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Encyclopedia of Production and Manufacturing Management

Paul Swamidass, *Auburn University*



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**ENCYCLOPEDIA OF PRODUCTION
AND MANUFACTURING
MANAGEMENT**

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ENCYCLOPEDIA OF PRODUCTION AND MANUFACTURING MANAGEMENT

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Printed on acid-free paper.

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To my parents:
Jacob M. and Gnanam Swamidass

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- Accounting System Implications of TOC, *Monte R. Swain, Stanley E. Fawcett, Brigham Young University, USA.*
- Activity-Based Costing, *Monte R. Swain, Stanley E. Fawcett, Brigham Young University, USA.*
- Activity-Based Costing: An Evaluation, *M. Michael Umble, Baylor University, USA; Elisabeth J. Umble, Texas A&M University, USA.*
- Aggregate Plan and Master Production Schedule Linkage, *Chen H. Chung, University of Kentucky, USA.*
- Agile Logistics (Enterprise Logistics), *Noel P. Greis, John D. Kasarda, University of North Carolina, Chapel Hill, USA.*
- Agile Manufacturing, *Pratrap S. S. Chinnaiah, Sagar V. Kamarthi, Northeastern University, USA.*
- Assembly Line Design, *Patrick R. McMullen, Auburn University, USA.*
- Balanced Scorecards, *Ramachandran Ramanan, University of Notre Dame, USA.*
- Bullwhip Effect in Supply Chain Management, *Hokey Min, University of Louisville, USA.*
- Capacity Management in Make-to-Order Production Systems, *V. Sridharan, Clemson University, USA.*
- Capacity Planning: Long-Range, *Gregory P. White, Southern Illinois University at Carbondale, USA.*
- Capacity Planning: Medium-and Short-Range, *Gregory P. White, Southern Illinois University at Carbondale, USA.*
- Capital Investment in Advanced Manufacturing Technology, *Ranga Ramasesh, Texas Christian University, USA.*
- Concurrent Engineering, *Morgan Swink, Michigan State University, USA.*
- Core Manufacturing Competencies, *Morgan Swink, Michigan State University, USA.*
- Core Manufacturing Competencies and Product Differentiation, *Morgan Swink, Michigan State University, USA.*
- Cost Analysis for Purchasing, *Robert B. Handfield, Michigan State University, USA.*
- Customer Service, Satisfaction, and Success, *Stanley E. Fawcett, Brigham Young University, USA; M. Bixby Cooper, Michigan State University, USA.*
- Customer Service Through Value Chain Integration, *Richard E. White, University of North Texas, USA; John N. Pearson, Arizona State University, USA.*
- Disaggregation in an Automated Manufacturing Environment, *Chen H. Chung, University of Kentucky, USA.*
- Dynamic Kanban Control for JIT Manufacturing, *Kendra E. Moore, ALPHATECH, Inc., USA; Elif Kizilkaya, Northeastern University, USA; Suren-dra M. Gupta, Northeastern University, USA.*
- Dynamic Routing in Flexible Manufacturing Systems, *H. Joseph Wen, Kenneth D. Lawrence, New Jersey Institute of Technology, USA.*
- Electronic Data Interchange in Supply Chain Management, *Hokey Min, University of Louisville, USA.*
- Environmental Issues and Operations Management, *Robert Klassen, University of Western Ontario, Canada*
- Environmental Issues: Reuse and Recycling, *Suren-dra M. Gupta, Pitipong Veerakamolmal, Northeastern University, USA.*
- Facilities Location Decisions, *Basheer M. Khumawala, Sukran N. Kadipasaoglu, University of Houston, USA.*
- Flexibility in Manufacturing, *Kenneth K. Boyer, DePaul University, USA.*
- Flexible Automation, *Kathryn E. Stecke, Rodney P. Parker, The University of Michigan, USA.*

