

Thomas E. Vollmann is Professor of Manufacturing Management at IMD in Lausanne Switzerland, the Wall Street Journal's top ranked MBA program in Europe. His areas of special interest are manufacturing, performance measurement, supply chain management and enterprise transformation. He is a consultant to numerous companies, lecturer in executive programs worldwide, and has taught at Indiana University, INSEAD, Boston University, the University of Rhode Island, and Dartmouth College. He received his BA, MBA, and Ph.D. from UCLA. Professor Vollmann's cases on Manufacturing and Supply Chain issues won the The European Case Writing Competition award in '97, '98, and '99. He is the author of numerous books and articles in the US and Europe and is a Fellow of the Decision Science Institute.

William L. Berry holds the Richard Ross Chair in Management and is Professor of Manufacturing Management at The Ohio State University Max M. Fisher College of Business. He is also the Director of the Center for Excellence in Manufacturing Management at Ohio State. During his nine years at Ohio State, Dr. Berry has received three Best MBA Instructor awards and has been cited in *BusinessWeek*. Prior to Ohio State, he was a faculty member at the University of North Carolina-Chapel Hill, IMD, the University of Iowa, Indiana University, and Purdue University. He has industrial experience in manufacturing management at the General Electric Company. He is a Past President of the Decision Science Institute and the Operations Management Association. Berry earned his BS from Purdue, an MS from Virginia Polytechnic, and DBA from Harvard.

D. Clay Whybark is Macon G. Patton Distinguished Professor of Operations, Technology and Innovation Management at the Kenan-Flagler Business School, University of North Carolina. International manufacturing and strategy are among his areas of expertise, and he has worked for the Boeing Company, Douglas Aircraft, and has served as consultant to corporations and government organizations. Whybark has taught and researched at universities in New Zealand, Switzerland, China, Hong Kong, Peru, and Chile, as well as Indiana, Purdue, Harvard, Arizona State and Stanford in the United States. He has taught in executive programs, some in Spanish, throughout the world and has authored more than 200 papers and business cases, two of which won European POM Case of the Year Awards. He is founding director of the Global Manufacturing Research Group, received the Distinguished Service Award of the Decision Sciences Institute, of which he is a fellow and past president. He is a fellow of the International Pan Pacific Business Association and past president of the International Society for Inventory Research. He received his PhD from Stanford, MBA from Cornell, and his BS from the University of Washington.

F. Robert Jacobs is E-II Faculty Fellow and Professor of Operations Management at the Kelley School of Business, Indiana University. He has degrees in Industrial Engineering, Computers and Information Science, an MBA, and a Ph.D. in Operations Management from The Ohio State University. He is the author of over 50 research articles on inventory control, design of manufacturing facilities, cellular manufacturing, and scheduling manufacturing operations. He is co-author of the widely used *Operations Management for Competitive Advantage* 10th edition and the novel *Why ERP? A Primer on SAP Implementation*. Professor Jacobs teaches the MBA core Operations Management course at the Kelley School as well as Supply Chain Management and E-OPS. Over his 20-years of professional experience, he has been a consultant to many companies, most recently with Honeywell Aircraft Landing Systems. Jacobs is a fellow and past president of the Decision Sciences Institute.

