

# ENCYCLOPEDIA OF PRODUCTION AND MANUFACTURING MANAGEMENT

*“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.”*

**Jerry J. Jasinowski, President  
The National Association of Manufacturers  
July 18, 1999 (In the Foreword of Encyclopedia  
of Production and Manufacturing Management)**

The **Encyclopedia of Production and Manufacturing Management** has been developed to serve this field as the fundamental reference work. In the last two decades, production and manufacturing management absorbed in rapid succession several new production management concepts: manufacturing strategy, focused factory, just-in-time manufacturing, concurrent engineering, total quality management, supply chain management, flexible manufacturing systems, lean production, mass customization, and more (see Table of Contents for a complete list). It is clear that with the increasing globalization of manufacturing, the field will continue to expand. This explosive growth in concepts and practices underscores the need for this volume.

The **Encyclopedia's** audience is a technically diverse one. It includes anyone concerned with manufacturing techniques, methods, and manufacturing decisions. The articles are fundamentally designed to serve as initial sources of information for all readers, with special emphasis on the needs of students and practitioners. In addition, most researchers in manufacturing deal fairly exclusively with a limited number of manufacturing areas. The **Encyclopedia** provides the researcher with an effective reference tool covering the *broad* spectrum of topics (new and classic) in production and manufacturing management. The entries in this encyclopedia include the most recent technical and strategic innovations in production and manufacturing management. Comprehensiveness and currency are the guiding principle of topics covered in the **Encyclopedia**.

The **Encyclopedia** consists of articles of varying lengths—the longer articles on important concepts and practices range from five to fifteen 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 intended to suit both student and professional audiences. The shorter entries provide digests of unfamiliar and complicated subjects. Difficult subjects are made intelligible to the reader without oversimplification.

The articles themselves are organized for a consistent presentation. The structural organization used in the majority of the articles is as follows: Description and basic concepts; Historical perspective; Strategic perspectives; Implementation; Technology perspective; Significant analytical models; Effect on performance; Timing—When it is appropriate?; Location—Where is it used or practiced?; Results; Cases and Collective wisdom.

A special feature of this encyclopedia is the list called Manufacturers and Organizations Discussed in the **Encyclopedia** following the Table of Contents. Several articles use real life examples from more than 100 manufacturing and other firms from the U. S., Japan, Europe, and other countries. The practices of some manufacturers such as Chrysler, Ford, GM, and Toyota are discussed. The list provides an easy and quick access to references about companies and organizations in the list. At the end of the Encyclopedia, there are two Appendixes with different bibliographies. **Appendix I** is organized alphabetically and includes writings on all topics covered by the encyclopedia. **Appendix II** is a topical bibliography under 21 broad topics from Capacity Planning to Supply Chain. The second bibliography can greatly speed the search for publications on a given topic. The two appendixes should serve as valuable research tools.

