assessment of its result in new modes of knowledge production. Hence, the traditional distinctions between science and technology and between discovery and invention (innovation and entrepreneurship) tend to lose relevance.

The Technological Constitution of the Entities Defining Disease

The central phenomenon of disease is given by technology. Technology provides the entities and events that are applied in defining diseases both in diagnostics and in treatment, in clinical practice and in research. The pathological morphology, chemical substances, biochemical agents, and biomolecular sequences studied in research, detected in diagnosis, and manipulated in therapy are grounded in technology. Light microscopy establishes basic structures, such as the cell, whereas stains and cultures constitute viral and bacterial agents, and electron microscopy and functional magnetic resonance imaging machines (fMRI) define a range of diseases.

The QRS complex, the echo-Doppler image and its corresponding indices, the scintigram and angiogram, establish a wide range of cardiac diseases which are generated by technology such as the electrocardiograph, ultrasound machine, gamma camera, and X-ray modality. Entities like *Helicobacter pylori*, *urea*, *cholesterol*, and *deoxyribonucleic acid* (DNA) are basic to the definitions of diseases such as *peptic ulcer*, *renal insufficiency*, *cholesterolemia*, and *Huntington's disease*.

Evans argues that technology constitutes the etiological agents that define disease (1991). For example, the technology which cultivates and identifies bacterial culture has led to the discovery of most bacteria causing diseases: The development of fluorescent antibody resulted in the discovery of *M. pneumoniae*, and the etiology of infectious mononucleosis. Furthermore, the growth of human B and T lymphocytes in suspension cultures led to the discovery of several important groups of viruses. In this manner, technology constituted a number of disease entities.

Correspondingly, the phenomena constituting *epilepsy* were in antiquity conceived as being humoral and spiritual (*the sacred disease*). Through technology, for example, electroencephalography and fMRI, the constitutive phenomena of epilepsy have come to be the electrical activity of the brain and the paroxysmal function of cerebral nerve cells.

Furthermore, we do not perceive entities like Helicobacter pylori and DNA directly, but they are provided by technology. We have no access to the time delays (T1 and T2) constituting the magnetic resonance image except through the MRI machine. The electrocardiogram (ECG) providing the signs of various cardiac diseases does not exist independently of the electrocardiograph. They are constituted by the armamentarium itself.

Hence, the basic phenomena and entities applied to define many central diseases are provided by technology. However, technology also influences the way we detect, identify, and interpret these phenomena. That is, technology strongly influences the content and formation of medical knowledge to be investigated in the following section.

The Technological Knowledge of Disease

Technology constitutes medical knowledge in several ways: It establishes the signs, markers, and end points that define the (epistemological) entities of disease. Furthermore, technology strongly influences the explanatory models of disease and the way medical knowledge is organized (its taxonomy).

Signs of Knowledge About Disease

Modern medicine relies on paraclinical signs for defining and detecting disease. For example, blood pressure and venous plasma glucose concentration define diseases such as *hypo-/hypertension* and *diabetes*. A variety of cardiac conditions are defined by specific ECG patterns, ultrasound Doppler flow and tissue stress measurements, and radiographic morphology. Paraclinical signs that define disease might be abnormalities of morphology, physiological aberrations, biochemical defects, genetic abnormalities, ultrastructural abnormalities, and etiological agents.

Such paraclinical signs are detected with chemical analyzers, X-ray modalities, ultrasonic devices, hemodynamic monitors, and CT, MRI, and PET scanners. Furthermore, they are manipulated by dialysis machines, lasers, diathermy, anesthesiological devices, and drugs of various kinds. In this manner, technology founds the paraclinical signs that define disease.

One important reason for the constitutive role of these paraclinical signs is their reproducibility. Technology makes the previously subjective and unreliable signs of disease dependable. Clinical signs earlier investigated by manual means are now tested by technology, and clinicians trust the results from instruments more than their own judgment. Reading the oxygenation in the color of the blood in a wound has been substituted by oxygenation measures, for example, pO_2 and SaO_2.

Moreover, success of technology in the generation and formation of knowledge in medicine has led to the application of technological tests in the detection of symptomatic diseases and syndromes as well. In fact, technology has become the gold standard for assessing and evaluating such conditions. *Lung infarction* is one example where pulmonary angiography and lung scintigraphy have been applied as a standard for diagnosing this symptomatic disease.

Furthermore, the set of technological tests is constitutive of how physicians conceive the symptoms of the patient. Chest pain of a certain kind immediately implies an ECG with a focus on the ST segment. In medical practice, the symptoms are transformed into paraclinical signs and tests. Symptoms gain significance only as projections of signs. Technology directs their significance and the way they are interpreted and acted upon.

Hence, technology influences the conception of symptoms in two ways. Firstly, technology is developed to detect symptoms. Secondly, the subjective experience of the patient is projected onto paraclinical signs and tests.

Markers and Risk Factors of Disease

In many cases, the signs that define diseases are not accessible (directly). However, various markers are applied to detect and identify them. For instance, changes in DNA are markers or risk factors for breast cancer and Alzheimer's disease. For such diseases, neither signs nor symptoms are detectable early in the development of the disease. However, genetic markers might indicate a disposition to them. Such markers are applied to identify and distinguish disease entities. As with paraclinical signs, disease markers are provided and founded by technology. Advances in technology facilitate the identification of new markers that will be treated as disease.

Thus, the technological constituted signs and markers are basic to the demarcation of disease. They define disease entities and are applied to recognize disease in the particular case and as such provide a technological semiology of disease.

Technological End Points

The signs and markers of disease also represent the measure of what is to be altered in order to make the patient healthy again. The general belief, in the existence of basic phenomena such as cells, calcium and potassium concentrations, or signs like ST segment displacement and markers like trisomy 21, causes physicians to try to influence and manipulate them. They become end points of medical treatment. The end point of the treatment of *hypertension* and *cholesterolemia* is the blood pressure and the level of cholesterol in the blood. The aim of genetic engineering is to repair or exchange defective DNA sequences, for example, in persons showing markers of *Huntington's disease*. Hence, technology defines the signs and markers to be detected, studied and manipulated in medicine, and thereby, it also constitutes the end points of medicine. In this, technology moves the attention away from patients' experience, as they do not feel high levels of cholesterol or Huntington genes (see below).

Technological Explanation of Disease

Important conceptual ties between different forms of causal thinking and conceptions of disease are widely recognized. Throughout history, disease has been conceived as an imbalance of the humors (Hippocrates, Galenus), as a disturbance of the morphological structure of the elements of the body, such as its organs (Morgagni), tissues (Bichat), or cells (Virchow), and as an error in the base pair sequence in deoxyribonucleic acid (DNA). Hence, the *explanatory language* of medicine is constitutive of the concept of disease. In addition, as argued, this language is today formed by technology, and it is technology that constitutes its expressions, measures, and aims. In other words, the causality of disease is limited by its frame of reference which is in turn technological methodology. The explanatory models of disease and its causality are constituted by technology (Engelhardt and Wildes 1995).

Moreover, technology has not only constituted the models of disease. It has influenced the models of man himself. The application of technology in medicine, successfully detecting, identifying, and treating disease, has made it a model for human physiology: The ear has been compared to an audio system, the eye has been viewed as an optical CCD system, and the brain that Descartes viewed as a hydraulic network has been modeled as a computer hard disk.

Technology is not only constitutive of the models of health and disease. It provides also for their metaphors. Furthermore, with the application of artificial organs such as pacemakers, cochlear implants, and advanced limb prosthesis, technology becomes a part of man's physical existence, that is, there is a fusion of man and technology. Hence, technology constitutes the explanatory models of disease and its symbolism, in addition to establishing the signs and markers that define diseases.

Technological Taxonomy

Furthermore, the organization of medical knowledge is influenced by technological innovation. Progress in science and technology changes the classification of disease. This is explicitly stated in the introduction to the International Classification of Disease. Since the time when technology began to impact on medicine, the number of disease entities has increased coherently with technological development which, while typically gauged by qualitative judgments, is generally believed to follow an exponential curve.

The influence of technology on medical taxonomy has been commented on in various ways. Jensen already long ago claimed that classification does not result from the nature of disease but from the apparatus of treatment (1983). Wulff correspondingly argues that the development of treatment strongly influences the classification of disease (1997). As will be argued later, technology is constitutive of medical treatment. Hence, a medical taxonomy founded on existing treatment must be influenced by technology.

According to Feinstein, the classification of diseases seems to follow three main organizing principles (1988). Firstly, diseases are classified according to clinical manifestations. Secondly, they are classified according to entities causing these manifestations. Thirdly, diseases are classified according to patterns and events following the clinical manifestations. The main argument so far is that the manifestations, the causal entities, and the resulting patterns and events are constituted, detected, and identified by technology. It follows from this that the organization of medical knowledge is also established by technology.

The influence of technology on the classification of disease appears in several ways. Firstly, technology creates new disease entities. Secondly, it changes existing disease entities. Thirdly, technology differentiates existing disease entities.

New Disease Entities

There are numerous examples of new disease entities generated by technological innovations. Only a few examples will be discussed to illustrate the point. It has been argued that the invention of the sphygmomanometer established *hypertensio arterialis* and that the *electrocardiograph* revolutionized the analysis of heart diseases, resulting in several new disease entities. For example, the clinical entity *atrial fibrillation* was established by the electrocardiogram (ECG).

The case of electrocardiography can be applied to illustrate another important aspect of the technological generation of new disease entities. It also constituted conditions such as *silent ischemia*. The electrocardiograph revealed that many patients had similar changes of their ECG under stress testing as patients with angina and that such changes predicted an increased risk of heart disease. In this way, the technological method established disease without the patient feeling ill. Hence, it was the technological test that defined and detected disease and that initiated medical activity and not the subjective experience of the patient.

In this way, technology has replaced the traditional meaning of disease, for example, bodily pain (*dolor corporis*), suspension of joy (*intermissio voluptatum*), and fear of death (*metus mortis*). Disease has become independent of the subjective experience of the person, and technology has endorsed a new range of disease entities: asymptomatic diseases. The development of molecular biology is a clear example of this. A great number of new disease entities are based on genetic abnormalities. A variety of genetic tests can detect diseases where the person tested does not feel ill.

How technology has made medicine less dependent on the subjective experience of the patient will be discussed in further detail later. Here, it has been argued that technology constitutes the classification of new disease entities and a wide range of them are asymptomatic diseases.

Technological Change of Disease Entities

When development in technology changes the phenomena that are used to define disease and the explanatory models of medicine, this correspondingly affects the classification of disease entities. Hence, disease entities alter with the advances of technology. Hence, people suffer and die from other diseases than before, for example, the introduction of the electrocardiograph (ECG) made people die of myocardial infarction rather than indigestion.

Disease terms such as “diabetes,” “epilepsy,” and “dropsy” have been applied in medicine since ancient times. Their meaning and extension, however, have changed. The name “dropsy” was replaced with “Bright’s disease,” which was exchanged with “nephritis” and lately with “end-stage renal disease” (ESRD). Changes in conceptual framework, for example, the prevailing entities, theories, and tests, result in alteration of disease entities. For example, diabetes has been conceived as a condition caused by excessive salt (Paracelsus) and excessive food, sex, or alcohol (Amatus Lusitanus), as a disturbance of the nervous system (Cullen), as a disturbance of the nutrition of the liver (Bernard), atrophy of the pancreas (1788–1910), and hydropic degeneration of the islets of Lagerhans (Opie). Today, diabetes is partly considered to be the result of infectious agents. Similarly, *infectious diseases* were earlier classified according to their respective organs. Today, they are classified separately. The technological detection of viral and bacterial specimens establishes the category *infectious diseases*.

Hence, technological development in medicine changes the definitions and taxonomy of disease entities.

Differentiation of Disease Entities

A third way in which technology has contributed to the development of disease entities is through the differentiation of existing entities. What was once reckoned to be one disease entity has through the development of technology evolved into a multitude of different diseases, for example, what was once called *acute respiratory disease* developed into many different infectious and chronic disease entities. One way both to differentiate and properly detect the various entities was by the use of proper laboratory technology. Diseases, previously diagnosed in only a vague manner, have now been rendered less ambiguous by technological means and can thus be clearly differentiated.

For example, angiography, echo-Doppler, tissue velocity imaging, and blood analysis have resulted in an extended classification of *myocardial infarction*. The application of the tank respirator in the 1950s established the differentiation between intercostal and bulbar polio. In the case of intercostal polio, the treatment with a respirator had an effect, but not in the case of bulbar polio (Rothman 1997).

So, technology has altered medical taxonomy: It has constituted new disease entities and changed and differentiated existing entities.

From Subjective Symptoms to Objective Signs

Technology has thus become constitutive in defining, classifying, and identifying disease entities. It has been argued that technology makes diagnosis and treatment objective and reliable. It facilitates direct access to the disease. This, however, has reduced the epistemological importance of the individual person for the concept of disease; it has reduced the importance of the subjective experience of the patient.

Before the eighteenth century, medicine was based on the patient's narrative of the symptoms. In addition to this subjective portrait of the illness, the physician observed the patient's appearance and behavior as well as any signs of disease. During the eighteenth and nineteenth centuries, medical instrumentation enabled and extended the physical examination of patients which made the physician less dependent on subjective narration. With the stethoscope, the physician could "listen to the disease directly." Measuring blood pressure gave an "objective account" of the internal conditions in the patient. The introduction of machines such as the ECG, X-ray, and chemical laboratory analyzers during the nineteenth and twentieth centuries further enhanced the objectivity of medicine. Technology enabled the physician to translate the language of symptoms and tests into the language of physiological processes. In this, the symptoms often had to be ignored in favor of underlying physiological or biochemical processes given by technological devices.

In addition to removing the errors introduced by subjective patients, technology also reduced the risk of error in physicians' judgments. Technology freed medicine from the subjective, the individual, and emotional, which confused the conception of "the real objective disease." Whereas the physician earlier was dependent on narration and clinical signs, he has nowadays come to rely on pathogenetic and etiological signs. Technology has guided medicine from basing its knowledge on symptoms to basing it on clinical signs, and from them to paraclinical signs and markers.

Technology has provided a detachment from the suffering of the patient. The capacities of technological medicine have replaced the individual patient as the epistemological basis of the disease concept. This has urged critics to maintain that medicine has become a "stranger medicine" and that technology has altered the patient's experience of being ill, for example, that the X-ray image becomes part of the patient's illness.

The Technological Gaze of Disease

One way to epitomize how technology has influenced the content and formation of medical knowledge is by the notion *technological gaze*. As argued, technology constitutes the signs, markers, and end points that define disease entities; it strongly influences the explanatory models of disease, and the way that medical knowledge is organized, that is, medical taxonomy. Hence, technology provides medicine with a new and radically different semiology.

Technology constitutes the categories of the medical gaze. It translates the physiological events into "the language of machines." Medical technology creates what the physician, the technician, or the researcher sees. And they see what they are looking for: *disease*. "The technology mediates between the seer and the seen and what is seen becomes largely constituted by technology. This is why practices change with the development of new technologies" (Cooper 1996). As argued, technology even transforms subjective symptoms into the realm of paraclinical signs.

The way we perceive diseases, name them, and talk about them is dependent on technology. Technology has become constitutive of the medical gaze and added to medical language. The change in medical gaze can be recognized in medical language. In pace with the technological development, the question of chest pain changed to the question of coronary heart disease, which is changed to the question of coronary artery disease.

Before the nineteenth century, *dropsy* was characterized and recognized by symptoms such as diminished urine and swollen legs. During the 1840s, patients with the same symptoms came to have *Bright's disease*. The technique of detecting albuminuria had, together with the recognition of different textures of autopsied kidneys, established a new disease entity. Furthermore, the application of the light microscope and cryoscopy during the 1850s established the disease entity *(glomerulo-) nephritis*. In the 1970s, the development of the dialysis machine and the method of transplantation established the *end-stage renal disease* (ESRD) as a disease entity.

Each new technology represented a new perspective and a new language which were distinctively different from the perspective and the language of the patients. Technology changed the physician's perception and made disease the physician's property, but at the same time removed him from it. There was an increasing electronic narration of disease.

This technological gaze in medicine has been criticized because it fits the illness of the patient to the skills of technology. As H. Spiro, a Yale professor in medicine, remarked:

> The worst problems come when the doctor fits the patients to his skills, something which is true for all professions. A woman comes to a gastroenterologist and gets a sigmoidoscopy, a barium enema and a high fibre diet. Going to a gynecologist, she runs the risk of laparoscopy and of losing her uterus if she continues to complain. . . . "I know that the minute I see the x-rays of the patient, before looking at the patient or before working on him, I will fit the patient's story into whatever the x-rays or other images are showing me." Here cited from Wolf and Berle (1981).

Altogether, medical knowledge is constituted by technology: Technology constitutes the signs, markers, and end points that are applied to define disease entities; it strongly influences the explanatory models of disease and the way that medical knowledge is organized. Hence, there is a *technological gaze* in medicine.

The Practical Formation of the Disease Concept

In addition to this crucial role of technology in the formation of medical knowledge and the constitutive role of technology to the (physiological, biochemical, biomolecular, and morphological) entities that are applied to define disease, there is a pragmatic influence on the conception of disease. The concept of disease is defined by its use, and the use of the term "disease" is constituted by the application of histopathological and chemical analyzers; CT, MRI, and PET scanners; and (radiation) therapy machines, surgical devices, and pharmaceuticals. Hence, technology does not only constitute the concept of disease by its subject matter and by medical knowledge, but also through medical practice. This practical formation of the disease concept will be investigated in the following sections.

The Technological Constitution of Medical Action

Conceptualizing disease is motivated by the purpose of medicine: to help the patient. The concept of disease is formed by the physician's capacity for action involving an obligation: Calling a set of phenomena a disease encompasses a medical commitment. And conversely, the need for medical intervention causes certain conditions to be perceived and classified as disease. The perspectives of the medical gaze and the concepts of medical language have an aim: medical action.

Diagnosis

The practical importance of technology is well illustrated in diagnostics, where ever more significance is attached to evidence provided by technology. The diagnostic methods give access to the signs and markers that define the disease entities. They provide the means to recognize the entities in clinical practice. The diagnostic methods of modern medicine are founded by technology, which ties the concept of disease even closer to technology.

In this way, technology comes to constitute an *operational definition* of disease where the concept of disease is defined with reference to a particular operational test. "Disease" is a term that applies to all those cases where a given technological test yields a specific outcome. *Diabetes mellitus* is defined as a fasting glucose concentration of the blood plasma above a given level. The practical identification of disease is given by the technological test.

Furthermore, it has been argued that the practical ability to detect phenomena in the human body has changed the meaning of these phenomena. Detectable phenomena, such as the electrical activity of the heart disclosed by ECG, gained importance by their correlation to various pathologies. The electrical activity was already known to a certain extent at the end of the nineteenth century but had no pathological significance before the development of the electrocardiograph.

Correspondingly, disease entities that earlier were detected using one technological method alter diagnosis with the emergence of new technology. *Myocardial ischemia* was earlier detected by angiography but was later diagnosed by ultrasound Doppler and tissue stress measurements, as well as blood troponin level. A change in diagnostic method has altered the conception of the disease.

It might be argued that there are a vast number of disease entities where there are no technological tests. Hence, technology cannot be constitutive of the definition and diagnosis of the disease entities. Even "new" disease entities, for example, whiplash and fibromyalgia, have (so far) no corresponding technological tests. These examples, as with other symptomatic diseases, do not, however, weaken the argument for the technological diagnosis of disease. On the contrary, these are controversial cases classified as syndromes much because they do not have a technological test. Nontechnological disease entities are low-status diseases precisely because they are not technologically testable and treatable (Album and Westin 2008).

Treatment

Practically, the fundamental role of technology in relation to the concept of disease is not limited to diagnosis. There is also a therapeutic constitution of disease. It has been claimed that a technological treatment of disease is the result of a technological conception of disease. A mechanically or technologically structured concept of disease requires a mechanically or technologically structured therapy.

However, the relationship between technology and treatment might also be conceived in a reverse mode: Technological treatability itself constitutes disease. It has been argued that it is not the concept of disease that decides whether something is treated or not; it is the treatability that makes something a disease. The success of technological medicine has made technology the criterion for the demarcation of treatment. The methods of technological medicine determine what is treatable and thereby set a precedent for what is to be treated. That is, medical technology has become the measure of what is to be treated and not, and hence, what is diseased and what is not.

Therapeutically, the technologies of corrective surgery, regulating blood pressure, and artificial fertilization have caused health care to treat these conditions as diseases: *hypoplastic left* *heart syndrome*, *hypertension*, and *infertility*. Decisions and prognosis have come to be based on technology. Furthermore, the possibilities of dialysis and transplantation of kidneys established *ESRD* as a disease entity.

However, treatability has not only changed the concept of disease by establishing new disease entities. It has also altered existing entities. For example, advanced surgical procedures tend to turn type 2 diabetes mellitus from being a metabolic disease to a surgical disease. The ability to detect and treat disease on an early stage has changed the symptoms that patients normally experience and the signs that the doctors relate to the disease. As pointed out earlier, with some diseases, the patient never experiences any symptoms at all. Hence, technological treatment alters the course of the disease (perceived by physicians) and the way patients experience it. In this manner, technology itself introduces new signs and symptoms that come to constitute the disease. Whereas patients with *nephritis* earlier experienced diminished urine, swollen legs, nausea, and headache, a patient with ESRD is subject to complications of dialysis treatment, such as dialysis-introduced cramps, clotting and infection of catheters and shunts, chronic anemia, renal bone disease, and aluminum toxicity.

Thus, technological treatment influences the concept of disease in a variety of ways. Whether technological treatment is a result of a technological conception of disease or technological treatability strongly influences the concept of disease, the conclusion is the same: Technological treatment is basic to the concept of disease. In the former case, the technological concept of disease is established by the pragmatic concern for diagnosis. One applies a technological concept of disease to be able to detect the phenomena of disease. In the latter, the concept of disease is founded by treatability. However, both diagnosis and treatment are established by technology.

The technological influence of diagnosis and treatment can also be recognized in the way medicine is organized. Disease taxonomy affects the centralization and specialization of medicine. This is displayed by the emergence of diagnostic departments, such as in radiology, nuclear medicine, and neurophysiology, and in centers for single technologies such as ultrasound and genetics. Correspondingly, there are therapeutic departments like chemotherapy, anesthesiology, and dialysis. Hence, there is a technological organization of diagnosis and treatment of disease.

Accordingly, disease is defined by the methodology of medicine, and that this is constituted by technology. Technology has become the *definiens* of disease. Due to this constitutive role in medical action, technology has become the paradigm method in medicine. This has influenced the status of disease, which will now be investigated.

The Technological Status of Disease Entities

In practice, technology has become the general method in medicine. Disease can now be measured using objective instruments, and technology has become the norm for detecting, identifying, and treating disease. The success of technology has extended the general belief in technological medicine, enhanced its status, and strengthened its paradigmatic position. Technology has become the criterion for the demarcation of what is "real medicine" and what are "true diseases."

In this way, technology has not only influenced the concept of disease but also the status of the disease entities. Acute high-tech diseases, for example, *myocardial infarction*, enjoy a higher status than chronic low-tech diseases in the same way that heart and brain surgery gain a higher position than geriatrics. *Malaria*, *tuberculosis*, and *cancer* are conceived as clear cases of disease, whereas color blindness, senility, and depression are vague cases. Thus, there is a technological influence on the status of the disease entities (Album and Westin 2008).

Sensitivity, Treatment Threshold, and the Technological Expansion of Disease

Technology has not only influenced the concept of disease by expanding medical knowledge, as discussed earlier. In practice, technology has also expanded the conditions qualifying for a disease entity. It has defined the normal values and increased the sensitivity to the paraclinical signs and markers. Hypertension and hypotension, hypercholesterolemia, polycythemia, and anemia are now recognizable and subject to quantitative assessment.

This methodological increase in sensitivity seems to be rich in its consequences. It expands the range of conditions qualifying as disease. More (and milder) cases are detected, which is conceived of as a success. One example is CT for pulmonary emboli which in areas has doubled the number of patients that got the diagnosis (but without any better treatment results). Dissection of craniovascular arteries has been diagnosed three to ten times more frequent after the introduction of MRI. Thus, technology increases the sensitivity and enables lower limits of disease. In this manner, the technological improvement of medical methods increases the prevalence of disease, that is, *technology generates disease*.

The increase in sensitivity combined with improvements in therapeutic capacity results in a lowered treatment threshold. This results in an apparent improvement in patient outcome and has made technological methods appear highly successful. This subsequently enhances the constitutive role of technology in defining, recognizing, and treating disease.

Concluding Remarks and Future Directions

All in all, it has been argued that technology is constitutive of concept of disease. Firstly, technology provides the physiological, biochemical, biomolecular, and morphological entities that are applied in defining diseases. Secondly, it constitutes the formation of medical knowledge. Technology constitutes the signs, markers, and end points that define disease entities, and it strongly influences the explanatory models of disease and medical taxonomy. Thirdly, technology establishes how we act toward disease: Thorough diagnosis and treatment technology establish the actions that constitute disease. Furthermore, the practical capability of technology increases the sensitivity and lowers the treatment threshold, resulting in an increased occurrence of disease.

Hence, medical technology has become the measure of all things, a kind of *ars mensura*. It has become the *technê metriké* of the modern age, the measure of what is good and bad, what is to be treated and not, and hence what is diseased and what is not. This can be entitled *the technological invention of disease*. What, then, are the consequences of such a "technological concept of disease"?

If the concept of disease is constituted by technology, this must be of relevance to the philosophy of medicine. The fundamental role of technology will be essential to the debate on the ontological and semantical status of the concept of disease. Furthermore, it will be of great importance to the debate on the value-ladenness of the concept of disease. The evaluative status of technology will be of relevance to whether disease is a value-laden concept. Hence, the status of technology is highly relevant to the debate on the concept of disease.

Moreover, the analysis illustrates the importance of paying attention to technology in the general discussion of medicine and health care. Technology has become crucial to understand modern health care, as it constitutes its basic concepts, its knowledge, and its actions. That makes technology essential to understand crucial challenges of modern health care such as medicalization, somatization, paternalism, and patient autonomy. For example, it has been argued that a mechanical conception of disease contributes to paternalistic medical practice due to the reduced role of the patient.

Furthermore, it is worth noting that the analysis does not presuppose a particular conception of technology. The argument that technology is constitutive to the concept of disease does not depend on a determinist view of medical technology, a phenomenological position, a social constructivist stance (Bennett 1977), or on the value-neutral dictum. Although perspectives from the science and technology studies are relevant, this analysis does not hinge on any particular perspective. The point here has been to argue that within any of these positions, technology is constitutive for the concept of disease: Technology has become the measure of disease. However, further research based on specific theories can clarify the technological invention of disease and should be encouraged.

Acknowledgment This entry is a revised version of Hofmann (2001). More references can be found here and in Hofmann (2002).

Cross-References

▶ Actor-Network-Theory and Creativity Research
▶ Analogies and Analogical Reasoning in Invention
▶ Directed Evolution® Technology
▶ Epistemic Governance and Epistemic Innovation Policy
▶ Invention Versus Discovery
▶ Levels of Invention
▶ Mode 1, Mode 2, and Innovation
▶ Mode 3
▶ Patterns of Technological Evolution
▶ Quadruple Helix
▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
▶ Technology Push and Market Pull Entrepreneurship
▶ Triple Helics

References

Album D, Westin S. Do diseases have a prestige hierarchy? A survey among physicians and medical students. Soc Sci Med. 2008;66(1):182–8.

Bennett IL. Technology as a shaping force. In: Knowles JH, editor. Doing better and feeling worse. New York: Norton; 1977. p. 125–33.

Cooper MW. The gastroenterologist and his endoscope: the embodiment of technology and the necessity for a medical ethics. Theor Med. 1996;17:394.

Davidson SN. Technological cancer: its causes and treatment. Healthc Forum J. 1995;38:52–8.

Engelhardt HT, Wildes KW. Health and disease – philosophical perspectives. In: Reich WT, editor. Encyclopedia of bioethics. New York: Macmillan; 1995. p. 1103.

Evans AS. Causation and disease: effect of technology on postulates of causation. Yale J Biol Med. 1991;64:513–28.

Feinstein AR. ICD, POR, and DRG. Unsolved scientific problems in the nosology of clinical medicine. Arch Intern Med. 1988;148:2269.

Fischer ES, Welch HG. Avoiding the unintended consequences of growth in medical care. J Am Med Assoc. 1999;281:446–53.

Freeman C. The diversity of national research systems. In: Barre REA, editor. Science in tomorrow's Europe. Paris: Economica International; 1997. p. 5–32.

Hellerstein D. Overdosing on medical technology. Technol Rev. 1983;86:12–17.

Hessels L, van Lente H. Re-thinking new knowledge production: a literature review and a research agenda. Res Policy. 2008;37:740–60.

Hofmann B. The technological invention of disease. J Med Ethics Med Hum. 2001;27:10–19.

Hofmann B. The technological invention of disease – on disease, technology and values [thesis]. Oslo: University of Oslo; 2002.

Jennett B. Medical technology, social and health care issues. In: Gillon R, editor. Principles of health care ethics. New York: Wiley; 1994. p. 872.

Jensen UJ. Sygdomsbegreber i praksis: det kliniske arbejdes filosofi og videnskabsteori. København: Munksgaard; 1983. p. 107.

Mitcham C. Thinking through technology. The path between engineering and philosophy. Chicago: The University of Chicago Press; 1994. p. 35.

Mitcham C. Philosophy of technology. In: Reich WT, editor. Encyclopedia of bioethics. New York: Macmillan; 1995. p. 2477.

Rothman DJ. Beginnings count: the technological imperative in American health care. New York: Oxford University Press; 1997. p. 45.

Tymstra T. The imperative character of medical technology and the meaning of "anticipated decision regret". Int J Technol Assess Health Care. 1989; 5:207–13.

Wolf S, Berle BB. The technological imperative in medicine. London/New York: Plenum Press; 1981. p. 45.

Wulff HR, Pedersen SA, Rosenberg R. Medicinsk filosofi. København: Mungsgaard; 1997. p. 95.

Technologies

▶ Cyberentrepreneurship and Proximity relationships

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Technology and Business Life Cycle

▶ Epidemiology of Innovation: Concepts and Constructs

Technology Evolution

▶ Technology Life Cycles

Technology Impact on Innovation

▶ Semantic Technologies in Knowledge Management and Innovation

Technology Life Cycles

Gregory Tassey
National Institute of Standards and Technology, Gaithersburg, MD, USA

Synonyms

Competitive dynamics; Nonlinear growth models; Technology evolution

The Dynamics of Technology-Based Growth

Most of innovation economics is cast in a static framework. Studies of cross-sectional relationships between inputs such as R&D and outputs such as invention, innovation, and productivity growth dominate this area of economic research. Even when assessments are undertaken of specific phases of the R&D cycle (basic research, applied research, and development), the linearity, feedback loops, and evolution of the associated markets that characterize the progression and utilization of technology are largely overlooked.

However, time is an extremely important dimension of economic growth and failure to manage it by both industry and government can lead to poor long-term performance for domestic industries. This perspective is particularly important in industries where technologies are a dominant driver of growth.

In essence, technologies evolve in cyclical patterns with shorter product-technology cycles embedded in longer cycles based on generic technology platforms. Successive platform technologies are themselves tied to one another by an underlying science base. A key economic characteristic of this "nested" set of cycles is the evolutionary pattern that alters the nature of technologies and hence investment incentives over each cycle.

The imperative to understand this process is the fact that economic growth is generated over an entire life cycle. Thus, the economic consequences of both corporate strategy and economic growth policy not taking cyclical patterns of technologies, markets, and hence investment patterns into account will be the loss of considerable domestic economic growth, either through inadequate rates of innovation in the early part of a cycle or through inadequate capital formation that results in offshoring of industries producing for domestic innovations in the middle and latter phases of these cycles (Tassey 2007, 2010).

The Nature and Structure of Technology Life Cycles

The shortest and most recognized life cycle is the *product* life cycle. Typically, a series of successive product cycles are derived from an underlying generic *technology platform*. Over much longer periods, a series of technology platforms emerge and fade, all which are based on a major advance in the underlying science. Collectively, the succession of these platform cycles form a "major cycle" (also called a "grand cycle" or "wave") that can cover decades (Tassey 2007, Chap. 7).

The Product Life Cycle. Business analysts have studied the product life cycle for decades.

They have found that as a product cycle evolves, attributes of the product technology become progressively standardized and the rate of change in specific attributes slows, indicating approaching exhaustion of potential new applications derived from the underlying technology platform. The result is an increasingly commoditized product.

A current example is the PC. With each product generation, the set of components and therefore product attributes become increasingly fixed and hence standardized. At these latter phases of the generic technology's life cycle, competition progressively shifts from major product innovation to reliance on incremental changes and process innovation. The greater emphasis on process efficiency means that competition is increasingly based on price (Abernathy and Utterback 1975).

The Technology Platform Cycle. Within a major technology's life cycle, significant innovations occur over time based on periodic advances in the underlying generic technology platform. For example, the limitations of stand-alone transistors wired together (speed, heat, weight) became obvious once experience with a series of product cycles was in hand. The need to improve these three attributes led to the invention of a new generic circuit technology – the integrated circuit (IC). Subsequently, a massive explosion of product cycles based on the IC ensued, as this new semiconductor platform technology evolved into multiple market applications. Parallel platforms also emerged, such as "quantum electronic devices" (semiconductor lasers and light emitting diodes) and "charged couple devices" (used in digital cameras).

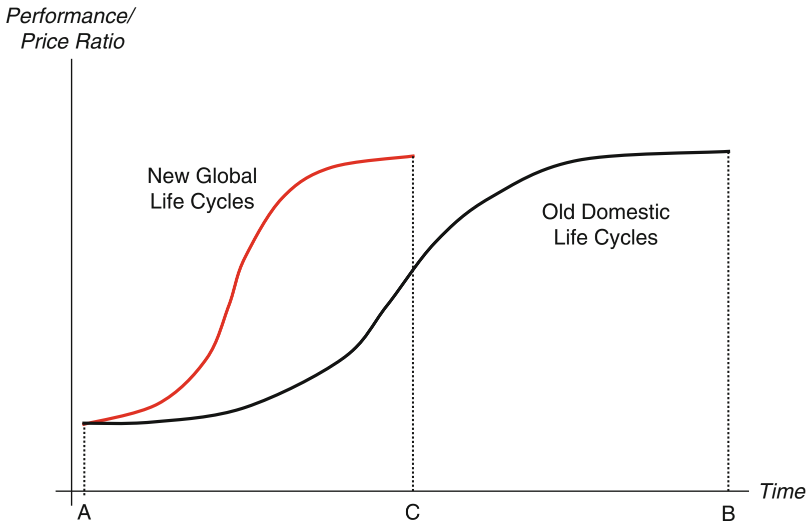
In addition to the complexity resulting from products based on multiple platforms, one technology platform cycle does not necessarily end when a new one is created that appears to replace it. In the case of semiconductors, the technology platform underlying the transistor continued to advance, responding to technological opportunity and also to the fact that both the IC and the transistor remain complementary components of higher-level electronic technologies. The important point is that final-demand products and services are increasingly met by complex technology systems and, therefore, the performance of all system components must advance more or less simultaneously.

Several additional points are implied from these examples. First, once the generic technology is largely available, industry can more efficiently innovate at the product level. Second, the generic platform technologies for each component of a technology system must be available to allow parallel innovation to occur and thereby advance the system technology. This is the ultimate objective because it is the system that satisfies final demand. A current dramatic example is "advanced manufacturing" in which multiple product and process technologies are evolving simultaneously. This presents a much more complex policy management problem.

The length of a technology platform cycle and the competitive position of the domestic industry over such cycles are particularly critical in the case of "general-purpose" technologies like semiconductors because they spawn a host of innovative industries, such as computers and communications equipment, with huge aggregate economic impact. Thus, significant opportunities present themselves to economies that support broad-based growth strategies that enable economies of scope to be captured from each technology platform within a major cycle. However, if high long-term growth rates are to be maintained, the factors shaping the S-shaped growth curves, which characterize platform technology life cycles, must be understood and the barriers to efficient progression managed.

Initially, such a framework may sound abstract, but technology-based economies are increasingly focusing growth policies on accelerating the early phases of these cycles in order to attain first-mover advantage from breakthroughs in science. The effect of this competition among multiple technology-based economies is to (1) make the bottom of the S-shaped growth curve steeper, that is, to shorten the early phases of a cycle and thereby accelerate innovation within the domestic economy, and (2) compress the length of the life cycle in time. Both of these effects are illustrated in Fig. 1.

The phases of the technology life cycle have been given different labels by various



Technology Life Cycles, Fig. 1 Compression of technology life cycles

researchers. However, most important is the economic explanation for the “S” shape of the life-cycle curve. The initial segment is flat because a new technology typically evolves unevenly with respect to the set of technical attributes that its products and processes embody. Such gaps retard growth of the overall performance-price (*P-P*) ratio and thereby slow the attainment of a *P-P* ratio that exceeds the maximum attained by the existing technology. The result is slower market penetration.

As Joseph Schumpeter (1950) observed over half a century ago, radically new technologies can remain dormant for long periods of time (i.e., the initial flat portion of the *P-P* curve is stretched out in time). Nevertheless, a take-off point is eventually reached (the initial segment of the steeper middle portion of the *P-P* curve). This take-off point occurs when the new technology attains a *P-P* ratio sufficiently superior to the maximum for the existing technology to enable rapid market penetration or, as emphasized by Schumpeter, when an economic crisis occurs that radically changes relative prices.

With time and consequent improvements in both products and processes, the new technology becomes dominant, and large economic benefits in terms of profits and employment are realized. Eventually, however, the ability to improve the *P-P* ratio begins to decline. The result is a flattening of the top portion of the *P-P* curve. At this point, the technology is set up for replacement.

The Major Cycle. Technology platforms evolve over time based on an underlying science base. Solid-state physics progressed for decades before this science eventually reached the breadth and depth sufficient to allow semiconductor technologies to begin to be developed. Such decade-long major cycles or “waves” also appear to display a general long-term “S” shape with respect to economic impact. In the case of semiconductor technology, the underlying science of solid-state physics eventually matured to a level that allowed devices to be designed and manufactured that outperformed the existing electronic science, specifically vacuum tubes.

Joseph Schumpeter, known for his conceptualization of the “process of creative destruction” and therefore as the “father of innovation economics,” had previously developed a theory of business cycles (1939) in which he was the first to observe that shorter cycles are nested within longer ones. He also characterized a “long wave” as having four stages: prosperity, recession, depression, and revival. The process of creative destruction begins slowly in stages two and three with invention but does not manifest itself in the form of significant marketplace penetration (innovation) until stage four.

