# Contents

# Chapter 1

# Introduction 1

- 1.1 The Nature of Management Science 21.2 An Illustration of the Management Science
- Approach: Break-Even Analysis 6
- **1.3** The Impact of Management Science 12
- **1.4** Some Special Features of This Book 14
- **1.5** Summary 17

Glossary 17

Learning Aids for This Chapter in Your MS Courseware 18 Solved Problem 18 Problems 18 Case 1-1 Keeping Time 20

# Chapter 2

## Linear Programming: Basic Concepts 22

- **2.1** A Case Study: The Wyndor Glass Co. Product-Mix Problem 23
- **2.2** Formulating the Wyndor Problem on a Spreadsheet 25
- **2.3** The Mathematical Model in the Spreadsheet 31
- **2.4** The Graphical Method for Solving Two-Variable Problems 33
- **2.5** Using Excel's Solver to Solve Linear Programming Problems 38
- **2.6** Risk Solver Platform for Education (RSPE) 42
- **2.7** A Minimization Example—The Profit & Gambit Co. Advertising-Mix Problem 46
- **2.8** Linear Programming from a Broader Perspective 51
- **2.9** Summary 53

Glossary 53

Learning Aids for This Chapter in Your MS Courseware 54 Solved Problems 54 Problems 54

- Case 2-1 Auto Assembly 60
- Case 2-2 Cutting Cafeteria Costs 61
- Case 2-3 Staffing a Call Center 62

# Chapter 3

#### Linear Programming: Formulation and Applications 64

- **3.1** A Case Study: The Super Grain Corp. Advertising-Mix Problem 65
- **3.2** Resource-Allocation Problems 71
- **3.3** Cost–Benefit–Trade-Off Problems 81

- **3.4** Mixed Problems 88
- **3.5** Transportation Problems 95
- **3.6** Assignment Problems 99
- **3.7** Model Formulation from a Broader Perspective 102
- **3.8** Summary 103
- Glossary 104

Learning Aids for This Chapter in Your MS

Courseware 104

Solved Problems 104

Problems 105

- Case 3-1 Shipping Wood to Market 114
- Case 3-2 Capacity Concerns 115
- Case 3-3 Fabrics and Fall Fashions 116
- Case 3-4 New Frontiers 118
- Case 3-5 Assigning Students to Schools 119
- Case 3-6 Reclaiming Solid Wastes 120
- Case 3-7 Project Pickings 121

# **Chapter 4**

## The Art of Modeling with Spreadsheets 124

- **4.1** A Case Study: The Everglade Golden Years Company Cash Flow Problem 125
- **4.2** Overview of the Process of Modeling with Spreadsheets 126
- **4.3** Some Guidelines for Building "Good" Spread-sheet Models 135
- **4.4** Debugging a Spreadsheet Model 141
- **4.5** Summary 144
- Glossary 145
- Learning Aids for This Chapter in Your MS
- Courseware 145
- Solved Problems 145
- Problems 146

Case 4-1 Prudent Provisions for Pensions 148

# Chapter 5

#### What-If Analysis for Linear Programming 150

- 5.1 The Importance of What-If Analysis to Managers 151
- **5.2** Continuing the Wyndor Case Study 153
- **5.3** The Effect of Changes in One Objective Function Coefficient 155
- **5.4** The Effect of Simultaneous Changes in Objective Function Coefficients 161
- **5.5** The Effect of Single Changes in a Constraint 169

- **5.6** The Effect of Simultaneous Changes in the Constraints 175
- **5.7** Summary 179

Glossary 179 Learning Aids for This Chapter in Your MS Courseware 180 Solved Problem 180 Problems 181 Case 5-1 Selling Soap 188 Case 5-2 Controlling Air Pollution 189 Case 5-3 Farm Management 191 Case 5-4 Assigning Students to

**Chapter 6** 

#### Network Optimization Problems 194

Schools (Revisited) 193

- 6.1 Minimum-Cost Flow Problems 195
- **6.2** A Case Study: The BMZ Co. Maximum Flow Problem 202
- **6.3** Maximum Flow Problems 205
- **6.4** Shortest Path Problems 209
- **6.5** Summary 218

