Contents

PART ONE
The Context and Importance of Inventory Management and Production Planning and Scheduling  1

CHAPTER 1
The Importance of Inventory Management and Production Planning and Scheduling  3

1.1 Why Aggregate Inventory Investment Fluctuates: The Business Cycle  5
1.2 Productivity and Performance of Existing Inventory Management and Production Planning and Scheduling Systems  7
1.3 The Concentration of Inventories within Industries  10
1.4 New Supply Chain Initiatives  11
1.5 Summary  12

CHAPTER 2
Strategic Issues  14

2.1 Corporate Strategy and the Role of Top Management  15
2.2 The Relationship of Finance and Marketing to Inventory Management and Production Planning and Scheduling  15
2.3 Operations Strategy  18
2.4 Measures of Effectiveness for Inventory Management and Production Planning and Scheduling Decisions  24
2.5 Summary  24

CHAPTER 3
Frameworks for Inventory Management and Production Planning and Scheduling  27

3.1 The Diversity of Stock-Keeping Units  27
### CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2 The Bounded Rationality of a Human Being</td>
<td>28</td>
</tr>
<tr>
<td>3.3 Decision Aids for Managing Diverse Individual Items</td>
<td>29</td>
</tr>
<tr>
<td>3.4 Frameworks for Inventory Management</td>
<td>30</td>
</tr>
<tr>
<td>3.5 A Framework for Production Planning and Scheduling</td>
<td>35</td>
</tr>
<tr>
<td>3.6 Costs and Other Important Factors</td>
<td>44</td>
</tr>
<tr>
<td>3.7 Three Types of Modeling Strategies</td>
<td>50</td>
</tr>
<tr>
<td>3.8 The Art of Modeling</td>
<td>51</td>
</tr>
<tr>
<td>3.9 Explicit Measurement of Costs</td>
<td>53</td>
</tr>
<tr>
<td>3.10 Implicit Cost Measurement and Exchange Curves</td>
<td>57</td>
</tr>
<tr>
<td>3.11 The Phases of a Major Inventory or Production Study</td>
<td>58</td>
</tr>
<tr>
<td>3.12 Summary</td>
<td>66</td>
</tr>
<tr>
<td>Appendix to Chapter 3</td>
<td>66</td>
</tr>
</tbody>
</table>

### CHAPTER 4

**Forecasting**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 A Strategic Overview of Forecasting</td>
<td>76</td>
</tr>
<tr>
<td>4.2 The Components of Time Series Analysis</td>
<td>80</td>
</tr>
<tr>
<td>4.3 The Three Steps Involved in Statistically Forecasting a Time Series</td>
<td>82</td>
</tr>
<tr>
<td>4.4 Some Aggregate Medium-Range Forecasting Methods</td>
<td>83</td>
</tr>
<tr>
<td>4.5 Individual-Item, Short-Term Forecasting: Models and Procedures</td>
<td>86</td>
</tr>
<tr>
<td>4.6 Measures of Forecast Errors</td>
<td>109</td>
</tr>
<tr>
<td>4.7 Handling Anomalous Demand</td>
<td>123</td>
</tr>
<tr>
<td>4.8 Incorporation of Human Judgment</td>
<td>123</td>
</tr>
<tr>
<td>4.9 Dealing with Special Class of Individual Items</td>
<td>125</td>
</tr>
<tr>
<td>4.10 Assessing Forecasting Procedures: Tactics and Strategy</td>
<td>130</td>
</tr>
<tr>
<td>Appendix to Chapter 4</td>
<td>134</td>
</tr>
</tbody>
</table>