At the global macroeconomic level, the post-World-War-II prosperity was built first on advances in manufacturing and then on information technologies. However, the emergence of Asian economies and, to a lesser extent, other emerging economies has changed relative prices and led to a global economic crisis resulting from efforts by industrialized economies to maintain their standard of living through debt. The current industrialized world (Europe, North America, and Japan) is somewhere between Schumpeter's stages two and three. One can see the seeds of the eventual stage-four revival in the rapidly increasing investment in global R&D. This investment will produce a wide range of new productivity-enhancing technologies that will drive advanced manufacturing and high-tech services. The resulting paradigm shift will redress the current imbalance between debt-driven economic growth and growth based on real (technology) assets.

Loss of Domestic Value Added over the Technology Life Cycle

Figure 1 implies that the highly competitive nature of the expanding technology-based global economy is reducing the risk-adjusted expected domestic value added from indigenous innovation and thereby affecting corporate investment decisions. Emerging economies covet the high-value added products and services arising from major technological advances in industrialized nations. They consequently initiate evolutionary growth strategies whereby their increasing technical skills and production capacity combined with lower labor costs allow attainment of global market shares in the middle and latter phases of an existing technology's life cycle.

This process of "convergence" in current technology life cycles with subsequent loss of market shares by the "first-mover" (innovating) economy begins when offshoring by the innovator's domestic industry is undertaken. At first, this strategy increases aggregate value added for the innovating industry, as larger global markets are penetrated. The offshoring takes the form of relocating the production of low and moderate technology-based products to be near new markets and to achieve labor cost savings. In the case of components, the cost savings allow reimportation by the original innovator or another firm in the domestic supply chain, which lowers domestic costs and thereby helps raise the productivity of the remaining domestic production.

Initially, such strategies yield larger profits for the remaining domestic production and help explain why US-based high-tech corporations had on average good balance sheets entering the recent Great Recession. Of course, these larger profits are derived from a smaller level of industrial activity within the relevant domestic supply chain (due to offshoring), and hence, the value added (the supply chain's aggregate contribution to GDP) may not grow and, in fact, may shrink.

To a significant degree, offshoring manufacturing from one or more tiers (industries) in a high-tech supply chain should be considered a strategic failure from a national economic growth strategy perspective. The reasons are (1) loss of domestic value added and (2) loss of co-location synergies in the domestic supply chain, which reduces the overall efficiency of the remaining industries. The more R&D intensive the supply chain, the greater the co-location synergies (Tassey 2010).

As technology life cycles mature, opportunities increase for converging economies to pick off portions of the value added in a supply chain. In the modern-day version of Schumpeter's creative destruction, Christensen (1997) argues that firms reaching market leadership positions through innovation increasingly focus on maintaining that lead through incremental innovation targeted at preferred customer segments of the overall existing markets. At some point, new entrants appear who may first focus on imitation aimed at serving neglected market segments. Eventually, however, some of these challengers or even yet additional entrants acquire sufficient technology development and deployment capabilities to take over larger or even dominant shares of existing markets.

As previously described for semiconductors, the cycle transition begins in the form of a hollowing out of incumbents' positions within the current technology life cycle. Christensen et al. (2004) characterize this process in terms of a "decoupling point." Typically, integrated manufacturers dominate the supply chain for a period of time until the interfaces between components are firmly established. These standardized interfaces allow innovative specialists in individual components to enter the industry. The tier in a supply chain at which the vertical disintegration occurs is the decoupling point. This point tends to move backward over time from the final product toward subsystems and then to component tiers.

In the current final phase of globalization of the technology-based economy, many nations are evolving beyond imitators to become innovators, thereby shortening windows of opportunity for achieving innovation and associated monopoly profits, as indicated in Fig. 1. This increased risk from greater competition and shorter investment time frames lowers expected rates of return on investment (RoI) in the next technology life cycle. A shorter technology life cycle means domestic firms, and their governments must anticipate the timing and nature of forthcoming life cycles and implement more efficient R&D strategies, as well as more efficiently promote follow-on scale-up and market penetration efforts. In summary, these trends have made the act of innovation more costly and risky for industry acting alone.

With respect to market penetration, when a new technology is initially commercialized, simultaneous scale-up of production capacity and product differentiation for multiple markets become critical issues. The importance of scale-up derives from the fact that the vast majority of the economic benefits from new technologies results from the growth of their markets after they have been first introduced (i.e., post-innovation). Early and substantial investment in process technologies and the actual scaling up of optimized production capacity are essential to attaining large market shares over the middle and latter phases of a technology's life cycle.

Finally, the global expansion of R&D and the use of the resulting technologies are stimulating highly differentiated demand and supply within product categories. The resulting pressure to at least semi-customize applications of high-tech product technology platforms is a fundamental change from the industrial revolution, where conditions for success were dominated by the imperative to achieve economies of *scale*. That is, markets in the past were driven by the need to produce large quantities of homogeneous products at low cost. This central tenet of economic growth required companies to become large enough to maintain capital structures sufficient to attain the desired economies of scale.

However, today scaling in the middle of the technology life cycle is becoming much more complex. Manufacturing processes increasingly must be flexible in order to achieve the economies of *scope* required to serve a heterogeneous set of sub-markets with the same generic production system. Doing so requires flexibility while maintaining low unit cost, which can only be achieved through new processing techniques, massive use of information technology, and a highly skilled and heterogeneous labor force. The forthcoming "smart revolution" will attain this "mass customization" objective, at least in the countries that make the required investments.

Thus, while scale-up – the process of achieving a minimum efficient scale of production – is still essential, the key attribute of competitive success over an entire life cycle will be the ability to achieve this minimum scale at low output rates and do so for a range of differentiated products. This is a massive systems problem and will require increased funding of process R&D, manufacturing engineering education, and technical infrastructure that supports integrating process technology components into highly flexible manufacturing systems. Productivity at the systems level therefore will be a determining factor in future competitive success.

Global Convergence over Technology Life Cycles

Longer term, it is this evolutionary process by which domestic supply chains of the innovating economy are hollowed out and are not replaced with new technologies that explains why aggressive emerging economies tend to "converge" with (grow faster than) established ones. This process of convergence, which usually takes place over several life cycles, has been well documented over the last several centuries encompassing two industrial revolutions, as technology became an increasingly significant factor in international competition. In the last four decades of the twentieth century, convergence accelerated significantly with a number of emerging economies doubling national income in 10–20 years compared with the 30–70 years required to double in the nineteenth century (Lucas 2009).

However, convergence in one technology life cycle no longer guarantees further progress in terms of global market shares in succeeding cycles. For example, since the invention of the transistor, most major semiconductor innovations have been made by US-based companies. However, competitive pressures have led US companies to establish an increasing share of advanced wafer fabrication facilities ("fabs") outside the United States or to rely on foreign "foundries," (specialized manufacturing companies) rather than invest in the domestic US economy. A number have become "fabless" or "fab lite" firms, focusing largely on design while contracting all or most product manufacturing to foundries. While the fabless strategy is extolled by corporate consultants, it has evolved out of necessity as many semiconductor firms failed to achieve large enough market shares to capture scale economies at the production stage in the early and middle phases of the technology life cycle.

Fabless semiconductor companies have been temporarily successful in the current mature phases of the CMOS technology life cycle by adopting highly accurate simulation techniques that drastically reduce the number of expensive and time-consuming iterations of the product design necessary to enable its manufacture. In the converging economies, dedicated foundries often do not even operate development-scale fabs, instead relying on real-time adjustments. Both of these single-phase strategies can work within the middle and latter phases of a particular technology's life cycle.

However, when disruptive technological change occurs (i.e., when a major new technology platform emerges), *both* strategies described above (contract manufacturing and design only) will hit a brick wall. The fabless firms will not be able to execute design for new manufacturing requirements without close interaction with manufacturing scale-up activity, and foundries will not be able to adapt to radically new product technologies without close interactions with the ongoing product R&D.

In contrast, the process of convergence among national economies in the modern global economy starts with a multinational company establishing an R&D capability in the host country to manage the offshored manufacturing. This capability serves as the genesis of a nascent innovation infrastructure. Supported by government investment in broader research capabilities for the emerging supply chain, domestic companies evolve "first-mover" capabilities for emerging technologies that drive future technology life cycles.

For example, Taiwan is achieving backward integration from test and assembly to wafer fabrication and more recently to design (the integrated device manufacturing model). Both Taiwanese industry and government now participate in global R&D networks to develop and assimilate new design and manufacturing skills. Taiwan's Technology Research Institute (ITRI) has collaborations with companies, universities, and governments all over the world. This is clearly a leading-edge technology strategy. While further behind in the convergence process, the Chinese are following the same backward integration path with the implication that their capacity to innovate will increase over time. Patent trends in nanoelectronics clearly show the threat of convergence in the next life cycle to be real. Economies that invest in more holistic technology-based growth strategies will find that the co-location synergies expand as supply-chain integration proceeds.

Thus, viewing the hollowing out of a domestic supply chain over a technology's life cycle as simply a matter of specialization according to the law of comparative advantage is turning out to be naïve in that not only is value added lost but co-location synergies often convey growing and permanent competitive advantage to those economies that adopt an integrated technology development and utilization model.

Loss of R&D and Manufacturing Advantage in the Next Life Cycle

As described above, major technology life cycles are of paramount importance to long-term economic growth because they enable a series of nested cycles that encompass a spectrum of related technology trajectories and hence markets. The cumulative economic impact is substantial. Unfortunately, the transitions between major cycles are usually traumatic. Schumpeter (1950) explained the cyclical pattern of technological change in terms of investments in capital stock and market relationships that lead to rigidity and decreasing returns on investment, setting the stage for a radically new technology to emerge and take over markets from the defender technology.

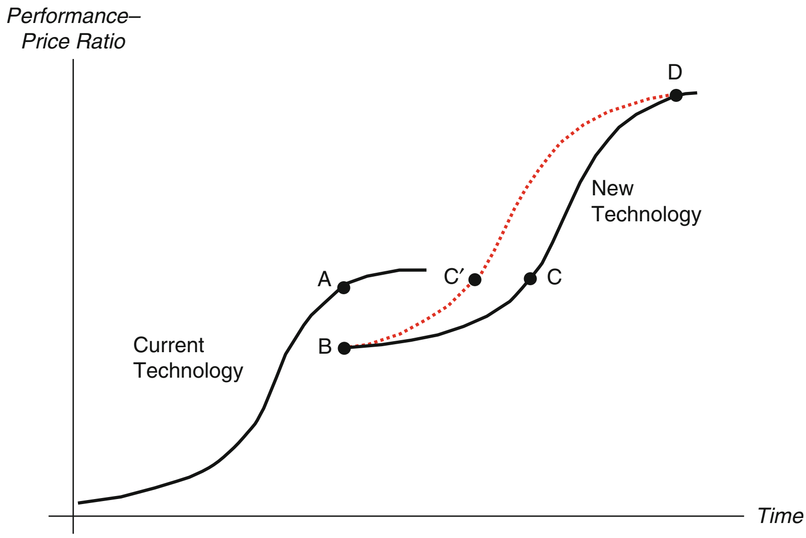
In the long run, the threat to the domestic industry that is the innovator in the current life cycle is the growing ability around the world to backward integrate to the underlying science itself. This acquisition of scientific capability gives a country's domestic industry a local supporting infrastructure that helps start the new life cycle. The global emergence of substantive research in nanoscience and nanotechnology is an excellent example.

The problem of cycle transition is accentuated the more the technologies underlying successive cycles are different. Technologies based on different science require different technology development and production approaches. Both the R&D and production infrastructures within the industry will need to change. In fact, the entire supply chain in which the industry is embedded will likely be different as will the supporting technical infrastructure.

Successive technology life cycles where the underlying technology platforms are dramatically different raise the question of whether it makes sense to refer to the two cycles as "successive" as opposed to simply different technologies. The correct conceptual framework is to start with the marketplace function (e.g., communications) and then examine the succession of major technologies that provide this function. Successive technology platforms can be radically different, as in the case of traditional pharmaceuticals (small molecule chemistry) and biotechnology-based drugs (cell-based biology involving mainly large molecules).

That is, some modern emerging technologies are so broad in their disciplinary base and in their potential market applications that they do not "follow" in a clear way from previous technology life cycles. For example, emerging MEMS ("micro-electromechanical systems") technology encompasses a much larger set of physical domains – electrical, mechanical, thermal, optical, fluidic, and more – than existing complex technologies such as semiconductor electronics. MEMS technology has already produced new higher-performance products such as accelerometers for automobile airbags, tiny nozzles for ink jet printers, and projectors for high-end video displays, and continued commercialization of MEMS technology has been characterized by some analysts as the prelude to a second semiconductor revolution that will drive growth in the global economy for decades to come. However, the complexity factor has resulted in MEMS fabrication processes not yet achieving adequate characterization with respect to these multiple physical domains. If not addressed through efficient co-located research entities, the initial flat portion of the S-shaped *P-P* curve will be stretched out in time.

Even if the domestic economy manages to maintain competitive advantage in the initial transition to a new technology paradigm, the impacts on industry structure and the supporting technical and institutional infrastructures are dramatic and provide subsequent opportunities for convergence in other economies. For example,



Technology Life Cycles, Fig. 2 Life-cycle market failure: generic technology

the traditional pharmaceutical industry has sunk an enormous amount of resources into a small-molecule chemistry from which drugs are "discovered" through a largely trial-and-error approach. Even sophisticated research techniques such high-throughput screening only modestly upgrade a very inefficient R&D process. The declining relative efficiency of this industry is evident in the increasing reliance on marketing (the industry spends more on advertising than on R&D).

In contrast, the emerging biopharmaceutical industry is based mainly on the development of large-molecule drugs derived from a more fundamental underlying science (cell biology). The latter requires much closer and intricate involvement with the scientific infrastructure and a very different set of technical infrastructures. However, a "black-box" model of innovation has been followed by the US National Institutes of Health (NIH), with the result that the productivity of biopharmaceutical R&D investment has been low. Recognition of this problem is finally turning the biopharmaceutical industry toward a multielement technology-based growth model. In the last few years, research has increasingly emphasized proof of concept and improved infratechnologies, such as biomarkers. At the same time, this slowness to adapt is providing an opportunity for other economies to catch up (i.e., converge) by using more efficient innovation ecosystems (Tassey 2010).

A major institutional policy response in an increasing number of economies is the technology cluster concept, which is emerging as an important strategy for not just efficiently conducting breakthrough research but also for increasing the efficiency of subsequent commercialization. For example, the Nanoscale Science and Engineering cluster at Albany State University promotes co-location synergies between researchers and innovating firms within the cluster to facilitate the increasingly difficult initial phases of fabrication. The resulting reduction in time and cost enhances efficient transition to high-volume industrial manufacturing. The bottom line is that achieving co-location synergies means the value added from both R&D and manufacturing will accrue to the innovating economy – at least when the technology is in the formative phases of its life cycle.

Conceptually, the barriers to such cycle transitions are indicated in Fig. 2. As the current technology (left curve) matures, all product attributes and hence performance are maximized, and costs are reduced through optimization of production processes. Eventually, the industry approaches a maximum performance-price ratio for market applications due to the inherent limitations of the underlying generic technology platform (say, point *A*), which explains the flattening of the top portion of the S-shaped *P-P* curve.

Such a "cash-cow" status and the investments made to achieve it act as barriers to private-sector investment in emerging technologies that have greater potential but initially have significant *P-P* deficiencies (right curve). Companies do some long-term research in anticipation of eventually having to shift to a new generic technology platform. However, life-cycle compression due to increasingly intense global competition reduces risk-adjusted expected RoI and thereby leads to substantial underinvestment in the next technology platform.

In the absence of effective government support, this situation leaves the emerging technology with a set of attributes that are only partially developed. Production processes are often initially adapted from other existing technologies and are therefore not optimized for the new technology. The result is a *P-P* ratio such as point *B*. Because *B* is less than *A*, the new technology makes little progress penetrating the current technology's markets.

This fundamental problem of life-cycle transition can be addressed by government policies that overcome cycle transition barriers and thereby shift the new technology's *P-P* curve backward in time (to the dotted line), thereby providing new technology platforms that enable commercial applications to occur earlier. For example, the *P-P* ratio originally not projected to be achieved until point *C* is now attained earlier in time at point C'. Note that these two points are on the same horizontal line as point *A* on the *P-P* curve for the existing technology. As point *A* is close to the maximum performance-price ratio for the existing technology, getting the new technology to this point initiates the "take-off" for the new technology's market penetration phase. This is reflected by a steepening of the S-shaped performance-price curve for the new technology beyond C'. That is, once the maximum economic potential of the existing technology is exceeded, the new technology rapidly penetrates the target market, and the Schumpeterian process of creative destruction is unleashed.

The Linear Model of Innovation and the Technology Life Cycle

Within a life cycle, the requirement to have a sufficiently developed technology platform in place in order to achieve efficiency in applied R&D implies a linear model of innovation. However, the R&D literature makes clear that feedback loops occur and "cross-links" develop between technology trajectories to fuse complementary technologies within technology systems. Feedback loops are regular occurrences in which marketplace experiences become inputs for the redirection of R&D. In fact, some attempts at innovation may be necessary simply to provide feedback on the adequacy of the current development of the platform technology. The cross-linking necessary to effectively develop system technologies creates demand for advances in complementary technologies. For these reasons, criticisms of linear models of innovation (basic science, generic platform technology, innovations in that order) are justified.

Nevertheless, a "linearity" is present across a technology life cycle with respect to the technology's development and commercialization. Modern technologies are extremely complex systems that largely prohibit the "eureka" moments that appear in Pasteur's quadrant. For example, it is hard to imagine apoptosis, antisense, RNA interference, monoclonal antibodies, or other biotechnology platforms being developed through product experimentation or feedback effects rather than being derived from previous advances in bioscience. In fact, the greatest difference between traditional pharmaceutical research and biotechnology research is that the former was largely trial-and-error chemistry, whereas the latter is based on fundamental science and a set of generic platform technologies that are evolving from this science. Faith-based pharmaceutical research may support the existence of a nonlinear model of innovation, but it is far less efficient than the more linear evolutionary pattern of biotechnology research.

Another issue associated with the linearity implied by the technology life cycle concept is the fact that underinvestment in radically new technologies is explained to a significant extent by excessive time discounting. Life-cycle transitions typically encounter multiple performance problems that are only addressed over time. Moreover, small initial markets for the emerging technology do not induce significant process technology investment. The consequent suboptimal production processes result in relatively high unit cost. The combined result is a lower initial performance-price ratio (point *B* in Fig. 2) than is the case for the current mature technology. These factors stretch out the life cycle and thereby discourage investment by industry in the applied R&D that leads to innovations.

Offshoring also can stretch out the life cycle by blocking compensating innovation in the domestic economy. Optoelectronics – an increasingly important industry because of the forthcoming migration of computers to photonics-based technologies – is in the process of transitioning from a discrete to an integrated technology format (a technology life-cycle transition). Monolithic integration has performance and cost advantages and could potentially be a growth industry for the United States.

However, at this early phase of its life cycle, the mature *discrete* technology can be produced more cheaply in Asia. This prolongs the typical situation in which the new technology has a lower *P-P* ratio in the early phase of its life cycle, thereby slowing market penetration. Failure by US firms to accelerate the evolution of *monolithic* technology and to scale-up for initial markets in spite of the stretch out in cost disadvantage may allow competing companies in other economies to eventually commercialize the new technology and gain first-mover advantages (Fuchs et al. 2011).

From an R&D investment perspective, the prospect of such an initial *P-P* deficit leads the private sector to assign substantial technical and market risk to the possibility of investing in the development of the new technology. This "risk spike" (also referred to as the "valley of death") produces a discontinuity (i.e., nonlinearity) in the R&D cycle, resulting in underinvestment by the private sector in early-phase generic technology platform research. The collection of barriers facing private firms at this early point in the R&D cycle creates the need for government support, not just for basic science but for early-phase, proof-of-concept technology research and the development of a range of supporting infratechnologies (Tassey 2007, 2008).

Conclusion and Future Directions

The fundamental meaning of technology life cycles is that the dynamic element of technology-based competition is relentless. The conventional wisdom is that advanced economies must automate to compete with cheap labor-intensive manufacturing modes in converging economies like China. Yet, in recent years the claim of "re-shoring" due to rising labor costs in China and other Asian countries has led established economies to think that the manufacturing challenge is subsiding, if not over.

In fact, the dynamic element of technology-based competition remains in place. For example, although Chinese and other Asian suppliers of electronic components have begun to experience profit margin compression due to rising labor costs, this trend will provide short respite at best for competing industrialized nations, as Asian companies are responding by automating at a fast rate. Most industrialized nations now have innovation-system programs to reduce the risk spike and thereby shorten the R&D cycle. These efforts include not only R&D subsidies but, more recently, promotion of more efficient R&D mechanisms, especially various forms of research collaboration. The most advanced form of collaboration, research consortia embedded in regional clusters, can not only enhance research efficiency in general but also significantly increase co-location synergies between adjacent tiers in high-tech supply chains.

For today's science-based technologies, innovating and then acquiring market share in the early phases of major life cycles require large numbers of scientists and engineers both in industry and supporting university and government institutions to advance and broaden the applications of the original innovation. For example, cell-based drug development has evolved as a research and manufacturing technique over the past 25 years only through the efforts of thousands of biologists, geneticists, and chemical engineers who perfected the fermentation systems that increased the capacity to produce recombinant proteins at least tenfold just in the past decade and 30-fold since the inception of biotechnology (DePalma 2005). The efficiency with which this process is unfolding is not just a matter of private-sector R&D investment but depends greatly on the efficacy of the entire innovation infrastructure.

More broadly, effective management of the entire technology life cycle requires a comprehensive national innovation system based on the triple or, more recently, the quadruple helix model (Carayannis and Campbell 2012). Such cross-linked and multi-institutional models are more realistic and hence more accurate than the simplistic "linear model" of innovation that ignores not only the range of institutional actors but the growing complexity of both the sources of innovation and the processes of deployment of the resulting technologies.

In summary, no matter what the final outcome with respect to the distribution of value added across national economies in one technology life cycle, global markets will increasingly experience shifts in leadership in the following life cycle. This greater competition is due to the fact that a larger number of economies are acquiring the requisite innovation infrastructure to become competitive in technology-based markets.

Cross-References

- ▶ Business Cycles
- ▶ Business Model
- ▶ Business Start-Up: From Emergence to Development
- ▶ Entrepreneurship and Business Growth
- ▶ Nonlinear Innovations
- ▶ Risk, Uncertainty, and Business Creation
- ▶ Techno-Globalization and Innovation
- ▶ Triple Helics

References

Abernathy W, Utterback J. A dynamic model of product and process innovation. Omega Int J Manag Sci. 1975;3:639–56.

Atkinson R. The past and future of America's economy: long waves of innovation that power cycles of growth. Cheltenham: Edward Elgar; 2004.

Carayannis EG, Campbell DFJ. Mode 3 knowledge production in quadruple helix innovation systems. 21st-century democracy, innovation, and entrepreneurship for development. Springer briefs in business, vol. 7. New York: Springer; 2012. http://www.springer.com/business+%26+management/book/978-1-4614-2061-3

Christensen C. The innovator's dilemma. Cambridge, MA: Harvard Business School Press; 1997.

Christensen C, Musso C, Anthony S. Maximizing the returns from research. Res Technol Manag. 2004; 47:12–8.

DePalma A. Twenty-five years of biotech trends. Genet Eng News. 2005;25(4):1.

Fuchs E, Field F, Roth R, Kirchain R. Plastic cars in China? The significance of production location over markets for technology competitiveness. Int J Prod Econ. 2011. doi:10.1016/j.ijpe.2011.03.008.

Lucas Jr R. Trade and the diffusion of the industrial revolution. Am Econ J Macroecon. 2009;1(1):1–25.

Perez C. Technological revolutions and financial capital: the dynamics of bubbles and golden ages. Cheltenham: Edward Elgar; 2002.

Schumpeter J. Business cycles: a theoretical, historical, and statistical analysis of the capitalist process, vol. 2. New York: McGraw-Hill; 1939.

Schumpeter J. Capitalism, socialism, and democracy. 3rd ed. New York: Harper & Row; 1950.

Tassey G. Modeling and measuring the roles of technology infrastructure. Econ Innov New Technol. 2008; 17:617–31.

Tassey G. Rationales and mechanisms for revitalizing U.S. manufacturing R&D strategies. J Technol Trans. 2010;35(June):283–333.

Tassey G. The technology imperative. Northampton: Edward Elgar; 2007.

Technology Push and Market Pull Entrepreneurship

Florin Paun
ONERA – The French Aerospace Lab,
Palaiseau Cedex, France

Synonyms

Collaborative process; Competitiveness; Eco-innovation; Innovation ecosystem; Open innovation

Technology push and market pull entrepreneurs' approaches are defined and analyzed in this entry. Some commonalities generally observed are reminded, and challenges to be achieved while developing technology for or with entrepreneurs (or entrepreneurial teams) are pointed. Particular entrepreneur/team competencies to be surveyed through various stages of the technology-based innovation process are highlighted. These various stages are related to the "technology readiness level" scale (Mankins 1995). To accelerate and better consolidate technology transfer agreements between R&D capabilities and entrepreneurs (but not only), a newly proposed scale "demand readiness level" (Paun 2011) is analyzed. This new scaling tool will be used as a measure of the entrepreneur's understanding degree of its targeted market-expressed need.

Notions of Market Pull and Technology Push Entrepreneurship Definitions

The purpose of this entry is to report the perception of the entrepreneurship from other innovation process actors' perspective and provide efficient guidelines to manage this type of relationship.

Since the first definition of the innovation process by Schumpeter, the role of the entrepreneur as a driving force of this process was pointed out. In course of time, other aspects like R&D push (Abernathy and Utterback 1975), customer as innovator (von Hippel 1988), or various systemic approaches (Tucker et al.) of the innovation management were developed. This entry simply reminds some fundamentals that the innovation process actors have in mind while speaking about entrepreneurship.

Entrepreneurship is largely associated with entrepreneur like an individual (original theory in Schumpeter 1934). But entrepreneurship could be understood as a generalization of the entrepreneur spirit, actions, and behaviors. Entrepreneurship is a state of actions oriented to create value by a successful exploitation of a new idea. An individual could be entrepreneurial as an enterprise could be or a regulation authority or even a market could behave like an entrepreneur if particular conditions are occurring.

When a given actor could behave like an entrepreneur? It is generally observed by two main reasons starting with the emergence of a new idea. Based on this new idea, an individual or a group will believe in a strong opportunity for a successful exploitation, and all their actions will be oriented in promoting and developing this expected exploitation regardless of their structural economic environment (they could be simply individuals or employees of a large or a small enterprise or state agents and all this in a spin-off or a spin-in approach. . .).

If this new idea is related to a new emerging technology, in this case, the innovation process could be defined as a technology push entrepreneurship. If this new idea is related to a market's newly identified need (demand), asking of being met by a new product or service offer, this type of innovation process, where the demand will ask for technology, could be defined as a market pull entrepreneurship.

Commonalities: Technology Development Chain and Staging on the TRL Scale

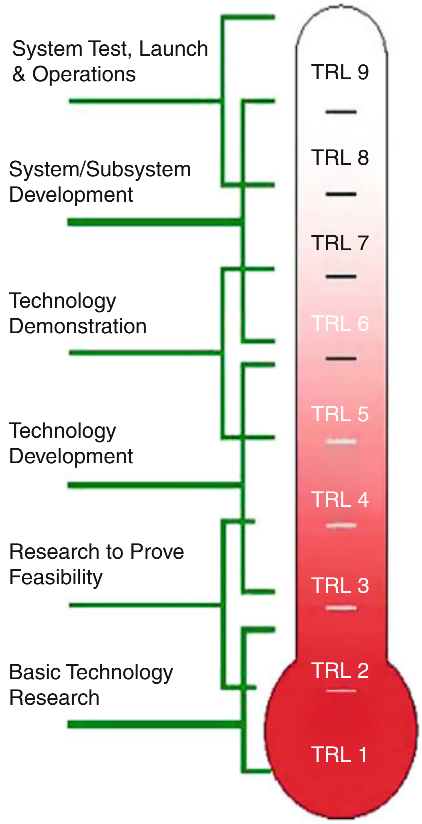
Let us take into consideration the commonalities occurring inside these two types of process specific to the technology-based innovation. Both approaches will integrate a technology development chain which will end with the introduction into a targeted market of a new product or service. The challenges related to the promotion, commercialization, and distribution of this new product or service are not the object of this entry. Let us focus on the challenges faced by the entrepreneurial team at various stages of the technology development chain.

The generally common tool adopted as referential perspective by the various technology-based innovation practitioner communities is the "technology readiness level – TRL" scale (Mankins 1995). Technology readiness level (Fig. 1) is a scale from 1 to 9 to assess the maturity of evolving technologies toward their successful certification and sales authorization for a given market. Only some of the important and major stages related to this scale will be pointed out.

Thus, TRL 1 represents fundamental (basic) research. TRL 2 represents the applied research. TRL 3–4 are relevant to the laboratory demonstration (feasibility and proof of concept), TRL 6–7 are relevant to the operational conditions demonstration and the industrial prototype, and finally the last stage, TRL 9, means the market certification and sales authorization.

Technology transfer offices, business incubators, R&D, strategy and supply chain industry executives, research and innovation agencies but also business angels or venture capital partners are looking and asking about the TRL while negotiating various agreements regardless of the technology push or market pull entrepreneurship.

All the decisions for various advancing actions will be referred to the current technology development or availability on the TRL scale. The entrepreneurial process will consist in permanently identifying, obtaining, and managing the needed and necessary capabilities (in terms of competencies plus means) able to assure the progress on the TRL scale. At each level, the actors are changing and their characteristics too. Up to the level of TRL3–4, the work will be carried by scientists, between TRL 3–4 and TRL 6–7 by industrial R&D offices competencies types, and beyond by industrial process designers. The decisions will be made on



Technology Push and Market Pull Entrepreneurship, Fig. 1 Technology readiness level original definition (Mankins 1995)

thinking patterns adopted by R&D directors, then by design offices, marketing directors, and production and supply chain managers. The investments will be driven from business angel to venture capital thinking patterns while progressing on the TRL scale.

All these actors are different, and the entrepreneurial team will need to understand, negotiate, and work with all of them using and being adapted to their specificities.

Hybridizing Market Pull with Technology Push

Using the TRL scale will provide an efficient tool in measuring the abilities of an entrepreneurial team to face and collaborate with all these actors.

Technology Push and Market Pull Entrepreneurship, Table 1 Demand readiness level original definition (Paun 2011)

Level	Description for the *demand readiness level*
1	Occurrence of a feeling "something is missing"
2	Identification of a specific need
3	Identification of the expected functionalities for the new product/service
4	Quantification of the expected functionalities
5	Identification of the systemic capabilities (including the project leadership)
6	Translation of the expected functionalities into needed capabilities to build the response
7	Definition of the necessary and sufficient competencies and resources
8	Identification of the experts possessing the competencies
9	Building the adapted answer to the expressed need on the market

But, using only this reference, all the thinking patterns will be technology push oriented. Why continue to refuse the evidence? Even the customer voice is sunk inside the TRL scale, and all minds are thus technology push driven.

How can the entrepreneurial team ability be measured to understand and identify a targeted market? Do market studies cross with technology acceptance studies? These type of tools completed by other various that the marketing profession has developed are not coming deep enough in the technology comprehension in order to be able to also measure and drive the technology development chain like the TRL scale is doing.

Pure market pull and pure technology push entrepreneurship is not existing. There is all the time a matching point between the two approaches. How to get this matching point? The successful exploitation of a new idea is always a result of a well-hybridized approach between the two of them (Paun 2012).

The "demand readiness level – DRL" scale (Paun 2011) completes the technology readiness level scale as matching tool for the hybridization between technology push and market pull entrepreneurship.

This new scale, the demand readiness level scale (Table 1), is able to measure the entrepreneurial team ability to understand and translate into needed capabilities the expressed need on a targeted market.

The "demand readiness level" (Paun 2011) is the new measure to assess the maturity of evolving demands identified by potential innovation actors toward an appropriate stage of conceptualization of the need in the market, allowing a matching point with scientific research teams capable to either propose as solution an existing scientific result through technology transfer process or translate the demand in new R&D projects. It actually means that it is the right timing to define an additional scale and plot it in a reverse manner related to the classic TRL scale in order to have the appropriate comprehension of the market pull process. Following schematic (Table 2) is reminded (Paun 2011) for a better comprehension.

For example, if an industrial partner has a DRL on 8, he will be able to identify and speak with the appropriate scientists to launch a collaborative R&D program for developing a new product or service. Same type of matching between different levels could be observed at each level of the previous table.

Looking in two reference systems, one for the technology push approach and the other one for the market pull approach, the given particular timing when a technology transfer agreement is ready for signature becomes predictable.

This is now better understood why "each case is a specific one" for various practitioners while facing entrepreneurs.

Innovation Process (Technological) Readiness Diagram: IRD Diagram

The following diagram (Fig. 2) combines the TRL scale with the DRL scale (Paun 2012). This diagram is showcasing the possible activities or transactions occurring at the different DRL and TRL levels.

As an example, if a company is advancing very high on the DRL at seventh to ninth level, its executives will be able to identify the existing

Technology Push and Market Pull Entrepreneurship, Table 2 Example of matching points between DRL and TRL levels allowing technology transfer agreements

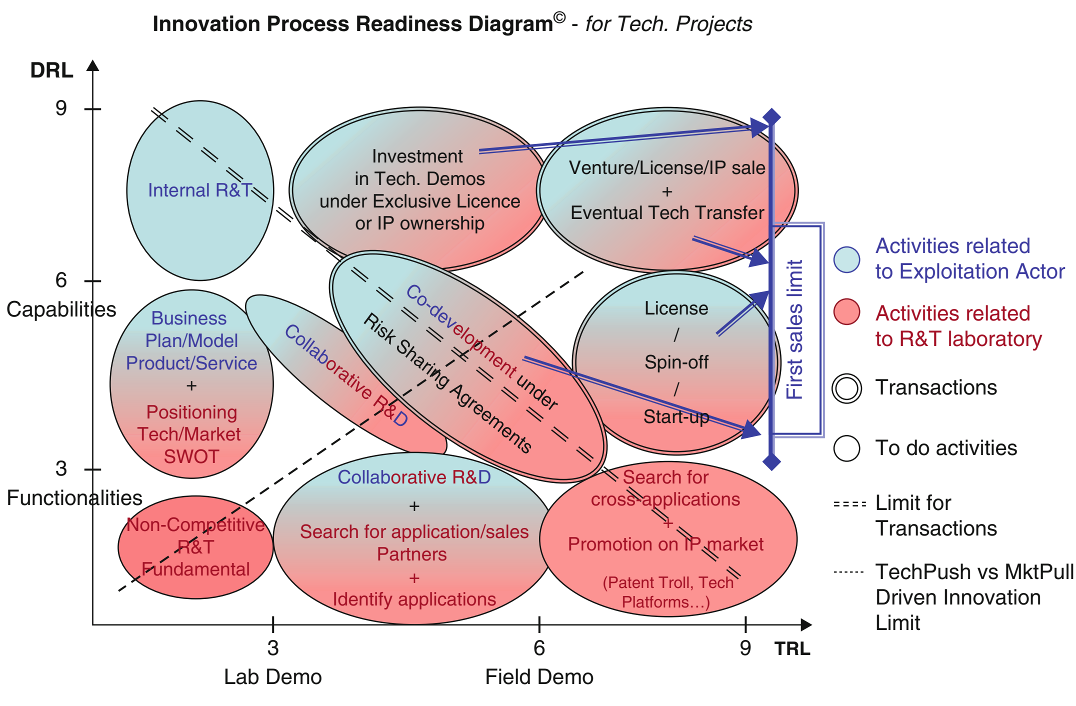
Level	Description for the *demand readiness level*	Description TRL level	Level
1	Occurrence of a feeling "something is missing"		
2	Identification of a specific need	Market certification and sales authorization	9
3	Identification of the expected functionalities for the new product/service	Product industrialization	8
4	Quantification of the expected functionalities	Industrial prototype	7
5	Identification of the systemic capabilities (including the project leadership)	Field demonstration for the whole system	6
6	Translation of the expected functionalities into needed capabilities to build the response	Technology development	5
7	Definition of the necessary and sufficient competencies and resources	Laboratory demonstration	4
8	Identification of the experts possessing the competencies	Research to prove feasibility	3
9	Building the adapted answer to the expressed need on the market	Applied research	2
		Fundamental research	1

experts possessing the right competencies for developing the innovative proposed product:

– If the existing state of the art shows only TRL 1–3 for the required technology, the company has all the interest to hire the existing experts and promote an aggressive internal research and technology program in order to get decisive competitive advantages.
– If the existing state of the art demonstrates that the existing technology already succeeds the proof of concept and the laboratory demonstration, the company will face three possibilities. If the demonstration was made by someone else, the company will invest in further developments (reducing the technology development risk for the existing developers) but only on the basis of an exclusive license relative to its domain. This could be made also on the basis of an IP acquisition. If the existing developer is one of the company's competitor, the company has all interest to consider the development of the intended new product on the basis of a concurrent technology starting with TRL 1–3 by hiring the right experts (return at the first described case). Finally, if by chance the existing laboratory demonstrated technology was obtained inside the company, this one will continue an investment program with reduced risk due to the high level of DRL reached in parallel.
– If the required technology needed to develop the intended innovative product corresponding the high level of obtained DRL was already demonstrated in operational conditions, this was made definitely by someone else, outside the company. This external actor could be someone who is currently running an innovation program in a technology push approach or someone who is already selling products or services with the needed technology in other market domain. Both cases will bring to a venture, a license, or an acquisition of IP rights. The type of transaction will mainly depend on the size of the external actor (a big industrial will prefer a venture if the business will be close to its core competencies or a license if it will be far, while a small industrial will better prefer a license or an IP acquisition).

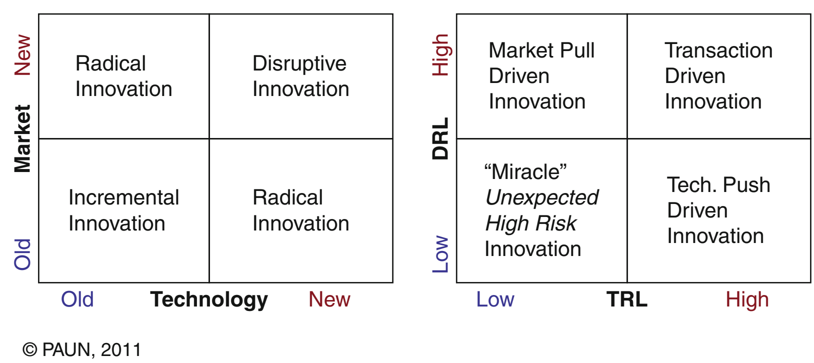
These high DRL possibilities were thus identified. Other "hot spots" represented on the innovation readiness diagram could be easily identified as well.