- Focused Factory, *Paul M. Swamidass, Neil Darlow, Auburn University, USA.*
- Forecasting Examples, *Benito E. Flores, Texas A&M University, USA.*
- Forecasting Guidelines and Methods, *Nada R. Sanders, Wright State University, USA.*
- Forecasting in Manufacturing Management, *Benito E. Flores, Texas A&M University, USA.*
- Global Facility Location Analysis, *Marc J. Schniederjans, University of Nebraska-Lincoln, USA.*
- Global Manufacturing Rationalization, *Stanley E. Fawcett, Kristie Seawright, Brigham Young University, USA.*
- History of Manufacturing Management, *James M. Wilson, Glasgow University, UK.*
- Human Resource Issues and Advanced Manufacturing Technology, *Corinne M. Karuppan, Southwest Missouri State University, USA.*
- Human Resource Issues in Manufacturing, *Thomas W. Dougherty, University of Missouri, USA; George F. Dreher, Indiana University, USA.*
- International Manufacturing, *Arnoud De Meyer, INSEAD, France.*
- Inventory Flow Analysis, *Edward W. Davis, University of Virginia, USA.*
- ISO 9000/QS-9000 Quality Standards, *James R. Evans, University of Cincinnati, USA.*
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- Kanban-Based Manufacturing Systems, *S. Sengupta, Oakland University, USA; S.P. Dutta, University of Windsor, Canada.*
- Lean Manufacturing Implementation, *JT Black, Auburn University, USA.*
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- Logistics: Meeting Customers' Real Needs, *Stanley E. Fawcett, Brigham Young University, USA.*
- Maintenance Management Decision Models, *Frank A. Van der Duyn Schouten, Tilburg University, The Netherlands.*
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- Manufacturing with Flexible Systems, *Paul G. Ranky, New Jersey Institute of Technology, USA.*
- Mass Customization, *Rebecca Duray, University of Colorado at Colorado Springs, USA.*
- Mass Customization and Manufacturing, *Pratap S. S. Chinnaiah, Sagar V. Kamarthi, Northeastern University, USA.*
- MRP (Material Requirements Planning), *V. Sridharan, R. Lawrence LaForge, Clemson University, USA.*
- MRP Implementation, *Chee-Chung Sum, Kwan-Ke Ng, National University of Singapore, Singapore.*
- New Product Development Through Supplier Integration, *Robert B. Handfield, Michigan State University, USA.*
- Order Release, *Jeffrey W. Herrmann, University of Maryland, USA.*
- Outsourcing of Product Design and Development, *Hilary Bates, University of Warwick, UK; David Twigg, University of Brighton, UK.*
- Performance Excellence: The Malcolm Baldrige National Quality Award Criteria, *James R. Evans, University of Cincinnati, USA.*
- Performance Measurement in Manufacturing, *Gregory P. White, Southern Illinois University at Carbondale, USA.*

- Process Approach to Manufacturing Strategy Development, *K. W. Platts, University of Cambridge, UK.*
- Process Industry Scheduling, *Sam G. Taylor, University of Wyoming; Steve Bolander, Colorado State University, USA.*
- Process Innovation, *Danny Samson, David Chalis, University of Melbourne, Australia.*
- Product Design, *Debashish N. Mallick, Boston College, USA.*
- Product Design for Global Markets, *K. Ravi Kumar, University of Southern California, USA; George C. Hadjinicola, University of Cyprus, Cyprus.*
- Product Development and Concurrent Engineering, *Christopher H. Loch, INSEAD, France; Christian Terwiesch, University of Pennsylvania, USA.*
- Product Innovation, *Danny Samson, University of Melbourne, Australia.*
- Product-Process Dynamics, *Paul M. Swamidass, Neil R. Darlow, Auburn University, USA.*
- Project Management, *James P. Lewis, The Lewis Institute, Inc., USA.*
- Purchasing: Acquiring the Best Inputs, *Stanley Fawcett, Brigham Young University, USA.*
- Purchasing: The Future, *Larry C. Giunipero, Florida State University, USA.*
- Quality Management Systems: Baldrige, ISO 9000, and QS 9000, *James R. Evans, University of Cincinnati, USA.*
- Quality: The Implications of Deming's Approach, *Elisabeth J. Umble, Texas A&M University, USA.*
- Reengineering and The Process View of Manufacturing, *Timothy L. Smunt, Wake Forest University, USA.*
- Resource Planning: MRP to MRPII and ERP, *V. Sridharan, R. Lawrence LaForge, Clemson University, USA.*
- Robot Selection, *Moutaz Khouja, University of North Carolina, Charlotte, USA; O. Felix Offodile, David E. Booth, Michael Suh, Kent State University, USA.*
- Safety Stocks: Luxury or Necessity, *R. Nat Natarajan, Tennessee Technological University, USA.*
- Schedule Stability, *R. Lawrence LaForge, Clemson University, USA; Sukran N. Kadipasaoglu, University of Houston, USA; V. Sridharan, Clemson University, USA.*
- Scientific Management, *James M. Wilson, Glasgow University, UK.*
- Setup Reduction, *John Leschke, University of Virginia, USA.*
- Simulation Analysis of Manufacturing and Logistics Systems, *Enver Yücesan, INSEAD, France; John W. Fowler, Arizona State University, USA.*
- Simulation Languages, *David L. Olson, Texas A&M University, USA; James R. Evans, University of Cincinnati, USA.*
- Simulation of Production Problems Using Spreadsheet Programs, *David L. Olson, Texas A&M University, USA; James R. Evans, University of Cincinnati, USA.*
- Simulation Software Selection, *Enver Yücesan, INSEAD, France; John W. Fowler, Arizona State University, USA.*
- SMED, *JT Black, Auburn University, USA.*
- Statistical Process Control Using Control Charts, *Amitava Mitra, Auburn University, USA.*
- Supplier Partnership as Strategy, *Brian Leavy, Dublin City University, Ireland.*
- Supplier Performance Measurement, *Robert B. Handfield, Michigan State University, USA.*
- Supplier Relationships, *Thomas F. Burgess, University of Leeds, UK.*
- Supply Chain Management: Competing Through Integration, *Stanley E. Fawcett, Brigham Young University, USA.*
- Synchronous Manufacturing using Buffers, *M. Michael Umble, Baylor University, USA.*
- Target Costing, *Ramachandran Ramanan, University of Notre Dame, USA.*
- Teams: Design and Implementation, *John K. McCreery, North Carolina State University, USA; Matthew C. Bloom, University of Notre Dame, USA.*
- Theory of Constraints in Manufacturing Management, *Monte R. Swain, Stanley E. Fawcett, Brigham Young University, USA.*
- Total Productive Maintenance (TPM), *Kathleen E. McKone, University of Minnesota, USA; Elliot N. Weiss, University of Virginia, USA.*
- Total Quality Management (TQM), *R. Nat Natarajan, Tennessee Technological University, USA.*
- U-Shaped Assembly Lines, *Gerald Aase, Northern Illinois University, USA; Robert F. Jacobs, Indiana University, USA.*
- Virtual Manufacturing, *Pratap S. S. Chinnaiah, Sagar V. Kamarthi, Northeastern University, USA.*