Write to us at
info.india@mheducation.com

www.mheducation.co.in

ISBN-13: 978-0-07-059839-3
ISBN-10: 0-07-059839-8



9 780070 598393

Mc
Graw
Hill
Education

5E

Control
Manufacturing Planning
for Supply Chain Management

658.72 VOL/M



Mc
Graw
Hill
Education

Mc
Graw
Hill
Education

Fifth Edition

Manufacturing Planning & Control for Supply Chain Management

Vollmann
Berry
Whybark
Jacobs

INDIAN EDITION

For sale in
India, Pakistan,
Nepal, Bangladesh,
Sri Lanka and Bhutan
Only

Brief Contents

| | |
|---|---|
| Preface xiv | 11 Production Activity Control 370 |
| Acknowledgments xxi | 12 Advanced Concepts in Sales and Operations Planning 412 |
| 1 Manufacturing Planning and Control 1 | 13 Strategy and MPC System Design 447 |
| 2 Demand Management 17 | 14 Advanced Concepts in Material Requirements Planning 476 |
| 3 Sales and Operations Planning 60 | 15 Advanced Concepts in Just-in-Time 502 |
| 4 Enterprise Resources Planning (ERP)—Integrated Systems 108 | 16 Advanced Concepts in Scheduling 539 |
| 5 Supply Chain Inventory Management—Independent-Demand Items 133 | 17 Supply Chain Management 577 |
| 6 Master Production Scheduling 168 | 18 Implementation 627 |
| 7 Material Requirements Planning 222 | 19 MPC: The Next Frontier 665 |
| 8 Distribution Requirements Planning 260 | Appendix 694 |
| 9 Just-in-Time 300 | Index 697 |
| 10 Capacity Planning and Utilization 336 | |

Table of Contents

| | |
|--|--|
| Preface xiv | Information Use in Demand Management 27 |
| Acknowledgments xxi | <i>Make-to-Knowledge</i> 27 |
| Chapter 1 | <i>Data Capture and Monitoring</i> 28 |
| Manufacturing Planning and Control 1 | <i>Customer Relationship Management</i> 28 |
| The Context for MPC 2 | <i>Outbound Product Flow</i> 29 |
| <i>Internationalization</i> 2 | Providing Appropriate Forecast Information 29 |
| <i>The Role of the Customer</i> 3 | <i>A Forecasting Framework</i> 29 |
| <i>Increasing Use of Information Technology</i> 3 | <i>Forecasting for Strategic Business Planning</i> 30 |
| The MPC System Defined 4 | <i>Forecasting for Sales and Operations Planning</i> 31 |
| <i>Typical MPC Support Activities</i> 4 | <i>Forecasting for Master Production Scheduling and Control</i> 31 |
| <i>Costs and Benefits of MPC Systems</i> 5 | Producing and Evaluating Detailed Forecasts 32 |
| An MPC System Framework 7 | <i>Moving-Average Forecasting</i> 32 |
| <i>MPC System Activities</i> 7 | <i>Exponential Smoothing Forecasting</i> 34 |
| Matching the MPC System with the Needs of the Firm 9 | <i>Evaluating Forecasts</i> 36 |
| <i>An MPC Classification Schema</i> 10 | Using the Forecasts 39 |
| Evolution of the MPC System 11 | <i>Considerations for Aggregating Forecasts</i> 39 |
| <i>The Changing Competitive World</i> 12 | <i>Pyramid Forecasting</i> 40 |
| <i>Reacting to the Changes</i> 12 | <i>Incorporating External Information</i> 42 |
| Concluding Principles 13 | Managing Demand 43 |
| References 13 | <i>Organizing for Demand Management</i> 43 |
| Discussion Questions 16 | <i>Monitoring the Demand Management Systems</i> 44 |
| | <i>Balancing Supply and Demand</i> 45 |
| | Company Examples 45 |
| | <i>Configuration Management at Dell Computer Corporation</i> 45 |
| Chapter 2 | <i>Forecasting at Ross Products</i> 47 |
| Demand Management 17 | <i>Customer Order Promising at Kirk Motors, Ltd.</i> 48 |
| Demand Management in MPC Systems 18 | Concluding Principles 51 |
| Demand Management and the MPC Environment 20 | References 52 |
| <i>The Make-to-Stock (MTS) Environment</i> 21 | Discussion Questions 54 |
| <i>The Assemble-to-Order (ATO) Environment</i> 22 | Problems 54 |
| <i>The Make (Engineer)-to-Order (MTO) Environment</i> 23 | |
| Communicating with Other MPC Modules and Customers 24 | Chapter 3 |
| <i>Sales and Operations Planning</i> 24 | Sales and Operations Planning 60 |
| <i>Master Production Scheduling</i> 25 | Sales and Operations Planning in the Firm 60 |
| <i>Dealing with Customers on a Day-to-Day Basis</i> 26 | <i>Sales and Operations Planning Fundamentals</i> 61 |
| | <i>Sales and Operations Planning and Management</i> 62 |