The various limits corresponding to MarketPull versus TechnoPush innovation projects, transaction-based innovation projects, and obviously the limit for the first sales are also presented on the diagram.



Source: Paun, 2012 (Figure 2: © Paun et Richard, June 2011)

Technology Push and Market Pull Entrepreneurship, Fig. 2 Innovation process readiness diagram for technology-based innovation



Technology Push and Market Pull Entrepreneurship, Fig. 3 Innovation typologies in DRL-TRL perspective (simplified IRD)

The following diagram proposed a simplified IRD, in Fig. 3, by simply classifying the various innovation processes in four categories: the MarketPull, the TechnologyPush, the transaction-based innovations, or the not-enough matured innovation process which could become eventually "miracle" innovations by investing with very high risk.

Conclusion and Future Directions

Since many years, the TRL scale allowed various analysis of the technology transfer and technological innovation processes by positioning the various stakeholders along this scale, including entrepreneurs. This entry reminds a new reference system for better addressing the market pull approach while doing technological innovation. The DRL scale could also be the object of the same dynamic exchanges, modifications, and analysis that the TRL scale induced among the academics or practitioner communities. The aim is that this new (only proposed in 2011) tool for a hybridized approach will significantly improve the entrepreneurship practices through a better understanding of the different factors and staging allowing the agreement signatures to create value.

DRL could also be used in the better understanding of the social innovation process especially, thanks to its capacity to identify stages and actors in the evolution of the demand from the simple identification of a need to the description of the specific solutions expected.

For a TT officer or a strategy industrial director, it will be important to survey the matching of the levels on the two scales while placing the participating actors, identifying the existing asymmetries between them, and activating compensation or reduction tools for dealing with these asymmetries. When the sum of the two indicators will equalize 10, the deal between the industrial and the R&D laboratory becomes feasible and will interest all the stakeholders of the innovation project, including the investors (private or public). Further research work is on the process together with members of ANRT, AI Carnot, C.U.R.I.E. network, Technology Transfer Society, in order to postulate that the technology transfer or development agreements are only possible if the sum DRL + TRL is at least equal to 10 regardless of the market pull or technology push entrepreneurship. If the sum will be smaller than 10, specific actions could be envisaged in market pull or in technology push approaches types.

With a better understanding and control of the hybridization strategy between technology push and market pull approaches, the innovation system tends to evolve toward a better compatibility with the social and environmental requirements inevitably market pull driven as in the case of eco-innovation.

Cross-References

► Entrepreneur
► Product Development
► Technology

References

Abernathy WJ, Utterback JM. A dynamic model of process and product innovation. Omega. 1975;3(6): 639–56.

AI Carnot, permanent references at http://instituts-carnot.eu/fr/aicarnot

ANRT, permanent references at http://www.anrt.asso.fr/

Chen J. The systematic view and framework on technology innovation. J Manag Sci China. 1999;2(3):66–73.

Freeman C. Technology policy and economic performance: lessons from Japan. London: Pinter; 1987.

Hardy C, Dougherty D. Powering product innovation. Euro Manag J. 1997;15(1):16–27.

Iansiti M. Technology integration: making critical choices in a dynamic world. Boston: Harvard Business School Press; 1998.

Mankins JC. Technology readiness levels, a white paper, April 6. Advanced Concepts Office, Office of Space Access and Technology, NASA; 1995.

Nash JF. Equilibrium points in n-person games. Proc Natl Acad Sci. 1950;36(1):48–9.

Nelson RR, editor. National innovation systems: a comparative analysis. New York: Oxford University Press; 1993.

Paun F. Demand readiness level as equilibrium tool for the hybridization between technology push et market pull approaches. ANR – ERANET Workshop; 2011 Feb 8; Paris (available on ssrn); 2011.

Paun F. The demand readiness level scale as new proposed tool to hybridize market pull with technology push approaches in technology transfer practices, in technology transfer in a global economy. Springer series: International Studies in Entrepreneurship. 2012; 28:397.

Rothwell R. Developments towards the fifth generation model of innovation. Technol Anal Strat Manag. 1992;4(1):73–5.

Schumpeter JA. The theory of economic development. Cambridge, MA: Harvard University Press; 1934.

Stephan R. Which practices for universities to enhance exchanges and transfer? French American foundation seminar "research & innovation: best practices for the future". Paris: University of Compiegne; 2006.

Stiglitz J, Weiss A. Asymmetric information in credit markets and its implications for macroeconomics. Oxford Econ Pap. 1992;44:694–724.

Tucker RB. Driving growth through innovation: how leading firms are transforming their futures. San Francisco: Berrett-Koehler; 2002.

Uzunidis D. Proximity and innovative milieu, forum the spirit of innovation III, Tacoma, Seattle, May 2008. Available from http://rrifr.univ-littoral.fr/wp-content/uploads/2008/05/seattledu.pdf
von Hippel E. The sources of innovation. New York: Oxford University Press; 1988.
Zimmermann JB. "Grappes d"entreprises et petits mondes (Company clusters and small worlds). Revue Economique. 2002;53(3):517–24.

Temperament

▶ Creative Personality

Tendencies

▶ Patterns of Technological Evolution

Tenure Track and Cross-Employment

▶ Cross-Employment

Terminal Care

▶ Palliative Care and Hospice - Innovation at End of Life

Territorial Design

▶ Entrepreneurship in Creative Economy

Territorial Management

▶ Cyberentrepreneurship and Proximity relationships

Territory

▶ Business Climate and Entrepreneurialism

Territory and Entrepreneurship

Fabienne Picard
University of Technology of
Belfort-Montbeliard, Belfort, France

Synonyms

Regional entrepreneurship

The Regional dimension of Entrepreneurship

Entrepreneurship is involved in the territory development by contributing to the renewal of productive system and promoting the economic growth. It is well known that national context (laws, regulations, taxes, administration, etc., determined by national governments) matters for entrepreneurship and will influence entrepreneurial behaviors. Despite globalization and global sourcing, entrepreneurship has a pronounced regional dimension, and several streams of literature stress the importance of regional level and focus on the link between new-firm start-up activity and region-specific characteristics and attributes (Fritsch and Schmude 2006) – with the region typically being a subnational territory. Differences between regions in newly founded businesses' rates and success, in entrepreneurial attitudes, indicate a distinct importance of space and the local environment for entrepreneurship, and such differences tend to be rather persistent and to prevail over longer periods of time according to empirical research (Dejardin and Fritsch 2011).

These approaches are founded on the acknowledgment that territory is not a neutral space, and factors associated with particular regions matter (Reynolds et al. 1994). Territory is a necessary condition of economic actors' (public and private) action, and this action builds the territory in turn. Considering that entrepreneurial activity or new-firm creation varies across geographic space, the questions are: Why do some territories have entrepreneurial activities and others none? How do territory characteristics impact entrepreneurial activity? Understanding this relationship between entrepreneurial activity and territory is crucial because high level of new-firm creation contributes to regional economic dynamics and to renewal of productive system. Various studies on determinants of entrepreneurship have investigated the characteristics of successful entrepreneurs by looking into individual characteristics such as personality, educational level, experience of work, ethnic origin (Storey 1994), and others look at more structural variations in geographical areas such as demand growth, expected profits, nature of barriers to entry or industrial concentration, and infrastructures (telecommunication and transportation systems). However, the emergence of knowledge-based economy will highlight other elements.

Notions Around Regional Entrepreneurship

Entrepreneurial Dynamics

The concept of entrepreneurial dynamics refers to creation, evolution, and cessation of economic activity in a given space that is to economics transformation of a territory. It results in creation of new organizations or in development of existing organizations but also in the removal of existing firms and/or activities. The analysis of entrepreneurial dynamics allows to trace territory trajectories and to understand the evolution of productive systems. Scholars recognize that economic transformation of a territory is a low and complex process. Empirical studies have showed the relative inertia of regional business portfolio due to the path-dependent nature of entrepreneurial process. In doing so, the entrepreneurial dynamics fosters the creation of territory-specific resources.

Generic and Specific Territory Resources

Resources contribute to activity development. Every territory has specific resources built over time from generic resources. Some of them are weakly mobile and strongly attached to a territory. These resources make the territory more or less attractive for new entrepreneurial activity. Specific resources include characteristics of labor (quality, know-how, adaptability, flexibility, etc.), industrial organization (cooperation, financial support), etc. There is a dialectical relationship between specific resources and entrepreneurship: On the one hand, entrepreneurial activity is built on territorial specific resources, but on the other hand, entrepreneurs play a role in the creation of specific resources. In fact, there is a close relationship between incumbent firm behavior and their ability to attract new firms and expend their business environment.

Endogenous Development of Territory

Endogenous development uses specifically local resources to sustain economic development. Here, the ability of local communities to exploit local resources is a crucial vector of territory development. Another characteristic of endogenous development is the local control of innovation or social regulations. The endogenous theory of development deals with small business, economic density, and social construction of market. Entrepreneurial activity anchors to local identity and draws on specific resources, and sometimes the proportion of local entrepreneurs who undertake in their natal territory is larger than the corresponding fraction of employees (Michelacci and Silva 2007).

Exogenous Development of Territory

Exogenous development of a territory is largely stimulated by public policy. Public decision makers use a range of tools in order to foster territory attractiveness (e.g., tax advantages) and increase the rate of localization of new organizations in their region.

Occupational Choice

New-firm creation echoes of individual decision process. Why does a person decide to be an entrepreneur and start a new firm? A large part of the literature addresses this question remembering that individuals are faced with occupational choice: being employees, staying jobless, or becoming

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an entrepreneur (▶ Individual Determinants of Entrepreneurship). In this approach, new-firm creation results from an individual decision process, and personal attributes (personality, education, entrepreneurial vision, alertness to business opportunities, proactivity, familial tradition, and ethnic origin) play a major role.

However, individual entrepreneurial preferences and ambitions not only depend on the personal assessment of own capabilities and resources available but also are strongly colored by actual and perceived market opportunities, conditions of profit formation, wages paid, financial constraints, local or regional demand, competition, etc. Consequently, the explanations of entrepreneurship can be found at the individual level, regional level, and national level (Bosma et al. 2008). In fact, environmental context – national but also regional – does not get neglected in this decision process. Thus, in declining industrial regions, individuals are faced with contraction of labor market and weakness of employee perspectives. So, the solution to have a job may be to create it and to be self-employed. But, in the same time, in depressed economic context with a decreasing local demand, profit perspectives may be reduced and weakly attractive to entrepreneurial creativity.

Agglomeration Effects

Agglomeration effects concern benefits derived for a firm from its location near other increase with the number of the firms with the same location. They include, among others, access to higher education, exploitation of local knowledge spillovers, and the presence of highly sophisticated markets which offer a variety of niches that can be exploited by new firms. Traditionally, two types of agglomeration effects are identified: (1) Marshall-Arrow-Romer effect (1973) refers to localization economics built on the economic density and the territorial specialization of activity and (2) Jacobs effect (1969) concerns urbanization economics and the fact that cities offer a great range of infrastructure, which is of interest especially for younger and/or more highly educated people. Agglomeration effects have positive effect on new-firm creation, because the presence of numerous firms in a delimited space impacts the demand, enhances access to skilled labor, and stimulates knowledge externalities and business information exchange between firms. In fact, whether clusters, industrial districts, or other forms of localized productive systems, the geographical concentration of businesses favors new-firm creation.

Knowledge-Based Economy: What Is Changing Between Territory and Entrepreneurship?

Tangible and Intangible Determinants of Regional Entrepreneurship

Relationship between entrepreneurial activity and territory is complex. Traditionally, a large part of literature investigates tangible and intangible determinants of regional entrepreneurship by focusing on various factors such as unemployment, population density/growth, industrial structure (market size, competition, specialization, and market concentration), human capital or cognitive resources (educational level, work experience), availability of financing, accessibility, university research and development, availability of cheap business location, level of regional income or welfare, but also social diversity and creativity (▶ Environmental Determinants of Entrepreneurship). All these factors influence significantly regional variation in new-firm birth rates. Beyond tangible regional attributes, the issue for entrepreneurial region is also to facilitate the networking of economic actors (▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)). Belonging to a local network allows access to specific local resources and to social capital, may be counseling, produces information exchange and new ideas, and is a transaction facilitator using reputation effect. These points are particularly important in knowledge economy to boost the competitiveness of new firms.

Regional Growth Regimes

Consequently, there are considerable differences of regional new-firm creation rates, and these differences have consequences for regional development, albeit in the long run and for the role that new firm plays for development. Extending the concept of the technological regime (Winter 1984) to regional growth, scholars identify different types of regional growth regime. Audretsch and Fritsch (2002), for example, propose to distinguish the entrepreneurial growth regime in a region if growth results from a high level of new-firm start-ups and a turbulent enterprise structure, and the routinized growth for regions where above-average growth goes together with a relatively stable structure of large, incumbent enterprises, and new businesses do not play an important role. The chance for survival and growth is much lower in routinized growth regime than in an entrepreneurial regime.

It is important to keep in mind a recent result of research about the effects of new business formation on regional development, namely, the most important growth effects of new business creation tends to occur with a time lag of up to 10 years (Dejardin and Fritsch 2011). The dynamics of this growth regime is largely path-dependency. Scholars observed that regions with relatively high rates of new business formation in the past are likely to experience a correspondingly high level of start-ups in the future, and regions with a low level of new businesses today can be expected to have only relatively few start-ups in the near future.

Moreover, these effects are not the same according the type of start-up (for instance, industry affiliation of new firm plays a role) and their regional environment (high-density areas vs. rural region, density, and variety of economic activity). Individual entrepreneurial behavior is also affected by regional entrepreneurial culture and regional attitudes toward entrepreneurship (risk takers, positive attitudes toward self-employment), and a high regional level of visibility of new entrepreneurs stimulates ambitious entrepreneurship at the individual level (Bosma et al. 2008). Reintroducing the cultural and institutional dimension, territory is thought as a set of rules and values and as the result of common and shared representations which may support entrepreneurship (▶ Clusters).

The Knowledge Spillover Theory of Entrepreneurship

The knowledge spillover view of entrepreneurship provides a clear link that entrepreneurial activity will result from investments in new knowledge and that entrepreneurial activity will be spatially localized within close geographic proximity to the knowledge source. The ability of a region to produce knowledge and to promote its diffusion is analyzed by knowledge spillover theory of entrepreneurship (Audretsch 1995). The spatial component of this approach focuses on the generation of entrepreneurial opportunities which are linked to knowledge spillover. Entrepreneurial opportunities come from large companies, investments by incumbent firms, and public research organizations. Consequently, regions without larger research organizations will probably have fewer spin-offs because of a lack of technically trained people and a shortage of ideas, and conversely.

Entrepreneurship World Cities and Creative Class

The purpose of the entrepreneurial world cities approach is to go beyond the analysis of regional differences within a single country and to propose cross-country comparisons on world cities taking into account the impact of the urban environment. The main argument is that urban cities or metropolitan areas, because of their size, generate urban externalities or urbanization economics in addition to localization externalities (▶ Entrepreneurship in Creative Economy). So, the entrepreneurial advantage of cities is based on agglomeration effects, the main argument why cities should have higher start-up rates than nonurban regions. Furthermore, besides the enhancement of demand, cities also have larger shares of highly educated people increasing the pool of potential entrepreneurs. Finally, perceptions about entrepreneurship in urban areas may be distinctive and affect the pool of potential entrepreneurs (willingness, perceived skills, and ability to become an entrepreneur) and the demand side of entrepreneurship.

Cities and regions seem to function as incubators of creativity and innovation, and human capital factors play an important role in spurring regional growth. The hypothesis is that entrepreneurship is positively associated with regional environments that promote diversity and creativity. Entrepreneurial activities require not only a productive and supportive business climate along with an educated population but also a climate where creativity, diversity, and innovation are encouraged and valued (Lee et al. 2004). Besides infrastructure, access to capital, and so on, the context of a knowledge-based economy increases the importance of creative environments. These creative environments are particularly present in cites and more especially in cities with a high-level share of creative class. Due to the existence of geography of talent hypothesis (Florida 2004), highly qualified people tend to live in close spatial concentration. Creative cities combine Florida's 3Ts: technology, talent, and tolerance. According to this author, visions with holistic and long-term approaches for cities and regions are needed to "update" old industrial towns and attract visionary people. There is an interdependent relationship between characteristics of a metropolitan city, the number of talented people within this city, and the amount of entrepreneurial activities. Talented people are more creative than the rest of the population, they are more entrepreneurial, and they prefer cities with certain attributes like tolerance, economic welfare, and knowledge intensity. And finally, if talented people need a certain kind of environment, they also contribute to create this culturally rich and creative environment due to their regional and social embeddedness.

Conclusions and Future Directions

Local roots of entrepreneurship change with knowledge-based economy. Despite globalization and growing digital world, entrepreneurs need to be connected to their local territory to develop their business. Regions need entrepreneurship to change their productive system and be adapted. However, considering the existence of a path-dependency and persistence over time of regional entrepreneurship, one must take into account that this process changes are slow. Therefore, a policy that is aiming at stimulating the regional level of entrepreneurship needs patience and a long-term orientation (Fritsch and Schmude 2006). One of the most promising ways to stimulate regional entrepreneurship is probably to create and innovative, creative and entrepreneurial climate and to design a policy to promote regional entrepreneurship.

Cross-References

▶ Clusters
▶ Entrepreneurship in Creative Economy
▶ Environmental Determinants of Entrepreneurship
▶ Individual Determinants of Entrepreneurship
▶ Innovative Milieux and Entrepreneurship (Volume Entrepreneurship)

References

Acs ZJ, Braunerhjelm P, Audretsch DB, Carlsson B. The knowledge spillover theory of entrepreneurship. Small Bus Econ. 2009;32:15–30.
Audretsch DB. Innovation and industry evolution. Cambridge, USA: MIT Press; 1995.
Audretsch DB, Fritsch M. Growth regimes over time and space. Reg Stud. 2002;36:113–124.
Bosma N, Sternberg R, Acs ZB. The entrepreneurial advantage of world cities. Scales research reports H200810, EIM Business and Policy Research. 2008.
Dejardin M, Fritsch M. Entrepreneurial dynamics and regional growth. Small Bus Econ. 2011;36:377–82. Special issue.
Feldman MP. The entrepreneurial event revisited: firm formation in a regional context. Indust Corp Change. 2001;10(4):861–91.
Florida R. Cities and the creative class. New-York: Routledge; 2005.
Florida R. The rise of the creative class. And how it's transforming work, leisure community and everyday life. New York: Basic Books; 2004.
Fritsch M. How does new business formation affect regional development? Introduction to the special issue. Small Bus Econ. 2008;30:1–14. Special issue.
Fritsch M, Schmude J, editors. Entrepreneurship in the region. New York: Springer; 2006.
Jacobs J. The economy of cities. New York: Vintage Books; 1969.
Lee SY, Florida R, Acs ZJ. Creativity and entrepreneurship: a regional analysis of new firm formation. Reg Stud. 2004;38(8):879–91.

Michelacci C, Silva O. Why so many local entrepreneurs? Rev Econ Stat (MIT Press). 2007;89(4):615–633.
OECD. Competitive cities: a new entrepreneurial paradigm in spatial development. Paris: OECD; 2007.
Reynolds P, Story DJ, Westhead P. Cross-national comparisons of the variation in new firm formations rates. Reg Stud. 1994;28(4):443–556.
Storey DJ. Understanding the small business sector. London: Routledge; 1994.
Winter SG. Schumpeterian competition in alternative technological regimes. J Econ Behav Org. 1984;5: 287–320.

Tertiary Education

▶ Higher Education and Innovation

Test of Creativity

▶ Measurement of Creativity

Thinking Skills, Development

▶ Inventive Thinking Skills, Development

Thought Experimentation

▶ Imagination

Trade Cycles

▶ Business Cycles

Training Methods

▶ Creativity Training in Design Education

Transdisciplinarity

▶ Interdisciplinarity and Innovation

Transdisciplinary Research (Transdisciplinarity)

Markus Arnold
Faculty of Interdisciplinary Studies (IFF), Institute for Science Communication & Higher Education Research (WIHO), Alpen-Adria University of Klagenfurt, Vienna, Austria

Synonyms

Mode 2 knowledge production; Post-normal science

Introduction

The term "transdisciplinarity (TD)" was coined to denote a search for the "unity" of knowledge or – more generally – the actual means with which such an integration of otherwise disciplinary fragmented knowledge can be achieved. Since its first appearance, "transdisciplinarity," in fact, stands for nothing less than "the contemporary version of the historical quest for systematic integration of knowledge" (Klein 2010, p. 24; cf. Klein 1990, pp. 63–73).

Just like interdisciplinarity, the basic objective of TD has been from its beginning to make science and higher education more responsive to the complexity of life-world problems and more relevant for the public good and the legitimate needs of the society. Since then TD has been seen as a means to help research organizations to become active agents of societal innovations. The ambitious goal has been to make their knowledge more effective by overcoming the increasing fragmentation of knowledge both within the different scientific disciplines and within the society at large.

However, compared to the notion of "interdisciplinarity," TD aims at a more thorough integration of knowledge by focusing either (1) on *transdisciplinary concepts and methods* which are shared by more than one scientific discipline or (2) on the implementation of *participatory processes* within the research process which allow from the beginning deliberations with practitioners, citizens, and stakeholders about the purposes of a research project on the one side and an integration of first-hand nonscientific knowledge on the other. Although both conceptions of TD can – under certain circumstances – complement each other, they do not always go necessarily hand in hand.

Historical Development of the Concept

At a seminal conference on Interdisciplinarity in Universities (organized 1972 by CERI, the Centre for Educational Research and Innovation, a department of the OECD, the Organization for Economic Co-operation and Development), two different accounts were recommended on how a thorough transdisciplinary integration of knowledge can be achieved. One proponent was the Swiss developmental psychologist and epistemologist Jean Piaget, and the other the Austrian astrophysicist Erich Jantsch from Stanford University.

"A Common System of Axioms": TD as Shared Concepts and Methods

In 1972, an influential publication, released in cooperation with the OECD, defined "Transdisciplinarity" as

> Establishing a common system of axioms for a set of disciplines (e.g. anthropology considered as 'the science of man and his accomplishments' . . .) (Briggs et al. 1972, p. 26).

In fact, this was a definition which was first of all advocated by Jean Piaget (1972) together with the mathematician André Lichnerowicz (1972). For Piaget, a transdisciplinary integration of different scientific disciplines was in fact first and foremost a task for mathematicians designing mathematical models: For example, he dreamed that someday, it would be possible to coordinate the relationships between physics and biology by new mathematical models similar to the relationships between mechanics and wave theory which have been finally coordinated within the new theory of wave mechanics (Piaget 1972, p. 138f.; cf. Lichnerowicz 1972).

Contemporary examples for this kind of TD would be, for instance, "social ecologic" models for the material and energy flow of societies, bridging the disciplinary boundaries between sociology and ecology by analyzing processes of society-nature interactions. But there are also TD concepts and methods which are not mathematical in essence, e.g., the (controversial) concepts of sociobiology where the principles of natural selection and evolutionist biology are applied to the study of social behavior and ethics. Further examples for nonmathematical TD concepts connecting different disciplines: narratology and semiotics (literary and media studies, linguistics, sociology, political science, history, epistemology), game theory (economics, political sciences, evolution theory), and systems theory (biology, sociology). TD research in this sense is searching for a kind of "meta-language" (Kim 1998, p. 21) in which problems of different disciplines can be expressed (for exponents of TD as shared concepts and methods see also: Lichnerowicz 1972; Kockelmans 1979, p. 128f.; Stichweh 1979; Miller 1982; Mittelstraß 1989, 2002).

"A Purpose-Oriented Coordination": TD as an Organizational Principle

At the same OECD conference, Erich Jantsch advocated a quite different concept of TD: For him inter- and transdisciplinarity were "the key notions for a systems approach to education and innovation" (Jantsch 1972, p. 107). Jantsch was the first who recognized that a transdisciplinary integration of different disciplines is not solely a problem of theories or methods, but a question of purpose. As he insisted: "*There is not a single system of science, there are as many systems as there are purposes*." (Jantsch 1972, p. 99) The purpose of research always influences the research outcome. As a rule, knowledge from different scientific disciplines is incompatible inasmuch as it has to serve different purposes. Therefore, if someone wants to integrate different knowledge domains, he or she must decide, first of all, which societal goals should be met and then to align the different purposes which are the main reasons for the fragmentation of knowledge into dispersed knowledge domains. Consequently, any TD integration presupposes a discussion of the intended aims and purposes before one can overcome the separation of disciplinary knowledge and expertise, hence the:

> essential characteristic of a transdisciplinary approach is the coordination of activities at all levels of the education/innovation system toward a common purpose. (Jantsch 1972, p. 114)

A thorough cross-disciplinary integration of disciplinary knowledge is only possible when at different organizational levels within the research organization, "political" decisions (in the broadest sense) about the intended purposes of the research outcome are made. He therefore conceptualized – in contrast to Piaget – TD first and foremost as an "organizational principle" (Jantsch 1972, p. 100) and proclaimed the need for a new kind of research organization, the "transdisciplinary university":

> The new purpose implies that the university has to become a political institution in the broadest sense, interacting with government (at all jurisdictional levels) and industry in the planning and design of society's systems, and in particular in controlling the outcomes of introducing technology into these systems. The university must engage itself in this task as an institution, not just through the individual members of its community. (Jantsch 1972, p. 102)

For Jantsch, however, "transdisciplinarity" still meant a unifying paradigm which is able to pull different scientific disciplines together within a vision of the reality as a whole. According to Jantsch one example of such a new "transdisciplinary vision" made its appearance in the 1970s with a new paradigm, the "self-organizing paradigm", which helped to find a unifying perspective "pulling together the physical and social sciences, the arts and the humanities, philosophy and knowledge transcending the rational domain, in short, the totality of human relations with the world." (Jantsch 1980, p. 308). For that reason he characterized his own concept of TD as "complementary" to the one of Jean Piaget (Jantsch 1972, p. 99). Furthermore, he did not explain clearly how the university should organize these interactions with the different societal actors and organizations; how a transdisciplinary university could achieve the competence and authority to plan for the society at large (Jantsch 1972, p. 121). In particular, how the university should cope with dissent within the society about the purposes and goals of research.

But nevertheless, with the emphasis on the purposes of knowledge and the organizational design of research institutions, Jantsch in fact shifted the focus from the level of concepts and theories to the realm of practical reasoning about legitimate societal demands and reasonable goals for TD research. Although he still insisted that a common purpose of knowledge could be the origin for a new set of unified theories and concepts, with the shift from theoretical to practical reasoning, a different kind of transdisciplinary integration of knowledge came into view: TD integration of knowledge not by means of systematic theories or theoretical models but on the basis of practical reasoning which first and foremost has to provide practical orientation and advice for public policies and collective decision making.

"A Transformative Practice of Knowledge": TD as Participatory Research

Although the term TD is sometimes used in a broad sense as "life-problem orientated" research which does not necessarily involve real participation of nonscientists and can therefore also be conducted by one researcher alone (see e.g. Jaeger and Scheringer 1998), many authors today define TD as a special kind of "life-problem orientated" research including some participatory procedures for different groups of stakeholders within the research process (Gibbons et al. 1994; Nowotny et al. 2001; Klein 2004; Pohl and Hirsch Hadorn 2007; Lieven and Maasen 2007; Russel et al. 2008; Arnold 2009; Hanschitz et al. 2009; Hirsch

Hadorn et al. 2008, 2010; Bogner et al. 2010). This kind of TD research implies among other things

> the giving up of sovereignty over knowledge, the generation of new insight and knowledge by collaboration, and the capacity to consider the know-how of professionals and lay-people. Collectively, transdisciplinary contributions enable the cross-fertilisation of ideas and knowledge from different contributors that leads to an enlarged vision of a subject, as well as new explanatory theories. Transdisciplinarity is a way of achieving innovative goals, enriched understanding and a synergy of new methods. (Lawrence 2004, p. 489)

Participatory TD opens new pathways for researchers to generate innovations, since new research topics and approaches become necessary to cope with the diversity of people, skills and knowledge domains which have to be integrated. However, this is not without consequences: for the benefit of (1) integrating scientific with nonscientific knowledge, (2) for getting closer to life-world problems, and (3) for focusing foremost on the creation of orientational knowledge to find workable solutions for decision making, the participatory kind of TD has to relax its criteria for transdisciplinary knowledge integration. It is one thing to integrate knowledge of different scientific disciplines within a unified theory but quite another thing to integrate diverse knowledge domains for the purpose of decision making and acting. In the former case, one is searching for a systematic theory or model, in the latter for practical knowledge, which provides orientation and advice for public policies and collective decision making.

Main Arguments for Participatory TD Research

The new claim that the concept of TD should be extended with instruments for the public participation of nonscientists is above all based on three connected arguments:

1. Since there is no societal consensus about purposes on which scientists can rely in their decisions, science has to enter into a dialog with society.
2. The division of labor in modern society leads to a division of know-how and a fragmentation of knowledge; therefore, a TD integration of knowledge has to be extended to the whole society and cannot be reduced to the integration of the knowledge of different scientific disciplines. Three problem areas can be identified:
   (a) *Experts* versus *principals (hierarchy)*: In the "knowledge society," experts at a lower level of the hierarchy have often knowledge and experience their principal lacks although the latter has the authority to decide.
   (b) *Experts* versus *experts (specialization)*: Specialists and single organizational departments have at their command only fragmented pieces of knowledge when they are tackling with societal problems. As one may say: "Communities have problems, every organization departments" (a variation on an often quoted phrase: "Communities have problems, universities departments," CERI 1982, p. 127).
   (c) *Experts* versus *citizens (practical experience)*: Contextual knowledge about circumstances apart from the abstract knowledge of scientific experts becomes more important when science has to be successfully applied in the daily life of common citizens.

The Three Phases of the Participatory TD Research Process

The participatory kind of TD research requires three distinct phases within the research process, dedicated to different tasks and in need of organizational designs. Although they can overlap, sometimes, it is even necessary to approach these phases in an iterative manner:

1. *Problem identification and structuring*: Typically, TD research has to start with only loosely defined objectives. Facts are unclear, problems vaguely defined, and values in dispute, but often it is much at stake for "those affected by the consequences" of the problem (Dewey 1927/1988). The very nature of the research purpose is often in dispute, since different interests and perspectives on the

problem are involved; therefore, it is highly recommended to deliberate with different stakeholders about a joint definition of the problem and on what research question the research should focus (Pohl and Hirsch Hadorn 2007; Hirsch Hadorn et al. 2008). Scientific experts need the help of citizens to identify the relevant societal problems and to define the research questions in a way that the research outcome will likely suit to the needs and expectations of those who are involved. Expert knowledge of different disciplines and professions along with important contextual knowledge and competences of laypeople should be examined for their relevance and integrated for a first problem definition. Furthermore, for scientific knowledge to become societally relevant, it is necessary to involve from the beginning those who are either affected by the consequences of these scientific and technological innovations or are in charge for implementing and using this knowledge later on in their occupational, family, or political life as citizens. The former can obstruct innovations later on when they think they are not in their interest, the latter can be reluctant to implement them.

2. *Problem investigation and analysis*: The joint problem definition has to be broken down into research questions which can be analyzed with the instruments and methods at hand. Different aspects have to be closely investigated to understand the complexity of the problem from different angles. Especially four central features have to be emphasized: It should deal "with problem fields in such a way that it can (a) grasp the complexity of problems, (b) take into account the diversity of scientific and life-world perceptions of problems, (c) link abstract and case-specific knowledge, and (d) develop knowledge and practices that promote what is perceived to be the common good." (Pohl and Hirsch Hadorn 2007, p. 20)
3. *Bringing results to fruition*: The TD research outcome has to be put in practice to trigger innovations within society. It is necessary to synthesize and to translate the research outcomes for the different stakeholders since they have to understand and implement this knowledge in their daily routines. As part of a joint quality assurance, the results have to be monitored: either by an "extended peer review" (including representatives of groups of different stakeholders) or more decentralized by separate evaluations by the scientific peers on the one hand and the different groups of stakeholders on the other (see "Evaluation of Participatory TD Research").

A Question of Knowing: Searching for New Sources of Knowledge

Another kind of knowledge the scientists sometimes lack but should be interested in is contextualized knowledge. To give an example, the political scientist and anthropologist James C. Scott convincingly argued that the modernization of agriculture in the twentieth century with the help of scientific standardizations but without taking the experience of the local peasants, woodsmen, and hunters into account repeatedly yielded catastrophic results. Many projects actually failed without the "nonscientific" practical knowledge of the local communities about local circumstances and their complex interrelations, like knowledge about seasonal time sequences in the local flora and fauna, specific differences in soil quality across the region, water supply, and changing weather conditions. Scott called this practical knowledge of the local communities "metis"; it consists of a set of "rules of thumb" acquired by long experience. The essence of this kind of knowledge is "[k]nowing how and when to apply the rules of thumb *in a concrete situation*" (Scott 1998, p. 316).

The Benefit of "Societal Learning": Triggering Social Innovations

At least since the 1970s, fundamental changes between science and democratic society occurred, when the severe criticism of antinuclear and environmental movements have become prominent, as well as the accusations against psychiatric and social expertise of being oppressive and of serving the vested interests of those who are in charge. Political dissent made it quite clear that in a democratic society, it is not easy to reach an agreement on a generally accepted definition of what constitutes a legitimate "public interest" and a common purpose at all. How then can research organizations find generally acceptable purposes of knowledge on which scientists and society alike can agree? At this point Erich Jantsch' concept of TD was adapted and became more sophisticated by taking up an idea first developed in the 1920s by the philosopher John Dewey: the idea of *participatory engagement of citizens* with the aim to deliberate about the desired aims and purposes (Dewey 1927/1988).

John Dewey proposed a new contract between scientific experts and those citizens who are affected by the consequences of scientific or technological innovations, since both can learn from each other. It is just as with shoemaking: "The man who wears the shoe knows best that it pinches and where it pinches, even if the expert shoemaker is the best judge of how the trouble is to be remedied" (Dewey 1927/1988, p. 207). For different reasons, participatory TD has therefore some common features with Eric von Hippel's concept of "user innovation," which is based on the deliberate attempt to support the participation of so-called lead users in the product development process (Hippel 1988, 2005).

(a) *Consensus conferences:* In fact, Dewey's idea of democratic deliberations about purposes has been taken up since the 1970s and put in practice by some researchers even before the term "transdisciplinarity" was first used. Most notably when in 1987 a participatory method of technology assessment was established with the first Danish "Consensus conference" (about genetic engineering) organized by the Danish Board of Technology (Blok 2007). As a dialog between experts and citizens about emerging technology issues, the consensus conference (also known as "citizens' panels") has been aimed especially at identifying potential side effects of technological change and evaluating its societal impact. Such public conferences intend to find socially accepted ways for technological changes, helping technological and scientific inventions to become socially accepted technological innovations by actively addressing emerging conflicts and until then unforeseen social consequences.

(b) *Postgraduate and adult education:* Other means of integrating scientific and nonscientific knowledge domains have been developed by some institutions since the 1970s especially in postgraduate and adult teaching courses (e.g., the 1979 established Austrian IFF: Arnold and Dressel 2009). When universities acknowledge that (especially vocational) students already bring considerable knowledge, skills, and competences to the university, they can redesign specific courses of study with the aim to encourage these students to share their professional experience and knowledge with their colleagues and to mobilize these resources in their research for their final thesis. Transforming the traditional professor-student relationship into a kind of transdisciplinary cooperation, treating students more like equal partners in a participatory research process. Basis for such a redefinition of the different social roles within the learning process is, however, a persistent focus of these study programs on life-world problems, which not only cross the narrow disciplinary boundaries of scientific knowledge but are also accessible for the lessons of life experience and the knowledge of practitioners. Only then is the hierarchy between scientific and nonscientific knowledge sufficiently leveled, so that a collaborative learning process seems promising.

A Question of Purpose: Searching for the Public Interest

In a society based on the division of labor and on individual rights of the citizens, the common good and common interests are never easy to identify. There is no authority to speak for society; if "society now 'speaks back' to science" (Nowotny et al. 2001, p. 50), it is never society as a whole but individual persons or institutions that may be in conflict with other parts of society. In this situation, participation is more complicated than some researchers may think. That is why critics have claimed that with the involvement of stakeholders and the participation of nonscientists in the research process, transdisciplinarity willingly compromises its credibility and "objectivity" by running the risk of becoming partisan and subservient to political interests. This criticism has to be taken seriously, particularly since some researchers seem to mistake the participation of one stakeholder with the successful inclusion of the common interests of a society. Nevertheless, society does not exist as one uniform entity. As science is divided into a variety of disciplines, society is shaped by the functional division of labor, conflicting interests, social hierarchies, and sometimes fierce competition. In other words, "socially robust knowledge" (Nowotny et al. 2001, p. 166ff.) can be achieved either by appeal to the consent of (at least) the majority or by alignment with the interests of the powerful. In the first case, scientific research is oriented toward the common good (which is compatible with traditional notions of "objectivity"); in the latter case, however, it becomes tinged with unreliability and social bias.

For example, if a transdisciplinary research team cooperates with a hospital with the aim to find out how to improve the quality of the hospital, the question is: With whom do they cooperate? Does their research network provide special participatory roles for all stakeholders? Is the hospital represented only by the management or the clinical staff? What about the patients and their relatives or the nonacademic nursing personnel? What about external stakeholders like the health ministry, the pharmaceutical industry, or the health insurance companies? In an ideal setting, all of them would have to be included. But sometimes conflicts between these stakeholders can be fierce and the weakening of organizational hierarchies, for example, between the scientific staff and the nursing personnel, may be opposed by those who benefit from these hierarchies. Transdisciplinary research has to fight against such obstacles, but in situations when conflicts between different interests and perspectives are threatening to break up the whole research network, a reasonable compromise in the research design has to be negotiated.

Evaluation of Participatory TD Research

A key question for transdisciplinary research networks remains: Who should evaluate the success and the quality of research outcomes? Should the evaluation of scientific quality by the scientific community be kept apart from the evaluation of research outcomes and benefits by (for) nonacademic research participants, or should transdisciplinary research foster a new kind of quality assurance by an "extended peer review" where judgments of scientific peers and nonscientific stakeholders can be integrated (Funtowicz and Ravetz 1993)?