# ALPHABETICAL LIST OF MAJOR ARTICLES

- Accounting Systems Implications of TOC**, Monte R. Swain, Stanley E. Fawcett, Brigham Young University
- Activity-Based Costing**, Monte R. Swain, Stanley E. Fawcett, Brigham Young University
- Activity-Based Costing: An Evaluation**, M. Michael Umble, Baylor University; Elisabeth J. Umble, Texas A&M University
- Aggregate Plan and Master Production Schedule Linkage**, Chen H. Chung, University of Kentucky.
- Agile Logistics (Enterprise Logistics)**, Noel P. Greis, John D. Kasarda, University of North Carolina
- Agile Manufacturing**, Pratrapp S. S. Chinnaiiah, Sagar V. Kamarthi, Northeastern University
- Assembly Line Design**, Patrick R. McMullen, University of Maine.
- Balanced Scorecards**, Ramachandran Ramanan, University of Notre Dame.
- Bullwhip Effect in Supply Chain Management**, Hokey Min, University of Louisville
- Capacity Management in Make-to-Order Production Systems**, V. Sridharan, Clemson University
- Capacity Planning: Long-Range**, Gregory P. White, Southern Illinois University at Carbondale.
- Capacity Planning: Medium-and Short-Range**, Gregory P. White, Southern Illinois University at Carbondale
- Capital Investment in Advanced Manufacturing Technology**, Ranga Ramasesh, Texas Christian University
- Concurrent Engineering**, Morgan Swink, Michigan State University
- Core Manufacturing Competencies**, Morgan Swink, Michigan State University
- Core Manufacturing Competencies and Product Differentiation**, Morgan Swink, Michigan State University
- Cost Analysis for Purchasing**, Robert B. Handfield, Michigan State University
- Customer Service, Satisfaction, and Success**, Stanley E. Fawcett, Brigham Young University; M. Bixby Cooper, Michigan State University
- Customer Service Through Value Chain Integration**, Richard E. White, University of North Texas; John N. Pearson, Arizona State University
- Disaggregation in an Automated Manufacturing Environment**, Chen H. Chung, University of Kentucky
- Dynamic Kanban Control for JIT Manufacturing**, Kendra E. Moore, ALPHATECH, Inc.; Elif Kizilkaya, Northeastern University; Surendra M. Gupta, Northeastern University
- Dynamic Routing in Flexible Manufacturing Systems**, H. Joseph Wen, Kenneth D. Lawrence, New Jersey Institute of Technology
- Electronic Data Interchange in Supply Chain Management**, Hokey Min, University of Louisville
- Environmental Issues and Operations Management**, Robert Klassen, University of Western Ontario, Canada
- Environmental Issues: Reuse and Recycling**, Surendra M. Gupta, Pitipong Veerakamolmal, Northeastern University
- Facilities Location Decisions**, Basheer M. Khumawala, Sukran N. Kadipasaoglu, University of Houston
- Flexibility in Manufacturing**, Kenneth K. Boyer, DePaul University
- Flexible Automation**, Kathryn E. Stecke, Rodney P. Parker, The University of Michigan
- Focused Factory**, Paul M. Swamidass, Auburn University; Neil R. Darlow, Cranfield University, UK.
- Forecasting Examples**, Benito E. Flores, Texas A&M University
- Forecasting Guidelines and Methods**, Nada R. Sanders, Wright State University
- Forecasting in Manufacturing Management**, Benito E. Flores, Texas A&M University
- Global Facility Location Analysis**, Marc J. Schniederjans, University of Nebraska-Lincoln
- Global Manufacturing Rationalization**, Stanley E. Fawcett, Kristie Seawright, Brigham Young University
- History of Manufacturing Management**, James M. Wilson, Glasgow University, UK.
- Human Resource Issues and Advanced Manufacturing Technology**, Corinne M. Karuppan, Southwest Missouri State University
- Human Resource Issues in Manufacturing**, Thomas W. Dougherty, University of Missouri; George F. Dreher, Indiana University
- International Manufacturing**, Arnoud De Meyer, INSEAD, France.
- Inventory Flow Analysis**, Edward W. Davis, University of Virginia
- ISO 9000/QS-9000 Quality Standards**, James R. Evans, University of Cincinnati
- JIT Evolution and Use in the United States**, Richard E. White, University of North Texas
- Just-In-Time Manufacturing**, Gregory P. White, Southern Illinois University at Carbondale
- Just-In-Time Manufacturing: Implications**, Thomas J. Billesbach, Northwest Missouri State University
- Kanban-Based Manufacturing Systems**, S. Sengupta, Oakland University, USA; S.P. Dutta, University of Windsor, Canada
- Lean Manufacturing Implementation**, J.T. Black, Auburn University
- Learning Curve Analysis**, Timothy L. Smunt, Wake Forest University
- Linked-Cell Manufacturing System (L-CMS)** J.T. Black, Auburn University
- Logistics: Meeting Customers' Real Needs**, Stanley E. Fawcett, Brigham Young University
- Maintenance Management Decision Models**, Frank A. Van der Duyn Schouten, Tilburg University, The Netherlands
- Manufacturing Analysis Using Chaos, Fractals, and Self-Organization**, Hamid Noori, D. Scott Slocombe, Wilfrid Laurier University, Canada.
- Manufacturing Cell Design**, J.T. Black, Auburn University.
- Manufacturing Flexibility**, Paul M. Swamidass, Auburn University
- Manufacturing Flexibility Dimensions**, Ranga Ramasesh, Texas Christian University

# ALPHABETICAL LIST OF MAJOR ARTICLES

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

The following authors have written one or more long articles and several short pieces for this encyclopedia. Authors of longer articles are identified at the beginning of each article.

