TECHNISCHE HOCHSCHULE DARMSTADT
Fachbereich 1
Gesamtbibliothek
Betriebswirtschaftslehre
Inventar-Nr. : 31.906
Abstell-Nr. : A 14/675
Sachgebiete: 1.6.9.1
4.3.1

Operations Research in Production Planning, Scheduling, and Inventory Control

Lynwood A. Johnson
Douglas C. Montgomery
Georgia Institute of Technology

JOHN WILEY & SONS, INC; New York · London · Sydney · Toronto

CONTENTS

Chapter 1 **Analysis of Production-Inventory Systems** 1

1-1 THE PROBLEM ENVIRONMENT 2

1-1.1 The Material Flow System 2
1-1.2 Types of Systems 3
1-1.3 Decision Problems 5
1-1.4 Criteria for Decisions 7

1-2 AN OVERVIEW OF THE BOOK 8

1-3 REFERENCES 11

Chapter 2 **Inventory Systems** 13

2-1 INTRODUCTION 13

2-1.1 Inventory Problems 13
2-1.2 Functions of Inventories 16
2-1.3 Measures of Effectiveness 18
2-1.4 Uncertainty in Inventory Processes 22
2-1.5 Inventory Policies 23
2-1.6 Analysis of Inventory Systems 25

2-2 DETERMINISTIC SINGLE-ITEM MODELS WITH STATIC DEMAND 26

2-3 MULTIPLE ITEMS AND CONSTRAINTS 33

2-4 QUANTITY DISCOUNTS 37

2-4.1 All-Units Discounts 37
2-4.2 Incremental Discounts 41

2-5 STOCHASTIC SINGLE-PERIOD MODELS 45

2-6 PERIODIC REVIEW MODELS 50

2-6.1 Multiperiod Models with No Fixed Ordering Cost 50
2-6.2 Multiperiod Models with a Fixed Ordering Cost 55
2-6.3 A Heuristic Treatment of the Periodic Review Case with Backorders 56

2-7 CONTINUOUS REVIEW MODELS 59

2-7.1 A Heuristic Treatment of the Fixed Reorder Quantity Policy with Backorders 59
2-7.2 A Heuristic Treatment of the Fixed Reorder Quantity System with Lost Sales 64
2-7.3 Base Stock Systems with Constant Lead Times 66
2-7.4 Base Stock Systems with Variable Lead Times 68

2-8 LOT-SIZE PROBLEMS WITH DYNAMIC DEMAND 71

2-8.1 Continuous Review Lot-Size Problem 71
2-8.2 Periodic Review Lot-Size Problem 74

2-9 REFERENCES 78

2-10 EXERCISES 79

Chapter 3 **Production Planning—Static Models** 103

3-1 INTRODUCTION 103

3-2 PRODUCT MIX DECISIONS 107

3-2.1 Linear Programming Formulations 108
3-2.2 Stochastic Product Mix Problems 110

3-3 PROCESS SELECTION PROBLEMS 115
3-4 BLENDING PROBLEMS 119
3-5 SIMULTANEOUS PRODUCTION OF MULTIPLE PRODUCTS BY A SINGLE ACTIVITY 122
3-6 SINGLE-FACILITY LOT-SIZE PROBLEMS 124
3-7 MULTIPERIOD PLANNING UNDER STATIC PROBABILISTIC DEMAND 129
3-7.1 Markov Models and Optimal Periodic Review Policies 129
3-7.2 A Model with Demand Dependent Upon Service Time 136
3-8 MULTISTAGE PLANNING PROBLEMS 139
3-8.1 Linear Programming Models 139
3-8.2 A Single-Period Stochastic Model 146
3-8.3 Multistage Base Stock Systems 148
3-8.4 A Multistage Periodic Review Model with Stochastic Demand 151
3-8.5 Multistage Economic Lot-Size Problems 154
3-9 REFERENCES 166
3-10 EXERCISES 167

Chapter 4 **Production Planning—Dynamic Models** 187
4-1 INTRODUCTION 187
4-2 MODELS WITH LINEAR COSTS 191
4-2.1 A Model with Only Production and Inventory Costs 191
4-2.2 A Model with Production Rate Change Costs and Backlogging 197
4-2.3 A Model with Employment Level and Overtime Decisions 199
4-3 DYNAMIC PROGRAMMING AND NETWORK MODELS 201
4-3.1 A General Dynamic Programming Model 201
4-3.2 Network Representations 204
4-3.3 Models with Convex Costs 207
4-3.4 Models with Concave Costs 212
4-4 PRODUCTION AND WORK FORCE SMOOTHING 225
4-4.1 Smoothing Problems and Aggregate Planning 225

