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Science and Engineering Classics

# Introduction to Management Science (Tenth Edition)

伯纳德·W·泰勒 (Bernard W.Taylor Ⅲ) 著 侯文华 改编

**四** 中国人民大学出版社



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本书是美国颇为流行的定量管理决策的教材,其作者是管理科学领域的资深专家与教育家,其良好的学识修养、对专业知识的全面把握和简洁流畅的文字表达能力、多年的研究与教学实践经验以及对读者接受定量分析方法的切入点的把握,都使本书成为管理科学领域著作中的佼佼者。这也使该教材 30 多年来一版再版,拥有众多的读者。

我们知道,管理既是一门艺术,又是一门科学。说它是艺术,是因为在管理实践中存在太多的技巧性、经验性知识。这种知识似乎很难从书本上学到,而要靠实践,甚至很大程度上取决于个人的悟性和偏好。而另一方面,管理的确又是一门科学。在管理决策过程中,人们总结出了很多规律,并发展了许多定量化的模型和方法,使管理实践变得具体,且富有逻辑内涵。这也使管理实践由"技巧性"变得更加"技术性"。

在书中,作者将原本枯燥的、技术化的理论赋予"灵魂",融入到丰富的实例中,使数学模型变得浅显易懂,将形象化思维与严谨的逻辑化思维有机地结合起来,使看似刻板、严肃的定量化方法及理论变得生动有趣和富有创造性。

管理科学是研究管理理论、方法和管理实践活动的一般规律的科学。今天,管理科学已经扩展到各个领域,形成内容广泛、门类齐全的独立学科体系。管理现代化要求应用现代科学的理论提高计划、组织和控制的能力,从而适应生产力的发展需要,使经验型的传统管理转变为科学型的现代管理。

为了实现管理现代化,管理者需要理解管理科学的原理及其应用,本书正是为此而作。

通过阅读本书,读者不仅能透彻地理解管理科学基本理论,而且能熟练地在管理实践中应用管理科学方法,理由如下:

在基本理论学习方面,本书在以下几方面可圈可点: (1) 理论内容丰富,章节安排由 浅入深,从简单的线性规划入手,到复杂的排队论、库存管理原理,内容涵盖线性规划、 线性规划的求解及灵敏度分析、整数规划、运输问题、网络流模型、项目管理、多准则决 策、非线性规划、决策分析、排队论、模拟、预测与库存管理。(2) 本书深入浅出,将复 杂的数学论证融于简明的分析中,易于掌握其理论的本质,有别于严肃刻板的管理科学著 作。(3) 课后习题丰富,便于读者及时检验对理论的掌握程度。(4) 趣味性强,不仅有很 多案例分析,而且不经意间会遇到有趣的休闲阅读。

在管理科学的应用方面,本书有以下突出表现: (1) 针对每一章节的理论,配有大量的应用案例,通过对这些案例进行分析,读者能够身临其境地体验应用管理科学的魅力。 (2) 授人以鱼,不如授人以渔,作者在讲解理论应用时,不仅采用案例分析方法,而且教授读者应用 Excel 和 Windows QM 求解与分析。 (3) 在每章末,作者又为读者提供了一个案例研究的练兵场——案例问题分析。

纵览全书, 我们欣喜地发现, 本书内容丰富, 章节安排由浅入深, 理论分析深入浅出, 通俗易懂, 可读性强, 案例丰富, 富有趣味, 不仅是管理科学理论的引路人, 也是在实践中应用管理科学的导师。

考虑到篇幅及教学需要, 删去了原书的第 11 章和各章末偶数题号的习题, 这部分内容 放在中国人民大学出版社工商管理分社的网站上供读者使用。

侯文华

# Preface\*

The objective of management science is to solve the decisionmaking problems that confront and confound managers in both the public and the private sector by developing mathematical models of those problems. These models have traditionally been solved with various mathematical techniques, all of which lend themselves to specific types of problems. Thus, management science as a field of study has always been inherently mathematical in nature, and as a result sometimes complex and rigorous. When I began writing the first edition of this book in 1979, my main goal was to make these mathematical topics seem less complex and thus more palatable to undergraduate business students. To achieve this goal I started out by trying to provide simple, straightforward explanations of often difficult mathematical topics. I tried to use lots of examples that demonstrated in detail the fundamental mathematical steps of the modeling and solution techniques. Although in the last two and a half decades the emphasis in management science has shifted away from strictly mathematical to mostly computer solutions, my objective has not changed. I have provided clear, concise explanations of the techniques used in management science to model problems, and provided many examples of how to solve these models on the computer while still including some of the fundamental mathematics of the techniques.