An extended peer review is a valuable option and indeed obligatory especially when research funds are dedicated to financing transdisciplinary research and research proposals have to be evaluated. Furthermore, an extended peer review can be a valuable tool to foster communication and deliberations between different groups within a TD research network, which can help to overcome disagreements and to broaden the perspective of each of the different research participants (including those of the scientists) through regular discussions about the aims and the quality of the research process.

Nevertheless, decentralized evaluations by the different participating groups within the research network remain a valuable alternative especially in situations where lasting conflicts between different societal actors are not expected to vanish during the research project and the network's capacities (in terms of time and money) would be overcharged by a mediation process. In such a situation, the expected societal influence of the project will be limited since these conflicts will be likely to overshadow any implementation process. But that does not necessarily mean that the results could not be valuable for scientists and some of the stakeholders as well.

Conclusion and Future Directions

TD is an attempt not only to add but to integrate different knowledge claims. Some still hope to find this unity of knowledge in a unified theory, others hope for a unity on a more local level;

some restrict TD to the integration of scientific knowledge within the academia and their different disciplines, others are searching with the help of participatory procedures for a more thorough integration of scientific and nonscientific knowledge. But all hope to provide better founded knowledge and more comprehensive solutions for relevant societal problems. However, TD – especially in its participatory version – is not only about crossing boundaries of knowledge, but (like interdisciplinarity) it is also about cooperation and bringing different people and organizations with different knowledge together. Hence, transdisciplinary research has to spend considerable time communicating about purposes, appropriate research questions, methods and conflicting knowledge claims, coping with problems of finding a common language and common interests, to put cooperative research and knowledge production on a firm and joint basis.

Despite the fact that the term "TD" was initially invented as designating a special kind of interdisciplinarity, today the core meaning of TD has shifted to describe participatory research in the first place. At least since then it became necessary to distinguish between interdisciplinarity and transdisciplinarity as two concepts, although closely linked but not identical. As a matter of fact, a disciplinary kind of TD is entirely possible when – without any interdisciplinary cooperation between different disciplines – participatory procedures are included in disciplinary research designs. But transdisciplinarity without interdisciplinarity does not seem worth aspiring for. It is unlikely to get the whole picture of the complexity of societal problems (not to mention finding appropriate solutions) without making recourse to the whole diversity of scientific methods and disciplinary systems of knowledge. Therefore, integrating transdisciplinary and interdisciplinary cooperations has to be more than ever an important aim for TD research projects in the future.

However, since TD is in fact more like a craft or an art than a science, there are unavoidable differences between discipline-oriented and practice-oriented members within every interdisciplinary TD research team. Scientists trying to explain natural and social phenomena have often different research questions than practitioners trying to devise actions, processes, or technical solutions that serve some specified purpose. An interdisciplinary and transdisciplinary research team has to bridge these differences, combining scientific analysis with real-world solutions.

To cope with this situation successfully, TD needs organizational expertise: Transcending institutional boundaries with the aim of knowledge integration requires some experience in project management, especially in building bridges between different social realms of experience. Therefore, to create, to maintain, and to share TD expertise, separate organizational units have to be established within universities (e.g., as departments) or as autonomous division within other research institutes. This represents the only way to nurture what can be called transdisciplinary "communities of practice" where not only the formal rules but also the nuts and bolts of TD practice can be learnt from colleagues as tacit knowledge in an informal way (cf. Wenger 1998; Arnold and Dressel 2009).

As long as the public was convinced that science is an instrument of technical and economic progress, scientific research could be seen as providing value-free devices for innovations whose use and best application could be discussed afterward. In all likelihood, since this consensus has vanished, public debates about the purposes and implications of scientific research will haunt the scientific communities in the future (Ezrahi 1990, 1994). Hence, with its participatory involvement of those who are affected by the consequences, TD research seems to be an adequate and needed instrument for scientific research in a plural democratic society with its debates about purposes and the accountability of public spending: It involves negotiating with stakeholders or citizens about purposes, drawing on their noncertified expertise as knowledge resource, and making it more probable and easier for the participants implementing scientific findings and new solutions in their day-to-day decisions. Therefore, important questions for future research are how to use this instrument successfully and what kind of problems one has to face in different social settings with different scientific disciplines involved.

Cross-References

► Interdisciplinary Research (Interdisciplinarity)
► Mode 1, Mode 2, and Innovation

References

Arnold M. Interdisziplinarität: Theorie und Praxis eines Forschungskonzepts. In: Arnold M, editor. iff – Interdisziplinäre Wissenschaft im Wandel. Wien-Münster: Peter Lang; 2009. p. 65–97.
Arnold M, Dressel G. iff – Geschichte einer interdisziplinären Institution. In: Arnold M, editor. iff – Interdisziplinäre Wissenschaft im Wandel. Wien-Münster: Peter Lang; 2009. p. 17–56.
Blok A. Experts on public trial: on democratizing expertise through a Danish consensus conference. Public Underst Sci. 2007;16(2):163–82.
Bogner A, Kastenhofer K, Torgersen H, editors. Inter- und Transdisziplinarität im Wandel? Neue Perspektiven auf problemorientierte Forschung und Politikberatung. Baden-Baden: Nomos; 2010.
Briggs A, et al., editors. Interdisciplinarity. Problems of teaching and research in Universities. Paris: OECD; 1972.
CERI. The University and the Community. The problems of changing relationships. Paris: OECD; 1982.
Dewey J. The public and its problems. Athens: Ohio University Press; 1927/1988.
Ezrahi Y. The descent of icarus: Science and the transformation of contemporary democracy. Cambridge, MA: Harvard University Press; 1990.
Ezrahi Y. Technology and the Illusion of the Escape from Politics. In: Ezrahi Y et al., editors. Technology, pessimism and postmodernism. Dordrecht: Kluwer; 1994. p. 29–37.
Funtowicz SO, Ravetz JR. Science for the post-normal age. Futures. 1993;25(7):735–55.
Gibbons M, Limoges C, Nowotny H, Schwartzmann S, Scott P, Trow M. The new production of knowledge. The dynamics of science and research in contemporary societies. London: Sage; 1994.
Hanschitz R-C, Schmidt E, Schwarz G. Transdisziplinarität in Forschung und Praxis. Chancen und Risiken partizipativer Prozesse. Wiesbaden: VS Verlag; 2009.
Hippel von E. The sources of innovation. Oxford: Oxford University Press; 1988.
Hippel von E. Democratizing innovation. Cambridge: The MIT Press; 2005.
Hirsch Hadorn G, Hoffmann-Riem H, Biber-Klemm S, Grossenbacher-Mansuy W, Joye D, Pohl C, Wiesmann U, Zemp E, editors. Handbook of transdisciplinary research. Berlin: Springer; 2008.
Hirsch Hadorn G, Pohl C, Bammer G. Solving problems through transdisciplinary research. In: Frodemann R et al., editors. The Oxford handbook of interdisciplinarity. Oxford: Oxford University Press; 2010. p. 431–52.
Jaeger J, Scheringer M. Transdisziplinarität: problemorientierung ohne Methodenzwang. GAIA. 1998;7(1):10–25.
Jantsch E. Towards interdisciplinarity and transdisciplinarity in education and innovation. In: Briggs A et al., editors. Interdisciplinarity. Problems of teaching and research in universities. Paris: OECD; 1972. p. 97–121.
Jantsch E. Interdisciplinarity: dreams and reality. Prospects. 1980;10(3):304–12.
Kim Y, editor. Transdisciplinarity: stimulating synergies, integrating knowledge. Paris: UNESCO (Division of Philosophy and Ethics); 1998.
Klein JT. Interdisciplinarity: history, theory, and practice. Detroit: Wayne State University Press; 1990.
Klein JT. Prospects for transdisciplinarity. Futures. 2004;36:515–26.
Klein JT. A taxonomy of interdisciplinarity. In: Frodemann R et al., editors. The Oxford handbook of interdisciplinarity. Oxford/New York: Oxford University Press; 2010. p. 15–30.
Kockelmans JJ. Why interdisciplinarity? In: Kockelmans JJ, editor. Interdisciplinarity and higher education. University Park/London: The Pennsylvania State University Press; 1979. p. 123–60.
Lawrence RJ. Housing and health: from interdisciplinary principles to transdisciplinary research and practice. Futures. 2004;36:487–502.
Lichnerowicz A. Mathematic and interdisciplinarity. In: Briggs A et al., editors. Interdisciplinarity. Problems of teaching and research in Universities, Paris: OECD; 1972. pp. 121–139
Lieven O, Maasen S. Transdisziplinäre Forschung. Vorbote eines ‚New Deal' zwischen Wissenschaft und Gesellschaft? GAIA. 2007;16(1):35–40.
Miller RC. Varieties of interdisciplinary approaches in the social sciences. Issues Integr Stud. 1982;1:1–37.
Mittelstraß J. Wohin geht die Wissenschaft? Über Disziplinarität, Transdisziplinarität und das Wissen in einer Leibniz-Welt. In: Mittelstraß J, Der Flug der Eule. Von der Vernunft der Wissenschaft und der Aufgabe der Philosophie. Frankfurt am Main: Suhrkamp; 1989. p. 60–88.
Mittelstraß J. Transdisciplinarity – new structures in science. In: Innovative structures in basic research (Ringberg-symposium October 4–7, 2000). Munich: Max-Planck-Gesellschaft; 2002. pp. 43–54
Nowotny H, Scott P, Gibbons M. Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge: Polity Press; 2001.
Piaget J. The epistemology of interdisciplinary relationships. In Briggs A et al., editors. Interdisciplinarity, Problems of teaching and research in Universities, Paris: OECD; 1972. pp. 127–139.
Pohl C, Hirsch Hadorn G. Principles for designing transdisciplinary research. Proposed by the swiss academies of arts and sciences. Munich: Oekom; 2007.

Russel AW, Wickson F, Carew AL. Transdisciplinarity: context, contradictions and capacity. Futures. 2008; 40:460–72.
Scott JC. Seeing like a state. How certain schemes to improve the human condition have failed. New Haven/London: Yale University Press; 1998.
Stichweh R. Differenzierung der Wissenschaft. Zeitschrift für Soziologie. 1979;8:82–101.
Wenger E. Communities of practice. Learning, meaning, and identity. Cambridge: Cambridge University Press; 1998.

Transformation

▶ Corporate Entrepreneurship

Translational Medical Science

▶ Translational Medicine and the Transformation of the Drug Development Process

Translational Medicine

▶ Translational Research

Translational Medicine and the Transformation of the Drug Development Process

Nikolaos G. Evangelatos[1] and
Elias G. Carayannis[2]
[1]Intensive Care Unit, Klinikum Nürnberg, Bayern, Germany
[2]Department of Information Systems & Technology Management, School of Business, The George Washington University, Washington, DC, USA

Synonyms

Basic science; Bench to bedside; Biologic agents; Clinical research; Clinical and translational science; Clinical trials; New molecular entities; Open source biotechnology; Personalized medicine; Pharmaceutical innovation; Pharmaceutical products; Research continuum; Translational medical science; Translational research; Translational science

Introduction

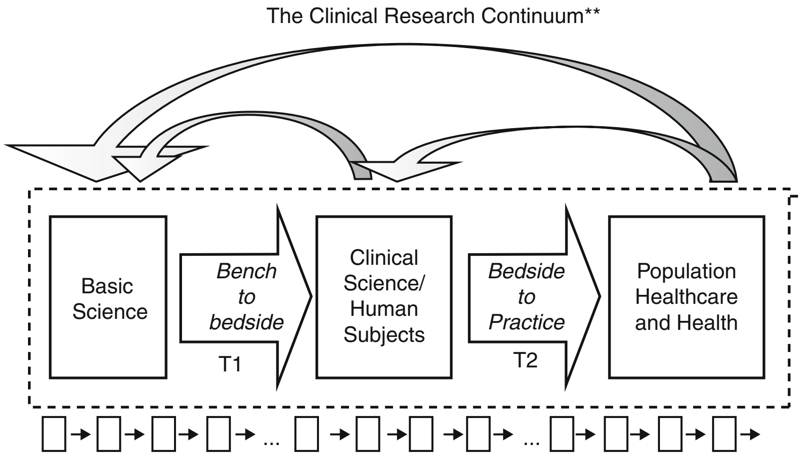
Since the advent of Modernity and the rationalization of medicine, research in biomedical sciences has traditionally been classified into basic (“the bench”) and clinical (“the bedside”). Basic research activities rely on advances in molecular biology techniques and, in the last two decades, have exploited our knowledge and understanding of the mechanisms of disease by opening the black box at the subcellular level.

On the other hand, clinical research in the form of clinical trials relies on observational high-quality research on population samples (in the sense that clinical trials focus on the inputs and outputs and not on the internal complexity, i.e., the mechanism of action of the drug) and has led to the generation of safety and efficacy data for new drugs and relevant health interventions, altering clinical practice in medicine.

In an attempt to combine the advantages of these arbitrary discrete areas of research in the field of biomedical sciences, the concept of translational medical research or, more commonly, translational medicine has emerged. The term was used in 1994 in the field of oncology in order to describe the bidirectional exchange of information between the laboratory and the clinic in an attempt to identify and exploit new molecular targets for the therapy of leukemia (Karp and McCaffrey 1994).

In its essence, “translational” research is an attempt to integrate advancements in molecular biology with clinical trials, in other words to successfully implement a laboratory concept into a clinical protocol, taking research from the “bench to bedside” (Goldblatt and Lee 2010). In order to come up with biologically and clinically meaningful results though, translational research should be bidirectional, i.e., not only from bench to bedside, but also from bedside to bench since

Translational Medicine and the Transformation of the Drug Development Process, Fig. 1 The clinical research continuum (Source: Sung et al. 2003)



research ideas often originate from observations in everyday practice and from the need to address certain public health concerns (Marincola 2003). In this sense, translational frameworks for public health research have already been proposed as a response to the complex reality of the public health environment (Ogilvie et al. 2009).

In an often cited model proposed from Sung et al. (Fig. 1) the clinical research continuum is depicted as a process ranging from basic research to clinical science involving human subjects and from there to improved population healthcare (Sung et al. 2003). In this model, potential barriers to progress are identified as translational blocks. These refer to impediments in transforming basic laboratory research findings into clinical science (first translational Block-T1) and obstacles in the processes of research translation into clinical practice (second translational Block-T2) (Zucker 2009).

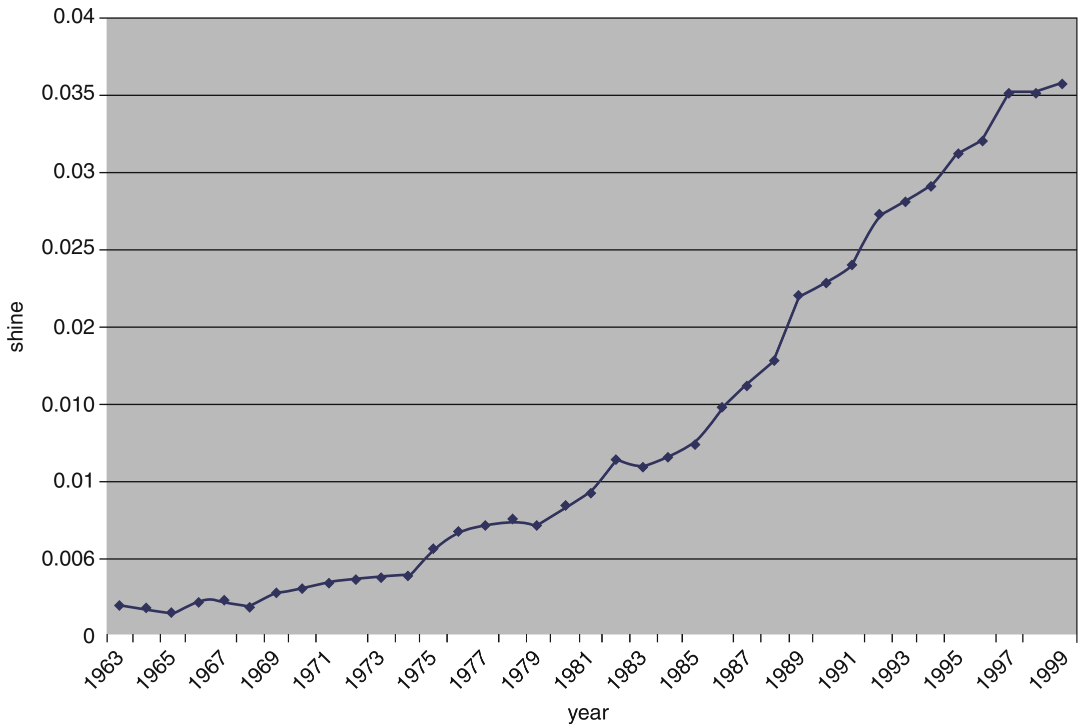
It should be noted that despite and to some extent because of its wide applicability, questions have been raised as to what exactly translational medicine is and whether it comprises merely an euphemism for preclinical and clinical pharmacology (Johnstone 2006; Dische and Saunders 2001).

Development and Dissemination of Translational Medicine

The emergence and dissemination of translational medicine relies on three major pillars, i.e., development of new technologies, increased funding and support in the form of relevant infrastructure, and change of the regulatory framework.

First, development of molecular techniques such as the polymerase chain reaction (PCR) and its variations has allowed the determination of the sequence of chemical base pairs which make up DNA (Bartlett and Stirling 2003) along with the physical and functional identification and mapping of the human genome, thus increasing by many factors the substrate for relevant research which can lead to the unveiling of pathogenetic mechanism and the development of appropriately designed drugs (International Human Genome Sequencing Consortium 2001). Furthermore, the development of information systems in the field of biomedical informatics and the wide dissemination of World Wide Web has allowed the efficient management of data, information, and knowledge from the bench to clinical practice and has enabled the networking between scientific groups and the pharmaceutical sector (Sarkar 2010).

Second, recognizing the increasing role of translational medicine in the development of new medicinal products, National Institutes of Health (NIH) have established the National Center for Advancing Translational Sciences, a new center to speed up movement of discoveries from lab to patients as well as a new program that will fund institutional Clinical and Translational Science Awards (CTSAs) (ncats 2012).



Translational Medicine and the Transformation of the Drug Development Process, Fig. 2 US research university patents as a percentage of all domestic-assignee US patents, 1963–1999 Source: (Mowery and Sampat 2005, p. 120)

Furthermore, NIH foster clinical and translational research by funding facilities and resources such as the General Clinical Research Centers, clinical-trial networks, and molecular-screening libraries, among others (Zerhouni 2005). This enormous progress has turned out to be a major challenge for the European Research Area as well. Trying to shorten delays in drug development the European Union has established EATRIS, the European Advanced Translational Research Infrastructure in Medicine, a distributed pan-European infrastructure consisting of a network of biomedical translation research centers across Europe with the aim to support a faster and more efficient translation of research findings into the final medicinal products (eatris 2012).

Third, the enactment of The Bayh–Dole Act or Patent and Trademark Law Amendments Act in 1980 allowed universities and small businesses to elect ownership of inventions made under federal funding for the purpose of further development and commercialization (P.L. 96–517 1980).

As an effect, a continuously increasing participation of US universities in the national patenting system has been documented since 1980 (Fig. 2) (Mowery and Bhaven 2005).

In this legislative and technologically and financially rapidly evolving environment, the emergence of translational medicine has promoted control of clinical research by the academic community, which was hitherto organized by the pharmaceutical industry, albeit using university hospital facilities (Stephen 2008).

As a result, a plethora of new companies has emerged, mainly in the form of small- to medium-sized biotechnology companies as spin-offs from renowned universities. The success of this revolutionary development within the biopharmaceutical industry can be seen in that between 1997 and 2002, 40% of the drugs introduced into medical practice came from biotechnology companies. With pharmaceutical companies having major holdings in some of these biotechnology firms, the biopharmaceutical revenues today have reached over US$60 billion (Demain 2010).

Discovery of a new molecular pathway in a university setting is followed by the development of a new biologic agent and, under the umbrella of the new regulatory framework, ends with the founding of a new biotechnology company. Companies that enter the biotechnology sector have already developed a relevant biological product and usually have completed phase I clinical trials, i.e., the experimental drug has been tested in a small group of people (20–80) for the first time to evaluate its safety, determine a safe dosage range, and identify side effects. However, due to the high costs of drug development, these companies cannot raise enough funding to support phase II and phase III clinical trials. Analysis from publicly available data shows great variations in cost estimates for drugs entering human clinical trials for the first time between 1989 and 2002, depending on many different factors such as the kind of therapy or the developing firm and ranging from US$500m to US$2b. High costs are in part owed to late-stage failures and the rising costs of phase II and phase III trials (Adams and Brantner 2006).

The opening of the black box and the unveiling of pathogenetic mechanisms underlying disease has led to the discovery and early development of a plethora of new biologic agents. This has led to the emergence of the concept of personalized medicine defined as the customization of healthcare, where treatment is being tailored to the individual patient by use of genetic or other information (POSTnote 2009). Knowledge of disease pathophysiology and genetic risk factors could enable the pharmaceutical industry to develop a more efficient drug development process. However, in terms of market shares, this would also mean the fragmentation of the relevant market for each drug. It is self-evident that personalized or targeted medicine means that the number of drugs involved in the treatment of a certain disease will increase since within this certain disease, there will be small groups of patients that share common characteristics and are expected to respond well to a therapy with different agents. Consequently, that would mean less revenue for the pharmaceutical company involved in the development and launch of the new agents whereas the developmental costs would grow higher since the recruitment of patients for the conduct of the necessary clinical trials would be significantly more difficult and time consuming. This inadequacy between expectation and reality could in part explain that although merger and acquisition (M&A) activity in the biotech industry looked robust in 2011, there was a noticeable lack of activity of the pharmaceutical industry. Given the critical role that the pharmaceutical companies could play in supporting the biotech innovation ecosystem, this lack of activity is unsettling (ernst and young 2012).

Although a number of tools have been developed as financial leverages for the small biotechnology companies which hold patents of new biologic agents, this is not enough to overcome the high R&D expenditure needed for the conduction of phase II and moreover phase III clinical trials. This unmet need has called for innovation in all aspects of drug development.

Translational Medicine as Promoter of Innovation

Innovation is recognized as a highly complex social phenomenon related at the level of the industry to every aspect of a sector. The pharmaceutical industry is one of the sectors that mostly rely on research. Indeed, the research-based pharmaceutical industry's key contribution is to turn fundamental research findings, both basic and applied, into effective treatments. Therefore, the pharmaceutical industry apart from being of high growth is almost by default innovation intensive. However, innovation is increasingly costly and risky. High costs are in part owed to late-stage failures and the rising costs of phase II and phase III trials. Furthermore, although the global pharmaceutical industry has demonstrated consistent strong growth patterns in the last years, productivity has fallen. Indeed, a substantial body of empirical evidence has shown that although R&D expenditures have been significantly increased over the last two decades, this increase has not been matched by a proportional growth in applications for new drug approvals (Schmid and Smith 2005; Paul et al. 2010).

These challenges call for change, for innovation. Scientific innovation is certainly part of the solution; however, there are many other levers of change. Innovation in the field of more traditional management processes such as cost containment tactics, acceleration of launch, effective multidimensional decision making (in terms of program termination, acceleration, resourcing, prioritization, etc.), talent management, portfolio, problem solving, and foremost reshaping of the relationships with the academia and the regulatory framework is necessary to reap significant rewards. The model of drug development is linear only in theory. In praxis, we are confronted with a messy, highly convoluted system of relationships within and between the industry, the academia and the regulatory framework. All these parameters need to be put in context.

The emergence of translational medicine was heralded as the advent of a new era in biomedical sciences. As already mentioned, the emergence and dissemination of translational medicine relied on three major pillars, i.e., development of new technologies, increased funding and support in the form of relevant infrastructure, and change of the regulatory framework. It is exactly those areas of activity within the pharmaceutical industry that have experienced innovative changes attributable at large to translational medicine. It can be argued that the impact of translational medicine on the innovativeness of the biopharmaceutical sector can serve as a case study for innovation systems in the sense of return of investment (RoI) in terms of innovation performance and innovation capabilities.

In the field of biomedical technology, translational medicine has necessitated the development of new molecular biology techniques. Combined with the developments in the field of computer science, the discipline of bioinformatics has emerged and a number of new medical technologies have been developed to "optimize the transformation of increasingly voluminous biomedical data, and genomic data in particular, into proactive, predictive, preventive, and participatory health" (Butte 2008). Based on the multipurpose generic technology of polymerase chain reaction, computerized tools have enabled the study of DNA copy aberrations, polymorphisms, genomic rearrangements, SNP arrays, mutation detection genome-wide studies, and high-throughput sequencing (Gonzalez-Angulo et al. 2010). New molecular methods such as the use of microarrays for gene expression analysis are novel approaches to the task of classification of neoplastic disease triggered by translational medicine whereas high-throughput and proteomic methods have allowed the use of groups of entities as biomarkers rendering the use of the latter clinically meaningful (Ginsburg and Willard 2009).

Translational medicine has also fostered the emergence of appropriate financial tools, new business models, and modern clinical trial designs. Manufacturing of biologics is a technologically complex, highly regulated process. In contrast to traditional drugs, manufacturing of new biologic agents requires more planning, investment, and skilled personnel. This has led to the development of new both public and private financial tools oriented at permitting and sustaining development in the sector. Furthermore, in the academic area, new university programs have been established that investigate the strategic aspects of discovery, marketing, finance, and business development in the biopharmaceutical industrial sector (Wharton 2012). New business models have also emerged. As the manufacturing of biologic agents is a highly complex process, the product is not defined merely by its molecular composition but, also, by the process with which it is made.

As a result, companies are required to invest in full-scale plants in order to perform phase III trials. As small-scale biotechnology companies cannot afford this level of investment, "contract manufacturing organizations" (CMOs) have emerged and have provided strategic value to the biotechnology industry with economically viable and sustainable models. Along with new financial tools and new business models, planning and conduction of clinical trials have also been influenced in the new era of translational medicine. More integrated models that use adaptive designs with the use of modeling and simulation have emerged, allowing for cost containment by early recognition of attritions and acceleration of launch in successful cases.

These profound changes have also necessitated changes in the relevant regulatory framework. In the early years, companies were required to file two license applications for a biologic product, a Product License Application (PLA) and an Establishment License Application (ELA) which have now been replaced by a single Biologics License Application (BLA), allowing companies to outsource manufacturing as long as product comparability is established. Furthermore, despite profound differences with the software industry and the relevant limitations, research has shown that open source practices are extensively used in biomedical research by universities and, to a lesser extent, by biotechnology companies mainly in the sense of involvement in research alliances based on open source practices such as sharing of R&D data including and especially focusing on pooling of data from clinical trials.

Conclusion and Future Directions

Translational medicine has offered the unique possibility for a tailored approach to patient treatment. From an innovation perspective it has greatly enhanced the innovativeness of the firms that constitute the biopharmaceutical sector. The emergence of new technologies, the development of new investment and business models, and the change of the regulatory framework have triggered a reciprocal development with positive feedback characteristics. Scientific and economic challenges along with operational issues present hindrances that still need to be overcome. In this direction, innovation in these fields can offer great services to this life-altering business.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Business Model
- ▶ Business Start-Up: From Emergence to Development
- ▶ Collaborative Innovation and Open Innovation
- ▶ Entrepreneurship and Business Growth
- ▶ Financing Entrepreneurship
- ▶ Patent System
- ▶ Product Innovation, Process Innovation
- ▶ Technological Invention of Disease
- ▶ Technology Life Cycles
- ▶ Translational Research
- ▶ University Research and Innovation

References

Adams CP, Brantner VV. Estimating the cost of new drug development: is it really $802 million? Health Aff. 2006;25(2):420–8.

Bartlett JMS, Stirling D. A short history of the polymerase chain reaction. Methods Mol Biol. 2003;226:3–6.

Butte AJ. Translational bioinformatics: coming of age. J Am Med Inform Assoc. 2008;15:709–14.

Demain AL. History of industrial biotechnology. In: Soetaert W, Vandamme EJ, editors. Industrial biotechnology. Sustainable growth and economic success. Weinheim: Wiley-VCH; 2010.

Dische S, Saunders M. Translational research-a new entity? Acta Oncol. 2001;40(8):995–9.

eatris. http://www.eatris.eu/SitePages/home.aspx (2012). Accessed 30 Nov.2012.

ernst & young. Beyond borders: global biotechnology report 2012: http://www.ey.com/GL/en/Industries/Life-Sciences/Beyond-borders—global-biotechnology-report-2012-Financing-remains-stuck-in-the-new-normal. Accessed 4 Dec 2012.

Ginsburg GS, Willard HF. Genomic and personalized medicine: foundations and applications. Transl Res. 2009;154:277–87.
Goldblatt EM, Lee W-H. From bench to bedside: the growing use of translational research in cancer medicine. Am J Transl Res. 2010;2(1):1–18.
Gonzalez-Angulo AM, Hennessy BTJ, Mills GB. Future of personalized medicine in oncology: a systems biology approach. J Clin Oncol. 2010; 28:2777–83.
International Human Genome Sequencing Consortium. Initial sequencing and analysis of the human genome. Nature. 2001;409(6822):860–921.
Johnstone D. Translational science – a sexy title for preclinical and clinical pharmacology. Br Pharmacol Soc. 2006;pA2 online 4:1–3, Vol 4 – Issue 2.
Karp JE, McCaffrey RP. New avenues of translational research in leukemia and lymphoma: outgrowth of a Leukemia Society of America–National Cancer Institute workshop. J Natl Cancer Inst. 1994;86: 1196–201.
Marincola FM. Translational medicine: a two-way road. J Transl Med. 2003;1:1.
Mowery DC, Bhaven NS. Universities in national innovation systems. In: The Oxford handbook of innovation. Oxford: Oxford University Press; 2005. p. 209–37.
ncats. http://www.ncats.nih.gov/. Access 30 Nov 2012.
Ogilvie D, Craig P, Griffin S, Macintyre S, Wareham NJ. A translational framework for public health research. BMC Public Health. 2009;9:116.
P.L. 96–517, Patent and Trademark Act Amendments of 1980.
Paul SM, Mytelka DS, Dunwiddie CT, Persinger CC, Munos BH, Lindborg SR, Schacht AL. How to improve R&D productivity: the pharmaceutical industry's grand challenge'. Nat Rev, Drug Discov. 2010;9:203–14.
POSTnote April 2009 Number 329 Personalised Medicine.
Sarkar IN. Biomedical informatics and translational medicine. J Transl Med. 2010;8:22.
Schmid EF, Smith A. Is declining innovation in the pharmaceutical industry a myth? Drug Discov Today. 2005;10(15):1031–8.
Stephen H. Translational science: past, present, and future. Biotech Preclin Dev. 2008;44(2):Pii–Pviii.
Sung NS, Crowley Jr WF, Genel M, et al. Central challenges facing the national clinical research enterprise. JAMA. 2003;289(10):1278–87.
Wharton. http://executiveeducation.wharton.upenn.edu/open-enrollment/health-care-programs/biotech-pharmaceutical-executives-program.cfm. Accessed 5 Dec 2012.
Zerhouni EA. Translational and clinical science-time for a new vision. N Engl J Med. 2005;353:1621–3.
Zucker DR. What is needed to promote translational research and how do we get it? J Investig Med. 2009;57(2):468–70.

Translational Research

Etienne Vignola-Gagné[1,2] and
Peter S. Biegelbauer[3]
[1]Competence Centre New Technologies, Fraunhofer Institute for Systems and Innovation Research ISI, Karlsruhe, Germany
[2]Life–Science–Governance Research Platform, Department of Political Science, University of Vienna, Vienna, Austria
[3]Department Foresight and Policy Development, Austrian Institute of Technology, Vienna, Austria

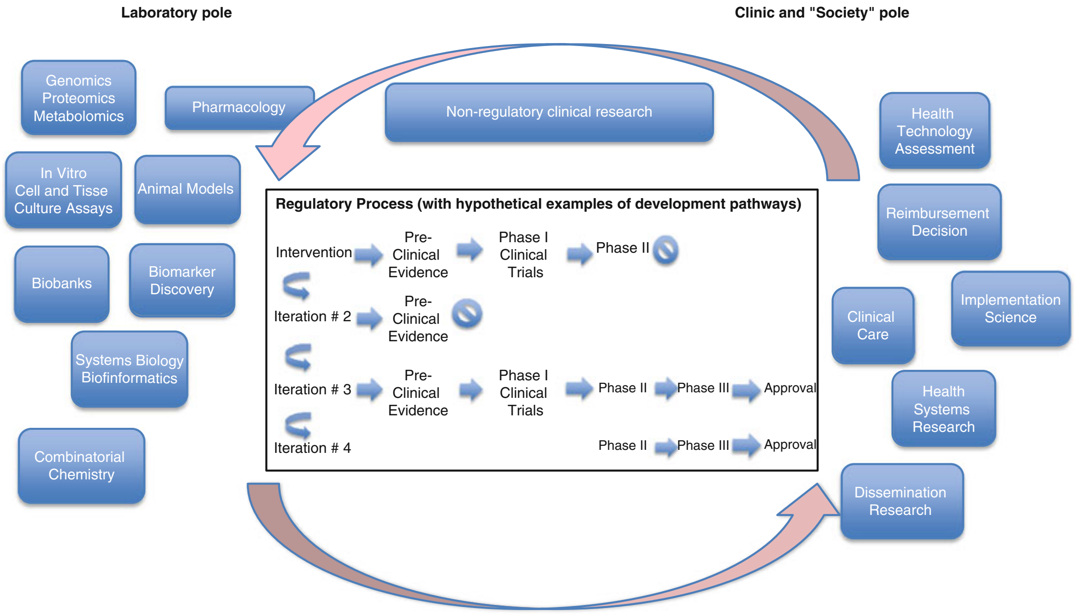
Synonyms

Translational medicine; Translational science

Definition

The terms translational research (TR), translational medicine, or translational science are currently seeing widespread usage in a variety of biomedical and health research fields. Yet, they remain slippery concepts which cannot be narrowly defined. Indeed, TR has been used to describe research and development activities taking place anywhere in the biomedical innovation process, from animal studies to verify hypotheses about the molecular mechanisms of disease or physiology to health outcomes or health technology assessment studies (Woolf 2008). Most often, however, TR is used by biomedical actors to design those studies which are performed to validate hypotheses that can lead to potential therapeutic or diagnostic developments. This includes studies with animals, in vitro cell cultures, biomarker discovery, and validation studies, but also early clinical trials up to proof of concept (Marincola 2003; Khoury et al. 2007; NCI 2007; Wehling 2010; Drolet and Lorenzi 2011).

Figure 1 offers a model of the research and technological development (RTD) process for new therapeutic products, indicating which



Translational Research, Fig. 1 *Sites of translational research*. Figure 1 represents a modelization of potential pathways in conducting TR. The *bubbles* represent clusters of practice, of expertise, and/or of material systems of experiment. Single TR projects may connect any number of these areas of scientific practice, and different projects do so differently. Passing from the laboratory to the clinic however, when it is accomplished through the development of new health interventions, requires regulatory approval of these interventions. The approval process is constructed by regulatory authorities as a linear sequence of stages that must be successfully completed to allow legal common usage of these innovations (Source: figure elaborated by the authors)

experimental approaches or sites are most likely to be mobilized specifically for TR efforts. Although the development of a new clinical innovation is always preceded, in time, by various forms of TR, no single experimental area in the model can be said to always, invariably be translational. Animal models studies, for example, are commonly employed both in research programs aiming at the advancement of theoretical knowledge of biology and over the course of development of a new drug (diagnostic development, for its part, might most likely not involve animal models at all).

Considering the proliferation of TR initiatives and the simultaneous difficulty of delineating a single area of research that can fruitfully be identified as the exclusive domain of this approach, it would be easy to dismiss TR as just a trendy expression, a repackaging of the well-established activities of drug discovery or biomedical RTD. The emergence of this new concept, however, is associated with a number of claims about how to increase the success rate of biomedical innovation in a time of pharmaceutical crisis. A situation of crisis is perceived based on observations that the cost of RTD for new drugs is steadily increasing in recent years, while approval of new products is decreasing over the same period. This productivity issue is compounded by a historical situation where current blockbuster drugs, that provide pharmaceutical firms with a sizable part of their profits, are falling off patent and are not being replaced by new patent-protected blockbusters (these issues are examined in greater detail in section "Historical Emergence of Discussions on Translational Research"). It is perhaps best to consider TR as a sort of reform movement within biomedical research with a specific agenda of privileged epistemic, institutional, and material practices. A definition that might capture this inherently performative dimension of TR concepts and models, while capturing the type of technical practices, material cultures, and institutions most often associated with TR, might be formulated like this:

> The term translational research denotes forms of cooperation and coordination in biomedicine that aim to intensify patient-oriented research and to increase the volume, success rate, and speed of research and technological development activities for new or improved health interventions.

Common proposals for achieving these goals, as advocated within TR approaches, include tightening the links between clinical practice and laboratory-based investigations, stepped-up efforts to develop biomarkers for drug development, or increasing attention to factors that shape the effectiveness of new health interventions in clinical contexts. Lander and Atkinson-Grosjean (2011) identify three pathways of performing TR, each associated with specific goals and domain of practices: clinical utility, commercial utility, and civic utility. Clinical utility is sought by doing "patient-oriented" (Chiorazzi 2009) laboratory or clinical research that may provide new interventions for improving the care of patients (most commonly drugs, surgeries, vaccines, or the advanced interventions involving manipulation of patients' cells and genetic material now starting to emerge; diagnostic devices; care management guidelines). Commercial utility is realized when biomedical innovation leads to revenues for sponsors of these new interventions (whether they be public or private organizations), in turn generating employment and institutional development, fuelling the bio- or health-economy sector promoted by many governments. Finally, civic utility can be said to be attained through research that leads to new knowledge that enables prevention and healthy living, exemplified perhaps best by public health guidelines. One could also consider, however, that civic utility is achieved through the formation of communities (such as patient groups) or when research efforts empower individuals by providing them with knowledge of their biological makeup, which they can then use in their daily negotiations with health, disease, and identity (Parthasarathy 2007).

Historical Emergence of Discussions on Translational Research

Rather than through a strict definition, scholars of biomedical policy are perhaps best informed about the specific set of issues that TR advocates and are concerned with by looking at the historical use of the concept. Indeed, it could be argued that the crucial feature of TR is an interest or sensibility for specific families of institutional, experimental, and material practices in biomedical innovation, rather than any single research or institution-building program.