| | |
|--|------------|
| Operations Planning and MPC Systems | 63 |
| Payoffs | 65 |
| The Sales and Operations Planning Process | 66 |
| The Monthly Sales and Operations Planning Process | 66 |
| Sales and Operations Planning Displays | 68 |
| Modifying the Sales and Operations Plan | 70 |
| The Basic Trade-offs | 72 |
| Evaluating Alternatives | 74 |
| The New Management Obligations | 77 |
| Top Management Role | 77 |
| Functional Roles | 77 |
| Integrating Strategic Planning | 80 |
| Controlling the Operations Plan | 81 |
| Operating with Sales and Operations Planning | 82 |
| Sales and Operations Planning at Compugraphic | 82 |
| Delta Manufacturing Company's Integrated Sales and Operations Planning Process | 85 |
| Hill-Rom's Use of Planning Bills of Materials | 96 |
| Concluding Principles | 97 |
| References | 98 |
| Discussion Questions | 98 |
| Problems | 99 |
| Chapter 4 | |
| Enterprise Resource Planning (ERP)—Integrated Systems | 108 |
| What Is ERP? | 109 |
| Consistent Numbers | 109 |
| Software Imperatives | 110 |
| Routine Decision Making | 110 |
| Choosing ERP Software | 111 |
| How ERP Connects the Functional Units | 111 |
| Finance | 112 |
| Manufacturing and Logistics | 112 |
| Sales and Marketing | 113 |
| Human Resources | 113 |
| Customized Software | 113 |
| Data Integration | 113 |
| How Manufacturing Planning and Control (MPC) | |
| Fits within ERP | 114 |
| Simplified Example | 115 |
| Supply Chain Planning with mySAP SCM | 116 |
| Supply Chain Execution with mySAP SCM | 116 |

| | |
|--|------------|
| Supply Chain Collaboration with mySAP SCM | 117 |
| Supply Chain Coordination with mySAP SCM | 117 |
| What Performance Metrics Evaluate ERP System Effectiveness? | 118 |
| The "Functional Silo" Approach | 118 |
| Integrated Supply Chain Metrics | 119 |
| Calculating the Cash-to-Cash Time | 121 |
| What Is the Experience with ERP? | 123 |
| Eli Lilly and Company—Operational Standards for Manufacturing Excellence | 123 |
| The Journey at "United Computer" | 126 |
| Lessons Learned at Scotts | 129 |
| Concluding Principles | 130 |
| References | 130 |
| Discussion Questions | 131 |
| Problems | 131 |
| Chapter 5 | |
| Supply Chain Inventory Management—Independent-Demand Items | 133 |
| Basic Concepts | 134 |
| Independent- versus Dependent-Demand Items | 134 |
| Functions of Inventory | 134 |
| Management Issues | 136 |
| Routine Inventory Decisions | 136 |
| Determining Inventory System Performance | 137 |
| Implementing Changes in Managing Inventory | 137 |
| Inventory-Related Costs | 138 |
| Order Preparation Costs | 138 |
| Inventory Carrying Costs | 138 |
| Shortage and Customer Service Costs | 139 |
| Incremental Inventory Costs | 139 |
| An Example Cost Trade-off | 140 |
| Economic Order Quantity Model | 141 |
| Determining the EOQ | 141 |
| Order Timing Decisions | 143 |
| Using Safety Stock for Uncertainty | 143 |
| The Introduction of Safety Stock | 144 |
| Continuous Distributions | 146 |
| Probability of Stocking out Criterion | 147 |
| Customer Service Criterion | 148 |
| Time Period Correction Factor | 149 |
| Forecast Error Distribution | 151 |
| Order Quantity and Reorder Point Interactions | 152 |