**Gerald Aase**, *Northern Illinois University*.

**Hilary Bates**, *University of Warwick, UK*  
Thomas J. Billesbach, *Northwest Missouri State University*  
JT Black, *Auburn University*  
Matthew C. Bloom, *University of Notre Dame*  
Steven F. Bolander, *Colorado State University*  
David E. Booth, *Kent State University*  
Kenneth K. Boyer, *DePaul University*  
Thomas F. Burgess, *The University of Leeds, UK*

**Pratap S. S. Chinnaiyah**, *Northeastern University*  
David Challis, *University of Melbourne, Australia*  
Chen H. Chung, *University of Kentucky*  
M. Bixby Cooper, *Michigan State University*

**Neil R. Darlow**, *Cranfield University, UK*  
Edward W. Davis, *University of Virginia*  
Arnoud De Meyer, *INSEAD, France*  
Rommert Dekker, *Eramus University Rotterdam, The Netherlands*  
Thomas W. Dougherty, *University of Missouri*  
George F. Dreher, *Indiana University*  
Rebecca Duray, *University of Colorado at Colorado Springs*  
S.P. Dutta, *University of Windsor, Canada*

**James R. Evans**, *University of Cincinnati*

**Benito E. Flores**, *Texas A&M University*  
Stanely E. Fawcett, *Brigham Young University*  
John W. Fowler, *Arizona State University*

**Larry C. Giunipero**, *Florida State University*  
Noel P. Greis, *University of North Carolina, Chapel Hill*  
Hasan K. Gules, *Selcuk University, Turkey*  
Surendra M. Gupta, *Northeastern University*

**George C. Hadjinicola**, *University of Cyprus, Cyprus*  
Robert B. Handfield, *Michigan State University*  
Jeffrey W. Herrmann, *University of Maryland*

**Sukran N. Kadipasaoglu**, *University of Houston*  
Sagar V. Kamarthi, *Northeastern University*  
John D. Kasarda, *University of North Carolina*  
Corinne M. Karuppan, *Southwest Missouri State University*  
Moutaz Khouja, *University of North Carolina*  
Basheer M. Khumawala, *University of Houston*  
Elif Kizilkaya, *Northeastern University*  
Robert Klassen, *University of Western Ontario, Canada*  
Michael G. Kolchin, *Lehigh University*  
K. Ravi Kumar, *University of Southern California*

**R. Lawrence LaForge**, *Clemson University*  
Kenneth D. Lawrence, *New Jersey Institute of Technology*  
Brian Leavy, *Dublin City University*  
John Leschke, *University of Virginia*  
James P. Lewis, *The Lewis Institute, Inc.*  
Christoph H. Loch, *INSEAD, France*

**Debasish N. Mallick**, *Boston College*.  
John K. McCreery, *North Carolina State University*.  
Kathleen E. McKone, *University of Minnesota*.  
Patrick R. McMullen, *Auburn University*.  
Hokey Min, *University of Louisville*.  
Amitava Mitra, *Auburn University*.  
Kendra E. Moore, *ALPHATECH Inc.*

**R. Nat Natarajan**, *Tennessee Technological University*  
Kwan-Kee Ng, *National University of Singapore, Singapore*  
Hamid Noori, *Wildred Laurier University, Canada*

**O. Felix Offodile**, *Kent State University*  
David L. Olson, *Texas A&M University*

**Rodney P. Parker**, *University of Michigan*  
John N. Pearson, *Arizona State University*  
K. W. Platts, *The University of Cambridge, UK*

**Ramachandran Ramanan**, *University of Notre Dame*  
Ranga Ramasesh, *Texas Christian University*  
Paul G. Ranky, *New Jersey Institute of Technology*

**Danny Samson**, *University of Melbourne, Australia*  
Nada R. Sanders, *Wright State University*  
Marc J. Schniederjans, *University of Nebraska*  
Kristie Seawright, *Brigham Young University*  
S. Sengupta, *Oakland University*  
D. Scott Slocombe, *Wilfrid Laurier University, Canada*  
Timothy L. Smunt, *Wake Forest University*  
V. Sridharan, *Clemson University*  
Kathryn E. Stecke, *University of Michigan*  
Michael Suh, *Kent State University*  
Chee-Chueng Sum, *National University of Singapore, Singapore*  
Monte R. Swain, *Brigham Young University*  
Paul M. Swamidass, *Auburn University*  
Morgan Swink, *Michigan State University*

**Christian Terwiesch**, *University of Pennsylvania*  
Sam G. Taylor, *University of Wyoming*  
David Twigg, *University of Brighton, UK*

**M. Michael Umble**, *Baylor University*  
Elisabeth J. Umble, *Texas A&M University*

**Frank A. Van der Duyn Schouten**, *Tilburg University, The Netherlands*  
Pitipong Veerakamolmal, *Northeastern University*

**Elliott N. Weiss**, *University of Virginia*  
H. Joseph Wen, *New Jersey Institute of Technology*  
Gregory P. White, *Southern Illinois University*  
Richard E. White, *University of North Texas*  
James M. Wilson, *Glasgow Business School, UK*

**Enver Yücesan**, *INSEAD, France*