In 1975, the US National Institutes of Health (NIH) director of the time, Dr. Donald S. Fredrickson, published his thoughts on the difficulties of bringing basic biomedical knowledge findings to bear in clinical contexts in a note called *On the Translation Gap*. With the completion of the Human Genome Project in 2003, the doubling of the NIH budget between 1998 and 2003, and the contemporary realization that increases in resources and basic knowledge would not easily or automatically lead to revolutionary new applications in healing and prevention practice, considerations about a gap between intensive laboratory efforts and their clinical application became all the more pressing. Stemming from this predominantly Anglo-Saxon context, discussions about the need of a TR agenda in biomedical research became increasingly formulated by actors in the field: an approach, field, or systematic awareness to improve the "translation" between the "worlds" of basic research, preclinical research, clinical research, and health care. The goal is to increase the rate of biomedical innovation with clinical impact, at a time of major crisis for the pharmaceutical industry. As of 2011, the concept of TR has taken a momentous leap in usage, with major research funds being dedicated to translational activities, training programs, and institutes sporting the label to advertise their focus in most OECD countries (for examples of such initiatives, see Zerhouni and Alving 2006; Collins 2011; Morgan et al. 2011; Shahzad et al. 2011).

The most likely origins of TR concepts can be traced to the development of a policy program devised at the National Cancer Institute of the US NIH called Specialized Programs of Research Excellence (SPORE – NCI 2007; Keating and Cambrosio 2012). Starting in 1992, the program established a series of specialized units within American academic medical centers with an explicit goal to support RTD efforts with a potential to lead to new interventions against cancer within a short-term horizon. SPORE centers are expected to support project mobilizing both cellular and molecular laboratory research and clinical care and research capacities, along with infrastructures for biobanking and for biostatistics, as well as to support the careers of professionals specializing in TR.

But the establishment of the SPORES and subsequent centers modeled after them did not take place in a vacuum. Three series of subsequent or parallel developments can be identified as strong factors in shaping the current practices labeled as TR. Each will be briefly examined here.

The capacity of academic medical centers to fruitfully engage and integrate practices in clinical research, clinical care and experimental medicine, and laboratory-based frontier research in biology has been tested by the increasing sophistication of both sides of the bio/medical field (Coller 2008; Wilson-Kovacs and Hauskeller 2012). Indeed, there is a long history of reform and realignment between laboratory biology and clinical innovation (Marks 1997). As such, many policy interventions have been elaborated with the hope of fostering brokering activities at the interface between clinical and laboratory practices, with attention centering especially on the support of classes of professionals such as clinician-scientists that can navigate these different fields and organizations and act as coordinators of projects spanning these various systems, including the typical TR project. Discussions of TR conceptualization and practice have thus made the participation of and support for clinician-scientists a central theme of many TR initiatives (Zerhouni 2003; Zerhouni and Alving 2006; Coller 2008, 2009; Wilson-Kovacs and Hauskeller 2012) and linked, to a large extent, the extension of TR capacities to the organizational core for experimental medicine and "patient-oriented" laboratory research provided by university clinics and medical faculties.

More recently, many advocates of the genomics focus in biomedical policy since the 1990s (best illustrated by the international Human Genome Project – HGP) had highlighted the potential of these projects and their experimental platforms for grounding future efforts in clinical innovation (Nightingale and Martin 2004; Martin et al. 2009; Hogarth et al. 2012). Yet, new major clinical innovations based on these previous efforts are still eagerly awaited, and commentators have decried a situation where the biomedical field would be sitting on a gold mine of post-genomic research just waiting to be properly exploited (Collins 2011). Many TR initiatives have thus sought specifically to make genomics relevant to the clinic (in contrast with increasing the rate of clinical innovation that succeeds, whichever the experimental source).

The latest, but possibly the most urging series of developments to have shaped the trajectory of TR concepts, has been the increased perception of a situation crisis in the pharmaceutical industry. With its 2004 report *Innovation/Stagnation*, the US Food and Drug Administration (FDA) brought together the development of TR capacities with needs for making the drug development process itself the object of experimental research and conceptual formalization:

> In FDA's view, the applied sciences needed for medical product development have not kept pace with the tremendous advances in the basic sciences. The new science is not being used to guide technology development process in the same way that it is accelerating the technology discovery process. For medical technology, performance is measured in terms of product safety and effectiveness. Not enough applied scientific work has been done to create new tools to get fundamentally better answers about how the safety and effectiveness of new products can be demonstrated, in faster time frames, with more certainty, and at lower costs (Food and Drug Administration 2004, p. ii).

The FDA also used statistics concerning the approval of new drugs and registration of new experimental compounds to support contention of diminishing innovation in the pharmaceutical industry, leading to higher RTD costs for lower amount of innovative drugs entering the clinic. In 2011, this prognosis seems to have partly realized, with large pharmaceutical companies slashing thousands of RTD jobs as their recently off-patent portfolio “blockbuster” drugs selling for billions annually had slowly started to not be replaced by new blockbusters (MacIlwain 2011; Milne 2009). As such, the TR initiatives aiming to revitalize academic experimental medicine as well as to make genomics compatible to the purposes of clinical innovation are also now expected to help the pharmaceutical industry refill its pipeline.

The Organization of Translational Research: Pharmaceutical RTD in Academic and Heterogeneous Settings

While section “Historical Emergence of Discussions on Translational Research” has shown the historic sequence of broader developments that have lead to the emergence of policy-level discussions (by which one should also understand exchanges between researchers in peer-reviewed journals on research priorities, notably) about the possibility of an area of research such as TR, it is still unclear what concrete experimental and institutional practices feed and realize these visions. This section briefly draws on preliminary results from recent empirical research of the authors to accomplish just that (Biegelbauer et al. 2012).

A most interesting characteristic of TR initiatives (as in other generic RTD initiatives – see Biegelbauer 2007) has been that they tend to place coordination responsibilities for RTD projects squarely in the academic camp (Silber 2010). While previous approaches such as biotechnology entrepreneurship or industry partnerships placed the locus of responsibility (both legal and coordinative) in either an arm’s length organization or in the private partner, now academic consortia are often expected to take the lead. This perception has implied the formation of large-scale consortia putting together various academic departments and institutions in bids to pool partners that might together provide the whole spectrum of experimental infrastructures and disciplinary expertise necessary to leading an RTD project from hypothesis of intervention, through preclinical testing, to phase I and phase II testing (for therapeutic modalities), and then to collaboration with a large pharmaceutical firm for regulatory approval and commercialization. This model has been translated into TR initiatives that try to create central research cores with specialized (and expensive) equipment of a scale previously employed mostly by industry and try to network these nodes with partners with complimentary capacities. The emphasis on medicine and the clinical experience in TR discourses means that most partners in TR consortia might end up being academic organizations, although industry is very present in some initiatives. It should also be noted that academics still resort often, within broader TR projects, to spin-off formation as a means to attract venture capital and displace commercial risks away from public institutes. Academic consortia may also well turn to contract research organizations to produce regulatory-compliant evidence from animal studies, for example, thus avoiding the need to establish complex and expensive in-house good manufacturing practice (GMP) production facilities.

Through the formation of these consortia, TR is bringing about a new form of organizing biomedical innovation, where experimental and commercial risks for pharmaceutical development seem to be displaced toward the public sector. In the authors’ own research, advocates of TR approaches have often mentioned how they considered the state of pharmaceutical crisis and the retreat of industry from the earlier stages of RTD to offer an opportunity for university and public institutions (Lehner et al. 2011). These organizational forms should be analyzed in comparison to previously studied forms of large-scale, multidisciplinary, and collaborative scientific enterprises (Vermeulen and Penders 2010). Especially interesting here is the role that clinician-scientists and other forms of brokers and coordinators that work across organizational and disciplinary boundaries play and of the intellectual and material practices through which clinical innovation is constructed. The later point indicates the need to better understand how advances in genomics and laboratory pathophysiology can be effectively mobilized to conduct experiments that are relevant to human biology and clinical contexts (with some ground having been recently covered by Keating and Cambrosio 2012).

More broadly, this overview of recurring organizational features of TR initiatives shows the interdependence of these emergent forms of governance with the development of the three policy issues identified above: expectations of increased RTD outsourcing from the pharmaceutical industry justify the extension of academic capacities for therapeutic product development, for example.

Current Analyses and Interpretations of TR

Few analyses have been published specifically on TR as a recent, emerging phenomenon in biomedicine by scholars from science and technology studies (STS), innovation studies, or more broadly with a social science background. This is in sharp contrast with reviews, commentaries, and editorials on the phenomenon, authored by members of the biomedical professions and which are abundant.

Nonetheless, a few important studies can be pointed out. Löwy (1996) provides an ethnography of the interactions between clinical and basic research teams in the course of developing potentially groundbreaking immunological interventions, touching on many of the issues that would later become core themes in discussions of the biomedical community about TR. Keating and Cambrosio (2003) have provided an interesting conceptual framework for analyzing the increasing integration of laboratory and clinical approaches, of biology and medicine, in modern biomedicine, based around the concept of "biomedical platforms" that cut across organizational and professional boundaries. Following these authors' argument, which states that medical practice and research into human biology are now deeply interdependent activities, the divides between "bench and bedside" diagnosed by many TR advocates would appear to be a comparatively minor point of resistance within an otherwise broadly realized convergence. In their latest work, Keating and Cambrosio (2012) contend that even as medical and biological research practices are increasingly interdependent, there is an increased perception within the biomedical community that *therapy* and *research* are becoming independent practices. TR emerges as a reaction to this drift, a set of initiatives trying to recapture earlier successes in having both repertoires of practices build on one another.

Lander and Atkinson-Grosjean (2011), defending the concept of the hospital and clinic as "hidden research system," argue that recent biomedical policy has overemphasized cooperation between industry and university in seeking to foster the development of new health interventions. Webster et al. (2011) have shown how, in the current field of stem cell therapeutics development, a pharmaceutical model of innovation coexists with a "medical innovation" model based on more restricted and clinically based networks of RTD work. Also working on the field of stem cells, Martin et al. (2008) contend that the relation between clinical and laboratory-based sites of biomedical knowledge production has indeed seen much variation over the last 60 years but that current implementations of TR are very much laboratory-centered and follow a science-push model (Biegelbauer 2000), relegating clinical experimental systems to subordinated instruments of evidence generation. Yet, the development of new therapeutics and innovative health interventions is often associated with the emergence of specific innovations and know-how in networks accomplishing clinical research (Keating and Cambrosio 2012), and it is now increasingly untenable to consider these areas of the biomedical enterprise as rote screening of fully formed products waiting for regulatory approval (Nightingale and Martin 2004).

Wainwright and colleagues (Wainwright et al. 2009a, b) have published a number of studies that capture the interactions and negotiations for authority taking place between the different disciplinary and institutional cultures taking place in the development of stem cell therapeutics. These authors use the theory of action and field from Pierre Bourdieu to analyze how the construction of knowledge, experimental platforms, and institutional settings for TR initiatives is determined by struggles for authority and for setting collective definitions of legitimate TR practices between the groups collaborating in them. Wilson-Kovacs and Hauskeller (2012) study the claims of clinician-scientists as a specific professional group vying to establish themselves as the privileged "translational investigators" within an arena of contesting disciplinary stakes over TR, hoping to make of their individual multidisciplinary competences in both laboratory research and clinical care a recognized principle of authority in the field. Morgan et al. (2011) have shown how policy initiatives aiming to support TR activities in academia such as a translational cluster they studied are likely to run into these competing disciplinary claims over the best way to conduct these efforts, with the clinical and industrial principles often required in TR projects being problematic to assert in contexts where the pursuit of experimental biology for its own sake may constitute the dominant frame for evaluating the worth of given research practices.

The disciplinary and professional tensions evident in TR initiatives, as well as the organizational specificities described in section "The Organisation of Translational Research: Pharmaceutical RTD in Academic and Heterogeneous Settings," may also make them interesting case studies for scholars interested in recent developments in practices of interdisciplinarity and transdisciplinarity. Large-scale collaborations to develop a new therapeutic may involve a number of experimental phases each demanding their own expertise and socio-technical systems, necessitating sophisticated coordination. Such organizational forms may be made unstable by the need of single participating groups to produce reputational attainments (linked to academic career advancement) that are distinctively their own rather than that of the whole network. In other words, these interdisciplinary collaborations may prompt fears that certain actors be subordinated to others (Barry et al. 2008) or that short-term applied problem solving does not contribute to the long-term maintenance of disciplinary jurisdiction and expertise (Lyall et al. 2011).

However, studies have shown that the stabilization of interdisciplinary fields can be supported by the mobilization of specific groups of investigators that act as "interdisciplinary integrators" and "boundary spanners" (Lyall et al. 2011; Calvert 2010). These categories might be fruitfully applied to the group of clinician-scientists, which have often been leaders in the establishment and diffusion of the notions of translational research. Taking this claim further, one could make use here of contentions that the emergence of interdisciplinary fields are the results of "scientific and intellectual movements" that seek to legitimate new or peripheral experimental or institutional practices in the face of established disciplinary customs. Disciplinary conflicts around TR projects would here be recast as "collective efforts to pursue research programs or projects for thought in the face of resistance from others in the scientific or intellectual community..." (Frickel and Gross 2005, p. 206). Emerging interdisciplinary research programs may threaten to destabilize existing jurisdictions over academic and scientific "resources, identities, and status" (Jacobs and Frickel 2009, p. 57).

Maienschein et al. (2008) have taken a more critical stance over the broad movement toward TR in recent biomedical policy. They warn against the potential dangers of prioritizing TR excessively, which may distort the long-term viability of the biomedical research enterprise by draining resources away from the basic research that might form the basis of future TR. To this critical approach, one could add recent studies of the biotechnology sector that have questioned the wisdom of massive public support for an industry that has yet, after 25 years of activity, to be profitable (Pisano 2006; Mirowski 2011) or that dispute the wisdom of making promises of short-term clinical innovation as a means to justify large-scale investments in biomedical research (Nightingale and Martin 2004; Martin et al. 2009).

The obvious step to take here is to ask just how is this that TR initiatives should be able to succeed where the biotechnology sector has failed. First attempts at evaluating the consequences of TR initiatives on research relevance have found a positive effect of these new modes of innovation, although using broader understandings of relevance then those usually emphasized in the biomedical and policy literature (van der Weijden et al. 2012). TR advocates consulted with through the authors' own empirical research often draw a distinction between the aims of TR and biotechs in how a dedicated firm becomes just a smaller instrument within a larger process. Further research on the experimental and institutional practices and structures found in TR initiatives could provide new empirical modalities outside those already established in the innovation studies literature on academic entrepreneurship and technology transfer (Grimaldi et al. 2011).

Finally, other commentators have put into doubt the very idea of a state of crisis in pharmaceutical innovation, arguing that figures of the costs of developing new drugs are greatly exaggerated (Light and Warburton 2011). If this argument is substantiated, then the perceived justification to develop biomedical RTD capacities in academic TR centers and public-private TR consortia would be seriously undermined: TR initiatives would then play into the industry's tendency to strategically downsize in-house RTD activities rather than act as an aid to an ailing sector. As such, the study of the material, intellectual, and institutional developments taking place in biomedicine in the wake of the TR movement might provide new and crucial empirical material for the strand of studies concerned with the critique of the global pharmaceutical industry (Fisher 2009; Pollock 2011).

Conclusions and Future Directions for Research

Hogarth et al. (2012, p. 121) note in their agenda for social science studies of "personalized medicine" that "Just as we invest billions of US dollars in identifying the mechanisms of disease, it is necessary to also put some resources to work in identifying the complex social interactions that allow new technologies to serve a socially beneficial role." Whether they are interested in analytical considerations or in more active participation in the governance of biomedical innovation systems, innovation studies and STS scholars cannot rest on previous achievements of their disciplines to make sense of the emerging institutional, epistemic, and material practices that the modern life sciences give rise to. Summarizing the empirical observations and arguments presented above, the following questions point the way toward promising directions for further research on translational research:

- Through which practices are clinically relevant biomedical innovations achieved? How are genomics knowledge and other basic laboratory biology knowledge typically mobilized in the clinical innovation process? What different models or regimes of practices can be identified (as in Webster et al. 2011)?
- How does the TR movement affect previous assumptions from the innovation studies field and from policy-making that center on biotechnology firm formation as a privileged instrument of biomedical innovation?
- TR claims to be able to bring clinical experience back into the biomedical innovation process. How is this achieved?
- How have TR policies implemented so far fared, and do these experiences hold lessons for forthcoming initiatives?

The following lines conclude this overview of TR by opening the emerging set of problematizations and reflections presented above to parallel developments in critical studies of biomedicine. Establishing links between these areas of reflection could advance STS scholars' comprehension of how the movement of TR is set to change not only the organization of biomedicine and its experimental practices but also the relations of the field to society more broadly.

TR advocates have argued that the approach offers new opportunities for supporting noncommercial biomedical research and for pushing further the integration of local communities and of a global health agenda into it (Milne and Kaitin 2009). It remains to be seen if the alternatives of "patient-centered research" put forward by TR advocates will, if at all, realign relations between citizens, patients, health-care providers, the pharmaceutical industry, and biomedical researchers. TR, in the iteration that seeks to make genomics relevant for clinical contexts, might increase the pressure to develop genomics screening directly advertised to buyers, for example, thus compounding developments toward the reframing of patients as consumers of health products that are relatively autonomous from health-care provision networks (Parthasarathy 2007). In some clinician-scientists' version of the story, however, the lead (but not the participation) of the pharmaceutical industry and the laboratory-based molecular biologists could be reduced to allow more clinically oriented research, with patients and local communities as privileged partners. Yet, TR could also be deployed as an intensified search for cost-effective and sophisticated health interventions for western patients, compounding the global pharmaceutical industry's drive toward subcontracting and delocalization of research in Asia, Africa, and South America (Mirowski 2011). TR is still unsettled, an area of biomedicine in the process of being constructed. There is much remaining to do to understand how existing epistemic, material, institutional, and political practices are reshuffled by it.

Cross-References

- ▶ Academic Entrepreneurship
- ▶ Citizen Science in Health Domain
- ▶ Entrepreneurship Policy
- ▶ Epistemic Governance and Epistemic Innovation Policy
- ▶ Healthcare and Innovation
- ▶ Innovation and Entrepreneurship
- ▶ Interdisciplinary Research (Interdisciplinarity)
- ▶ Interdisciplinarity and Innovation
- ▶ Technology Push and Market Pull Entrepreneurship
- ▶ Translational Medicine and the Transformation of the Drug Development Process

References

Barry A, Born G, Weszkalnys G. Logics of interdisciplinarity. Econ Soc. 2008;37(1):20–49.

Biegelbauer P. 130 years of catching up with the west: a comparative perspective on hungarian industry, science and technology policy-making since industrialization. Aldershot(Vermont): Ashgate; 2000.

Biegelbauer P. Learning from abroad: the Austrian competence centre programme Kplus. Sci Public Policy. 2007;34(9):606–18.

Biegelbauer P, Vignola-Gagné, E, Lehner D. Translational research and the governance of the emerging genomic medicine. Presented at Workshop The Governance of Innovation and Socio-Technical Systems in Europe: New Trends, New Challenges. 2012 March 1–2; Copenhagen: Copenhagen Business School.

Calvert J. Systems biology, interdisciplinarity and disciplinary identity. In: Parker JN, Vermeulen N, Penders B, editors. Collaboration in the new life sciences. Farnham: Ashgate; 2010. p. 201–18.

Chiorazzi N. The association for patient-oriented research. Clin Transl Sci. 2009;2(3):175–7.

Coller B. Translational research: forging a new cultural identity. Mt Sinai J Med. 2008;75:478–87.

Coller B. Translational research and the physician-scientist. In: Schafer AI, editor. The vanishing physician-scientist? Ithaca: Cornell University Press; 2009. p. 67–83.

Collins FS. Reengineering translational science: the time is right. Sci Transl Med, 2011; 3(90):90 cm17.

Drolet BC, Lorenzi NM. Translational research: understanding the continuum from bench to bedside. Transl Res. 2011;157(1):1–5.

Food and Drug Administration (FDA). Innovation or stagnation. Challenge and opportunity on the critical path to new medical products. Washington, DC: U.S. Department of Health and Human Services; 2004.

Fisher JA. Medical research for hire. Piscataway: Rutgers University Press; 2009.

Frickel S, Gross N. A general theory of scientific/intellectual movements. Am Sociol Rev. 2005;70(2):204–32.

Grimaldi R, Kenney M, Siegel DS, Wright M. 30 years after Bayh-Dole: reassessing academic entrepreneurship. Res Policy. 2011;40(8):1045–57.

Hogarth S, Hopkins MM, Faulkner A. Personalized medicine: renewing the social science research agenda. Personal Med. 2012;9(2):121–6.

Jacobs JA, Frickel S. Interdisciplinarity: a critical assessment. Annu Rev Sociol. 2009;35:43–65.

Keating P, Cambrosio A. Biomedical platforms. Cambridge, MA: MIT Press; 2003.
Keating P, Cambrosio A. Cancer on trial. Oncology as a new style of practice. Chicago/London: University of Chicago Press; 2012.
Khoury MJ, Gwinn M, Yoon PW, Dowling N, Moore CA, Bradley L. The continuum of translational research in genomic medicine: how can we accelerate the appropriate integration of human genome discoveries into health care and disease prevention? Genet Med. 2007;9(10):665–74.
Lander B, Atkinson-Grosjean J. Translational science and the hidden research system in universities and academic hospitals: a case study. Soc Sci Med. 2011;72:537–44.
Lehner D, Rantanen E, Vignola-Gagné E. 'Therapeutic eagerness': clinician-scientists as interdisciplinary integrators and their hopes for large-scale translational research. Presented at the Society for Social Studies of Science 2011 Conference, November 2–5, 2011, Cleveland.
Light DW, Warburton R. Demythologizing the high costs of pharmaceutical research. BioSocieties. 2011;6:34–50.
Löwy I. From bench to bedside. Science, healing and Interleukin-2 in a cancer ward. Cambridge, MA: Harvard University Press; 1996.
Lyall C, Bruce A, Tait J, Meagher L. Interdisciplinary research journeys. London: Bloomsbury Publishing; 2011.
MacIlwain C. Pharmaceutical industry must take its medicine. Nature. 2011;470:141.
Maienschein J, Sunderland M, Ankeny RA, Robert JS. The ethos and ethics of translational research. Am J Bioeth. 2008;8(3):43–51.
Marincola FM. Translational medicine: a two-way road. J Transl Med. 2003;1:1.
Marks HM. The progress of experiment. Cambridge: Cambridge University Press; 1997.
Martin P, Brown N, Kraft A. From bedside to bench? Communities of promise, translational research and the making of blood stem cells. Sci Cult. 2008;17(1):29–41.
Martin P, Hopkins MM, Nightingale P, Kraft A. On a critical path: genomics, the crisis of pharmaceutical productivity and the search for sustainability. In: Atkinson P, Glasner P, Lock M, editors. Handbook of genetics and society. London/New York: Routledge; 2009. p. 145–62.
Milne C-P. Can translational medicine bring us out of the R&D wilderness? Personal Med. 2009;6(5):543–53.
Milne C-P, Kaitin KI. Translational medicine: an engine of change for bringing new technology to community health. Sci Transl Med. 2009; 5(1): 5 cm5.
Mirowski P. Science-mart. Cambridge, MA: Harvard University Press; 2011.
Morgan M, Barry CA, Donovan JL, Sandall J, Wolfe CD, Boaz A. Implementing 'translational' biomedical research: convergence and divergence among clinical and basic scientists. Soc Sci Med. 2011;73: 945–52.
National Cancer Institute (NCI). Transforming translation – harnessing discovery for patient and public benefit. Report of the Translational Research Working Group of the National Cancer Advisory Board; 2007.
Nightingale P, Martin P. The myth of the biotech revolution. Trends Biotechnol. 2004;22(11):564–9.
Parthasarathy S. Building genetic medicine. Cambridge, MA: MIT Press; 2007.
Pisano G. Science business: the promise, the reality, and the future of biotech. Boston: Harvard Business School Press; 2006.
Pollock A. Transforming the critique of Big Pharma. BioSocieties. 2011;6(1):106–18.
Shahzad A, McLachlan C, Gault J, Cohrs R, Wang X, Köhler G. Global translational medicine initiatives and programs. Transl Biomed. 2011;2(3):2.
Silber BM. Driving drug discovery: the fundamental role of academic labs. Science Transl Med. 2010; 2(30): 30 cm16.
van der Weijden I, Verbree M, van den Besselaar P. From bench to bedside: the societal orientation of research leaders: the case of biomedical and health research in the Netherlands. Sci Public Policy. 2012;39:285–303.
Vermeulen N, Penders B. Collecting collaborations: understanding life together. In: Parker JN, Vermeulen N, Penders B, editors. Collaboration in the new life sciences. Farnham: Ashgate; 2010. p. 3–14.
Wainwright SP, Michael M, Williams C. Shifting paradigms? Reflections on regenerative medicine, embryonic stem cells and pharmaceuticals. Sociol Health Illn. 2009a;30(6):959–74.
Wainwright SP, Williams C, Michael M, Cribb A. Stem cells, translational research and the sociology of science. In: Atkinson P, Glasner P, Lock M, editors. Handbook of genetics and society. London/New York: Routledge; 2009b. p. 41–58.
Webster A, Haddad C, Waldby C. Experimental heterogeneity and standardization. Stem cell products and the clinical trials process. BioSocieties. 2011;6: 401–19.
Wehling M. Principles of translational science in medicine. Cambridge: Cambridge University Press; 2010.
Wilson-Kovacs D, Hauskeller C. The clinician-scientist: professional dynamics in clinical stem cell research. Sociol Health Illn. 2012;34(4):497–512.
Woolf SH. The meaning of translational research and why it matters. J Am Med Assoc. 2008;299(2):211–3.
Zerhouni EA. The NIH roadmap. Science. 2003;302: 63–5.
Zerhouni EA, Alving B. Clinical and translational science awards: a framework for a national research agenda. Transl Res. 2006;148(1):4–5.

Translational Science

► Translational Medicine and the Transformation of the Drug Development Process
► Translational Research

Trend-Following

► Networks and Scientific Innovation

Trends

► Patterns of Technological Evolution

Triple Helics

► National Innovation Systems (NIS)

Triple Helix of University-Industry-Government Relations

Loet Leydesdorff
Amsterdam School of Communication Research (ASCoR), University of Amsterdam, Amsterdam, The Netherlands

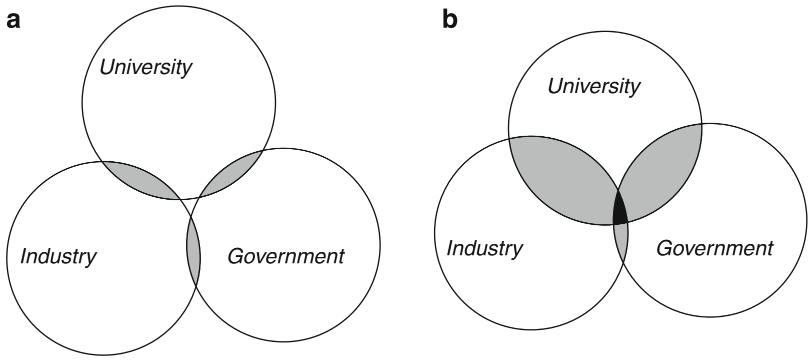
Introduction

Etzkowitz and Leydesdorff (2000) further elaborated the Triple Helix of University-Industry-Government Relations (cf. Etzkowitz and Leydesdorff 1995; Lowe 1982) into a model for studying knowledge-based economies. A series of workshops, conferences, and special issues of journals have developed under this title since 1996. In various countries, the Triple Helix concept has also been used as an operational strategy for regional development and to further the knowledge-based economy, for example, in Sweden (Jacob 2006) and Ethiopia (Saad et al. 2008). In Brazil, the Triple Helix became a "movement" for generating incubators in the university context (Almeida 2005).

Normatively, a call for collaborations across institutional divides, and the awareness that the roles of partners in such collaborations are no longer fixed in a knowledge-based economy, provides a neo-corporatist model of economic and social development that is compatible with neo-liberalism (Mirowski and Sent 2007; cf. Rothwell and Zegveld 1981). The city of Amsterdam, for example, adapted the Triple Helix as its working model for economic development as recently as 2010. (See at http://www.iamsterdam.com/nl/economic-development-board/over-edba/visie-ambitie/hoe-werken-we.) In the Latin American context, the Triple Helix model accords with Sábato's (1975) "triangle" as a program for endogenous development of technology and innovation. The emphasis on bottom-up learning processes (Bunders et al. 1999) can help to avoid reification of systems (or states and inter-state dependency relations) as barriers to innovation. In an overlay of communications between industrial, academic, and administrative discourses, new options and synergies can be developed that can strengthen knowledge integration at the regional level. In a study about regional innovation systems, Cooke and Leydesdorff (2006), for example, noted the possibility of "constructed advantages."

The Origins of the Triple Helix Model

The Triple Helix thesis emerged from a confluence between Etzkowitz' longer-term interest in the study of university-industry relations (e.g., Etzkowitz 2002) and Leydesdorff's interest in an evolutionary model that can generate a next-order hyper-cycle – or in terms of the TH, an overlay of communications (cf. Leydesdorff 1995). After Etzkowitz' (1994) participation in a workshop and a proceedings volume, the metaphor of a Triple Helix emerged in discussions about organizing a follow-up



Triple Helix of University-Industry-Government Relations, Fig. 1 A triple helix configuration with negative and positive overlap among the three subsystems

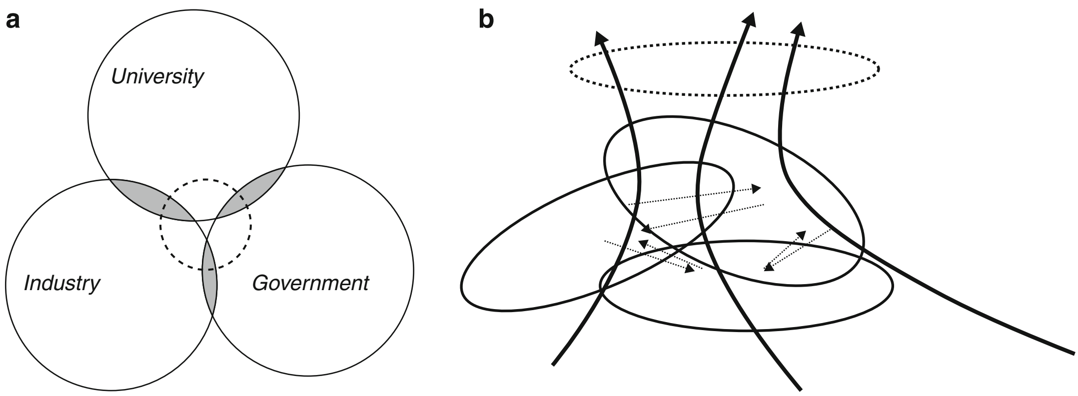
conference under this title in Amsterdam in January 1996 (Etzkowitz and Leydesdorff 1995; cf. Lowe 1982).

From a (neo-)evolutionary perspective, a double helix can be expected to generate a relatively stable trajectory when the two subdynamics mutually shape each other in a coevolution. For example, in a political economy, the market and the state can be expected to generate equilibria (cf. Aoki 2001) which are upset by knowledge-based innovations (Nelson and Winter 1977, 1982; Schumpeter 1939). Alternatively, when the state and its knowledge infrastructure constrict market forces (as in the former Soviet Union), a suboptimal lock-in can be sustained for considerable periods of time. The interaction of three (analytically independent) subdynamics, however, can destabilize, hyper-stabilize, metastabilize, or eventually globalize a relatively stabilized system and thus change the system at the regime level in terms of lock-ins and path-dependencies (Dolfsma and Leydesdorff 2009; Dosi 1982; Viale and Pozzali 2010).

The Triple Helix model of university-industry-government relations is depicted in Fig. 1 as alternating between bilateral and trilateral coordination mechanisms or – in institutional terms – spheres. The systems remain in transition because each of the partner institutes also develops its own (differentiating) mission. Thus, a trade-off can be generated between integration and differentiation, and new systems in terms of possible synergies can be explored and potentially shaped. As the various bilateral translations function, a Triple Helix overlay can also be expected to develop as a system of meaning exchanges among differently coded expectations (Fig. 2).

If one envisages the overlay (in Fig. 2a) as hovering above the sheet, one can imagine a tetrahedron emerging from the bottom with four (three plus one) different types of communications involved. Political, scientific, and economic exchanges are different, but these media (e.g., power, truth, and money; Luhmann 1995) can also be exchanged. In the overlay, translations among the various media can further be invented and developed.

Etzkowitz and Leydesdorff (2000) specified the top-level overlay as a *sub*dynamic and therefore differently from the specification of "mode-2" by Gibbons et al. (1994; cf. Nowotny et al. 2001). "Mode-2" replaces "mode-1," but a subdynamic functions among other subdynamics. The complex system can operate "transdisciplinarily," and one can translate contexts of discovery and justification into contexts of application (and *vice versa*), without damaging the integrity of the underlying processes. This imaginative restructuring may loosen existing boundaries at the institutional level and thus begin to reshape "systems of innovation." Unlike discussions about national (Lundvall 1988; Nelson 1993) or regional (Braczyk et al. 1998) systems of innovation, the Triple Helix model enables an analyst to consider empirically whether specific dynamics (e.g., synergies) among the three composing media emerge at national and/or regional levels. In other cases, sectors and/or technologies (e.g., biotechnology)



Triple Helix of University-Industry-Government Relations, Fig. 2 A differentiated triple helix with dynamic overlay

may be more relevant systems of reference for innovations than geographical units of analysis (Carlsson 2006).

Globalization: A Transformation of the Triple Helix?

In the case of Japan, for example, and using a specific operationalization, Leydesdorff and Sun (2009) found that since the opening of China and the demise of the Soviet Union (1991) – both major changes in international competition – the national system of Japan has increasingly become a retention mechanism for international relations. Thus, a further differentiation between the national and the global level emerged in this explanation. In principle, the Triple Helix indicator – that is, the mutual information among three dimensions – can be extended to more than three dimensions (Kwon et al. 2012).

In a study about Hungary, Lengyel and Leydesdorff (2011) found that its national system of innovations fell into three regional systems of innovation following the transition of the 1990s and the accession to the EU in 2004. The authors distinguish (1) a metropolitan area around Budapest, (2) a knowledge-based innovation system in the western part of the country which is integrated into other EU countries, and (3) an eastern part of the country where the old (state-led) dynamics still prevail. The national level no longer adds synergy to these three regional systems.

The roles of the academic, industrial, and governmental contributions are also not given. The central role of universities in many TH studies is based on the assumption that this system is more adaptive than the others because of the continuous flux of students (Shinn 2002). In a recent study of Norway, however, Strand and Leydesdorff (in press) found foreign direct investment via the offshore (marine and maritime) industries in the western part of the country to be a greater source of synergy in the knowledge-based developments of regions than the university environments of the major centers in Trondheim and Oslo.

Two conclusions can be drawn from these nation-based studies: (1) medium-tech industry is more important for synergy than high-tech and (2) the service sector tends to uncouple from geographical location because a knowledge-intensive service is versatile and not geographically constrained. These conclusions accord with the emphasis in the literature on embeddedness (Cohen and Levinthal 1989) and the footlooseness of high-tech industries (Vernon 1979). Certain Italian industrial districts, for example, while very innovative, are under the continuous threat of deindustrialization because incumbent multinational corporations may buy and relocate new product lines

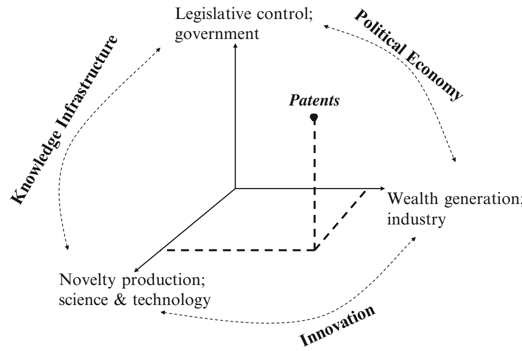
(Beccatini 2003; dei Ottati 2003). In institutional analyses that focus on local and regional development using the Triple Helix model, these structural effects of globalization are sometimes backgrounded.

Different Versions of the Triple Helix Model

The Triple Helix (TH) can be considered as an empirical heuristics which uses as *explanantes* not only economic forces (e.g., Schumpeter 1939; Nelson and Winter 1982), and legislation and regulation by (regional or national) governments (e.g., Freeman 1987; Freeman and Perez 1988), but also the theoretically endogenized dynamics of transformations by science-based inventions and innovations (Noble 1977; Whitley 1984). The TH model does not exclude focusing on two of the three dynamics – for example, in studies of university-industry relations (Clark 1998; Etzkowitz 2002) or as in the "variety of capitalism" tradition (Hall and Soskice 2001) – but the third dynamics should at least be declared as another source of variation.

TH models can be elaborated in various directions. Firstly, the networks of university-industry-government relations can be considered as neo-institutional arrangements which can be made the subject of social network analysis. This model can also be used for policy advice about network development, for example, in the case of transfer of knowledge and the incubation of new industry. The new and potentially salient role of universities in knowledge-based configurations can then be explored in terms of different sectors, regions, countries, etc.. (Godin and Gingras 2000; Shinn 2002). Over the past ten years, this neo-institutional model has also been developed into a discourse about "entrepreneurial universities" (Etzkowitz 2002; Mirowski and Sent 2007). Regions are then considered as endowed with universities that can be optimized for a third mission and different from higher education and internationally oriented research.

Secondly, the networks span an architecture in which each relation occupies a position. One can

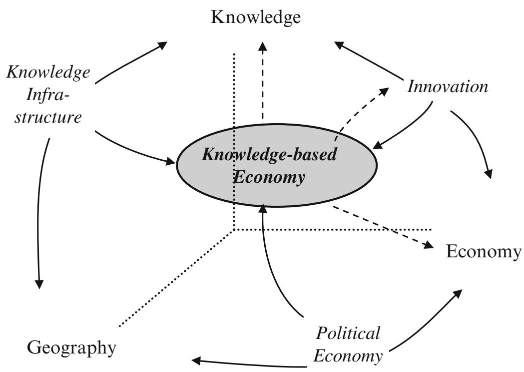


Triple Helix of University-Industry-Government Relations, Fig. 3 Patents as events in the three-dimensional space of triple helix interactions (Source: Leydesdorff 2010, at p. 370)

thus obtain a systems perspective on knowledge-based innovation in a hypothesized space; this theoretical construct – the knowledge-based economy – can be informed by systematic data analysis (e.g., Leydesdorff and Fritsch 2006).