| | |
|---|------------|
| Service Levels and Order Quantities | 152 |
| Total Cost Criterion | 154 |
| The Iterative Q, R Procedure | 156 |
| Multi-Item Management | 157 |
| Single-Criterion ABC Analysis | 157 |
| Multiple-Criteria ABC Analysis | 157 |
| Concluding Principles | 162 |
| References | 162 |
| Discussion Questions | 163 |
| Problems | 164 |
| Chapter 6 | |
| Master Production Scheduling | 168 |
| The Master Production Scheduling Activity | 169 |
| The MPS Is a Statement of Future Output | 169 |
| The Business Environment for the MPS | 170 |
| Linkages to Other Company Activities | 171 |
| Master Production Scheduling Techniques | 173 |
| The Time-Phased Record | 173 |
| Rolling through Time | 175 |
| Order Promising | 176 |
| Consuming the Forecast | 179 |
| Mitel Corporation: Order Promising with ATP | 181 |
| Bill of Materials Structuring for the MPS | 183 |
| Key Definitions | 183 |
| The Modular Bill of Materials | 184 |
| The Planning Bill of Materials | 186 |
| The Final Assembly Schedule | 188 |
| Relation to the MPS | 188 |
| The Hill-Rom FAS | 189 |
| The Master Production Scheduler | 192 |
| The MPS as a Set of Firm Planned Orders | 192 |
| The Job | 192 |
| Company Examples | 195 |
| The Ethan Allen Master Production Schedule | 195 |
| Master Production Scheduling at Jet Spray | 197 |
| Master Production Schedule Stability | 200 |
| Ethan Allen Stability | 200 |
| Freezing and Time Fencing | 201 |
| Managing the MPS | 202 |
| The Overstated MPS | 202 |
| MPS Measures | 203 |
| Monitoring the MPS at Ethan Allen | 203 |
| Concluding Principles | 206 |
| References | 206 |

| | |
|--|------------|
| Discussion Questions | 208 |
| Problems | 208 |
| Chapter 7 | |
| Material Requirements Planning | 222 |
| Material Requirements Planning in Manufacturing Planning and Control | 223 |
| Record Processing | 224 |
| The Basic MRP Record | 224 |
| Linking the MRP Records | 232 |
| Technical Issues | 235 |
| Processing Frequency | 235 |
| Bucketless Systems | 236 |
| Lot Sizing | 236 |
| Safety Stock and Safety Lead Time | 237 |
| Low-Level Coding | 238 |
| Pegging | 238 |
| Firm Planned Orders | 238 |
| Service Parts | 239 |
| Planning Horizon | 239 |
| Scheduled Receipts versus Planned Order Releases | 240 |
| Using the MRP System | 240 |
| The MRP Planner | 240 |
| Exception Codes | 242 |
| Bottom-up Replanning | 243 |
| An MRP System Output | 245 |
| System Dynamics | 245 |
| Transactions During a Period | 246 |
| Rescheduling | 247 |
| Complex Transaction Processing | 247 |
| Procedural Inadequacies | 248 |
| Concluding Principles | 249 |
| References | 250 |
| Discussion Questions | 250 |
| Problems | 250 |
| Chapter 8 | |
| Distribution Requirements Planning | 260 |
| Distribution Requirements Planning in the Supply Chain | 261 |
| DRP and the MPC System Linkages | 261 |
| DRP and the Marketplace | 263 |
| DRP and Demand Management | 264 |
| DRP and Master Production Scheduling | 265 |