Glossary 219

Learning Aids for This Chapter in Your MS Courseware 219 Solved Problems 219 Problems 220 Case 6-1 Aiding Allies 224 Case 6-2 Money in Motion 227 Case 6-3 Airline Scheduling 229 Case 6-4 Broadcasting the Olympic Games 230

#### **Chapter 7**

# Using Binary Integer Programming to Deal with Yes-or-No Decisions 232

- 7.1 A Case Study: The California Manufacturing Co. Problem 233
- **7.2** Using BIP for Project Selection: The Tazer Corp. Problem 239
- 7.3 Using BIP for the Selection of Sites for Emergency Services Facilities: The Caliente City Problem 241
- **7.4** Using BIP for Crew Scheduling: The Southwestern Airways Problem 246
- 7.5 Using Mixed BIP to Deal with Setup Costs for Initiating Production: The Revised Wyndor Problem 250
- **7.6** Summary 254

Glossary 255

Learning Aids for This Chapter in Your MS Courseware 255

- Solved Problems 255
- Problems 257
- Case 7-1 Assigning Art 261
- Case 7-2 Stocking Sets 263
- Case 7-3 Assigning Students to Schools (Revisited) 266
- Case 7-4 Broadcasting the Olympic Games (Revisited) 266

#### **Chapter 8**

#### Nonlinear Programming 267

- 8.1 The Challenges of Nonlinear Programming 269
- **8.2** Nonlinear Programming with Decreasing Marginal Returns 277
- 8.3 Separable Programming 287
- 8.4 Difficult Nonlinear Programming Problems 297
- **8.5** Evolutionary Solver and Genetic Algorithms 299
- **8.6** Using RSPE to Analyze a Model and Choose a Solving Method 306
- **8.7** Summary 310
- Glossary 311

Learning Aids for This Chapter in Your MS

Courseware 312

Solved Problem 312

- Problems 312
- Case 8-1 Continuation of the Super Grain Case Study 317
- Case 8-2 Savvy Stock Selection 318
- Case 8-3 International Investments 319

## **Chapter 9**

#### Decision Analysis 322

- **9.1** A Case Study: The Goferbroke Company Problem 323
- **9.2** Decision Criteria 325
- **9.3** Decision Trees 330
- **9.4** Sensitivity Analysis with Decision Trees 333
- **9.5** Checking Whether to Obtain More Information 338
- **9.6** Using New Information to Update the Probabilities 340
- **9.7** Using a Decision Tree to Analyze the Problem with a Sequence of Decisions 344
- **9.8** Performing Sensitivity Analysis on the Problem with a Sequence of Decisions 351
- **9.9** Using Utilities to Better Reflect the Values of Payoffs 354
- **9.10** The Practical Application of Decision Analysis 365
- **9.11** Summary 366

Glossary 367

Learning Aids for This Chapter in Your MS Courseware 368 Solved Problems 368

Problems 369

- Case 9-1 Who Wants to Be a Millionaire? 379
- Case 9-2 University Toys and the Business Professor Action Figures 379
- Case 9-3 Brainy Business 380
- Case 9-4 Smart Steering Support 382

#### Chapter 10

#### Forecasting 384

- **10.1** An Overview of Forecasting Techniques 385
- **10.2** A Case Study: The Computer Club Warehouse (CCW) Problem 386
- **10.3** Applying Time-Series Forecasting Methods to the Case Study 391
- **10.4** The Time-Series Forecasting Methods in Perspective 410
- **10.5** Causal Forecasting with Linear Regression 413
- **10.6** Judgmental Forecasting Methods 418

**10.7** Summary 419

Glossary 420

Summary of Key Formulas 421

Learning Aids for This Chapter in Your MS Courseware 421 Solved Problem 421 Problems 422 Case 10-1 Finagling the Forecasts 429