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Manufacturers and Organizations Discussed in the Encyclopedia

One of the special features of this encyclopedia is that it gives several real life examples from manufacturing firms from around the world. The list below contains over 100 manufacturers, from the U.S., Japan, Europe, Korea and other nations. In addition, it includes trucking and transportation companies and leading retailers, who are used as examples in various articles. Some manufacturers such as Chrysler, GM, IBM, Motorola, and Toyota are discussed in several articles.

Manufacturers and organizations are listed on the left column. The articles in which the organization is mentioned are listed in the right column.

Organization	Article where discussed
3M	Environmental issues and operations mgmt. JIT evolution and use in the United States New product development through. . .
ABB Group	Environmental issues and operations mgmt.
ADAC Laboratories	Performance excellence: The Malcolm. . .
Aerotech Services Corporation	Virtual manufacturing
AIAG	JIT evolution and use in the United States
Albany International	Just-in-time manufacturing implications
Allegheny Ludlum Corporation	Core manufacturing competencies
Allen Edmonds Shoe Corporation	Supplier performance measurement
Allen-Bradley	Core manufacturing competencies and. . .
Allied-Signal	Purchasing: Acquiring the best inputs
Amdahl	Supplier partnership as strategy
Anderson Windows	Mass customization and manufacturing
Anheuser-Busch	Facilities location decision
ANSI	Electronic data interchange in supply chain ISO 9000/QS 9000 quality standards
Apple	Supplier partnership as strategy
Applied Materials, Inc.	Virtual manufacturing
Applied Services Corporation	Virtual manufacturing
Army Ordnance	Quality: The implications of Deming's. . .
ASA	Quality: The implications of Deming's. . .
ASME	Quality: The implications of Deming's. . .
ASQC, ASQ	ISO 9000/QS 9000 quality standards
ASTM	Quality: The implications of Deming's. . .