| | |
|---|------------|
| DRP Techniques | 265 |
| <i>The Basic DRP Record</i> | 266 |
| <i>Time-Phased Order Point (TPOP)</i> | 267 |
| <i>Linking Several Warehouse Records</i> | 268 |
| <i>Managing Day-to-Day Variations</i> | |
| from Plan | 270 |
| <i>Safety Stock in DRP</i> | 275 |
| Management Issues with DRP | 276 |
| <i>Data Integrity and Completeness</i> | 277 |
| <i>Organizational Support</i> | 278 |
| <i>Problem Solving</i> | 279 |
| Company Example | 282 |
| Concluding Principles | 288 |
| References | 288 |
| Discussion Questions | 289 |
| Problems | 290 |
| Chapter 9 | |
| Just-in-Time | 300 |
| JIT in Manufacturing Planning and Control | 301 |
| <i>Major Elements of Just-in-Time</i> | 301 |
| <i>JIT's Impact on Manufacturing Planning and Control</i> | 303 |
| <i>The Hidden Factory</i> | 304 |
| <i>JIT Building Blocks in MPC</i> | 305 |
| A JIT Example | 307 |
| <i>Leveling the Production</i> | 307 |
| <i>Pull System Introduction</i> | 309 |
| <i>Product Design</i> | 313 |
| <i>Process Design</i> | 313 |
| <i>Bill of Materials Implications</i> | 314 |
| JIT Applications | 316 |
| <i>Single-Card Kanban</i> | 316 |
| <i>Toyota</i> | 317 |
| <i>Hewlett-Packard</i> | 319 |
| Nonrepetitive JIT | 321 |
| <i>A Service-Enhanced View of Manufacturing</i> | 321 |
| <i>Flexible Systems</i> | 321 |
| <i>Simplified Systems and Routine Execution</i> | 322 |
| Joint-Firm JIT | 322 |
| <i>The Basics</i> | 323 |
| <i>Tightly Coupled JIT Supply</i> | 324 |
| <i>Less Tightly Coupled JIT Supply</i> | 324 |
| <i>"JIT" Coordination through Hubs</i> | 325 |
| <i>Lessons</i> | 325 |

| | |
|--|------------|
| JIT Software | 325 |
| <i>The MRP-JIT Separation</i> | 326 |
| <i>JIT Planning and Execution</i> | 326 |
| <i>An Example</i> | 327 |
| <i>JIT Execution with SAP Software</i> | 327 |
| Managerial Implications | 328 |
| <i>Information System Implications</i> | 328 |
| <i>Manufacturing Planning and Control</i> | 328 |
| <i>Scorekeeping</i> | 328 |
| <i>Pros and Cons</i> | 329 |
| Concluding Principles | 330 |
| References | 330 |
| Discussion Questions | 331 |
| Problems | 331 |
| Chapter 10 | |
| Capacity Planning and Utilization | 336 |
| The Role of Capacity Planning in MPC | |
| Systems | 337 |
| <i>Hierarchy of Capacity Planning Decisions</i> | 337 |
| <i>Links to Other MPC System Modules</i> | 338 |
| Capacity Planning and Control Techniques | 339 |
| <i>Capacity Planning Using Overall</i> | |
| Factors (CPOF) | 339 |
| <i>Capacity Bills</i> | 341 |
| <i>Resource Profiles</i> | 343 |
| <i>Capacity Requirements Planning (CRP)</i> | 344 |
| Scheduling Capacity and Materials | |
| Simultaneously | 347 |
| <i>Finite Capacity Scheduling</i> | 347 |
| <i>Finite Scheduling with Product Structures:</i> | |
| Using APS Systems | 350 |
| Management and Capacity Planning/Utilization | 352 |
| <i>Capacity Monitoring with Input/Output Control</i> | 353 |
| <i>Managing Bottleneck Capacity</i> | 355 |
| <i>Capacity Planning in the MPC System</i> | 356 |
| <i>Choosing the Measure of Capacity</i> | 357 |
| <i>Choice of a Specific Technique</i> | 358 |
| <i>Using the Capacity Plan</i> | 359 |
| Example Applications | 360 |
| <i>Capacity Planning at Montell USA, Inc.</i> | 360 |
| <i>Capacity Planning at Applicon</i> | 360 |
| <i>Capacity Planning with APS at a Consumer Products Company</i> | 363 |

| | |
|-----------------------|-----|
| Concluding Principles | 364 |
| References | 365 |
| Discussion Questions | 365 |
| Problems | 366 |

Chapter 11 Production Activity Control 370

| | |
|--|-----|
| A Framework for Production | |
| Activity Control | 370 |
| <i>MPC System Linkages</i> | 371 |
| <i>The Linkages between MRP and PAC</i> | 372 |
| <i>Just-in-Time Effect on PAC</i> | 372 |
| <i>The Company Environment</i> | 373 |
| Production Activity Control Techniques | 373 |
| <i>Basic Shop-Floor Control Concepts</i> | 374 |
| <i>Lead-Time Management</i> | 376 |
| <i>Gantt Charts</i> | 377 |
| <i>Priority Sequencing Rules</i> | 377 |
| <i>Theory of Constraints (TOC) Systems</i> | 379 |
| <i>Vendor Scheduling and Follow-up</i> | 389 |
| <i>The Internet and Vendor Scheduling</i> | 390 |
| Production Activity Control Examples | 391 |
| <i>TOC Scheduling at TOSOH</i> | 392 |
| <i>Vendor Scheduling at Liebert</i> | 393 |
| <i>Vendor Scheduling at Caterpillar</i> | 396 |
| Concluding Principles | 401 |
| References | 401 |
| Discussion Questions | 403 |
| Problems | 403 |