4-4.2 Models with Production Change Costs 226
4-4.3 Models with Work Force Change Costs 229
4-4.4 Other Approaches to Aggregate Planning 233

4-5 ADAPTIVE MODELS FOR PRODUCTION CONTROL 236

4-5.1 Production Control Rules 236
4-5.2 Effect on Production and Inventories 239

4-6 MULTIPRODUCT MODELS 242

4-6.1 Multiproduct Linear Programming Models 242
4-6.2 Multiproduct Models with Nonlinear Costs 247

4-7 MULTISTAGE MODELS 258

4-7.1 Structure of Multistage Models 258
4-7.2 Linear Programming Models 262
4-7.3 Network Models 271

4-8 STOCHASTIC MODELS 287
4-8.1 Dynamic Programming Models for a Single Product 289
4-8.2 Chance-Constrained Programming Models 290

4-9 REFERENCES 293

4-10 EXERCISES 296

Chapter 5 **Operations Scheduling** 321

5-1 INTRODUCTION 321

5-2 JOB SHOP SCHEDULING 322

5-2.1 *n* Jobs, One Machine 323
5-2.2 *n* Jobs, Two Machines 325
5-2.3 *n* Jobs, Three Machines 328
5-2.4 Two Jobs, *m* Machines 336
5-2.5 *n* Jobs, *m* Machines 338
5-2.6 Scheduling to Minimize Total Setup Costs 339
5-2.7 Priority Dispatching in Dynamic Job Shops 345

5-3 PROJECT SCHEDULING 349

5-3.1 The Critical Path Method (CPM) 349
5-3.2 Program Evaluation and Review Technique (PERT) 356
5-3.3 Resource Allocation in Project Network Models 360

5-4 ASSEMBLY LINE BALANCING 363

5-4.1 Mathematical Programming Formulations 365
5-4.2 Heuristic Assembly Line Balancing Procedures 368

5-5 REFERENCES 375

5-6 EXERCISES 376

Chapter 6 **Forecasting Systems** 399

6-1 INTRODUCTION 399

6-1.1 Nature and Uses of Forecasts 399
6-1.2 Sources of Data 401
6-1.3 Models and Criteria 402

6-2 REGRESSION METHODS 405

6-3 MOVING AVERAGE METHODS 410

6-3.1 A Constant Process 410
6-3.2 A Linear Trend Process 412

6-4 EXPONENTIAL SMOOTHING METHODS 416

6-4.1 Single Exponential Smoothing for a Constant Process 416
6-4.2 Double Exponential Smoothing for a Linear Trend Process 421
6-4.3 Higher-Order Polynomial Models 424
6-4.4 Winters' Method for Seasonal Variation 427
6-4.5 Adaptive Smoothing 432
6-4.6 Choice of Smoothing Constant 441

6-5 FORECASTING OVER LEAD TIMES 442

6-6 THE TRACKING SIGNAL AND ANALYSIS OF FORECAST ERRORS 444

6-7 FORECASTING THE PROBABILITY DISTRIBUTION OF DEMAND 448

6-8 ADAPTIVE CONTROL MODELS 451

6-9 BAYESIAN METHOD IN FORECASTING 456

6-10 THE BOX-JENKINS MODELS 461

6-10.1 A Class of Time Series Models 462
6-10.2 Forecasting with the Box-Jenkins Models 467

6-11 REFERENCES 477

6-12 EXERCISES 478

Chapter 7 **Systems Design and Implementation** 495

7-1 THE SYSTEM DEVELOPMENT PROCESS 496

7-1.1 Problem Identification 496
7-1.2 Conceptual Design 499
7-1.3 Economic Justification 500
7-1.4 Implementation 501
7-1.5 Personnel and Other Resources 502

7-2 SYSTEM OPERATION 503

7-2.1 Routine Decisions 503
7-2.2 Nonroutine Decisions 503
7-2.3 Maintenance 504
7-2.4 Education 504
7-2.5 Operating Responsibility 504

7-3 REFERENCES 505

Appendix 507

Index 519