#### Chapter 11

#### Queueing Models 433

- **11.1** Elements of a Queueing Model 434
- **11.2** Some Examples of Queueing Systems 440
- **11.3** Measures of Performance for Queueing Systems 442
- **11.4** A Case Study: The Dupit Corp. Problem 445
- **11.5** Some Single-Server Queueing Models 448
- **11.6** Some Multiple-Server Queueing Models 457
- **11.7** Priority Queueing Models 463
- **11.8** Some Insights about Designing Queueing Systems 469
- **11.9** Economic Analysis of the Number of Servers to Provide 473

**11.10** Summary 476

Glossary 477

Key Symbols 478

- Learning Aids for This Chapter in Your MS
- Courseware 478
- Solved Problem 478
- Problems 479
- Case 11-1 Queueing Quandary 485
- Case 11-2 Reducing In-Process Inventory 486

# Chapter 12

#### **Computer Simulation: Basic Concepts** 488

- **12.1** The Essence of Computer Simulation 489
- **12.2** A Case Study: Herr Cutter's Barber Shop (Revisited) 501
- **12.3** Analysis of the Case Study 508
- **12.4** Outline of a Major Computer Simulation Study 515
- **12.5** Summary 518
- Glossary 518
- Learning Aids for This Chapter in Your MS
- Courseware 519
- Solved Problem 519
- Problems 519
- Case 12-1 Planning Planers 523
- Case 12-2 Reducing In-Process Inventory (Revisited) 524

#### Chapter 13

# Computer Simulation with Risk Solver Platform 525

- **13.1** A Case Study: Freddie the Newsboy's Problem 526
- **13.2** Bidding for a Construction Project: A Prelude to the Reliable Construction Co. Case Study 536
- **13.3** Project Management: Revisiting the Reliable Construction Co. Case Study 540
- **13.4** Cash Flow Management: Revisiting the Everglade Golden Years Company Case Study 546
- **13.5** Financial Risk Analysis: Revisiting the Think-Big Development Co. Problem 552
- **13.6** Revenue Management in the Travel Industry 557
- **13.7** Choosing the Right Distribution 562
- **13.8** Decision Making with Parameter Analysis Reports and Trend Charts 575
- **13.9** Optimizing with Computer Simulation Using RSPE's Solver 583
- **13.10** Summary 590
- Glossary 591
- Learning Aids for This Chapter in Your MS
- Courseware 591
- Solved Problem 591
- Problems 592
- Case 13-1 Action Adventures 596
- Case 13-2 Pricing under Pressure 597

Appendix A Tips for Using Microsoft Excel for Modeling 599

Appendix B

Partial Answers to Selected Problems 605

### Supplements on the CD-ROM

Supplement to Chapter 2: More about the Graphical Method for Linear Programming Supplement to Chapter 5: Reduced Costs Supplement to Chapter 6: Minimum Spanning-Tree Problems

Supplement 1 to Chapter 7: Advanced Formulation Techniques for Binary Integer Programming Supplement 2 to Chapter 7: Some Perspectives on Solving Binary Integer Programming Problems Supplement 1 to Chapter 9: Decision Criteria Supplement 2 to Chapter 9: Using TreePlan

Software for Decision Trees

Supplement to Chapter 11: Additional Queueing Models

Supplement to Chapter 12: The Inverse Transformation Method for Generating Random Observations

# Chapters on the CD-ROM Chapter 14

#### Solution Concepts for Linear Programming

- **14.1** Some Key Facts about Optimal Solutions
- **14.2** The Role of Corner Points in Searching for an Optimal Solution
- **14.3** Solution Concepts for the Simplex Method
- **14.4** The Simplex Method with Two Decision Variables
- **14.5** The Simplex Method with Three Decision Variables
- **14.6** The Role of Supplementary Variables
- 14.7 Some Algebraic Details for the Simplex Method
- **14.8** Computer Implementation of the Simplex Method
- **14.9** The Interior-Point Approach to Solving Linear Programming Problems