Organization	Article where discussed
AT&T	Agile manufacturing
Auto Air	Environmental issues: Reuse and recycling
AVO, Inc.	Supplier performance measurement
B.F. Goodrich	Virtual manufacturing
BAAN	Facilities location decision
Bally Engineered Structures	Enterprise resource planning (ERP)
Bausch & Lomb	MRP implementation
Bechtel	Agile manufacturing
Ben & Jerry's Ice Cream	Mass customization
Bennetton	Product design for global markets
Black and Decker	Mass customization and manufacturing
BMW	Balanced scorecard
Boeing	Agile Logistics
Bose Corporation	Logistics: Meeting customer's real needs
Boston Consulting Group	Supplier partnership as strategy
Briggs and Stratton	Electronic data interchange in supply chain
Bristol-Myers Squibb	JIT evolution and use in the United States
British Airways	Mass customization and manufacturing
Burlington	Environmental issues and operations mgmt.
CAM-I	Learning curve analysis
Camtronics Medical Systems	Manufacturing flexibility
Carolina Freight	Product design for global markets
Caterpillar	Supplier performance measurement
CERES	Purchasing: The future
Chrysler	Learning curve analysis
	Quality: The implications of Deming's...
	Bullwhip effect in supply chain
	Environmental issues and operations mgmt.
	Bullwhip effect in supply chain
	Activity-based costing: An evaluation
	Capital investment in advanced technology
	New product development through...
	Cost analysis for purchasing
	Electronic data interchange in supply chain
	Logistics: Meeting customer's real needs
	Total quality management
	Environmental issues and operations mgmt.
	Agile manufacturing
	Concurrent engineering
	Electronic data interchange in supply chain
	Facilities location decision
	New product development through...
	Outsourcing of product design...

Organization	Article where discussed
	Product innovation
	Purchasing: Acquiring the best inputs
	Quality management systems: Baldrige...
	Supplier performance measurement
	Supplier relationships
	Virtual manufacturing
Coca-Cola	Mass customization and manufacturing
	Product design for global markets
Colgate	Product design for global markets
Compaq	Agile Logistics
	Human resource issues in manufacturing
	Mass customization and manufacturing
	Electronic data interchange in supply chain
Consolidated Freightways	Focused factory
Copeland Corporation	Logistics: Meeting customer's real needs
Council of Logistics Management	Virtual manufacturing
C-TAD systems	Concurrent engineering
Cummins Engine	Learning curve analysis
Curtis-Wright Corporation	Mass customization: Implementation
Custom Clothing Technology	Performance excellence: The Malcolm...
Custom Research Inc. (CRI)	Global manufacturing rationalization
Daewoo (Korea)	JIT evolution and use in the United States
Daihatsu Motors	Target costing
	Environmental issues and operations mgmt.
Daimler-Benz	Performance excellence: The Malcolm...
Dana Commercial Credit	Total quality management
Dana Corporation	Virtual manufacturing
DARPA	Agile Logistics
Dell	Bullwhip effect in supply chain
	Supplier partnership as strategy
Digital Equipment Corporation	Virtual manufacturing
DMSO	New product development through...
Dodge	History of manufacturing management
Du Pont	ISO 9000/QS 9000 quality standards
	Just-in-time manufacturing: Implications
	Total productive maintenance
Dun and Bradstreet	Purchasing: Acquiring the best inputs
Electro	Customer service, satisfaction and success
Eli-Lilly	Bullwhip effect in supply chain
	Environmental issues and operations mgmt.
Exxon	Facilities location decision
Federal Express	Agile Logistics
Fisher Technology	Purchasing: The future

Organization	Article where discussed
Florist Telegraph Service (FTD)	Agile Logistics
Ford	Agile manufacturing Assembly line design Concurrent engineering Electronic data interchange in supply chain Facilities location decision History of manufacturing management ISO 9000/QS 9000 quality standards Purchasing: Acquiring the best inputs Quality management systems: Baldrige... Quality: The implications of Deming's... Reengineering and the process view of... Statistical process control using control... Supplier performance measurement Total quality management U-shaped assembly lines Virtual manufacturing
Ford-VW	Outsourcing of product design...
Freightliner	ISO 9000/QS 9000 quality standards
Fuji	New product development through...
Fuji-Xerox	Product design for global markets
GAAP	Accounting system implications of TOC Activity-based costing
Gateway	Agile Logistics
GE	Facilities location decision JIT evolution and use in the United States Mass customization and manufacturing Purchasing: The future Total productive maintenance Total quality management
GE Fanuc	Agile manufacturing Mass customization and manufacturing
General Foods	Facilities location decision
Gillette	Mass customization and manufacturing
GM	Agile manufacturing Concurrent engineering Core manufacturing competencies Core manufacturing competencies and... Facilities location decision Global manufacturing rationalization Human resource issues in manufacturing ISO 9000/QS 9000 quality standards Logistics: Meeting customer's real needs