### PART TWO

**Traditional Replenishment Systems for Managing Individual-Item Inventories**

### CHAPTER 5

**Order Quantities When Demand is Approximately Level**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Assumptions Leading to the Basic Economic Order Quantity (EOQ)</td>
<td>150</td>
</tr>
<tr>
<td>5.2 Derivation of the Economic Order Quantity</td>
<td>151</td>
</tr>
<tr>
<td>5.3 Sensitivity Analysis</td>
<td>156</td>
</tr>
</tbody>
</table>
5.4 Implementation Aids 157
5.5 Quantity Discounts 159
5.6 Accounting for Inflation 164
5.7 Limits on Order Sizes 168
5.8 Finite Replenishment Rate: The Economic Production Quantity (EPQ) 170
5.9 Incorporation of Other Factors 172
5.10 Selection of the Carrying Charge \((r)\), The Fixed Cost Per Replenishment \((A)\), or the Ratio \(\frac{A}{r}\) Based on Aggregate Considerations—The Exchange Curve 179
5.11 Summary 182
Appendix to Chapter 5 182

CHAPTER 6
Lot Sizing for Individual Items with Time-Varying Demand 198
6.1 The Complexity of Time-Varying Demand 199
6.2 The Choice of Approaches 200
6.3 General Assumptions and a Numerical Example 201
6.4 Use Of A Fixed Economic Order Quantity 203
6.5 The Wagner-Whitin Method: An "Optimal" Solution Under an Additional Assumption 205
6.6 Heuristic Approaches For A Significantly Variable Demand Pattern 210
6.7 Handling Of Quantity Discounts 219
6.8 Aggregate Exchange Curves 221
6.9 Summary 222
Appendix to Chapter 6 222

CHAPTER 7
Individual Items with Probabilistic Demand 232
7.1 Some Important Issues and Terminology 233
7.2 The Importance of the Item: A, B, C Classification 236
7.3 Continuous Versus Periodic Review 236
7.4 The Form Of The Inventory Policy: Four Types Of Control Systems 237
7.5 Specific Cost And Service Objectives 241
7.6 Two Examples of Finding the Reorder Point \(s\) In A Continuous-Review, Order-Point, Order-Quantity \((s, O)\) System 247
7.7 Decision Rules for Continuous-Review, Order-Point, Order-Quantity (s, Q) Control Systems 253
7.8 Implied Costs and Performance Measures 274
7.9 Decision Rules for Periodic-Review, Order-Up-To-Level (R, S) Control Systems 275
7.10 Variability in the Replenishment Lead Time Itself 280
7.11 Exchange Curves Involving Safety Stocks For (s, Q) Systems 284
7.12 Summary 294
Appendix to Chapter 7 295

PART THREE
Special Classes of Items 313

CHAPTER 8
Managing the Most Important (Class A) Inventories 315
8.1 The Nature of Class A Items 315
8.2 Guidelines for Control of A Items 316
8.3 Order-Point, Order-Quantity (S, Q) Systems for Slow-Moving A Items 318
8.4 Simultaneous Determination of s and Q for Faster-Moving Items 325
8.5 Decision Rules for (s, S) Systems 331
8.6 Decision Rules for (R, s, S) Systems 336
8.7 Coping with Nonstationarity 341
8.8 Controlling the Inventories of Intermittent Demand Items 343
8.9 Comments on Multiple Sources of Supply and Expediting 343
8.10 Summary 344
Appendix to Chapter 8 345

CHAPTER 9
Managing Routine (Class C) Inventories 358
9.1 The Nature of C Items 358
9.2 Control of C Items Having Steady Demand 359
9.3 Control of Items with Declining Demand Patterns 364
9.4 Reducing Excess Inventories 367
9.5 Stocking Versus Not Stocking an Item 372
9.6 Summary 376
Appendix to Chapter 9 376
CHAPTER 10

Style Goods and Perishable Items 382
10.1 The Style Goods Problem 383
10.2 The Simplest Case: The Unconstrained, Single-Item, News Vendor Problem 385
10.3 The Single-Period, Contained, Multi-Item Situation 393
10.4 More than One Period in Which to Prepare for the Selling Season 396
10.5 The Multiperiod News Vendor Problem 397
10.6 Other Issues Relevant to the Control of Style Goods 398
10.7 Inventory Control of Perishable Items 403
10.8 Summary 404
Appendix to Chapter 10 404