14.10 Summary

Glossary

Learning Aids for This Chapter in Your MS Courseware Problems

# Chapter 15

### **Transportation and Assignment Problems**

- **15.1** A Case Study: The P & T Company Distribution Problem
- **15.2** Characteristics of Transportation Problems
- **15.3** Modeling Variants of Transportation Problems
- **15.4** Some Other Applications of Variants of Transportation Problems

- **15.5** A Case Study: The Texago Corp. Site Selection Problem
- **15.6** Characteristics of Assignment Problems
- **15.7** Modeling Variants of Assignment Problems

**15.8** Summary

Glossary

Learning Aids for This Chapter in Your MS

Courseware

Problems

Case 15-1 Continuation of the Texago Case Study

#### **Chapter 16**

#### **PERT/CPM Models for Project Management**

- **16.1** A Case Study: The Reliable Construction Co. Project
- **16.2** Using a Network to Visually Display a Project
- **16.3** Scheduling a Project with PERT/CPM
- **16.4** Dealing with Uncertain Activity Durations
- **16.5** Considering Time–Cost Trade-Offs
- **16.6** Scheduling and Controlling Project Costs
- **16.7** An Evaluation of PERT/CPM from a Managerial Perspective
- 16.8 Summary
- Glossary
- Learning Aids for This Chapter in Your MS

Courseware

Problems

- Case 16-1 Steps to Success
- Case 16-2 "School's Out Forever ... "

## Chapter 17

#### **Goal Programming**

- **17.1** A Case Study: The Dewright Co. Goal-Programming Problem
- **17.2** Weighted Goal Programming
- **17.3** Preemptive Goal Programming
- **17.4** Summary
- Glossary

Learning Aids for This Chapter in Your MS

Courseware

- Problems
- Case 17-1 A Cure for Cuba
- Case 17-2 Remembering September 11

## Chapter 18

#### **Inventory Management with Known Demand**

- **18.1** A Case Study: The Atlantic Coast Tire Corp. (ACT) Problem
- **18.2** Cost Components of Inventory Models
- **18.3** The Basic Economic Order Quantity (EOQ) Model

- **18.4** The Optimal Inventory Policy for the Basic EOQ Model
- **18.5** The EOQ Model with Planned Shortages
- **18.6** The EOQ Model with Quantity Discounts
- **18.7** The EOQ Model with Gradual Replenishment

18.8 Summary

Glossary

Learning Aids for This Chapter in Your MS Courseware

Problems

Case 18-1 Brushing Up on Inventory Control

#### **Chapter 19**

# Inventory Management with Uncertain Demand

- **19.1** A Case Study for Perishable Products: Freddie the Newsboy's Problem
- **19.2** An Inventory Model for Perishable Products
- **19.3** A Case Study for Stable Products: The Niko Camera Corp. Problem
- **19.4** The Management Science Team's Analysis of the Case Study
- **19.5** A Continuous-Review Inventory Model for Stable Products
- **19.6** Larger Inventory Systems in Practice
- **19.7** Summary

Glossary

# Learning Aids for This Chapter in Your MS Courseware

#### Problems

Case 19-1 TNT: Tackling Newsboy's Teachings

Case 19-2 Jettisoning Surplus Stock

#### **Chapter 20**

#### **Computer Simulation with Crystal Ball**

- **20.1** A Case Study: Freddy the Newsboy's Problem
- **20.2** Bidding for a Construction Project: A Prelude to the Reliable Construction Co. Case Study
- **20.3** Project Management: Revisiting the Reliable Construction Co. Case Study
- **20.4** Cash Flow Management: Revisiting the Everglade Golden Years Company Case Study
- **20.5** Financial Risk Analysis: Revisiting the Think-Big Development Co. Problem
- **20.6** Revenue Management in the Travel Industry
- **20.7** Choosing the Right Distribution
- **20.8** Decision Making with Decision Tables
- **20.9** Optimizing with OptQuest
- 20.10 Summary

Glossary

Learning Aids for This Chapter in Your MS Courseware

Solved Problem

Problems

- Case 20-1 Action Adventures
- Case 20-2 Pricing under Pressure