In Fig. 3, patents are considered as positioned in terms of the three social coordination mechanisms of (1) wealth generation on the market by industry, (2) legislative control by government, and (3) novelty production in academia. Whereas patents are output indicators for science and technology, they function as input into the economy. Their main function, however, is to provide legal protection for intellectual property. In other words, events in a knowledge-based economy can be positioned in this three-dimensional space of industry, government, and academia. When events (e.g., patents) can also circulate, a three-way interaction can be expected. This knowledge-based economy contributes to the political economy by ensuring that the social organization of knowledge as R&D is endogenized into the system dynamics (Fig. 4).

The three functions in Fig. 3 can also be considered as interaction terms among relational exchange processes (e.g., in an economy), political positions in a bordered unit of analysis (e.g., a nation), and the reflexive and transformative dynamics of knowledge. When these interaction terms exhibit second-order interaction, a knowledge-based economy can increasingly be shaped (Fig. 4) (Foray 2004; Leydesdorff 2006).



Triple Helix of University-Industry-Government Relations, Fig. 4 The first-order interactions generate a knowledge-based economy as a next-order system (Source: Leydesdorff 2010, at p. 379)

In my opinion, the crucial research question is under which conditions do the three functions operate synergetically, to what extent or at which level, and at what price. Is a country or region able to retain "wealth from knowledge" and/or "knowledge from wealth" (as in the case of oil revenues)? Such a synergy can be expected to perform a life cycle. In the initial stage of emergence, "creative destruction" of the relevant parts of the old arrangements is the driving force. New entrants (scientists, entrepreneurs) can be expected to attach themselves preferentially to the originators – the innovation organizers – of the new developments.

In addition to "creative destruction" as typical for Schumpeter Mark I, Soete and Ter Weel (1999) proposed considering "creative agglomeration" as typical of the competition among corporations. This changes the dynamics of development in the later stage of development and is sometimes called "Schumpter Mark II" (Freeman and Soete 1997; Gay 2010). In a bibliometric study of the diffusion of the new technology of RNA interference (Fire et al. 1998; Sung and Hopkins 2006), Leydesdorff and Rafols (2011) found a change of preferential attachments from the inventors in the initial stage to emerging "centers of excellence" at a later stage. In the patent market, however, a quasi-monopolist was found (Leydesdorff and Bornmann 2012) located in Colorado, whereas the research centers of excellence were concentrated in major cities such as London, Boston, and Seoul. Drug development requires a time horizon different from that required by the application of the technique in adjacent industries, such as the production of reagents for laboratories (Lundin 2011).

In other words, the new technologies can move along trajectories in all three relevant directions and with potentially different dynamics. The globalization of the research front requires an uncoupling from the originators and a transition from mode-1 to mode-2 research in order to make the technique mutable (Latour 1987). From this perspective, "mode-1" and "mode-2" are no longer considered as general systems characteristics of society and policy making but as stages in the life cycles of technological transformations. An analogon of Schumpeter Mark I and Mark II within the domain of organized knowledge production and control can thus be specified.

Universities are poorly equipped for patenting (Leydesdorff and Meyer 2010). Some of the original patents may profitably be held by academia. In the case of RNA interference, for example, two original US patents ("Tuschl-I" and "Tuschl-II") were co-patented by MIT and the Max Planck Society in Germany (MIT Technology Licensing Office 2006), but a company was founded as a spin-off to further develop the technology. As noted, the competition thereafter shifted along a commercial trajectory. In summary, whereas one can expect synergies to be constructed, the consequent system "self-organizes" in terms of relevant selection environments while leaving behind institutional footprints. Three dimensions are important: the economic, political, and socio-cognitive potentials for change. Both local integrations and global pressures for differentiation can continuously be expected.

Conclusions and Future Directions

What is the contribution of these models in terms of providing heuristics to empirical research? First, the neo-institutional model of arrangements among different stakeholders can be used in case study analysis. Case studies can be enriched by addressing the relevance of the *three* major dimensions of the model on an equal footing *ex ante*. Research can then inform about specifics, such as path dependencies (e.g., Etzkowitz et al. 2000; Viale and Campodall'Orto 2002). Thus, the Triple Helix perspective does not disclaim the legitimacy of studying, for example, bilateral academic-industry relations or government-university policies. However, one can expect more interesting results by studying the interactions among the three subdynamics.

Secondly, the model can be informed by the increasing understanding of complex dynamics and simulation studies from evolutionary economics (e.g., Malerba et al. 1999; Windrum 1999). Thirdly, the Triple Helix model adds to the metabiological models of evolutionary economics the sociological notion of meaning being exchanged among the institutional agents (Leydesdorff 2011; Luhmann 1995). Finally, on the normative side of developing options for innovation policies, the Triple Helix model provides an incentive to search for *mismatches* between the institutional dimensions in the arrangements and the social functions performed by these arrangements.

The frictions between the two layers (knowledge-based expectations and institutional interests), and among the three domains (economy, science, and policy) provide a wealth of opportunities for puzzle solving and innovation. The evolutionary regimes are expected to remain in transition as they are shaped along historical trajectories. A knowledge-based regime continuously upsets the political economy and the market equilibria as different subdynamics. Conflicts of interest can be deconstructed and reconstructed, first analytically and then perhaps also in practices in the search for solutions to problems of economic productivity, wealth retention, and knowledge growth.

The rich semantics of partially conflicting models reinforces a focus on solving puzzles among differently codified communications reflexively. The lock-ins and bifurcations are systemic, that is, largely beyond control; further developments are based on the variation and the self-organizing dynamics of interactions among the three selection environments. These subdynamics can also be considered as different sources of variance which disturb and select from one another. Resonances among selections shape trajectories in coevolutions and the latter may recursively – that is, selectively – drive the system into new regimes. This neo-evolutionary framework assumes that the processes of both integration and differentiation in university-industry-government relations remain under reconstruction.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Business Incubator
- ▶ Creative Destruction
- ▶ Creativity and Systems Thinking
- ▶ Knowledge Society, Knowledge-Based Economy, and Innovation
- ▶ Mode 1, Mode 2, and Innovation
- ▶ *N*-Tuple of Helices
- ▶ Quadruple Helix
- ▶ Quintuple Innovation Helix and Global Warming: Challenges and Opportunities for Policy and Practice
- ▶ University Research and Innovation

References

Almeida M. The evolution of the incubator movement in Brazil. Int J Technol Glob. 2005;1(2):258–77.

Aoki M. Towards a comparative institutional analysis. Cambridge, MA: MIT Press; 2001.

Beccatini G. The development of tuscany: industrial districts. In: Beccatini G, dei Bellandi M, Ottati G, Sforzi F, editors. From industrial districts to local development: an itinerary of research. Cheltenham/Northhampton: Edward Elgar; 2003. p. 11–28.

Braczyk H-J, Cooke P, Heidenreich M, editors. Regional innovation systems. London/Bristol: University College London Press; 1998.

Bunders JFG, Broerse JEW, Zweekhorst MBM. The triple helix enriched with the user perspective: a view from Bangladesh. JTechnol Trans. 1999;24(2):235–46.

Carlsson B. Internationalization of innovation systems: a survey of the literature. Res Policy. 2006;35(1):56–67.

Clark BR. Creating entrepreneurial universities: organization pathways of transformation. Guildford: Pergamon; 1998.

Cohen WM, Levinthal DA. Innovation and learning: the two faces of R & D. Econ J. 1989;99(397):569–96.

Cooke P, Leydesdorff L. Regional development in the knowledge-based economy: the construction of advantages. J Technology Trans. 2006;31(1):5–15.

dei Ottati G. Local governance and industrial districts' competitive advantage. In: Beccatini G, Bellandi M, dei Ottati G, Sforzi F, editors. From industrial districts to local development: an itinerary of research. Cheltenham/Northhampton: Edward Elgar; 2003. p. 184–209.

Dolfsma W, Leydesdorff L. Lock-in & break-out from technological trajectories: modeling and policy implications. Technol Forecast Soc Chang. 2009;76(7): 932–41.

Dosi G. Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change. Res Policy. 1982;11(3):147–62.

Etzkowitz H. Academic-industry relations: a sociological paradigm for economic development. In: Leydesdorff L, van den Besselaar P, editors. Evolutionary economics and chaos theory: new directions in technology studies. London: Pinter; 1994. p. 139–51.

Etzkowitz H. MIT and the rise of entrepreneurial science. London: Routledge; 2002.

Etzkowitz H, Leydesdorff L. The triple helix – university-industry-government relations: a laboratory for knowledge-based economic development. EASST Rev. 1995;14:14–9.

Etzkowitz H, Leydesdorff L. Universities and the global knowledge economy: a triple helix of university-industry-government relations. London: Pinter; 1997.

Etzkowitz H, Leydesdorff L. The endless transition: a "Triple Helix" of university-industry-government relations, introduction to a theme issue. Minerva. 1998;36:203–8.

Etzkowitz H, Leydesdorff L. The dynamics of innovation: from national systems and 'Mode 2' to a triple helix of university-industry-government relations. Res Policy. 2000;29(2):109–23.

Etzkowitz H, Webster A, Gebhardt C, Terra BRC. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. Res Policy. 2000;29(2):313–30.

Fire A, Xu SQ, Montgomery MK, Kostas SA, Driver SE, Mello CC. Potent and specific genetic interference by double-stranded RNA in *Caenorhabditis elegans*. Nature. 1998;391(6669):806–11.

Foray D. The economics of knowledge. Cambridge/ London: MIT Press; 2004.

Freeman C. Technology, policy, and economic performance: lessons from Japan. London: Pinter; 1987.

Freeman C, Perez C. Structural crises of adjustment, business cycles and investment behaviour. In: Dosi G, Freeman C, Nelson R, Silverberg G, Soete L, editors. Technical change and economic theory. London: Pinter; 1988. p. 38–66.

Freeman C, Soete L. The economics of industrial innovation. London: Pinter; 1997.

Gay B. Innovative network in transition: from the fittest to the richest. 2010. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1649967. Accessed August 20, 2012.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P, Trow M. The new production of knowledge: the dynamics of science and research in contemporary societies. London: Sage; 1994.

Godin B, Gingras Y. The place of universities in the system of knowledge production. Res Policy. 2000;29(2):273–8.

Hall PA, Soskice DW, editors. Varieties of capitalism: the institutional foundations of comparative advantage. Oxford, etc: Oxford University Press; 2001.

Jacob M. Utilization of social science knowledge in science policy: systems of innovation, triple helix and VINNOVA. Soc Sci Inf. 2006;45(3):431–62.

Krippendorff K. Information of interactions in complex systems. Int J Gen Syst. 2009;38(6):669–80.

Kwon, K. S., Park, H. W., So, M., & Leydesdorff, L. Has globalization strengthened south korea's national research system? National and international dynamics of the triple helix of scientific co-authorship relationships in South Korea. Scientometr. (2012);90(1):163–75. doi: 10.1007/s11192-11011-10512-11199.

Latour B. Science in action. Milton Keynes: Open University Press; 1987.

Lengyel B, Leydesdorff L. Regional innovation systems in Hungary: the failing synergy at the national level. Reg Stud. 2011;45(5):677–93.

Leydesdorff, L. (1995). The challenge of scientometrics: the development, measurement, and self-organization of scientific communications. Leiden: DSWO Press, Leiden University. http://www.universal-publishers.com/book.php?method=ISBN%26book=1581126816. Accessed August 20, 2012.

Leydesdorff L. The knowledge-based economy: modeled, measured, simulated. Boca Raton: Universal Publishers; 2006.

Leydesdorff L. The knowledge-based economy and the triple helix model. Ann Rev Information Sci Technol. 2010;44:367–417.

Leydesdorff L. "Meaning" as a sociological concept: a review of the modeling, mapping, and simulation of the communication of knowledge and meaning. Soc Sci Inf. 2011;50(3–4):1–23.

Leydesdorff L, Bornmann L. Mapping (USPTO) Patent Data using Overlays to Google Maps. Journal of the American Society for Information Science and Technology, 2012;63(7):1442–1458.

Leydesdorff L, Fritsch M. Measuring the knowledge base of regional innovation systems in Germany in terms of a triple helix dynamics. Res Policy. 2006;35(10): 1538–53.

Leydesdorff L, Meyer M. The decline of university patenting and the end of the Bayh-Dole effect. Scientometrics. 2010;83(2):355–62.
Leydesdorff L, Rafols I. How do emerging technologies conquer the world? An exploration of patterns of diffusion and network formation. J Am Soc Inf Sci Technol. 2011;62(5):846–60.
Leydesdorff L, Sun Y. National and international dimensions of the triple helix in Japan: university-industry-government versus international co-authorship relations. J Am Soc Inf Sci Technol. 2009;60(4):778–88.
Lowe CU. The triple helix – NIH, industry, and the academic world. Yale J Biol Med. 1982;55(3–4):239–46.
Luhmann N. Social systems. Stanford: Stanford University Press; 1995.
Lundin P. Is silence still golden? Mapping the RNAi patent landscape. Nat Biotechnol. 2011;29(6):493–7.
Lundvall B-Å. Innovation as an interactive process: from user-producer interaction to the national system of innovation. In: Dosi G, Freeman C, Nelson R, Silverberg G, Soete L, editors. Technical change and economic theory. London: Pinter; 1988. p. 349–69.
Malerba F, Nelson R, Orsenigo L, Winter S. 'History-friendly' models of industry evolution: the computer industry. Ind Corp Chang. 1999;8(1):3–35.
Mirowski P, Sent EM. The commercialization of science, and the response of STS. In: Hackett EJ, Amsterdamska O, Lynch M, Wajcman J, editors. Handbook of science, technology and society studies. Cambridge/London: MIT Press; 2007. p. 635–89.
MIT Technology Licensing Office (2006). Licensing for RNAi Patents. http://web.mit.edu/tlo/www/industry/RNAi_patents_tech.html. Retrieved 19 Oct 2011.
Nelson RR, editor. National innovation systems: a comparative analysis. New York: Oxford University Press; 1993.
Nelson RR, Winter SG. In search of useful theory of innovation. Res Policy. 1977;6:35–76.
Nelson RR, Winter SG. An evolutionary theory of economic change. Cambridge, MA: Belknap Press of Harvard University Press; 1982.
Noble D. America by design. New York: Knopf; 1977.
Nowotny H, Scott P, Gibbons M. Re-thinking science: knowledge and the public in an age of uncertainty. Cambridge, etc: Polity; 2001.
Park HW, Leydesdorff L. Longitudinal trends in networks of university-industry-government relations in South Korea: the role of programmatic incentives. Res Policy. 2010;39(5):640–9.
Rothwell R, Zegveld W. Industrial innovation and public policy. London: Pinter; 1981.
Saad M, Zawdie G, Malairaja C. The triple helix strategy for universities in developing countries: the experiences in Malaysia and Algeria. Sci Public Policy. 2008;35(6):431–43.
Sábato J. El pensamiento latinoamericano en la problemática ciencia–technología–desarrollo-dependencia. Buenos Aires: Paidós; 1975.
Schumpeter J. Business cycles: a theoretical, historical and statistical analysis of capitalist process. New York: McGraw-Hill; 1939/1964.
Shinn T. The triple helix and new production of knowledge: prepackaged thinking on science and technology. Soc Stud Sci. 2002;32(4):599–614.
Soete L, ter Weel B. Schumpeter and the knowledge-based economy: On technology and competition policy. Research Memoranda 004. MERIT, Maastricht Economic Research Institute on Innovation and Technology; 1999.
Strand O, Leydesdorff L. Where is synergy in the Norwegian innovation system indicated? Triple helix relations among technology, organization, and geography. Technol Forecasting Social Change. (in press).
Sung JJ, Hopkins MM. Towards a method for evaluating technological expectations: revealing uncertainty in gene silencing technology discourse. Technol Anal Strateg Manag. 2006;18(3):345–59.
Vernon R. The product cycle hypothesis in a new international environment. Oxf Bull Econ Stat. 1979;41(4):255–67.
Viale R, Campodall'Orto S. An evolutionary triple helix to strengthen academy-industry relations:suggestions from European regions. Sci Public Policy. 2002;29(3):154–68.
Viale R, Pozzali A. Complex adaptive systems and the evolutionary triple helix. Crit Sociol. 2010;36(4): 575–94.
Whitley RD. The intellectual and social organization of the sciences. Oxford: Oxford University Press; 1984.
Windrum P. Simulation models of technological innovation: a review. Am Behav Sci. 1999;42(10):1531–50.

TRIZ Forecasting

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TRIZ Software for Creativity and Innovation Support

Boris Zlotin and Alla Zusman
Ideation International Inc., Farmington Hills, MI, USA

Introduction

The Theory of Inventive Problem Solving (TRIZ) has many tools of various degrees of complexity.

Typical TRIZ knowledge includes numerous examples and illustrations (learned from instructors and accumulated from one's own experience) and other (mostly tacit) knowledge about how to successfully utilize TRIZ methods and tools resulting in long learning curve necessitated by the large amount of knowledge that must be acquired from various sources and through substantial practice before becoming a successful practitioner.

The first attempt to facilitate utilization of TRIZ was made by G. Altshuller in the mid-1960s when he built an electromechanical version of the Contradiction Matrix with the 40 Innovation Principles. The first ideas for utilizing a computer for TRIZ-based inventive problem solving was discussed in 1978 (correspondence between Zlotin and Altshuller). In the mid-1980s, the emergence of personal computers allowed for the computerization of selected instruments of classical TRIZ (principles, standards, effects) conducted under the leadership of Valery Tsourikov. Since then, various software packages have been developed, mostly converting existing TRIZ tools into electronic format and offering limited value as they still required substantial TRIZ education for effective use. Other software offer ways to search for information with various degree of effectiveness or represent attempts to create simplified and engaging software (TechOptimizer, Goldfire Innovator, CreaTRIZ, TriSolver, TRIZ Explorer, TRIZContrasolve, Guided Brainstorming, and others).

New approach to TRIZ computerization was introduced in the early 1990s. It was based on the following considerations:

1. The computerization is a part of the automation of human activity. Studies in the history of automation show that the most common mistake in the automation process is the attempt to build machines that copy the human ways of operation. For example, the first locomotives had "legs," the first sewing machines had "hands," etc. History has shown that attempts such as these do not succeed; real success comes only after the old technology (process) is replaced with the one that has been invented with automation in mind. In the case of the sewing machine, it was the invention of a needle with the hole in the sharp end and the use of two threads instead of one.
2. There are two main issues in every computerization attempt: (a) the existing process that has to be computerized and (b) available software developer tools. These two issues are connected like two communicating vessels: the clearer and better the process is defined, the less sophisticated software tools are necessary for its computerization.

Given the above, the new approach was focused on substantial restructuring of existing multiple TRIZ processes and tools originally created for mental utilization and development of new ones to ensure successful computerization and thus facilitating mass utilization of TRIZ (Zlotin 1999; Zlotin and Zusman 2005).

Analytical and Knowledge-Based Tools of TRIZ

Classical TRIZ (TRIZ developed between 1946–1986 by Altshuller and under his leadership) included the following set of tools:

1. 40 Principles & Contradiction Matrix
2. Separation principles
3. The System of (76) Standard Solutions
4. Effects
5. Patterns/Lines of Evolution
6. Selected Innovation Examples
7. Substance-Field Analysis
8. Algorithm for Inventive Problem Solving (ARIZ)

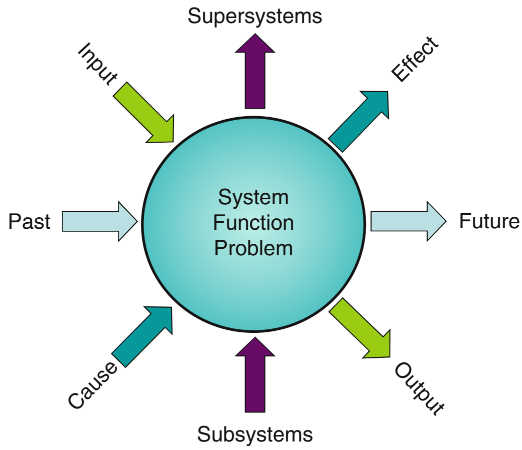
The first step in restructuring TRIZ was dividing all tools into two groups:

- Knowledge-based - tools offering knowledge extracted from patents and other sources of information representing the best innovation practices (positions 1–6 from the list above).
- Analytical – tools helping to analyze the initial problem situation and formulating directions for solutions (positions 7 and 8).

This understanding of the existing tools' nature helped identify the main directions for further improvement with computerization in mind:

- Integration of existing tools to avoid confusion caused by their multiplicity
- Development of “missing” analytical tools to provide complete support of all steps in the problem-solving process, including problem definition and formulation

As a result, two new analytical tools have been developed: Innovation Situation Questionnaire® and Problem Formulator®. The other results included development of the System of Operators – an integrated knowledge-based tool.



TRIZ Software for Creativity and Innovation Support, Fig. 1 System approach (Ideation International 2004). Each *arrow* represents a possible angle to look at the situation

Innovation Situation Questionnaire®

The Innovation Situation Questionnaire® (ISQ®) (trade mark of Ideation International) is a set of questions helping collect and organize available knowledge about a problem situation for the purpose of supporting the problem-solving process. Although typically subject matter experts for a given system know their system well, this knowledge is usually focused on performance and/or production. While this is helpful and even necessary, knowledge of this type can produce strong psychological inertia factors that hinder the creative process.

ISQ questions are divided into three sections:

1. Looking for solutions to the problem as it is originally stated by subject matter experts exploring relevant knowledge base representing best innovation practices collected across various engineering disciplines.
2. Creating detail description of the problem situation, based on *TRIZ system approach* (see the Fig. 1 below), including the structure and functioning of the system in which the problem occurs, root causes of the problem (if they are known; if not, specific instructions helping finding them are offered) and possible consequences if the problem remain unsolved.
3. Understanding and documenting system’s resources and limitations, including criteria the solutions found and should comply with.

The intended results of working with the ISQ are:

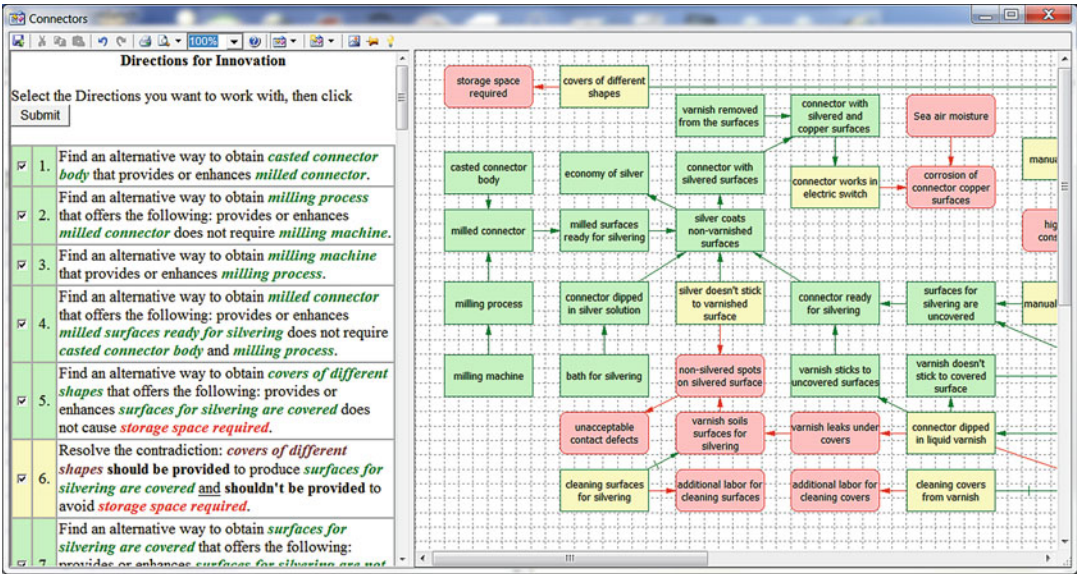
- Documented knowledge necessary for problem solving
- A creative “mindset” that increases the probability of generating new ideas
- Preliminary new ideas for solving the problem

Problem Formulator®

The Problem Formulator® (trade mark of Ideation International) is an analytical tool for transferring knowledge about a particular problem situation from the user’s mind into a comprehensive set of Directions for Innovation (problem statements). Problem Formulation process included two steps (see Fig. 2):

- Building a diagram (visual model) that describes the problem (innovation) situation in terms of cause-effect relationships
- Converting the diagram into an exhaustive set of Directions for Innovation

On the diagram above, green boxes denote useful factors; red boxes, harmful or undesired factors; yellow boxes, contradictions (see below). The arrows between the boxes indicate cause-effect relationships.



TRIZ Software for Creativity and Innovation Support, Fig. 2 Problem Formulator Diagram and computer-generated Directions for Innovation (Innovation WorkBench® software from Ideation International)

Each computer-generated Direction for Innovation serves as a "pointer" to a relevant portion of the knowledge base.

Integrated and Structured TRIZ Knowledge Base

Historically, various TRIZ knowledge-based tools such as the 40 Innovation Principles, the separation principles, effects, and others were developed as independent tools (Altshuller 1984; Altshuller et al. 1989). The expectation existed that older tools would eventually be replaced or absorbed by more advanced and effective tools (such as a complete System of Standard Solutions). As a result, by 1980s, many TRIZ schools practically stopped teaching the 40 Innovation Principles providing only brief information about this tool.

Later, it became apparent that excluding the 40 Innovation Principles from a practitioner's "toolbox" had a negative impact on one's practical problem-solving abilities, primarily due to the fact that the older tool had its own advantages, like simplicity. Also, several very effective recommendations from the 40 Innovation Principles were not included in the System of Standard Solutions (e.g., "transformation of harm into a benefit"). On the other hand, simple reinstating of all 40 Innovation Principles would result in duplication because in many cases similar recommendations were included in different tools.

All problems mentioned above have been resolved through the development of an integrated operational knowledge-based tool (System of Operators) that included all recommendations contained in the 40 Innovation Principles, System of Standard Solutions, Utilization of Resources, etc. This new system should work with any problem model known in TRIZ: technical contradictions, physical contradictions, substance-field models, etc.

It is also interesting to note that the original principles were much more specific than the 40 Innovation Principles known today. Many of them had adaptations to specific characteristics they were intended to deal with. For example, the principle "segmentation" for the purpose of weight reduction differed from the "segmentation" used to reduce dimensions (Altshuller 1964). Later, Altshuller withdrew such specifics from the principles, apparently for the sake of universality and compactness of the Contradiction Matrix. However, this "detailization" can now be reconsidered in the light of the possibility of utilizing computers.

Besides "picking up" (selecting for use) an operator based on a particular characteristic, it would be useful to do this based on the type of drawback involved or on a desired function. Providing such "entrances" to the System of Operators requires that the operators be classified according to their possible application. For this, a complete redesign of all existing operators (principles, standard solutions, etc.), making them much more detailed and specific, can be achieved. This work has been started by Lev Pevsner (Pevzner 1990) and proved to be extremely useful. Such "detailization" can be accomplished in two ways: through segmentation of the existing operators (from the top down) and through the generalization of illustrations associated with each operator (from the bottom up).

The first TRIZ knowledge-based tool – 40 Innovation Principles – did not have any structure, just a set. To offset the lack of structure, Altshuller has created Contradiction Matrix to allow selecting from one to four principles from the set for a particular pair of parameters in conflict. The next knowledge-based tool – separation principles - did not require any structure because their number was rather small (four to seven depending on interpretation). There were several attempts to increase the number of innovation principles, within TRIZ and outside (Polovinkin 1988), with limited or no success, mainly because extended number of principles required certain structure to help with their utilization.

The System of Standard Solutions was the first knowledge-based tool with a structure corresponding with SF-models and certain problem-solving and innovation needs. At the same time, a need to build SF-model prior to selecting an appropriate group of solutions substantially limited its effectiveness as it required extensive training. In addition, this tool was lacking the technical language typical engineer was used to.

Based on the considerations above, a general list that included all operators derived from the existing principles, standard solutions, lines of evolution, etc., was developed. After excluding instances of duplication, a preliminary structure of the operators was suggested as follows (Tables 1, 2):

TRIZ Software for Creativity and Innovation Support, Table 1 Main groups of operators

Group name	Area of application	Example
Universal	Any	Inversion
Semi-universal or general	Wide	Increasing function efficiency
Specific (i.e., specialized)	Narrow	Increasing convenience

Later, several additional groups were introduced:

- Auxiliary (smart introduction of substances and fields)
- Selected patterns/lines of evolution

Altogether, about 400 operators have been created (some are not included in the count above, e.g., over 60 direct and associated operators for resolving contradictions). Apparently, this number can be effectively utilized once stored in professional full scope software (Innovation WorkBench® software, Ideation TRIZSoft®). Another structure was suggested for a simplified software or "mental" use.

Using Contradiction as a Structure for Operators

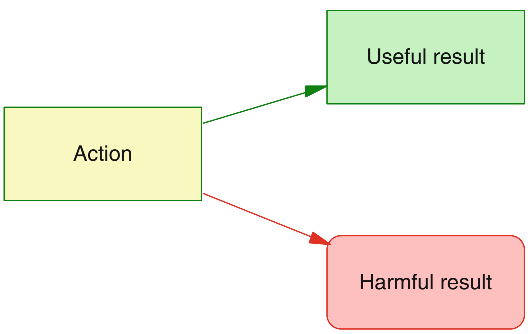
The following is a well-known TRIZ statement: if one has a difficult problem, one has faced a contradiction. A typical contradiction in most cases could be graphically described as shown on Fig. 3:

This graphical depiction of a contradiction is quite convenient because it can be utilized for both types of contradictions known in TRIZ – technical and physical:

- Technical contradiction: An action creates an improvement (useful result) but also causes deterioration (harmful result).
- Physical contradiction: An action should be provided to achieve useful result and not provided to avoid harmful result.

TRIZ Software for Creativity and Innovation Support, Table 2 Structure of the system of operators (see more detail in Appendix)

Group name	Subgroup name (number of purposes/specific factors were applicable)	Number of operators	
		Direct	Additional
Universal	Inversion	3	
	Integration	3	
	Segmentation	5	
	Partial/excessive action	4	
Semi-universal (general)	System synthesis (3)	9	
	Increasing effectiveness	8	
	Eliminating harmful effects (6)	30	
Specialized	Improve useful features (12)	91	100+
	Reduce an undesired factor (18)	148	150+
	Improve a system for management/control (3)	23	25+
Auxiliary	Introducing substances (11)	41	45+
	Introducing fields (3)	18	8+
	Utilization of resources (7)	38	60+
Selected patterns/lines of evolution	Increasing ideality	12	100+
	Building bi- and poly-systems	16	
	Segmentation	4	
	Developing substance structure	4	
	Dynamization	5	
	Increasing controllability	10	10+
	Universalization	4	6+
	Matching/mismatching	4	



TRIZ Software for Creativity and Innovation Support, Fig. 3 Graphical depiction of contradiction (Ideation International 2004)

Traditionally, classical TRIZ provides two knowledge-based tools to address the above: a set of several innovation principles (from the list of 40) and separation principles (4–7). However, vast experience of numerous TRIZ practitioners has shown that no matter how desirable it could be, not every contradiction can be resolved, especially when the given system is on its maturity stage, and resources for further development within the existing paradigm are practically exhausted (Zlotin and Zusman 2009). At the same time, it does not mean that the situation cannot be improved. Based on the graphical model shown above, the following typical directions for solutions could be identified:

1. Find a way to eliminate, reduce, or prevent harmful result under conditions of the given action.
2. Find an alternative way to obtain useful result that does not require the given action (meaning, the associated harmful result does not take place).
3. Resolve the contradiction: the given action should be provided to produce useful result and should not be provided to avoid harmful result.

TRIZ Software for Creativity and Innovation Support, Table 3 Simplified set of operators

Elimination	Alternatives	Resolution
• Remove/modify the source of harm • Modify harmful effect • Counteract harmful effect • Protect the subject of harm • Increase the resistance to harm • Eliminate the effect of the harm • Convert harm into benefit • Exclude the subject of harm	• Modify existing way • Mobilize internal resources • Increase effectiveness of the action • Change the principle of operation • Find additional benefits	• In space • In time • Between the parts and the whole • Based on different conditions

TRIZ Software for Creativity and Innovation Support, Table 4 Complete innovation platform and corresponding knowledge-based tools (Zlotin et al. 2011)

Application name	Short description	Knowledge-based tools
Inventive Problem Solving (IPS)	Solving difficult problems and improvements in technical and non-technical areas	• System of Operators for solving technological problems • Operators for solving non-technical problems (business, management, logistics, services, etc.) • Innovation guide (collection of physical, chemical, and other effects) • Collection of illustrations
Anticipatory Failure Determination (AFD)	Proactive process for analyzing, predicting, and eliminating failures in systems, products, and processes	AFD checklists: • Ways to produce harm • Operators for failure prevention/elimination
Directed Evolution® (DE)	Predicting next generations of products, services, and technologies via inventing and developing a comprehensive set of scenarios describing future generations of a system.	• Patterns and lines of evolution (12 patterns and over 500 lines) • Bank of evolutionary alternatives (futuristic concepts for various industries)
Control (Management) of Intellectual Property (CIP)	Evaluation and enhancement of intellectual property (IP) related to proprietary technologies, inventions, patents, and patent portfolios	IP checklists: • Invention evaluation (over 35 parameters) • Invention enhancement

From the list above, three groups of operators could be identified: elimination, alternatives, and resolution (Fulbright 2011).

For each group, a set of operators is suggested as in Table 3.

This structure and the limited number of operators make it easier to memorize and thus to become an element of TRIZ way of thinking in addition to a number of universal operators and the main TRIZ concepts like ideality, contradictions, resources, system approach, and patterns/lines of evolution.

The first extensive knowledge base and new process was developed for inventive problem solving (IPS) (Zlotin 1999).

Complete Innovation Platform

IPS is only one of the existing innovation needs. To address all needs and develop a complete innovation and problem-solving system suitable for computerization the following steps have been taken:

TRIZ Software for Creativity and Innovation Support, Table 5 Extended Structure of the System of Operators

Group name	Subgroup name	Specific factor/purpose	Number of operators Direct	Number of operators Additional
Universal	Inversion	n/a	3	
	Integration	n/a	3	
	Segmentation	n/a	5	
	Partial/excessive action	n/a	4	
Semi-universal (general)	System synthesis	Improve a prototype	1	
		Use other systems	1	
		Combine known systems	7	
	Increasing effectiveness	n/a	8	
	Eliminating harmful effects	Isolation	8	
		Counteraction	6	
		Other impact	6	
		Eliminate cause	2	
		Mitigate the results	4	
		Benefit from harm	4	
Specialized	Improve useful features	Reliability	4	5+
		Action speed	1	17+
		Mechanical strength	7	9+
		Composition stability	5	6+
		Convenience	18	30+
		Productivity	2	25+
		Manufacturing accuracy	12	20+
		Dispensing accuracy	10	10+
		Shape	8	10+
		Universality	4	6+
		Controllability	10	10+
		Degree of adaptability	6	10+
		Selective mode	4	2
	Reduce an undesired factor	Weight	17	5+
		Dimensions	7	6+
		Energy consumption	5	10+
		Object complexity	20	30+
		Energy waste	8	10+
		Time waste	9	30+
		Cost	20	30+
		Mechanical impact	9	20+
		Mechanical obstacles	4	10+
		Wear	12	10+
		Noise	5	
		Contamination	4	7+
		Overheating	6	5+
		Undesired adhesion	3	10+
		Fire or explosion	4	10+
		Interaction with environment	8	5+

(*continued*)

TRIZ Software for Creativity and Innovation Support, Table 5 (continued)

Group name	Subgroup name	Specific factor/purpose	Number of operators	
			Direct	Additional
		Potential harm from humans	6	
		Incompatible useful actions	1	10+
	Improve a system for management/control	Bypass the problem	5	5+
		Direct ways	14	10+
		Indirect ways	4	10+
Auxiliary	Introducing substances	Exclude elements	3	5+
		Substitute	3	10+
		Transient use	4	10+
		Substance withdrawal	2	5+
		Use copy or model	2	5+
		Introduce additives	6	10+
		Introduce void/foam	3	
		Devices for energy accumulation	1	1
		Introduce a mediator	7	6+
		Substance modification	6	5+
		Transformation to mobile state	4	10+
	Introducing fields	Intensification	2	3+
		Transformation	8	5+
		Generate informational field	8	
	Utilization of resources	Substance	10	30+
		Field	3	10+
		Space	6	
		Time	10	30+
		Informational	5	
		Functional	2	2+
		Transformation	2	2+
Selected patterns/lines of evolution	Increasing ideality		12	100+
	Building bi- and poly-systems		16	
	Segmentation		4	
	Developing substance structure		4	
	Dynamization		5	
	Increasing controllability		10	10+
	Universalization		4	6+
	Matching/mismatching		4	

1. Identifying all needs related to problem solving and innovation and development of a comprehensive set of applications that will address these needs.
2. Development of computer-aided processes for each application.

This approach resulted in development of the following applications and corresponding knowledge – based tools (Table 4) and supported by the family of TRIZ-based software (Ideation TRIZSoft®):

Conclusion and Further Directions

1. To facilitate TRIZ dissemination around the world, computer support becomes an essential productivity tool.
2. Historical attempts to develop software tools were mostly converting various TRIZ tools into electronic format and offering limited value as they still required substantial TRIZ education for effective use.
3. New approach to computerization undertaken by the authors has resulted in restructuring existing and development of new analytical and knowledge-based tools embedded into various professional software packages. Simplified tools could be utilized mentally and/or utilized via abridged software tools.
4. Further directions in developing software for creativity and innovation support could be:
   - Building more interactive and engaging user interfaces suitable for novices and younger generation
   - Enhancing analytical TRIZ tools
   - Updating and enlarging knowledge-base tools
   - Developing new TRIZ tools and processes facilitating computerization, including adopting new enabling informational technologies, like voice recognition, artificial intelligence, semantic analysis, etc.

Cross-References

▶ Creativity and Innovation: What Is the Difference?
▶ Directed Evolution® Technology
▶ Invention and Innovation as Creative Problem-Solving Activities
▶ Inventive Problem Solving (TRIZ), Theory
▶ Inventive Resources
▶ Patterns of Technological Evolution

Appendix: Extended Structure of the System of Operators

See Table 5.