PART FOUR

The Complexities of Multiple Items and Multiple Locations 421

CHAPTER 11

Coordinated Replenishments at a Single Stoclng Point 423
11.1 Advantages and Disadvantages of Coordination 424
11.2 The Deterministic Case: Selection of Replenishment Quantities in a Family of Items 425
11.3 The Deterministic Case with Group Discounts 430
11.4 The Case of Probabilistic Demand and No Quantity Discounts 434
11.5 Probabilistic Demand and Quantity Discounts 438
11.6 The Production Environment 443
11.7 Shipping Consolidation 453
11.8 Summary 453
Appendix To Chapter 11 453

CHAPTER 12

Supply Chain Management and Multiechelon Inventories 471
12.1 Supply Chain Management 471
12.2 Structure and Coordination 476
12.3 Deterministic Demand 477
12.4 Probabilistic Demand 486
12.5 Remanufacturing and Product Recovery 503
PART FIVE
Production Planning and Scheduling 533

CHAPTER 13
An Overall Framework for Production Planning and Scheduling 535
13.1 Characteristics of Different Production Processes 535
13.2 A Framework for Production Decision Making 537
13.3 Options in Dealing with the Hierarchy of Decisions 545
13.4 Summary 551

CHAPTER 14
Medium-Range Aggregate Production Planning 555
14.1 The Aggregate Planning Problem 555
14.2 The Costs Involved 559
14.3 The Planning Horizon 564
14.4 Two Pure Strategies: Level and Chase 565
14.5 Feasible Solution Methods 566
14.6 Linear Programming Models 572
14.7 Simulation Search Procedures 577
14.8 Modeling the Behavior of Managers 579
14.9 Planning for Adjustments Recognizing Uncertainty 581
14.10 Summary 583

CHAPTER 15
Material Requirements Planning and its Extensions 592
15.1 The Complexity of Multistage Assembly Manufacturing 592
15.2 The Weaknesses of Traditional Replenishment Systems in a Manufacturing Setting 594
15.3 Closed Loop Material Requirements Planning 595
15.4 Material Requirements Planning 597
15.5 Capacity Requirements Planning 614
15.6 Distribution Requirements Planning 616
CONTENTS

15.7 Weaknesses of MRP 617
15.8 Enterprise Resource Planning (ERP) Systems 620
15.9 Summary 623

CHAPTER 16
Justin-Time and Optimized Production Technology 631
16.1 Production Planning and Scheduling in Repetitive Situations: Just-in-Time 631
16.2 Planning and Scheduling in Situations with Bottlenecks: Optimized Production Technology (OPT) 646
16.3 Summary 659

CHAPTER 17
Short-Range Production Scheduling 667
17.1 Issues in Short-Term Scheduling 668
17.2 Techniques for Short-Term Scheduling 672
17.3 Deterministic Scheduling of a Single Machine: Priority Sequencing Rules 676
17.4 Deterministic Scheduling with Two or Three Machines 687
17.5 Scheduling of a Single Machine with Probabilistic Processing Times 688
17.6 Probabilistic Scheduling with Two Machines 689
17.7 General Job Shop Scheduling 691
17.8 Summary 701
Appendix to Chapter 17 701

CHAPTER 18
Summary 709
18.1 Operations Strategy 709
18.2 Changing the Givens 710
18.3 Future Developments 711

APPENDIX A
Elements of Lagrangian Optimization 713
A.1 Illustration 713
A.2 Illustration 715
APPENDIX B

The Normal Probability Distribution 719

B.1 The Probability Density Function 719
B.2 Moments 719
B.3 The Unit (or Standard) Normal Distribution 720
B.4 Relating Any Normal Distribution to the Unit Normal 722
B.5 Further Properties Needed for the Appendix of Chapter 10 723

APPENDIX C

C.1 Approximations and Excel Functions for the Normal Distribution 735
C.2 Excel Functions for the Gamma Distribution 737

Author Index 739
Subject Index 749