Chapter 12 Advanced Concepts in Sales and Operations Planning 412

| | |
|--|-----|
| Mathematical Programming Approaches | 413 |
| <i>Linear Programming</i> | 413 |
| <i>Mixed Integer Programming</i> | 415 |
| Other Approaches | 417 |
| <i>The Linear Decision Rule</i> | 417 |
| <i>Search Decision Rules</i> | 418 |
| Disaggregation | 419 |
| <i>The Disaggregation Problem</i> | 419 |
| <i>Hierarchical Production Planning</i> | 419 |
| <i>Disaggregation through Mathematical Programming</i> | 421 |

| | |
|---|-----|
| Company Example: Lawn King, Inc. | 424 |
| <i>Company Background</i> | 425 |
| <i>Deciding on a Planning Model</i> | 425 |
| <i>The Linear Programming Model</i> | 426 |
| <i>Developing the Planning Parameters</i> | 427 |
| <i>Solving the Linear Programming Model and Understanding the Results</i> | 431 |
| <i>Sales and Operations Planning Issues</i> | 432 |
| <i>Using Microsoft Excel Solver</i> | 433 |
| Applications Potential | 436 |
| Data Issues | 436 |
| The Future | 437 |
| Concluding Principles | 438 |
| References | 438 |
| Discussion Questions | 439 |
| Problems | 439 |

Chapter 13 Strategy and MPC System Design 447

| | |
|--|-----|
| MPC Design Options | 447 |
| <i>Master Production Scheduling Options</i> | 447 |
| <i>Detailed Material Planning Options</i> | 449 |
| <i>Shop-Floor System Options</i> | 451 |
| Choosing the Options | 453 |
| Market Requirements | 453 |
| <i>The Manufacturing Task</i> | 454 |
| <i>Manufacturing Process Design</i> | 454 |
| <i>MPC System Design</i> | 455 |
| The Choices in Practice | 459 |
| <i>Moog, Inc., Space Products Division</i> | 460 |
| <i>Kawasaki, U.S.A.</i> | 461 |
| <i>Applicon</i> | 463 |
| <i>The Driver Is the Marketplace</i> | 464 |
| Integrating MRP and JIT | 465 |
| <i>The Need to Integrate</i> | 466 |
| <i>Physical Changes That Support Integration</i> | 466 |
| <i>Some Techniques for Integrating MRP and JIT</i> | 467 |
| <i>Strategy for Combining MRP and JIT</i> | 467 |
| Extending MPC Integration to Customers and Suppliers | 467 |
| <i>TelTech</i> | 468 |
| <i>Customer-Supplier MPC Integration at TelTech</i> | 468 |

Concluding Principles 469
 References 470
 Discussion Questions 471
 Problems 471

**Chapter 14
 Advanced Concepts in Material
 Requirements Planning 478**

Determining Manufacturing Order Quantities 479
Economic Order Quantities (EOQ) 480
Periodic Order Quantities (POQ) 481
Part Period Balancing (PPB) 481
Wagner-Whitin Algorithm 482
Simulation Experiments 483
 Buffering Concepts 484
Categories of Uncertainty 484
Safety Stock and Safety Lead Time 485
*Safety Stock and Safety Lead Time
 Performance Comparisons* 487
Scrap Allowances 488
Other Buffering Mechanisms 488
 Nervousness 489
Sources of MRP System Nervousness 489
Reducing MRP System Nervousness 491
 Concluding Principles 491
 References 492
 Discussion Questions 494
 Problems 494