References

Altshuller G. Basics of the method of inventing. Voroneg: Central Chernosem Publishing House; 1964. p. 240.
Altshuller G. Creativity as an exact science. New York: Gordon and Breach; 1984. p. 319.
Altshuller G, et al. The search for new ideas: from insight to methodology. Kishinev: Kartya Moldovenyaska Publishing House; 1989.
CreaTRIZ, at www.creax.com
Goldfire Innovator, at www.invention-machine.com
Guided Brainstorming, at www.gbtriz.com
Ideation TRIZSoft®, at www.ideationtriz.com
Pevzner LH. A concept for development of micro-standards for solving problems with the help of a computer (in Russian). J TRIZ. 1990;1(2):44–9.
Polovinkin AI. Basics of technical creativity; 1988.
TechOptimizer, at www.invention-machine.com
TriSolver, at www.trisolver.com
TRIZ Explorer, at www.insytec.com
TRIZContrasolve, at www.ideacore.com
Zlotin B, Zusman A. An integrated operational knowledge base. In: TRIZ in progress. Southfield MI: Ideation International; 1999a. p. 114–22.
Zlotin B, Zusman A. Managing innovation knowledge. In: TRIZ in progress. Southfield, MI: Ideation International; 1999b. p. 123–40.
Zlotin B, Zusman A. Producing TRIZ solutions: odds of success. TRIZCON. 2009.
Zlotin B, Zusman A. Theoretical and practical aspects of development of TRIZ-based software systems. Presented at conference TRIZFuture 2005. Graz; 2005 November.
Zlotin B, Zusman A, Fulbright R, Ph.D. TRIZ-based platform for software supported innovation. TRIZFest conference, S. Petersburg, Russia; 2011.

Twenty-First Century Fractal Research and Education and Innovation Ecosystem (FREIE)

▶ Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: Quintuple Helix and Social Ecology

Two Hs from Harvard to Habsburg or Creative Semantics About Creativity: A Prelude to Creativity

Phillip Sinclair Harvard
EIGSI – University of La Rochelle, La Rochelle, France

Synonyms

Comparative word analysis; Semantic survey; Vocabulary research

Introduction

An American legend tells how a Puritan preacher founded a famous school in Boston, but in reality, he did not. At the time, printing presses were rare; hence, any books were treasures greater than gold. After his death in 1638, his books were donated to the local community school, so his fellow theologians from Cambridge requested his surname be given to the school. Very creative thinking for New World Puritans known for their black-white/wrong-right binary mental images! What follows is a semantic safari through time, hence history, and especially through language, to hunt for answers to the question: How to be more creative? Constructive Cartesian criticism subdivides what is important to understand into smaller, more precise parts, making it easier to understand it all as a complete whole. Part by part/piece by piece, it is possible to construct what is considered to be critical to understand. To understand creativity, it is necessary to consider a five syllable English lexem from the Latin root, *créo*, to make. Following French Cartesian thinking, it is logical to subdivide the word into its ten letters: C-R-E-A-T-I-V-I-T-Y. Following a more Puritan binary mentality, it is easy to imagine a bipolar analysis comparing two opposing ideas linked to each letter. For creativity's sake, each letter is elegantly embellished by the French touch of *Patricia de Beaunant*, whom the late Wally Findlay considered to be one of the greatest living pastelists of our day.

Cultivate/*Communicate*. Language communicates the memory of humanity cultivating the cultural heritage of the human race. Recorded human history began with the invention of writing language down to communicate what happens. Ever since languages have made an eternal contribution to the preservation of civilization over the centuries. The Persians engraved on metal plates and the Egyptians on stone tablets while today we attempt to scratch out electronically what is worth remembering. The Bible and the Koran communicate ideas from monotheistic Semitic cultures about right and wrong. The Greeks cultivated the beauty of feelings and thoughts and defined perfection as corporal, mental, and spiritual equilibrium. The lengthy verses of the *Mahabharata* communicate centuries of Indian culture and inspired the *Gitanjali* offering another highly cultivated point of view about human existence: The absence of harmony is violence. France's enlightened philosopher, *Montesquieu*, defined culture as habits of living or *moeurs*. The dancing and chanting of African cultures gave the beat, the rhythm, everyone listens to and lives by in the twenty-first century. The Polynesian cultures carved their sacred taboos on wooden staffs passed down through tribal patriarchs while North American Indian cousins communicated through their tall wooden carved totem poles. Ancient pictographics, logographics, ideographics, and hieroglyphics have been replaced by virtual screen graphics of I.C.T. (Information and Communication Technologies) tools which monopolize a new global culture. Do websites and E-mails cultivate cultural harmony better than Sumeria's 600 cuneiform symbols or Biblical Hebrew's 22 letters? Who are the culturally responsible scribes in the twenty-first century? Mark Zuckerberg of Facebook? Taylor Thomson of Canada? Are websites, laptops, Ipods, cell phones, cinema, etc., the virtual tentacles of an omniscient I.C.T. octopus siphoning out individual cultural identity? Creative people are responsible for the future of the human race because their creativity can cultivate civilization. How to be more creative? Be more sensitive to culture and civilization.

Reason/Rupture. For most industrialists, creativity means technological innovation. What is the difference between inventions and innovations? An invention only becomes an innovation after it is legally registered, therefore protected, then put to use, and becomes profitable. Innovations can result from market necessity, market opportunities, or through internal company Research and Development initiatives and can eventually cause a market rupture. An innovation is considered to be a rupture when the application of it, access to it, and the use of it are universal enough to change the lifestyle of society. Cell phones had first a limited military market but after becoming accessible to the general public, and almost every member of a household, they caused so great a change in the way society lives today there has been a rupture with past buying habits creating a new cell phone lifestyle. Rupture innovation usually has a reason behind it explaining why/how the rupture occurred as a direct result of an innovation. Originally, security was the reason behind military cell phones later catalyzing a universal market opportunity for the general public changing the way we live forever. Consider the English schoolboy, Wills (William Webb Ellis), who in 1823 simply broke the rules of the game, a form of rupture, by running all the way down the sports field of his school holding the ball in his hands to the goal line posts and changed Rugby forever. Between 1750 and 1859, handling the ball was forbidden and the number of players unlimited, resulting in myriad mauls and injuries. The boys at the same school published the first set of rules in 1870 making their innovation universally accessible on the sports market. A catalytic reason behind it all can be traced to the headmaster who wanted to increase his influence on the educational market. The way football was played at his school in the city of Rugby, England became the good example of his philosophy, emphasizing sports as an essential element to a balanced education for fine young English gentlemen or P.L.U. (people like us). How to be more creative? Spend more time and energy making available now what was not accessible before.

Expand/Evolve. For industry, creativity has a strong degree of utility and therefore must be productive. Being productive means expanding the market position in evolving markets. The market is a mirror reflecting the economy and follows the economy's ups and downs as Keynesian cycles of supply and demand. Perhaps on the horizon of today's economy, there is greater possibility to envisage an economic model based on economic survival cycles that go from one crisis to another rather than from/to depressions or recessions or expansion. The main tools of production in any economy are also cyclic. Beginning with primitive times, mankind, as a hunter, was the main source of economic production, while animals were a vital economic resource for food, shelter, clothing, tools, and weapon making in a nomadic world. After a nomadic-based economy, man evolved into a more sedentary society of farmers creatively cultivating and storing food in the same location on the same land from year to year. Animals became the main tool of economic production while rich fertile land became the major economic resource. Agriculturally based economies eventually evolved into industrialized societies where man's mechanical and technological creativity replaced animals by machines, by electronics, by automation, by computers, by robots, and now mechatronics. Recent renewal of the importance of human creativity puts man again at the very heart of economic expansion because knowledge has become the main source of economic development. Today, companies must manage employee know-how, skills, and brains as well as vacations, health care, and retirement. Today, company production tools require continual creative redesigning to maintain a profitable position on globally competitive markets. In any economic system, in any century, man's ability to judge and make choices to decide makes him superior to animals, all machines, or any technology. His exponentially creative genius shall remain the main tool of future economic production whatever economic resources are available or depleted. How to be more creative? Develop greater capacities to judge, choose, and decide.

Antiquity/Assets. Subdividing the cultural heritage of the human race into six successive succinct segments of economic creativity shows how, since antiquity, human creativity appears to be an East/West romance of competition. To begin, around 5000 B.C., there were pockets of economic creativity in Asia with local assets of pottery, farms, and fishing. Africa's Nile River area assets included grain harvests, painting, weaving, and sculpturing. Europe's Macedonian farms prospered as did her stone and copper craftsmen but America's nomadic hunters just kept on hunting. 3000 B.C. brought wheeled transportation, ceramics, metals, and walled cities in Asia plus bronze, cuneiform writing, pyramids, and hieroglyphs in Africa. Europeans built Stonehenge and America's assets became pottery and planted corn. 1000 B.C. is when Asia's Aryan tribes gathered along the Ganges River, Egypt's Pharaohs flourished, and Semitic monotheism expanded. Europe's Mycenaean assets were based on Aegean Sea trade while America's Olmecs now had hieroglyphs and calendars plus farms appeared along the Ohio River Valley. In 1000 A.D., the assets of gun powder, silk, and spice from Asia modernized the world but Byzantine, Rome, and Slavic Christians suffered from religious strife. Vikings visited North America and the Amazon River Valley became a trading corridor in South America. It is only around 1500 A.D. when

Western creativity surpassed Eastern creativity. The assets of America's Aztecs now included metal, stonework, sculpturing, and painting. Asia's Ming Capital had Mongolian tribe troubles, Africa's tribal empires developed, and Europe's Gutenberg contributed to the cultural heritage of the human race the timeless asset of his printing press. The year 2001 imposed global management of assets via the Organization of Petroleum Exporting Countries, Europe's Economic Community, North America's Free Trade Agreement, the International Monetary Fund and the World Bank. Today, Asia's Pacific Rim Economic Cooperation is recuperating pockets of economic creativity back from the West into her Eastern spheres. How to be more creative? Be a survivor. Be more competitive.

Taylorism/Taoism. At the apogee of the industrial revolution, a young steel worker in Pennsylvania, Frederick W. Taylor, was creative enough to follow his employee instincts and intelligently observe the industrial reality around him and let his imagination fly by asking, What if? What if the employer supplied the employees with tools, materials, specialized training, and bonuses for achieving objectives set? What if employee advancement and promotions were based on individual achievement and merit? What if the employer accepted responsibility for on-the-job safety? Could an employee be safer by doing the same task over and over again until he became a specialized expert in that particular task, thus reducing the risk of work accidents? What if each task was scientifically analyzed step by step, then compared to possible optional ways of performing the same task to find the most efficient way to carry out that task? He creatively convinced his superiors to furnish smaller shovels to the workers shoveling coal into the steel furnaces, thus increasing the total daily amount of coal shoveled by minimizing individual physical fatigue from each shovel-full lifted up. On the other side of the world, Asian creativity had blossomed with ideas of Taoism. Applied to industry, Taoism promotes indirect material management intervention. Taoism proposes controlling first the immaterial and intangible, permitting a more natural and spontaneous happening of that which is material. It means managing indirectly and outside of the material setting or managing beforehand before the work is executed. In other words, work well planned is work well done. Though centuries apart, Taoism is like Taylorism because they both prescribe foreseeing all that is necessary beforehand. This is very different from the Chinese *wu-wei* interpreted as laisser-faire by France's *François de Quesnay* in the eighteenth century. Taylorism and Taoism encourage trusting and having confidence in employees, so employees feel free to work naturally and spontaneously favoring a mind-set more fertile for creative employee thinking to occur. How to be more creative? Be free thinking and more imaginative.

Instinct/Intelligence. Intelligence has several sources, forms, and modes of operation. The most common source of intelligence seems to be that which is tacit or simple, natural and often unexpressed, not learned but instinctive. Unlike twentieth century thinking, twenty-first century creative thinkers do not ignore instinct as a source of intelligence and recognize, encourage, and applaud human instincts in global decision making. Another source of intelligence is the implicit or that which is evident, schematic, and rules based being learned by observation. The highest source of intelligence to consider is structured, rich, profound, articulate and acquired through being taught. Various forms of employee creativity can include discovered intelligence (facts, data, descriptions, qualitative, and objectives), organized intelligence (differences, changes, insight, vision, calculated, corrected and condensed forms) plus applied intelligence (judgments, choices, decisions, qualitative actions/reactions). Describing, having insight, and judging are results of employee instinct tempered by work experience. In most work settings, employee intelligence operates, or is manifested, in a linear mode of authority under a hierarchy, or a circular mode of cooperation in teamwork, or the boomerang mode of feedback through follow-up. Instinct holds its own in all three operating modes as a legitimate source of employee creativity. Following authority, effective team participation, benefitting from feedback, requires a certain degree of instinctive employee awareness and consciousness. Intelligent employees optimize opportunities to increase their creativity through meetings, training programs, reporting, E-mails, faxes, memos, telephone calls, coffee breaks and lunch hours, or hi-how-are-you moments in hallways, elevators, and underground parking or other sharing moments in front of lavatory mirrors, water fountains, and coffee machines. Increasing employee intelligence increases employee creativity. Hence, employee intelligence scarcity can lead to an overall corporate state of creative amnesia. How to be more creative? Cooperate instinctively and communicate more intelligently.

Vision/Violence. If the twenty-first century is uncreative it will be because man will have forgotten how to think. Without a renewing of mental images and imagination to be more creative; civilization will die. Man must not be afraid to think creatively by exploring the corridors of his mind, open those closed doors, and trespass thresholds of new mental images. Only creative thinking will find the saving solutions to heal a world of violence. There are many forms of violence today other than military conflicts such as pollution, waste, oligopolies, cartels, maintained unemployment, institutionalized poverty, economic racism, consumer hedonism, hard drugs, pagan pedophiles, etc. Is not violence simply the absence of creativity? Is creativity a plausible remedy for violence? No, creativity may not stop violence immediately but it can be an intermediate, even long term, balm of Gilead; a healing salve soothing smoothly pain and wounds resulting from various forms of violence. In Post World War II society, there was a new generation of Americans who witnessed bilateral harmonizing of the businessman's value of profitability with the artist's value of sensitivity. Updating for today's global society, the new generation will more than likely be one of creative people with a trilateral vision harmonizing business, art, and science for future enrichment of the cultural heritage of the human race. Both artistic scientific businessmen and scientific business-minded artists will be able to offer a kaleidoscope of creativity overlapping opposing ideas to efface all forms of world violence. In other words, the twenty-first century may well witness a renaissance of creativity through scientists with a keen sense of utility plus an artistic sensitivity and a business sense of profitability. The life of Leonardo de Vinci, a mentor and a hero for creativity in the twenty-first century, is an example of harmony between art and science from which his patrons greatly profited. Aside from his artistic and scientific contributions to the cultural heritage of the human race, his life shows us it is important to renew creativity from generation to generation. How to be more creative? Increase reactivity to renew the hope of improving things.

Individual/Industry. One main difference in industrial management practices between the twentieth and the twenty-first centuries is well expressed in 12 words; 6 for the twentieth and 6 for the twenty-first. A very common management policy in the twentieth century was: "Stop talking and get to work.", but later became "Start talking and go to work." in the twenty-first century. Steve Jobs was known to say: "Hire intelligent people and let them tell you what to do." One can summarize twentieth century industrial mentality in three key ideas: efficient teams + bossy superiors + business objectives which now transform into individual interaction + conscientious coaching + moral responsibility in the twenty-first century.

Individual identity in industry is no longer sacrificed for the group because today's teamwork is a balanced blending of individual differences, meaning greater self-investment resulting in richer results and increased industrial creativity. People working together in industry, who have almost everything in common, cannot really work very creatively because their sameness breeds similarity not creativity. Differences breed creativity. It was the courageous creative thinking of individuals such as the Wright brothers, Fayol, Ford, Edison, Einstein, Job, Gates, and others who made the twentieth century industry so creative. The new management model of the twenty-first century is moving on from the traditional American Janistic groupthink model to a more transcultural approach (continent to continent around the globe), fostering more creative bosses who are closer to the Latin word, *pater*, meaning: father. This semantic root of the French lexem for *patron* (boss) implies paternalistic consideration for individual employee cultures and differences and is very similar to Robert Greenleaf's servant leadership. Acultural corporate conformity can kill individual creativity. Creativity is spontaneous and contagious and feeds on confidence and trust between fellow team members through mutual cultural respect. Creativity is neither exclusive nor monopolistic. It was Peter Drucker who suggested creativity may well be a new basis of competition in twenty-first century post capitalistic society. How to be more creative? Promote cultural equilibrium and avoid economic excess.

Tomorrow/Today. The engineer's role in industry is to creatively benefit today from the past to foresee the future. The priority is timing not time. This means engineering continuity should be out of time and place as well as timely. Shall Renault's *AVANTIME* model and Toyota's Today Tomorrow concept be seen as prophetic or as pathetic marketing concepts? Bill Gates perceives tomorrow's talent today more in several Asian locations (Bangalore, New Delhi, Singapore, Sydney, Hong Kong, Guangzhou, Shanghai, Taipei, Beijing, Tokyo) and less in North American locations (San Francisco, Toronto, Boston, New York). These pockets of creativity attract, like magnets, the highest I. (Intelligence) Q. (Quotient) potential, thus the best of the present generation. Will it last? Can China's population continue without women? Will India's or Brazil's or Russia's infrastructures ever be updated? Are **B**razil/**R**ussia/**I**ndia/**C**hina today's most promising of **BRIC**ks to build tomorrow's world economy? Free Market Capitalism breeds consumer credit, inflation, pop culture, juvenile delinquency, and social unrest. Perhaps twentieth century technology Wizards of Oz may become twenty-first century Wizards of Oops? In the 1930s, the creativity of the French born design engineer, Raymond Loewy, relooked America (household appliances/television/radios/cars/trains/planes/buses/Coca-cola bottles/Shell logo, etc.). Lowey remains out of time and place because he is still the reference point inspiring today the vision of what modern tomorrow is expected to look like. Modern society could never exist without his concept of aerodynamic lines. Good taste is timeless. Class has always been a question of perception. Tomorrow needs people today to prepare it and make it happen. A Russian born philosopher from the same 1930s' American creative scene warned about future consumerism: "Whoever you are, you who are hearing my words, I am speaking ...to your mind, and I say...whoever you are – you who are alone with my words at this moment, with nothing but your honesty to help you understand – the choice is still open to be a human being." How to be more creative? Foresee now what to do later better.

You/Yourself. "WHO are YOU?" The answer to this question is what dear Alice was so desperately running around asking everyone else about in her Wonderland. Updating for twenty-first century society, this Victorian fairytale by an Oxford Mathematics professor suggests the anxious Alice in each of us is latently looking for answers to questions like: WHAT is YOUR work culture? No doubt the professional labyrinths, in your wonderful Workland, have their own overzealous inefficient energy wasting Mad Hatters or always late unorganized arrogant rabbits or dogmatic dreary, but deadly, queens of no heart! Questions like: "WHO are YOU?" and WHAT is YOUR work culture? are equivalent to How creative ARE you? What you are determines how creative you are. Perhaps such questions are more appropriate to industry, when asked in a more different creative way such as: Who ARE you? and What IS your work culture? The verbs "are" and "is" are plural and singular conjugations of the infinitive "to be" and refer to what is going on now in the present, or the way things really are, not euphoric conceptual possibly might-be and should-be pronouns like "who" or "you." Do you want to be more creative? Then concentrate more on the "are" and the "is" and less on the "who" or "you." Think and act more in terms of "us" and "we" and less in terms of "them" and "me."

Knowing who you are, your limits and potential, will allow you to be more creative.

Leave behind the Shrek film's Pinocchio self-protection syndrome; "Well, I know where he is not." and admit: No, I do not know; so please tell me!. Only then can you, yourself, blossom. The first step in learning and improving is recognizing that we do not know because only then will we take time to make the effort to learn. Creativity is based on knowledge acquisition. No matter whatever wonderful Workland you stumble in and meander through, continual employee knowledge acquisition is the golden thread of Adrian to follow, leading you safely in and out of professional labyrinths to escape the Minotaurs of unemployment. How to be more creative? Know yourself better by discovering what you do not know.

Conclusions and Future Directions

As this neuron creativity cruise now comes to port and is moored at the docks of our thoughts, another legend again unfolds but this time in the Old World almost four centuries later. In 2009, a fellow Thunderbird MBA graduate, Marcus of Austria, accompanied me to visit a historical sight frequented somewhat by tourists in Stratford-Upon-Avon. The private guide was kindly provided by the Shakespeare Trust who oversees and manages the sight visited. As the guide recounted how the sight was identified then saved, her story seemed to inspire an almost comical Cartesian dichotomy for my Habsburg friend but a binary black-white/wrong-right judgmental Puritan mental image of disappointment for me. It seems the reality of this legend is a local social figure, a so-called actress or patron of the arts, who persuaded, in her own very creative way, her wealthy American friend and benefactor, an alumnus of that so very famous school in Boston, to financially arrange the acquisition and caring of the English cottage in question. The English cottage in question is considered to be an ancestral family residence through the maternal lineage of our pious Puritan preacher who never founded anything. Oh may her audacious, but useful, creativity not inspire him to roll over in his grave! Is creativity French Cartesian logic or binary Puritan black-white/wrong-right thinking? Is being more creative seeing what others cannot or will not? How to be more creative? Being more creative is neither Old World Habsburg nor New World Harvard. Being more creative is simply seeing things in ways others do not.

Cross-References

- ► Creativity
- ► Culture
- ► Knowledge Management

References

Carayannis E, Chanaron J-J. Leading and managing creators, inventors, and innovators. Westport: Praeger; 2007.

Carayannis E, Kwak YH, Anbari FT. The story of managing projects. Westport: Praeger; 2005.

Harvard P. The binary roots & the multidimensional future of the MBA. Int Grad. 2002;3(6):5–6. Empire Publishing Company.

Harvard P. Maslow; mazes, minotaurs; updating employee needs and behavior patterns in a knowledge-based global economy. J Knowl Econ. 2010;1(2):117–27. Springer.

Morison SE. The founding of Harvard College. Cambridge, MA: Harvard University Press; 1995.

Owen D. "Harvard House – Special Visit", The Shakespeare Birthplace Trust's staff newsletter. Trust Weekly, 2–8 Feb 2009, Stratford-upon-Avon, UK.

www.ancientgreece.com

www.ayanrand.org

www.culture.com

www.gatesfoundation.org

www.historyworld.net

www.latinamericastudies.org

www.rugbyfootbalhistory.com

www.stevejobs.fr

www.trueorigin.org/language01.asp

www.wikipedia.org

U

Unconscious Awareness

► Effects of Intuition, Positive Affect, and Training on Creative Problem Solving

Underlying Epistemic Structure

► Epistemic Governance and Epistemic Innovation Policy

University (Research University)

► Higher Education and Innovation

University Entrepreneurship

► Academic Entrepreneurship

University Governance

► Higher Education and Innovation

University Research and Innovation

Georg Krücken
International Centre for Higher Education Research (INCHER), University of Kassel, Kassel, Germany

From the Linear Model of Innovation to Complex Networks

The role of university research in innovation processes has been discussed in innovation research and policy since about the 1950s. In the beginning, to a large extent the debates took place in the United States, but eventually European scholars and policymakers followed suit. Through international organizations, in particular the OECD and the World Bank, the whole discourse has become so widespread and globalized that research conducted in universities and its contribution to technological innovations are currently emphasized in very different and heterogeneous regions and national systems of the world. Roughly, one can distinguish between two different conceptualizations over time. In these conceptualizations, the role of university research and its carriers shifts from being merely a provider of basic knowledge to a more complex picture, in which active networking and entrepreneurship are seen as equally important.

According to the linear model of innovation that was dominant until the 1980s, universities

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were mainly responsible for carrying out basic research. Based on this input, applied research and development would eventually follow and lead to product and process innovations in industry. In this model, university research does not contribute directly to innovations. The link is rather indirect and mediated through different stages, and the boundaries between the academic sphere and the economic sphere seem to be clear-cut. Likewise, university researchers do not actively engage themselves in entrepreneurial activities that take place in the business sector. While innovation in business firms requires managerial capacities and overall planning processes, basic research as an invaluable resource is inherently uncertain. It requires creativity and inventive behavior that can neither be planned nor managed. Another marked difference between the academic sphere and the economic sphere is seen in the public character of university research. According to a seminal paper by Nelson (1959), due to the inherent uncertainties in basic research and the related difficulties in expropriating individual benefits, firms tend to underinvest in basic research. Therefore, publicly sponsored basic research at universities serves best in providing national economies with a sufficiently strong knowledge base on which firms can rely in order to develop marketable innovations. This strong case for basic research as the main function of universities in innovation processes has been confirmed by subsequent research. In particular, Mansfield (1991) has given evidence of the importance of basic research to industrial innovation. With data from different industries, he shows that academic research has led to considerable innovation in industry, in particular the pharmaceutical sector, within the rather short time span of 15 years. However, as the effects of basic research on industrial innovation are more widespread and rather long term in character, Mansfield and other innovation researchers assume that such measurements only grasp the tip of the iceberg of universities' contributions to innovations in industry. For a long time, these arguments provided the rationale of research and innovation policies in technologically advanced countries. By heavily funding basic research and its main location, that is, universities, a public knowledge stock was created, which could be tapped by industry to ensure national economic progress.

Over time, however, such policies were met with increasing skepticism. In particular, the idea that basic research more or less automatically falls out or spills over from the academic to the industrial sphere became a target of much criticism. The fact that potential users have access to public knowledge does not guarantee the use of this knowledge. This holds particularly true for small and medium-sized enterprises which hardly have the "absorptive capacity" (Cohen and Levinthal 1990) to appropriate academic research. Taking these limitations of the linear model of innovation into account, better linkages between the different stages of the innovation process and the actors involved were asked for. Where university-industry relations are concerned, this implies that academic researchers and universities are expected to get actively involved in the process of knowledge transfer. In addition, transfer is no longer conceptualized as a one-way street leading from basic research to industrial application. Rather, academic researchers engage in cooperation with industrial partners, learn about the needs of their partners, and redraw their research agenda accordingly. The most visible sign of this conceptual and policy turn was the creation of offices for knowledge and technology transfer at universities. Since the 1970s and 1980s, such offices were created at universities in most OECD countries in order to tighten the linkages between university research and industrial application. In this, a more direct role of the university and academic researchers in the innovation process was acknowledged. However, the high hopes that led to the institutionalization of transfer offices in most cases were not met in practice. The effectiveness of transfer offices was questioned by studies and assessments which revealed a huge variation with regard to the number of staff, the size of transfer offices, the actual task structure, and the degree of professionalization of staff members. In a review of literature on the experiences made with transfer offices in the United States and Europe, Geuna and Muscio (2009) reveal striking similarities and differences concerning their institutionalization and success. Though technology transfer has become a strategic issue in the governance of university-industry relations in all countries observed, the success rate of transfer offices is highly uncertain and depends on critical factors like the importance of management experiences of staff, a critical size of the office, and close interactions with academic researchers already in the early stage of the invention. But even if these conditions are met, there is hardly any common formula for success as context-specific aspects prevail.

Furthermore, the embeddedness of transfer offices in university bureaucracy, their culture, policies, and inflexibility can be a serious barrier to effective knowledge and technology transfer. An even more systematic and fundamental limit to the effectiveness of transfer offices lies in the fact that knowledge and technology transfer between universities and industry is a highly personalized process. Transfer offices can act on behalf of university researchers, but they can hardly substitute their active involvement in innovation processes which span the boundary to partners in industry. This problem is two-faced. On the one hand, university-industry relations require a high degree of trust between partners from both sides. Trust building is a tedious and iterative process among those persons in university and industry who are actively involved, but not among organizational units. On the other hand, research implies a high degree of very specific expertise consisting of formal and tacit knowledge which also requires the active involvement of researchers. Staff members of transfer units can support such activities, but they can hardly substitute the direct engagement of university researchers.

The creation of transfer offices did not alter the traditional images and differences between the university as the main locus for basic research and the industrial firm as the main locus for generating innovations for the market. However, this changed from the 1980s onward as the university and individual researchers were increasingly seen as economic actors themselves. In becoming entrepreneurial, traditional identity concepts are transcended, both at the organizational level of the university and the individual level of the researcher. Furthermore, university research is no longer regarded as the starting point of a linear model of innovation, but instead as an integral part of highly complex and nonlinear innovation networks in which the difference between basic research and commercialization activities becomes increasingly blurred. Like in the previous phase, in which stronger ties between university research and industry were sought through transfer offices, research universities and federal policies of the United States pioneered such transformation processes. An important legislative milestone was the Bayh-Dole Act in 1980 which entitled universities to patent and to issue licenses to inventions developed with federal funding. Its actual impact on the rise of entrepreneurial activities of universities and university researchers, however, is contested. Mowery et al. (2004) argue that the Act has had only very little real effect on such activities. Nonetheless, its highly symbolic value has beyond doubt granted legitimacy to directly involving universities and university researchers into commercialization and market-like behavior in innovation processes. In particular, universities with a strong research base and faculty in the life sciences and in the field of information and communication technology were spearheading this trend. Shapin (2008, Chap. 7), for example, gives strong illustrative insights into entrepreneurial activities among UC San Diego's life science faculty. Likewise, there are numerous accounts of the close interactions between Stanford University and the computer and internet industry in the California Silicon Valley (Kenney 2000). It is obvious that here, the differences between university research and industrial application become blurred. Complex interactions and hybrid roles substitute the traditional linear and clear-cut innovation model and related role concepts of university research.

Conclusion and Future Directions

As it is seen in this very overview, the role of university research in innovation processes changed over time. Up to the 1970s, public university research was mainly seen as an indispensable resource for innovations in industry, without questioning the boundaries and cultural differences between both sectors. With the advent of technology transfer offices in the 1970s and 1980s, this concept was added by attempts at fostering a more active role for universities and university researchers in the transfer of knowledge and technology. Spearheaded again by the United States, in particular since the 1990s, hybrid organizational forms and the blurring of boundaries between university research and industrial application have been cherished both in theory and practice. However, doubts remain concerning the viability of conceptualizing universities and university researchers as economic actors. On the one hand, comparative analysis has shown that such concepts easily diffuse among policymakers, while their effectiveness is bound to particular circumstances which can hardly be found in settings that are different from the Silicon Valley or the San Diego biotechnology cluster. Casper (2007), for example, comes to a highly skeptical conclusion in his analysis of attempts at imitating these success stories in Europe. Furthermore, the intensification of close ties between university research and industrial application is not without serious concerns. Critics warn of the perils of "academic capitalism" (Slaugther and Leslie 1997; Slaughter and Rhoades 2004). Innovation systems are in need of a strong public research base which stands in contrast to the direct appropriation of research results through commercial activities. Likewise, the inherent uncertainties of academic research require an organization of work which is different from industrial application. Therefore, the long-term effects of current trends in university-industry relations have to be closely monitored by innovation researchers. In addition to this, further research on universities and innovation should focus in particular on two issues that have been widely neglected so far in the research presented above.

On the one hand, the intimate link between technological and social innovations should be further explored. The overwhelming majority of contributions in the field exclusively deals with technological innovations and the role universities play therein. Early insights by Smith, Marx, and Schumpeter on the mutual dependencies between technological and social change are mostly left out of sight. The examples are also manifold with regard to university research and innovation. The research laboratory as protected space where researchers could work and experiment without immediate economic or moral pressures is certainly a social innovation. Beginning at German universities in the mid-nineteenth century, this innovation rapidly diffused into industry as industrial laboratories were modeled accordingly and soon into other industrial countries. Though often forgotten, there is no doubt that the research laboratory as a new organizational form was responsible for many technological innovations that are so familiar to us. Likewise, one might argue that many technological innovations that are currently at the forefront of attention could only be fully understood if their related social innovations are also taken into account. One might think, for example, of open source software development where new and non-appropriatory forms of knowledge generation and sharing are developed which transcend traditional rules of the innovation process. Furthermore, if one broadens the agenda by also including social innovations, the contributions of many more academic disciplines and fields become visible as compared to technological innovations, where relevant university research stems from the natural sciences and engineering. Academic researchers, however, also contribute to social innovation processes by the participation in and the evaluation of new social arrangements, especially in local and regional settings. A second limitation of current research on universities and innovation is the overly strong focus on the research function of universities. Through this, mainly research-intense universities come into sight, and the contribution of universities by teaching and education is downplayed. Skills and competencies embodied in individuals educated and trained at universities are of paramount importance for fully understanding the role of universities in larger innovation processes. Such a focus would allow to include also less research-intense universities and a broader array of higher education institutions in current research on universities and innovation, and a richer picture of the multiplicity and heterogeneity of universities' contributions to innovation might emerge.

Cross-References

- ▶ Academic Entrepreneur, Academic Entrepreneurship
- ▶ Academic Entrepreneurship
- ▶ Higher Education and Innovation
- ▶ National Innovation Systems (NIS)
- ▶ Social Innovation

References

Casper S. Creating silicon valley in Europe: public policy towards new technology industries. New York: Oxford University Press; 2007.

Cohen WM, Levinthal DA. Absorptive capacity: a new perspective on learning and innovation. Adm Sci Q. 1990;35(1):128–52.

Geuna A, Muscio A. The governance of university knowledge transfer: a critical review of the literature. Minerva. 2009;47:93–114.

Kenney M, editor. Understanding silicon valley: the anatomy of an entrepreneurial region. Palo Alto: Stanford University Press; 2000.

Mansfield E. Academic research and industrial innovation. Res Policy. 1991;20(1):1–12.

Mowery DC, Nelson RR, Sampat BN, Ziedonis AA. Ivory tower and industrial innovation: university-industry technology transfer before and after the Bayh-Dole Act. Palo Alto: Stanford University Press; 2004.

Nelson RR. The simple economics of basic scientific research. J Polit Econ. 1959;67(3):297–306.

Shapin S. The scientific life: a moral history of a late modern vocation. Chicago: University of Chicago Press; 2008.

Slaughter S, Rhoades G. Academic capitalism and the new economy. Baltimore: Johns Hopkins University Press; 2004.

Slaugther S, Leslie LL. Academic capitalism: politics, policies, and the entrepreneurial university. Baltimore: Johns Hopkins University Press; 1997.

Unveil

▶ Invention Versus Discovery

User Innovators

▶ Entrepreneurship in Creative Economy

Using Movement, Music, and Humor - Creative Approaches to Enhance Student Engagement

Billy Strean
Faculty of Physical Education and Recreation, University of Alberta, Edmonton, AB, Canada

Synonyms

Creative music education; Interest and creativity

Key Concepts and Definition of Terms

Student Engagement

The phrase "student engagement" has come to describe "how *involved* or *interested* students appear to be in their learning and how *connected* they are to their classes, their institutions, and each other" (Axelson and Flick 2011, p. 38). Some teachers find that contemporary students display attitudes of simply wanting the information the teacher wants them to know for the test. Teachers and students may develop an unspoken pact whereby both parties get what they want; yet this seriously compromises real education. There is a continuum of what is meant by "student engagement" and an attendant range of benefits from capturing attention to facilitating deep learning. Particularly in higher education, where there tends to be enlarged focus on the cognitive domain and decreased concentration on physical and emotional considerations, it is valuable to include classroom approaches that begin with enhancing attention and move toward deepening learning.

Background: Attention and Discussion

The literatures on attention problems in lectures as well as patterns of discussions in groups support the merits of all the approaches suggested here. An additional basis for including movement, music, and humor in classroom settings emerges from our understanding of attention span in lectures. Various reports (e.g., Young et al. 2009) demonstrate that when listening to a lecture, attention drops precipitously after 10–30 min. Diverse teachers seek to combat attention problems with straight lecture by using discussion. Unfortunately, studies of student participation in these discussions found that in groups of five, the most engaged person contributes 43 %, but the least engaged member only contributes 7 %; in groups of eight, the least engaged five members contribute a mere 3–9 % (Gibbs 1992). One need only speculate slightly to imagine to how small an extent most members in a typically sized class will be engaged.

The challenges of attention and discussion may be overcome and the benefits of student engagement can be achieved by using many techniques and methods, including three advocated here: movement, music, and humor.

Approach 1: Movement

Due to these challenges of attention span, an excellent way to elevate energy and engagement is with physical movement. It is ideal when movement can be incorporated directly with the learning objectives of the day (see below), but short activities simply to shift attention and awaken the students is beneficial. Teachers can use their creativity to invent options that work best in their own contexts. Some examples include having all the students do some imaginary biking or hiking in their chairs. Or perhaps students can have a real or imaginary ball to pass around the room. It could be as basic as a simple "stand, stretch, and breathe" moment. Some instructors enjoy employing laughter exercises as they have the multiple benefits of mood enhancement, increased oxygen, and playful movement. In many situations, movement may facilitate learning, enhance class cohesion, offer an environment that promotes laughter and fun while engaging learners, and it can heighten students' interest in attending and participating in class. There are times when a teacher may notice either at the start of a class or during a session, that the group seems lethargic. (This happens frequently during mid-semester exam week.) By having students stand up and do some playful activities, it easily produces some laughs, increases the energy level, and gets the group more engaged in the learning that will follow.

An assortment of movements and activities can be essential in getting learning "into the body." The overall point is rather than speaking about a concept, students can live it. For example, instead of a discussion of rapport, students could work in pairs and do exercises that involve mirroring or a two-step. Other examples of using movement to teach bodily dispositions of leadership, flow and optimal performance, and how to embody humor have been elaborated elsewhere (Strean 2010).

Approach 2: Music

A second set of approaches to overcome attention challenges and to engage students involves the use of music. Music can humanize, personalize, and energize classrooms. Music may tap into students' interests and prompt positive feelings and associations. Music may assist in creating relevant and meaningful interactions between and among students. From a physiological viewpoint, there is mounting evidence that music can effectively stimulate highly pleasurable emotional responses (e.g., Krumhansl 1997; Rickard 2004). Other studies (such as those using techniques like neuroimaging) have supported those responses and shown improved functional and effective connectivity between regions of the brain related to reward and they offer insight into understanding why listening to music is such a gratifying and enjoyable experience. Interestingly, music-induced emotional states have been connected to release of dopamine, the chemical that sends "feel good" signals to the rest of the body. Music communicates straight to our emotions and it allows us to connect with the core of our aliveness. Music circumvents the cognitive filters and works wonders in a variety of ways to enhance student engagement. In addition to setting a mood or increasing energy, a well-chosen music clip can help to reinforce a learning point.

Approach 3: Humor

Although learning is serious business, heaviness and negative emotions can impede successful pedagogy. In addition to fostering valuable lightness, humor builds the teacher-student connection (e.g., Berk 1998), and this connection is essential for learning, satisfaction, and retention. Research demonstrates that with humor, students learn better and remember more; and absorb information more quickly and retain it longer. Furthermore, humor can assist teaching by offering amusement, breaking up content, captivating attention, lightening the mood, increasing motivation, reducing monotony, and providing a mental break. Humor escalates students' enjoyment of learning, perceptions of how much they learned and positive feelings about the course and instructor. Humor-based teaching is distinctly more engaging and interesting for the students and incorporating humor into the classroom can have a positive effect on learning in higher education. Interested readers can find more information on both the benefits of laughter and humor and specific strategies to use humor in the classroom elsewhere (e.g., Berk 1998; Strean 2008).