Organization	Article where discussed
	Manufacturing flexibility dimensions
	Manufacturing strategy
	Mass customization
	Quality management systems: Baldrige...
	Supplier partnership as strategy
	Supplier performance measurement
	Total quality management
	Virtual manufacturing
Graphic Enterprises	Quality: The implications of Deming's...
Harley-Davidson	Just-in-time manufacturing
Heineken	Product design for global markets
Heinz	Facilities location decision
Hermann Miller	Environmental issues and operations mgmt.
Hershey	Customer service, satisfaction and success
Hewlett Packard	Product design for global markets
	Concurrent engineering
	Environmental issues: Reuse and recycling
	International manufacturing
	JIT evolution and use in the United States
	Mass customization and manufacturing
	Virtual manufacturing
Hino	JIT evolution and use in the United States
Hitachi Seiki	Core manufacturing competencies
Home Depot	Supply chain management
Honda	Concurrent engineering
	Cost analysis for purchasing
	Product design for global markets
Honeywell	Agile manufacturing
	Facilities location decision
	JIT evolution and use in the United States
IBM	Agile Logistics
	Customer service, satisfaction and success
	Environmental issues: Reuse anrecycling
	JIT evolution and use in the United States
	Mass customization and manufacturing
	Total quality management
	Virtual manufacturing
Ikea	Product design for global markets
Imperial Chemical	Facilities location decision
Individual, Inc.	Mass customization and manufacturing
Institute of management Accountants	Activity-based costing: An evaluation
Intel	JIT evolution and use the United States
	Virtual manufacturing

Organization	Article where discussed
ISO	ISO 9000/QS 9000 quality standards
J.B. Hunt	Electronic data interchange in supply chain
J.C. Penny	Bullwhip effect in supply chain
J.D. Edwar	Enterprise resource planning (ERP)
JIPE	Total productive maintenance
JIPM	Total productive maintenance
John Crane Limited	Core manufacturing competencies
John Deere	Agile manufacturing Virtual manufacturing
Johnson and Johnson	Facilities location decision
JUSE	Quality: The implications of Deming's...
Kawasaki	Just-in-time manufacturing
Kia (Korea)	Bullwhip effect in supply chain
K-Mart	Bullwhip effect in supply chain
Kodak	Facilities location decision Environmental issues and operations mgmt.
Komatsu	Total quality management
KPMG	Balanced scorecard
Lawrence Livermore National Laboratory	Electronic data interchange in supply chain
Lawson Software	Enterprise resource planning (ERP) Activity-based costing
Lego	Mass customization: Implementation Product design for global markets
Levi-Strauss	Agile Logistics Human resource issues in manufacturing Mass customization: Implementation Product design for global markets
Lockheed Corporation	Learning curve analysis
Lutron Electronics Company	Mass customization and manufacturing
MacDonnell Aircraft/Aerospace	Manufacturing flexibility Virtual manufacturing
Mack Trucks	ISO 9000/QS 9000 quality standards
MANTECH	Virtual manufacturing
Marks and Spencer	Supplier partnership as strategy
Marriott	Product design for global markets
Mars	Product design for global markets Agile manufacturing
Massachusetts Institute of Technology	Flexible automation
Matlack	Electronic data interchange in supply chain
Matsushita	Target costing Agile manufacturing Mass customization and manufacturing Virtual manufacturing

Organization	Article where discussed
Mazda	JIT evolution and use in the United States
McDonalds	Product design for global markets
McKesson	Bullwhip effect in supply chain
Mercedes Benz	Mass customization and manufacturing Target costing
Metro Bank	Balanced scorecard
Mobil	Facilities location decision
Motorola	JIT evolution and use in the United States Mass customization and manufacturing Product design for global markets Purchasing: The future Statistical process control using control. . . Supplier relationships Total quality management
NAPM	Purchasing: Acquiring the best inputs
Nashua Corporation	Just-in-time manufacturing: Implications Quality: The implications of Deming's. . . Statistical process control using control. . .
National Association of Accountants	Capital investment in advanced technology
National Bureau of Standards	Virtual manufacturing
National Insurance	Balanced scorecard
National Semiconductor	Logistics: Meeting customer's real needs
Navistar International	ISO 9000/QS 9000 quality standards
NCPDM	Logistics: Meeting customer's real needs
Nestle	Facilities location decision
Nissan	JIT evolution and use in the United States Mass customization and manufacturing
NIST	Total quality management
Northern Telecom	Environmental issues and operations mgmt.
Nokia	U-shaped assembly lines
NUMMI	Core manufacturing competencies Just-in-time manufacturing Total quality management
Nuskin	Customer service, satisfaction and success
Olympus Optical Company	Target costing
Omark Industries	JIT evolution and use in the United States Setup reduction
Oracle	Enterprise resource planning (ERP) MRP implementation
Oxford	Bullwhip effect in supply chain
PACCAR, Inc.	ISO 9000/QS 9000 quality standards
Packard Electric	Manufacturing strategy
Panasonic	Agile manufacturing