**Chapter 15
 Advanced Concepts in Just-in-Time 502**

A JIT Research Framework 503
 Scheduling 503
*Scheduling Mixed Model Assembly Lines
 under JIT* 503
Schedule Stability in Implementing JIT 509
 Supply Chain Coordination 510
 Production Floor Management 516
Setup Time Reduction 516
Determining the Optimal Number of Kanbans 520
 JIT Performance and Operating Conditions 524
Variability in Operating Conditions 525
Lot Size 526
Comparing MPC System Approaches 528

Concluding Principles 530
 References 531
 Discussion Questions 533
 Problems 533

**Chapter 16
 Advanced Concepts in Scheduling 539**

Basic Scheduling Research 539
The One-Machine Case 540
The Two-Machine Case 540
Dispatching Approaches 542
Sequencing Rules 542
 Advanced Research Findings 545
Due Date Setting Procedures 545
Dynamic Due Dates 546
Labor-Limited Systems 549
Group Scheduling and Transfer Batches 550
*Scheduling Manned Cellular Manufacturing
 Systems* 553
 Multiple-Constraint Scheduling 555
*Buffers between Constraint Operations:
 Rods* 555
Multiple-Constraint Scheduling Algorithm 556
*Example Multiple Constraint Scheduling
 Problem* 560
 Concluding Principles 565
 References 566
 Discussion Questions 567
 Problems 567

**Chapter 17
 Supply Chain Management 577**

Supply Chain Management and MPC
 Systems 578
New MPC Linkages 580
Strategic Thinking 583
The Bullwhip Effect 583
Orchestration 586
 Supply Chain Optimization—Examples
 and Supporting MPC Systems 590
*Suboptimal MPC Design in a Paint Supply
 Chain* 590
*An Interfirm MPC Example for Coordinated
 Packaging* 591

*Interfirm Reengineering Drives MPC Design
 for Airline Catering* 593
*Nokia's Superior MPC Systems for Supply Chain
 Management* 596
MPC Enhancements to Support Outsourcing 600
*MPC Systems to Support Quality in Complex
 Supply Chains* 601
 Enhancements to Basic MPC Systems 603
MPC Design Issues 603
Enhancing ERP Systems 605
Enhancing JIT-Based Systems 608
Dyad-Based MPC Systems 610
Mass Customization 615
 Concluding Principles 619
 References 620
 Discussion Questions 621
 Problems 622

**Chapter 18
 Implementation 627**

Internal Integration 628
*From Lean Manufacturing to Lean Organization
 to Lean Enterprise* 628
MPC Implementation for Lean Manufacturing 630
MPC Implementation for Lean Organization 632
MPC Implementation for Lean Enterprise 633
*Component and Database Commonality/
 Rationalization* 635
 Interfirm Integration 638
A New Paradigm 638
Dyad Relationships 638
Partnership/Trust 641
Third-Party Logistics Providers 642
 Transformation 643
Stair-Step Transformations 644
Moving up the Value Chain 648
 Project Management 650
Continuous MPC Enhancements 650
MPC Project Justification 651
Project Planning and Resource Commitment 653
Goldratt's Critical Chain Concepts 654

Benchmarking and Auditing 656
Flawless Execution and Database Integrity 656
Evolution and Revolution 657
Benchmarking versus Industrial Tourism 658
Auditing 658
 Concluding Principles 660
 References 661
 Discussion Questions 661
 Problems 661

**Chapter 19
 MPC: The Next Frontier 665**

A Supply Chain Development Framework 666
Historical Perspective for MPC Development 666
Interorganizational (Chain) Design 668
Chain Strategy Development 669
Chain Infrastructure Development: Work 671
*Chain Infrastructure Development:
 Infrastructure* 674
 Competitive Drivers/Challenges 676
Outsourcing 676
Regionalization/Globalization 678
Customer Concentration 679
Lock-on 680
 Cross-Firm MPC Design 680
E-Based Systems 681
Orchestration 683
Hubs 684
 Examples and Techniques 686
ChemUnity 686
SourcingParts 687
Dyator 688
 Concluding Principles 690
 References 690
 Discussion Questions 691
 Problems 691

**Appendix 694
 Index 697**