One of the easiest ways to incorporate humor into one's classes is using one's self as the easy target. By poking fun at one's self, a teacher can decrease the distance between students and "the professor." By showing one's own humanity and foibles, educators can make it easier for students to relax and to take risks. Particularly at the beginning of activities that may engender some anxiety, such as when students are about to participate in a novel task, humor can be especially effective to reduce tension and to enhance learning and performance.

Theoretical Background and Open-Ended Issues

Somatics

Somatics provides a valuable way of considering our students and ourselves that informs and supports the use of movement, music, and humor in learning. Although the seriousness of this background is in stark contrast to humor, it provides an important rationale for why the particular approaches advocated here are valuable in enhancing engagement and learning. The term "somatics," comes from *soma* – the body in its wholeness. From a somatic perspective, we cannot distinguish the self from the body. The characteristics that constitute the self (emotions, actions, beliefs, interactions, perceptions, ethics, morals, and drive for dignity) all emerge from the physical form (Strozzi-Heckler 2007). Somatics rejects the notion that there is a disembodied, self-contained self that is separate from the life of one's body. Clearly these ideas depart drastically from pervasive Cartesian discourses that have dominated and also posited a determinable, objective reality disconnected from subjective experience (Strean and Strozzi-Heckler 2009). The loss of somatic knowing and the worldview derived from Descartes's dualism carries its own logical conclusion: Since I have no immediate contact with any of the actualities of my everyday life, I can be deceived about any of them.

Most of our understanding of the mind and rationality are based on metaphors that are not supported by cognitive science. Take, for example, the persistent idea that rational thought is dispassionate. We know this to be incorrect from studies in neuroscience. Those who cannot be emotionally engaged in their lives cannot reason appropriately about moral issues. The traditional Western conception of the person with disembodied reason and an objective world has to be supplanted by the conception of an embodied person. Among the important implications for teaching and learning is the recognition of the centrality of emotion. All learning occurs in a mood and part of fostering student engagement includes attending to and managing the mood of the classroom.

Movement, music, and humor can reawaken our somatic awareness and assist fuller and deeper learning experiences.

Implications for Theory, Policy, and Practice

Early childhood educators seem to recognize readily the importance of supportive environments to foster effective learning. As we progress along the developmental spectrum of schooling, there appears to be a callousing and concomitant loss of consideration to the safety of the atmosphere, the importance of emotions, and the value of multisensory practice. In planning effective implementation of movement, music, and humor, educators can be reminded of these crucial and useful basics. A positive, enlivened, and active environment enhances both the experience and the outcomes of learning.

Conclusion and Future Directions

Increasing student engagement is serious business. Paradoxically, bringing some lightheartedness to the process tends to make us more effective. As we ponder and explore various methods to connect with and to engage our students, movement, music, and humor appear to be three valuable methods. As learning approaches and technologies continue to grow and change, the fundamental importance of human connection will remain central and may become progressively challenging to maintain. Attending to the core needs of students will improve engagement and learning.

Cross-References

- ► Creativity Training in Design Education
- ► Effects of Intuition, Positive Affect, and Training on Creative Problem Solving
- ► Intrinsic and Prosocial Motivations, Perspective Taking, and Creativity

References

Axelson RD, Flick A. Defining student engagement. Change. 2011;43:38–43. doi:10.1080/00091383.2011.533096.

Berk R. Professors are from mars, students are from snickers: how to write and deliver humor in the classroom and in professional presentations. Madison: Magna Publications; 1998.

Gibbs G. Discussion with more students: book 3 of the teaching more students project. Oxford: Polytechnics & Colleges Funding Council; 1992.

Krumhansl CL. An exploratory study of musical emotions and psychophysiology. Can J Exp Psychol. 1997;51:336–52. doi:10.1037/1196-1961.51.4.336.

Rickard NS. Intense emotional responses to music: a test of the physiological arousal hypothesis. Psychol Music. 2004;32:371–88. doi:10.1177/0305735604046096.

Strean WB. Evolving toward laughter in learning. Collect Essays Learn Teach. 2008;1:165–71.

Strean WB. Moving (literally) to engage students: putting the (physically) active in active learning. Collect Essays Learn Teach. 2010;3:33–7.

Strean WB, Strozzi-Heckler R. (The) body (of) knowledge: somatic contributions to sport psychology. J Appl Sport Psychol. 2009;21:91–8. doi:10.1080/10413200802575726.

Strozzi-Heckler R. Leadership dojo. In: Holman P, Devane T, Cady S, editors. The change handbook. 2nd ed. San Francisco: Berrett-Koehler; 2007. p. 239–43.

Young MS, Robinson S, Alberts P. Students pay attention! combating the vigilance decrement to improve learning during lectures. Act Learn High Educ. 2009;10:41–55. doi:10.1177/1469787408100194.

Utopian Socialism

► Entrepreneur in Utopian Thinking

V

Valuable

► Creativity in Puzzles, Inventions, and Designs: Sudden Mental Insight Phenomenon

Valuation

► Small Businesses - Value, Transmission, and Recovery

Values

► Creativity and Confucianism

Variation

► Product Innovation, Process Innovation

Varieties of Capitalism

► National Innovation Systems (NIS)
► Venture Capital and Small Business

Venture Capital and Small Business

Christian Poncet
ART-Dev, University of Montpellier, Montpelier CEDEX 01, France

Synonyms

Private equity; Risk management; Varieties of capitalism

Venture Capital Traders in Their Environment

Breakthrough innovations tend to be found in small innovating businesses which, in order to develop, must call on external funding. Therefore, the capital requirements of companies with high growth potential, become an obstacle for their development and, hence, for the innovation process which they provide. Therefore, the capital investors take on the role of privileged players in the small companies' finances, since this activity corresponds with strategies for the diversification of the fund managers' portfolios, as well as equity requirements which these companies express. The capital part of the investment, specifically dedicated to these growth start-up

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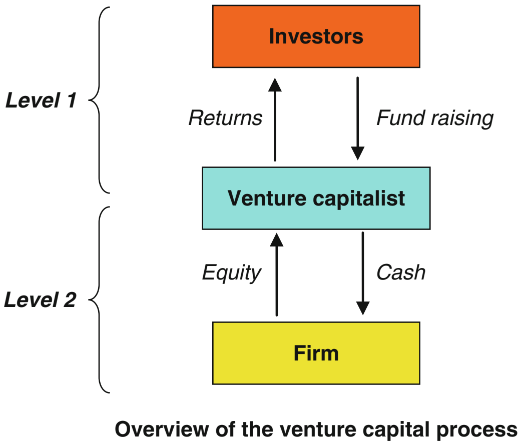
companies therefore takes the form of "venture capital." The term "*venture capital*" shows the use of funds which is typically created in the USA. From this perspective, moving to other environments which have the principles on which the setting up of these funds are based, like the strategies of those players who run it, raises the question of their performance, when they find themselves isolated from their original environment. If the principle of capital investment (and by extension, venture capital) is found in all forms of modern capitalism the traders' activity such as the guidance given for these investments is immersed in the context in which they form and develop. Each country (or group of countries) covers distinct attributes (legal, political, financial, scientific, etc.) inherited from its history which shapes the political, industrial, and financial environment within which the various actors evolve. Institutions and their purposes then represent for each country (or group of countries) the result of unique stories, which over time have contributed to the construction of different varieties of capitalism (in the terminology of Amable and the French regulationist school al. 1997). These varieties then generate environmental conditions which spread through the behavior of the players who grow in this setting. More specifically, the extent of the capital investor's knowledge in companies with high growth potential depends on the environment in which his operations are practiced. The role of venture capital traders in Anglo-Saxon countries and its place in the dynamics of support for small innovative companies stands out clearly from the activity of their namesakes in many European countries. Historically, the principle of *venture capital* appeared in the USA after World War II and even if the idea was created by an immigrant with French origin (the General Georges Doriot in 1946), it is resolutely embedded in the North American culture and history. The historical and cultural specifics of the USA involve the *venture capitalist* at all levels of the implementation. Although not exhaustive, those characteristics profoundly influence the source of the savings which feed these funds (notably through the existence of pension funds), the type of traders and the skills which they bring (the sharing of roles, the size, the degree of specialization), the nature and density of their networks, methods of public authorities' involvement (see below), or even the adaptability of the legal support activities *(common law)*. The observed differences in the roles of *venture capital* traders on both sides of the Atlantic, plunge their roots in the historical conditions which marked the construction of their respective environments.

Definition

In the USA, venture capital funds are presented "as independently managed, dedicated pools of capital that focus on equity or equity-linked investments in privately held, high-growth companies" (Gompers et Lerner 2004, p. 17). The expression: "independently managed" certainly includes a financial implication of the *venture capitalist* but also (and especially) a managerial one through the skills which he can pass on to the small business. Its position (see Fig. 1) at the interface between the fund manager (financial) and the entrepreneur (industrial), actually creates this dual function but only within the framework of an independent management. The attempt to imitate this activity in a different context (for example, in continental Europe) comes to extract the *venture capital* trader from his original environment. However, in an environment where the management of long-term savings and the financing of small businesses are mainly taken over by banking institutions and insurance companies (*bank based*), it seems natural to see a screenshot of the capital investor activity by these institutions. In this context, a sort of atrophy of the managerial dimension of the *venture capitalist* is produced for the benefit of its financial activity and this change is largely reflected in the trader's performance. Is it then appropriate to merge the two types of activity on either side of the Atlantic. The following presentation aims to show that the distance, which is between the two aspects of the financing of small innovative companies, only represents a continuation of the



Venture Capital and Small Business, Fig. 1 Overview of the venture capital process (Source: Gompers P. et Lerner J. 2004)

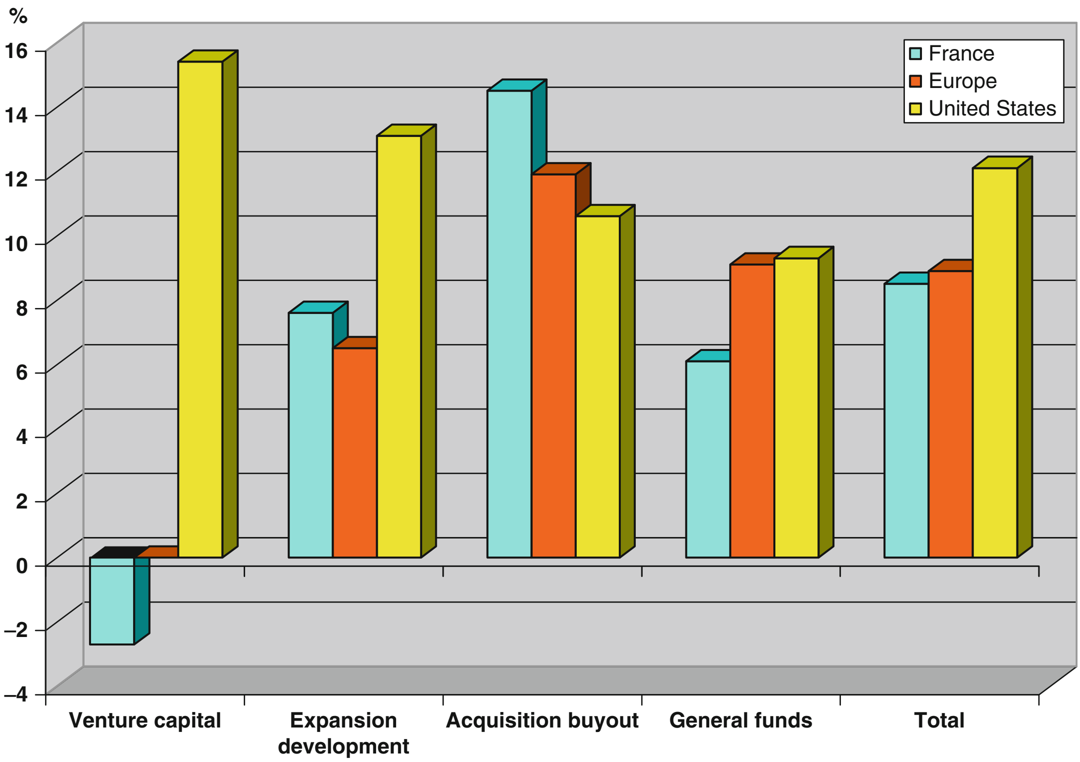
historical conditions at the origin of the construction of certain forms of capitalism.

The Construction of Venture Capital

An efficient construction of the "*venture capital cycle*" in the USA is based on four conditions which, outside the Anglo-Saxon context mentioned above, seem far from being fulfilled:

- The first resides in the existence of large enough funds, mainly oriented toward capital investment and picked up by *venture capitalists* (Since 1979, the modification of the Employee Retirement Income Security Act – ERISA – allows pension funds to invest in venture capital.) Pension funds come under special contribution schemes, traditionally underdeveloped in the majority of European countries (except the UK) which dominate the pay-as-you-go pension scheme principle.
- The second is based on the presence of independent (*venture capital*) traders that combine the functions of fund manager and manager, all in one institutional environment (legal and financial) ensuring a relative fluidity in the interventions. Now the plurality of available skills (financial, managerial techniques etc.), like the regulation of the players through specific markets, create a dynamic difficult to replicate in the European context (except the UK).
- The third states that the yield of the operation considerably depends on the conditions in which one leaves *venture capital* that is the intrinsic capacity of the environment to generate investors who are capable of taking over from the previous. Thus, the amount which this new transaction will reach will determine the level of capital gain reached through negotiation and, therefore, the efficiency of the operation. The scarcity of such take-overs in the environment of the investor limits the level of capital gains for which he can hope and, therefore, the attractiveness of the investment: the prospects for leaving greatly influence the entrance of investors in *venture capital*.
- The fourth condition relates to the selection of projects and companies who carry them out. Hence, the use of funding of the *venture capital* is based on the existence of relatively advanced projects which have benefited from previous support of a sufficient amount to allow them to develop. This process of developing innovative projects, acts as a filter by selecting and supporting companies which have strong potential for growth (particularly thanks to public aid and the existence of a dense network of *angel investors*). This implies that *venture capitalists* are generally only found in a limited number of companies (selection effect), for relatively high amounts (in relation to the progress of the project). Companies which do not reach this level of development then fall into the "*equity gap*," i.e., they can make the financial connection between the first support and a better longer-term capital investment.

An international comparison of private equity performance (Fig. 2) reveals a contrast between the mediocre results of the *venture capital* in Europe (which were even poor in France) and yields observed in the USA. These differences tend to make up for the other phases of the intervention of capital investment, even to reverse the "buyout acquisition." This graph clearly shows a profound difference in the yields obtained by the venture capital on both sides of the Atlantic. It is the result of a form of inadequacy among the European players (particularly French), the specific risk



Venture Capital and Small Business, Fig. 2 2009 comparison of the IRR calculated from the start of the funds, according to the operation stages (Sources AFIC, Ernst & Young, Thomson Reuters)

management implications of supporting a small innovative company, inadequacy for which the origins ought now to be found.

Environmental Influences on the Intervention Logic of the Venture Capitalist

As highlighted in Fig. 1, the fund manager (limited partners) directs a portion of the savings entrusted to him toward risk investments in order to diversify his portfolio (and possibly responding to public authority incentives).

This part is then captured by independent investors (general partners) who, in addition to funds raised, provide companies with their management skills and industrial, commercial, and legal networks... Thus, investment funds (pension funds, insurance, funds of hedge funds), by diversifying their investments in regards to *venture capital* traders, rely on an increase in expected total returns while limiting their risk exposure. The *venture capital* trader fundraises from these lessors, which he then invests in innovative companies. Both types of skills that the *venture capitalists* in the USA combine (financial and managerial) lead them to specialize in industrial targeted activities and specific stages of implementation.

The Venture Capitalists' Efficiency in the Market-Based Model

Industrial skills accumulated through the specialization of *venture capital* traders, create synergies with their financial activities, which reflects the overall performance of these investments. Indeed, the appropriate management of information on company activities, such as its environment (industrial, commercial, etc.), allow the venture capitalist to accurately evaluate the potential of a project (by its expertise potential and selection criteria), to closely follow its evolution and to provide advice and resources likely to favorably guide its development. The investor involvement at all levels contributes to a better risk assessment and a more rigorous monitoring of the company which ultimately enhances financial returns on the investment. The *venture capital* trader becomes a strategic component for the limited partner as part of a global management of its funds, its management particularly based on portfolio diversification.

To summarize, if the first level of involvement (level 1, in Fig. 1) is built mainly on the principle of financial management of portfolios (diversification of investments in limited partner), the second level (level 2) is based on expertise and managerial capabilities of the general partner. These skills become apparent from the moment of the venture capitalists selection process until his retirement from the company. The various roles which emerge from this presentation, gives the whole a genuine effective for the financing of small innovative companies, provided that the relationship between the various operators are part of a friendly environment. This environment is particularly expressed by the nature of institutional structures responsible for the regulation of trade and, in the USA, markets tend to emerge as the dominant form (*market based*). In this country, and despite appearances, the public authorities heavily influence the running of the process, but generally favoring incentive schemes that aid private initiatives. The effects stemming from the levers of public authority intervention are an excellent example in the implementation of the Small Business Investment Company Program (SBIC) in the USA in 1958 (see Box 1). Three examples illustrate the procedures for public authority intervention in this country, accompanying the dynamics generated by the markets while integrating the constraints imposed by the financing of small innovative companies:

- They are financially involved at the beginning of the process but by limiting their involvement, by a systematic research of leverage and financial independence of public bodies (see the case of the Small Business Administration – SBA – presented in the box).
- Financial innovations also help the process, through making tools available which improve risk management, particularly through items better suited to the constraints faced by *venture capital* investors (hybrid titles, Cumming and MacIntosh (2001), Gompers (1998), Kaplan and Strömberg (2001)).
- Finally, to ensure the traders' output, and thus to encourage them to enter into the process, public authorities are involved in the creation and regulation of ad hoc markets facilitating assets negotiations venture capital operations.

These three examples illustrate the ways of supporting small innovative companies through public policies which are based on market regulation, limiting a direct intervention by the various players.

Box 1: The Small Business Investment Companies (SBIC)

The SBICs, created in 1958 are private investment companies involved in the financing of small businesses with high growth potential (whose net assets are less than 18 million dollars and who have a net profit which has not exceeded six million dollars over the past 2 years). These companies are under the supervision of the Small Business Administration (SBA created in 1953), federal structure that gives them a license, after the applicant for SBIC status has raised five to ten million dollars of private capital, which corresponds to regulatory capital.

The SBIC must then maintain this level of capital in order to keep the license. Once the license has been obtained, the SBICs have the possibility of financing themselves by issuing bonds or equity securities, guaranteed and sometimes purchased by the SBA (by paying 3 % of the nominal value of the operation and then 1 % per year on the amount of debt still outstanding and equity securities issued). Finally, the SBA imposes a share of profits from the SBIC (around 10 %). In exchange, the SBA provides a guarantee to investors (*limited partner*), which covers the principal as well as the interest. Concerning equity securities that are the main source of funding for SBICs, for every dollar raised from private investors, it can receive $2 from the SBA in the form of equity. Finally, the SBA is financed by trading on the securities markets, guaranteed by offering buyers an interest rate equal to that of treasury bonds over 10 years, plus a premium based on market conditions. For its part, the SBIC may only invest in smaller companies and ones eligible under the criteria set by the SBA. These criteria stipulate that they may not exceed 18 million dollars in net assets and six million dollars in net profit, on average for the last 2 years. Investments in companies take many forms, loans, equity loans, or investments on the level of equity. Finally, the public funds are only involved to a limited extent because the SBA is financed by bond issue and, under these conditions, the effects of leverage for public funds are also very important. Since its creation (in 1958), the SBIC program has funded 58.2 billion dollars (2009 figures), more than 107,000 small businesses. During 2009, 11 new SBICs obtained a license bringing the total number to 315 for 16.8 billion dollars of capital. In 2010, (US Small Business Administration 2011) amounts invested amounted to two billion dollars business in 2,455 businesses (an average of 834,000 dollars per company) and one third of these funds have funded enterprises under the age of 2 years, 93 % of these sums are directed to capital investments in small businesses. For comparison, the very year 2010 (Venture Capital Association 2011), total investments in venture capital reached 21.8 billion dollars in the USA, allowing the financing of 3,276 companies ($6.7 million on average per company). This data allows two comments to be made which show the importance of SBICs in the US model: They finance a large number of companies (40 % of businesses supported are supported by the SBICs) and they are funding companies whose needs are proving far less great than those supported by risk-capital, they are positioned so as not to compete for risk-capital but upstream, reducing the problem of the equity gap for the companies concerned.

The Establishment of *Venture Capitalists* in the *Bank-Based* World

By continuing this presentation, it is brought to light that the paramount role played by markets in the USA in the financing of small innovative companies (*market based*), opposes the sustained involvement of the banking and financial system (*bank based*) in many countries in continental Europe. This distinction (already highlighted in Black and Gilson 1998) can be considered as the emerging part of a deeper partition between "varieties of capitalism" (Hall and Soskice 2001; Hall and Gingerich 2009). The predominance of regulation by the market (*market based*) actually does allow the emergence of a clear distinction between *limited partner* and *general partner*, a distinction upon which the prerogatives of the *venture capitalist* rest. But in a *bank based* context, such separation sharply fades and even tends to disappear as a form of vertical integration carried out by a bank or insurance company. In this case, the financial logic to which these traders conform takes over the managerial dimension of *venture capitalists*. However, the effective management of *venture capital* funds in the US model is based particularly on a risk assessment which requires the collection of relevant information about the target company.

For example, this risk assessment starts with the expertise that the venture capitalist can bring to a project, it continues through their involvement in business management and the knowledge which it allows him to improve, and can finally include his expertise in negotiations over the company release. On the contrary, in a *bank-based* model, an investor from a bank or financial institution addresses the question of risk in a more sensitive and often less precise way, and this perception is combined with an often prudential attitude which investors traditionally adopt. The combination of these two attitudes causes the trader to significantly reduce his commitments in operations which are too risky, to transfer them to safer capital investments (capital transfer or general funds). Under these conditions, with the scarcity of available funds to invest in innovative small firms, if a withdrawal of *venture capital* traders from their managerial function is superimposed, the reference model (such as the US model) is deprived of the main components which contribute to its effectiveness. In countries dominated by the *bank-based* model, the public authority involvement in supporting innovative companies takes two directions which are often complementary, helping to compensate for the absences revealed previously: a tax incentive to channel savings toward investments in companies with high growth potential (mutual fund investments in innovation – innovation funds – or Local Investment Fund – PIF), accompanied by an often direct involvement in the financing of small innovative firms (e.g., regional venture capital funds).

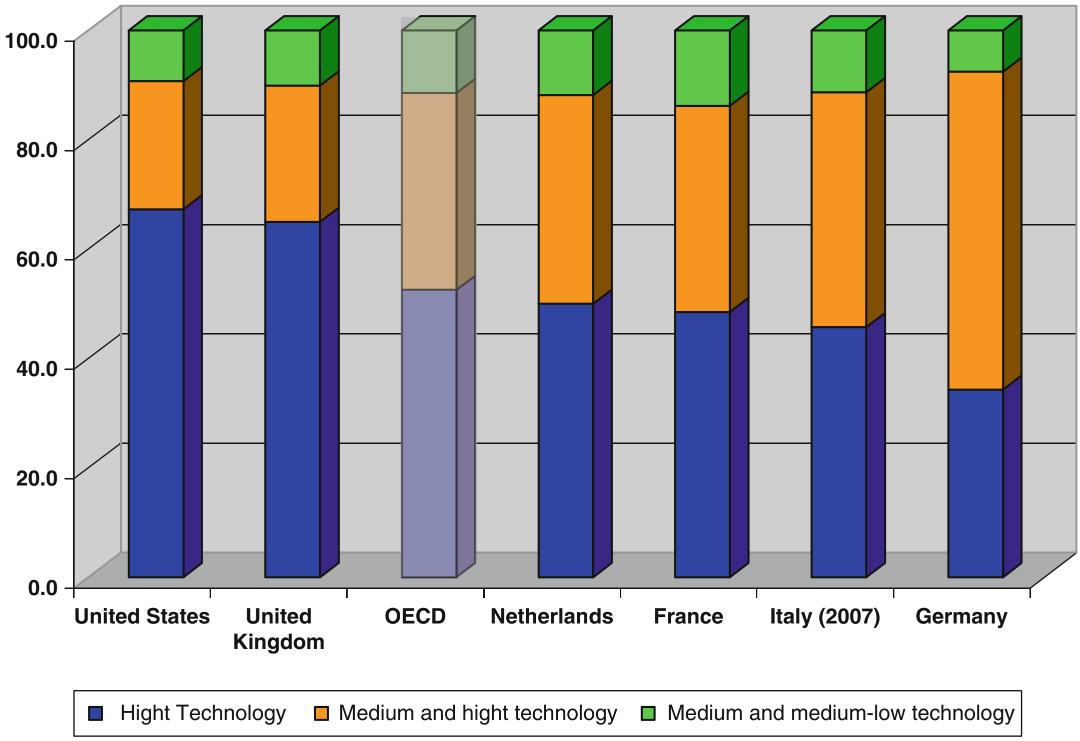
Implications on the Dynamics of Innovation

The *bank-based* context therefore places the venture capital activity in a situation radically different from the one observed in the USA, and these differences lead to differences in profitability as shown in Fig. 2. The sustained profitability which the *venture capital* investments generate in the USA, justifies the influx of funds for this type of investment but also their appeal to a significant number of venture capitalists. The attractiveness of this investment goes far beyond this upstream, stimulating a record number of *angel investors*, which play an essential role in the emergence of innovative small businesses. Downstream, the differences observed between the *bank-based* and *market-based* models extend in the direction of industrial investment in research and development (see Fig. 3) and, therefore, in the very nature of the innovations which result. The breakthrough innovations concentrated in small firms, regions of the world having developed effective support structures (particularly, by sustained investment in venture capital in a market based context), also correspond to those where investments in high technology develop.

In summary, from the observations above, it can be argued that the dynamics of *venture capital* traders in Anglo-Saxon countries is right at the origin of the observed differences in Fig. 3, with respect to investments in high technology. The domination of the *bank-based* model in continental Europe, and thus the limitation in the *venture capitalists*' prerogatives, directs support to less risky operations and more assured yield (medium and low technology).

Conclusions and Future Directions

Since the 1980s, following the Anglo-Saxon models, market regulation tends to become the essential reference to bring more efficiency to the economic systems. Without returning to the ideological assumptions that support these claims, one cannot fail to notice that this movement has led many countries to encourage the emergence of market forms of regulation at the expense of traditional modes of coordination which traditionally prevailed (public, social-democrat...) (Amable et al. 1997). This trend implies a gradual transformation of institutional dominant structures and therefore profound structural changes for the companies concerned. Therefore, there seems to be a contrast between the slow pace of institutional transformations and the more sustained changes imposed by public policy. The financing of small innovative firms is completely in line with the shift that is emerging from the long-term institutional changes and the shorter one of the expected impact of the implementation of public policies. It is from the disjunction observed in these time frames, that the gap is widening between the venture capital delay in the bank-based model, with the relative efficiency observed in the market-based model. Thus, (short term) public policy such as is developed in many European countries, operate



Venture Capital and Small Business, Fig. 3 Research Business Development in the manufacturing sector classified according to their technological intensity as a percentage of the internal expenditure on research and development companies in the manufacturing sector (2006) (Source: OECD, (2009))

on narrow segments, isolated from support for small innovative companies (taxation, public investment funds, public support for the creation etc.), in a (bank based) environment which does not adapt fast enough to support these measures (and therefore even dampens the effects sometimes). For example, an incentive fund aiming to provide capital-risk funds (Innovative Mutual Funds in France, for example) far from leading to the emergence of *venture capital* traders (in its Anglo-Saxon sense), leads to support of these funds by the institutions (banks and insurance companies) which already structure the *bank-based* model. Therefore, in the absence of an environmental (long term) transformation, these public interventions generally reinforce the role of banking institutions and insurance companies, and thus make the direct involvement of public authorities durable. If these public policies to support small innovative companies do not prove themselves to be totally ineffective in many continental European countries, they do not make it evident, on the development of a system of financing small innovative companies as effective as in the Anglo-Saxon countries. These measures, rather than changing the environment and cause a shift toward a *market-based* model, often tend to reinforce the interventionist character of the public authorities, and therefore the influence of banks or insurance companies. The whole question then lies in how to design structures for financing of small innovative companies adapted to the context in which they operate. This is the major challenge that confronts the innovation process in a *bank-based* model. In addition, the *market-based* model inexorably links the innovation dynamic with the fluctuations observed in financial markets. However, does the question of dependence not contest the effectiveness of a model which submits the financing of innovation to the operation of these markets? The drop in investments in small innovative companies in the USA during the last financial crisis reinforces the relevance of the question.

Cross-References

▶ Angel Investors
▶ Business Start-Up: From Emergence to Development
▶ Entrepreneurship Financing
▶ Financing Entrepreneurship

References

Amable B, Barré R. et Boyer R. Les systèmes d'innovation à l'ère de la globalization. Economica, Paris; 1997.
Black BS, Gilson RJ. Venture capital and the structure of capital markets: bank versus stock markets. J Financ Econ. 1998;47:243–77.
Cumming DJ, MacIntosh JG. Venture capital investment duration in Canada and the United States. J Multinat Financ Manage. 2001;11:445–63.
Gompers P. An examination of convertible securities in venture capital. Working paper, Harvard Business School, 1998.
Gompers P, Lerner J. The venture capital cycle. 2nd ed. Cambridge: MIT Press; 2004.
Hall P, Gingerich D. Varieties of capitalism and institutional complementarities in the political economy: an empirical analysis. Br J Polit Sci. 2009;39(3): 449–82.
Hall P, Soskice D, editors. Varieties of capitalism: the institutional foundations of comparative advantage. Oxford: Oxford University Press; 2001.
Kaplan S, Strömberg P. Venture capitalists as principals: contracting, screening, and monitoring. Am Econ Rev. 2001;91:416–30.
National Venture Capital Association. Corporate VC stats as of 12/31/2010 by year. Arlington; 2011.
U.S. Small Business Administration. SBIC program financing to small businesses – fiscal year 2010: use of proceeds by the financed businesses. Washington, DC; 2011.

Vision

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X

X-Inefficiency and Innovation

▶ Organizational Slack and Innovation

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List of Terms

CREATIVITY – INDICATIVE LIST OF TERMS

4P-model
Adaptive creativity
Art and business
Associations
Barriers (cognitive, cultural, social, etc)
Brainstorming
Business creativity
Change management
Combination
Communications
Conflicts
Continuous creativity strategy
Convergent thinking
Creative behavior
Creative class
Creative climate
Creative climate assessment
Creative decision support systems
Creative destruction
Creative economy
Creative Education
Creative employee / workers
Creative industries
Creative intelligence
Creative knowledge environments
Creativity policy (policies)
Creative leadership
Creative management
Creative occupations
Creative person
Creative potential
Creative problem solving
Creative process
Creative product
Creative skills
Creative software
Creative styles
Creative styles assessment
Creative techniques
Creative tests
Creative thinking
Creative training programs
Creative ventures
Creativity across cultures
Creativity and age
Creativity and culture
Creativity and decease
Creativity and democracy
Creativity and dictatorship
Creativity and entrepreneurship
Creativity and innovation
Creativity and invention
Creativity and knowledge
Creativity and labor
Creativity and leadership
Creativity and psychological health
Creativity and wisdom
Creativity assessment
Creativity cultivating
Creativity development
Creativity economy
Creativity in advertisement
Creativity in business
Creativity in science
Creativity in the military
Creativity levels
Creativity management
Creativity optimization
Creativity psychology

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Creativity sociology
Creativity theories
Creatology, the science of creativity
Cross-cultural studies on creativity
Cultural environment
Cultural impact
Definitions of creativity
Destructive creativity
Divergent thinking
Everyday creativity
Financial creativity
Focal object technique
Gender differences
Gestalt
Group creativity
Heuristics techniques
Idea
Ideal Final Result (IFR)
Individualism-Collectivism
Innovative creativity
Investments in creativity
Kaizen
Learning / Training Centers
Measuring creativity
Morphological method
Motivation
Music and business creativity
Myths on creativity
National programs on creativity development
Newness
Novology, the science of newness
Organizational creativity
Organizational culture
Organizational structure
Paradigm
Political creativity
Pragmatic approach
Problem
Problem matrix
Problem solving
Random stimulus
Randomness
Risk
Social aspects
Social creativity
Social environment
Stimulation

INVENTION – INDICATIVE LIST OF TERMS

Ability Identification
Affect and creativity
Analogies and analogical reasoning
Artistic creativity versus scientific discovery in invention
Beliefs about creativity in invention
Brainstorming and invention
Chance-configuration theory of scientific creativity and invention (
Cognitive components of creativity in invention
Confluence models of creativity in invention
Corporate creativity
Creative products and creative processes
Creativity and design as exploration
Creativity and the need for being original
Creativity in product invention
Creativity in science
Creativity, intelligence and personality
Creativity in the classroom
Creativity Research
Creativity support tools: accelerating discovery and invention
Deliberate practice and the development of expertise
Distributed and shared creativity
Divergent versus convergent thinking
Emotional components of creativity in invention
Evaluation Criteria
Experiments with Computational Creativity
Flow and the Psychology of Discovery and Invention
Freedom and constraints in creativity
Generality versus domain specificity in inventions
Guided discovery learning
Imagery and creativity
Incubation and illumination in creativity
Individual Characteristics
Inductive learning and reasoning
Insight and problem solving
Intrinsic and prosocial motivations, perspective-taking, and creativity
Intuition, Insight, Imagination and Creativity
Invention as social act

Managing Creativity in Small Worlds
Managing invention and innovation
Mathematical creativity
Measuring the capacity to think creatively in invention
Metacognition in creativity
Metaphors and models in creative invention
Methods of research on creativity
Model construction and invention
Modeling co-creativity in art and technology
On creative ideas and creative people
Ordinary versus extraordinary thinking in creativity
Past Success and Creativity over Time
Performance Factors
Personality Traits
Problem solving
Real word modelling and invention
Psychology of invention
Social psychology of creativity
Strategic thinking and creativity
Technological change
Technological creativity
The creative leap
The creative personality
The creative personality in the arts and sciences
Theories of creativity in invention
Unconscious thinking in creative invention
Understanding creativity and invention

INNOVATION – INDICATIVE LIST OF TERMS

Academic Firm (and Commercial Firm)
Ambidexterity (and Innovation)
Applied Research
Arts and Innovation (Artistic Innovation)
Basic Research (Academic Research)
Citizen Science
Clinical Innovation
Creative Knowledge Environments (and Innovation)
Darwenian Sea
Democracy of Knowledge
Democratic Innovation (Democracy Innovation)
Democratizing Innovation
Digital Divide
Disruptive Innovation
Early Adopters
Early Mover
Economic Innovation
Educational Innovation
Energy Innovation
Epistemic Governance (Governing Knowledge)
Evaluation of Innovation
Evolution of Innovation (Evolution and Innovation)
Experimental Development
Fast Follower (Late Follower)
Future Innovation
Global Innovation
Governance of Innovation (Governance by Innov.)
Health Innovation System
Incremental Innovation
Induced Innovation
Innovation and Creativity
Innovation and Growth
Innovation and Knowledge
Innovation and Migration
Innovation and/or Invention (Innov. vs. Invention)
Innovation Culture
Innovation Economics
Innovation Financing
Innovation in the Arts
Innovation in the Sciences
Innovation in Writing
Innovation Leadership
Innovation Management
Innovation Networks
Innovation Paradigms (Shift)
Innovation Policy (Innovation Policies)
Innovation Saturation
Innovation Technology
Innovative Entrepreneur
Institutional Innovation
Interdisciplinarity (Interdiciplinary)
Knowledge Democracy
Knowledge Economy
Knowledge Society
Linear Model of Innovation
Linguistic Innovation
Market Innovation
Mode 1 and Mode 2

Mode 3
Multi-Level Innovation Systems
National System of Innovation
Networks (Innovation Networks)
Non Knowledge-Based Innovation
Non-Economic Innovation
Non-Linear Model of Innovation
Open Innovation
Organizational Innovation
Pasteur's Quadrant
Personal Genomics
Political Innovation (Political Innovations)
Process Innovation
Product Innovation
Public-Private Partnerships
Quadruple and Quintuple Helix
Quality Assurance / Quality Enhancement of Innovation
Quality Management of Innovation

ENTREPRENEURSHIP – INDICATIVE LIST OF TERMS

Academic entrepreneurship
Accompaniment and business creation
Angel Investors
Biotech entrepreneurship
Business Culture
Business cycles
Business Incubation
Business Model
Business plan
Clusters
Co-conception and entrepreneurial strategies
Craftsman
Creative Destruction
Cyber-entrepreneurship and proximity relationships
Digital economy and business creation
Entrepreneur
Entrepreneur's Resources potential
Entrepreneur's Social capital
Entrepreneur's Social Responsibility
Entrepreneurial Capability
Entrepreneurial Competency
Entrepreneurial Leadership
Entrepreneurial organization
Entrepreneurship education
Entrepreneurship in developing countries
Entrepreneurship Policy (global and local)
Financing entrepreneurship
Green Business and entrepreneurship
Incentives for enterprise creation (market, legal, financial)
Individual initiative (individual determinants)
Industrial Atmosphere and small business creation/development
Industrial Emergence and shakeout
Information asymmetries and business creation
Innovation and Entrepreneurship
Innovative Milieu
Innovator
Intellectual Property and entrepreneurial strategies
Interactive process and new entrepreneurship
Intrapreneurship (internal venture)
Knowledge capital
Love money
Love Money
Management and Entrepreneurship
Market potential and business creation (environmental determinants)
Microfirms
Network and entrepreneurship
Open Innovation and entrepreneurship
Partnerships and entrepreneurship expansion
Patents and entrepreneurship
Product development and business concept
Proximity and entrepreneurship
Psychological aspects of entrepreneurial dynamics
Risk, Uncertainty and business creation
Small Business
Small enterprises and entrepreneurial alliances
Social entrepreneurship
Social network and entrepreneurship
Start-up
Technology Push and Market Pull Entrepreneurship
Territories and business creation and location
The Schumpeterian entrepreneur
Trajectory
Venture Capital

List of Entries

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This encyclopedia includes no entries for Y and Z.