Organization	Article where discussed
Peoplesoft	Enterprise resource planning (ERP) MRP implementation
Pininfarina, Italy	Outsourcing of product design. . .
Pizza Hut	Product design for global markets
Polaroid	Product design for global markets
Portsmouth Block Mill	History of manufacturing management
Pratt and Whitney	Supplier performance measurement
Procter and Gamble	Global manufacturing rationalization Supply chain management
Quaker Oats	Facilities location decision
RCA	Facilities location decision
Reebok	Mass customization and manufacturing
Renault	International manufacturing
RJR Nabisco	Electronic data interchange in supply chain
Roadway Express	Electronic data interchange in supply chain
Ross Controls	Mass customization
Ryan Transport Management Systems	Quality: The implications of Deming's. . .
Samsonite	Theory of constraints in manufacturing. . .
Samsung	International manufacturing
SAP	Activity-based costing Enterprise resource planning (ERP) MRP implementation
Schrader Bellows	Activity-based costing: An evaluation
Seagate Technologies	Facilities location decision
Siemens	Kanban-based manufacturing systems
Skoda	Manufacturing analysis using Chaos, . . .
Sony	Virtual manufacturing Environmental issues and operations mgmt.
Space Electronics, Inc.	Mass customization and manufacturing
Standard Oil Company	Facilities location decision
Stanford University	Quality: The implications of Deming's. . .
Subway	Product design for global markets
Sun Microsystems	ISO 9000/QS 9000 quality standards
Sundstrand Corporation	Flexible automation
Surgical Focused Care	ISO 9000/QS 9000 quality standards
Taco Bell	Reengineering and process view of. . .
Target	Bullwhip effect in supply chain
Tektronics	New product development through. . .
Telco (India)	Mass customization and manufacturing
Telepad, Inc.	Virtual manufacturing
Tennant	JIT evolution and use in the United States
Texas Instruments	Concurrent engineering Learning curve analysis

Organization	Article where discussed
	Reengineering and process view of . .
	Supplier performance measurement
The Gap	Logistics: Meeting customer's real needs
Thomas Register	Purchasing: Acquiring the best inputs
Thomson Consumer Electronics	Concurrent engineering
Timkin Company	Performance measurement
Toronto Plastics Ltd.	ISO 9000/QS 9000 quality standards
Toyo Ink	International manufacturing
Toyota	Core manufacturing competencies
	Customer service through system. . .
	JIT evolution and use in the United States
	Kanban-based manufacturing systems
	Lean manufacturing implementation
	Mass customization and manufacturing
	Product development and concurrent. . .
	Product innovation
	Supplier relationships
	Target costing
	Total quality management
Toys-R-Us	Supply chain management
Trident Precision Manufacturing	Performance excellence: The Malcolm. . .
Tyco	Product design for global markets
U.S. Air Force	Flexible automation
	Virtual manufacturing
U.S. Department of Defense	Electronic data interchange in supply chain
	Environmental issues: Reuse and recycling
U.S. Navy	History of manufacturing management
U.S. Postal Service	Performance excellence: The Malcolm. . .
UCAR Composites	Virtual manufacturing
UNEP	Environmental issues in operations mgmt.
Unilever	Logistics: Meeting customer's real needs
United Airlines	Supplier performance measurement
UPS	Electronic data interchange in supply chain
USCAR	Agile manufacturing
	Virtual manufacturing
Valic	Facilities location decision
Volkswagen	Outsourcing of product design. . .
	Purchasing: Acquiring the best inputs
Wal-Mart	Bullwhip effect in supply chain
	Electronic data interchange in supply chain
	Logistics: Meeting customer's real needs
	Purchasing: The future
	Supplier partnership as strategy

Organization	Article where discussed
War Department	Supply chain management
War Production Board	Virtual manufacturing
Watertown Arsenal	Quality: The implications of Deming's . . .
Western Textile Products	Quality: The implications of Deming's . . .
Westinghouse	Scientific management
Whirlpool	Theory of constraints in manufacturing. . .
World Trade Organization (WTO)	JIT evolution and use in the United States
Xerox	Activity-based costing: An evaluation
	Global facility location analysis
	Product design for global markets
	Customer service, satisfaction and success
	Environmental issues: Reuse and recycling
	Quality: The implications of Deming's . . .
	Supplier relationships
	Total quality management
Yamaha	Concurrent engineering
Yamazaki Machinery (Japan)	Capital investment in advanced technology
Yellow Freight	Electronic data interchange in supply chain
Yokohama Corporation (Japan)	Target costing



Foreword

In the last 20 years, we have witnessed the historic resurgence of manufacturing in the United States. This has been due, in part, to the power of emerging ideas in production and manufacturing management. The widespread use of these new developments has made American manufacturers lean, aggressive and successful competitors.

At the National Association of Manufacturers (NAM), we represent and promote the interests of 14,000 manufacturing firms and organizations. Having worked with manufacturing firms for decades, I am convinced that in this age of heightened global competition, the need for manufacturers to be informed and prepared for the challenges of the global economy is more acute and immediate than ever. The *Encyclopedia of Production and Manufacturing Management* is a valuable contribution by Dr. Paul Swamidass to that end. It provides timely, useful data to managers and manufacturing economists on issues ranging from industrial trends to recent progress in manufacturing management. I expect this single volume encyclopedia to become a standard reference work for managers and students of production and manufacturing management.

Dr. Paul Swamidass has collaborated with the National Association of Manufacturers since 1990 in studying the use of manufacturing technology for improving manufacturing processes in the United States. So far, in collaboration with the National Science Foundation, we have jointly completed three such studies, which are now available as the NAM's "Technology on the Factory Floor" series of reports. Industrial leaders and policy makers have used these reports for nearly ten years. Dr. Swamidass' work reflects a clear understanding of the needs of practicing managers and provides them with useful information that enhances their decision-making and professional performance.

Dr. Swamidass is exceptionally qualified to bring a well-rounded perspective to this complex subject. He holds a degree in mechanical engineering and has done graduate work in production management. He has seven years of industrial experience in production management and for decades has taught production management to students in American universities. I have long found that his strong academic background has complemented his real-world grasp of the problems of practicing managers.

This encyclopedia is an important work. It deserves widespread use by everyone who cares about American manufacturing at the dawn of the new century. I am pleased to commend it to persons who work in manufacturing management and to everyone who cares about the future of American industry.

Washington, D.C.
July 18, 1999

A handwritten signature in black ink, appearing to read "Jerry J. Kasinowski".

Jerry J. Kasinowski
President

The National Association of Manufacturers

Preface

The *Encyclopedia of Production and Manufacturing Management* is a specialized encyclopedia developed to serve as a basic reference resource for the practitioner, researcher, and student. Because of its specialized focus, this one-volume work is able to cover the entire field of production and manufacturing management. It contains factual and conceptual information for fundamental understanding while serving as a starting point for a deeper researched investigation. The material is state-of-the-art, covering the field of operations management and its exciting recent developments. These developments are covered extensively in this volume.

CONTENT AND PURPOSE: In the past twenty years, the field of production and operations management has grown with incredible speed, stretching its boundaries in all directions. For example, in the last two decades, production and manufacturing management absorbed in rapid succession several new production management concepts, including manufacturing strategy, focused factory, just-in-time manufacturing, concurrent engineering, total quality management, supply chain management, flexible manufacturing systems, lean production, and the list goes on. These considerable changes and developments in manufacturing highlight the critical need for an efficient, authoritative reference tool for manufacturing management students and practicing managers. Today's manufacturing managers are now expected to think more broadly than their counterparts two to three decades ago. The most notable change has been the need for manufacturing managers to think in technological, strategic and competitive terms. As a matter of record, technological and strategic developments have been the instrumental factors in the resurgence in manufacturing worldwide. The entries in this encyclopedia focus on these on-going technological and strategic changes in production and manufacturing management.

In addition to the technological advances in manufacturing, a special feature of this encyclo-

pedia is the number of successful manufacturers and manufacturing organizations illustrated and examined in the encyclopedia. Throughout the volume, "real-world" examples are drawn from more than 100 international firms whose business operations originate from a variety of countries in Asia, America, and Europe. Moreover, the practices of an array of major manufacturers, including Chrysler, Ford, GM, and Toyota are examined in a number of the topical entries. To assist the reader in locating these operational examples, the table provides an easy-access list of the references of where these "real world" examples can be found in the encyclopedia.

Added to the encyclopedia's entries are two valuable appendixes, each with unique bibliographies. Appendix I is a bibliography organized alphabetically and includes writings on all topics covered by the encyclopedia. Appendix II is a topical bibliography covering 21 broad topics from Capacity Planning to Supply Chain. The second bibliography can greatly speed the search for publications on a given topic. These two appendixes should serve as valuable research tools.

ORGANIZATION: The encyclopedia's topical treatments vary in length. The longer articles on important concepts and practices range from three to ten pages. There are about 100 such articles written by nearly 100 authors from around the world. In addition, there are over 1000 shorter entries on concepts, practices and principles. The range of topics and depth of coverage is designed to fit the needs of students and professional managers. The shorter entries provide digests of unfamiliar and complicated subjects. Difficult subjects are made intelligible to the reader without oversimplification.

While some entries – because of their special nature – present a free-form discussion of the topic, the majority of the encyclopedia's entries are structured to provide the following: *introduction or description, historical context of the topic, seminal works, a strategic perspective, a technological perspective, significant analytical models,*

short examples or cases from real-life, implementation issues and references. The material in these articles is arranged in sections using the titles below:

This encyclopedia is an organized summary of basic knowledge and important information in production and manufacturing management. One of the goals of this encyclopedia is to make

Content	Title of the Section
<i>What is it?</i>	Description or Introduction
<i>How did it evolve and seminal works?</i>	Historical perspective
<i>Why is it important?</i>	Strategic perspectives
<i>How is this practiced or implemented?</i>	Implementation
<i>What technologies are essential?</i>	Technology perspective
<i>Problem solving with analytical models</i>	significant analytical models
<i>Effect on performance</i>	Effect
<i>When is it appropriate?</i>	Timing
<i>Where is it used or practiced?</i>	Location
<i>What results and problems to expect?</i>	Results
<i>Who uses them?</i>	Cases
<i>Caveats</i>	Collective wisdom
<i>References to Seminal works</i>	References

A variety of entries examine a strategic perspective on the topic. *The Strategic Perspective* includes some or all of the following:

1. Long-term implications of the process/issue.
2. Its contribution to the organization's competitiveness.
3. The competitive advantages bestowed by the process or practice to the user.
4. Examples, short cases and illustrations.

There are topical entries that require a technological examination of the topic. *The Technological Perspective* includes some or all of the following:

1. The nature and magnitude of investments in specific technologies needed.
2. Historical evolution of the technology.
3. Recent advances in the technology.
4. Benefits of the technology, and illustrative cases.

Driving manufacturing competitiveness has been the strategic and technological responses of manufacturing firms to the increasing level of world wide competition. These two factors – increasing competition and the strategic implementation of manufacturing technology – are inextricably tied together. Hence strategy and technology are examined in the longer entries of the encyclopedia. In addition with the increasing use of hard and soft manufacturing technologies, examining the technological perspectives in appropriate topical entries provides an essential framework for understanding the “on-going technological revolution” in manufacturing and its future developments.

the large volume of material easily accessible to its users. A network of cross-references enables the reader to start from a topic and move speedily to several related topics. Entries are arranged alphabetically (letter-by-letter) for ease of access with each entry ending with generous cross-references. An Index of all entries is provided at the beginning of the encyclopedia, followed by an alphabetical list of longer articles and their authors.

For those interested in pursuing a topic beyond the encyclopedia, longer articles contain several references to seminal and authoritative books and articles. All these references and additional reading materials are listed alphabetically in a comprehensive Bibliography in Appendix I. Appendix II is a topical bibliography covering 21 broad topics. Appendix III is an information resource of selected journals and periodical on production and manufacturing management.

The combination of my many years of teaching university level production and manufacturing management courses and my work with numerous manufacturing firms has underscored to me the need for a functional reference tool for the field. I hope that our efforts in producing the *Encyclopedia of Production and Manufacturing Management* represent an important step in satisfying this need.

CONTRIBUTING AUTHORS AND BOARD OF ADVISORS: The Advisory Board, composed of internationally known experts, provided guidance

during the development of the encyclopedia. Collectively, the Board of Advisors for this encyclopedia represents hundreds of years of experience in the research, teaching and practice of production and manufacturing management. The Board's members have published numerous books on the subject, and they know the field intimately. Their input has measurably improved this volume. This distinguished Board of Advisors provided input in selecting the encyclopedia's topical treatment based on each topic's importance, usefulness and currency. Our objective was to be as comprehensive as possible within a one-volume framework. We have made choices realizing that this is a fast moving field and on its horizon there are new developments underway that will need to be addressed in future editions.

Through this encyclopedia, I am delighted to present to the reader the works of over one hundred experts and scholars. The authors of

articles are international experts with a record of research, teaching and publications on the topic. The scholarship of the authors ensures the reliability of the entries. It was my privilege to work with each author.

It was a pleasure to work with Gary Folven, OR/MS publisher, who was also associated with the *Encyclopedia of Management Science and OR*. His experience with encyclopedia development and production provided me with the necessary assurance to undertake the project. Nevertheless, preparing an encyclopedia is a formidable undertaking but I was fortunate to have access to Linda Patillo's skills at Auburn, and the talents of Carolyn Ford and Kristin Piper at the editorial offices of Kluwer.

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