The stuff of management science can seem abstract, and students sometimes have trouble perceiving the usefulness of quantitative courses in general. I remember when I was a student I could not foresee how I would use such mathematical topics (in addition to a lot of the other things I learned in college) in any job after graduation. Part of the problem is that the examples used in books often do not seem realistic. Unfortunately, examples must be made simple to facilitate the learning process. Larger, more complex examples reflecting actual applications would be too complex to help the student learn the modeling technique. The modeling techniques presented in this text are, in fact, used extensively in the business world, and their use is increasing rapidly because of computer and information technology. Therefore, the chances that students will use the modeling techniques that they learn from this text in a future job are very great indeed.

Even if these techniques are not used on the job, the logical approach to problem solving embodied in management science is valuable for all types of jobs in all types of organizations. Management science consists of more than just a collection of mathematical modeling techniques; it embodies a philosophy of approaching a problem in a logical manner, as does any science. Thus, this text not only teaches specific techniques but also provides a very useful method for approaching problems.

My primary objective throughout all revisions of this text is readability. The modeling techniques presented in each chapter are explained with straightforward examples that avoid lengthy written explanations. These examples are organized in a logical step-by-step fashion that the student can subsequently apply to the problems at the end of each chapter. I have tried to avoid complex mathematical notation and formulas wherever possible. These various factors will, I hope, help make the material more interesting and less intimidating to students.

### Learning Features

This tenth edition of *Introduction to Management Science* includes many features that are designed to help sustain and accelerate the student's learning of the material. Several of the strictly mathematical topics—like the simplex and transportation solution methods—are on the accompanying Companion Web site at www.pearsonhighered.com/Taylor. This frees up text space for additional modeling examples in several of the chapters, allowing more emphasis on computer solutions such as Excel spreadsheets, and added additional homework problems. In the following sections, we will summarize these and other learning features that appear in the text.

Text Organization An important objective is to have a well-organized text that flows smoothly and follows a logical progression of topics, placing the different management science modeling techniques in their proper perspective. The first 10 chapters group together those chapters related to mathematical programming that can be solved using Excel spreadsheets, including linear, integer, nonlinear, and goal programming as well as network techniques.

Within these mathematical programming chapters, the traditional simplex procedure for solving linear programming problems mathematically is located on the Companion Web site at www.pearsonhighered.com/Taylor that accompanies this text. It can still be covered by the student on the

<sup>\*</sup> 为使读者了解原书全貌, 未作删改。——改编者注

computer as part of linear programming, or it can be excluded, without leaving a "hole" in the presentation of this topic. The integer programming mathematical branch and bound solution method is also on the Companion Web site. In Chapter 6, on the transportation and assignment problems, the strictly mathematical solution approaches, including the northwest corner, VAM, and stepping-stone methods, are also on the accompanying Companion Web site. Because transportation and assignment problems are specific types of network problems, the two chapters that cover network flow models and project networks that can be solved with linear programming, as well as traditional model-specific solution techniques and software, follow Chapter 6 on transportation and assignment problems. In addition, in Chapter 10, on nonlinear programming, the traditional mathematical solution techniques, including the substitution method and the method of Lagrange multipliers, are on the Companion Web site.

Chapters 11 through 14 include topics generally thought of as being probabilistic, including probability and statistics, decision analysis, queuing, and simulation. A module on Markov analysis is on the accompanying Companion Web site. Also, a module on game theory is on the Companion Web site. Forecasting in Chapter 15 and inventory management in

Chapter 16 are both unique topics related to operations management.

Excel Spreadsheets This new edition continues to emphasize Excel spreadsheet solutions of problems. Spreadsheet solutions are demonstrated in all the chapters in the text (except for Chapter 2, on linear programming modeling and graphical solution), for virtually every management science modeling technique presented. These spreadsheet solutions are presented in optional subsections, allowing the instructor to decide whether to cover them. The text includes more than 175 Excel spreadsheet screens for the latest Excel 2007. Most include reference callout boxes that describe the solution steps within the spreadsheet. Files that include all the Excel spreadsheet model solutions for the examples in the text are included on the Companion Web site and can be easily downloaded by the student to determine how the spreadsheet was set up and the solution derived, and to use as templates to work homework problems. In addition, Appendix B at the end of the text provides a tutorial on how to set up and edit spreadsheets for problem solution. Following is an example of one of the Excel spreadsheet files (from Chapter 3) that is available on the Companion Web site accompanying the text.

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Spreadsheet "Add-Ins" Several spreadsheet add-in packages are available with this book, often in trial and premium versions. For complete information on options for downloading each package, please visit www.pearsonhighered.com/Taylor.

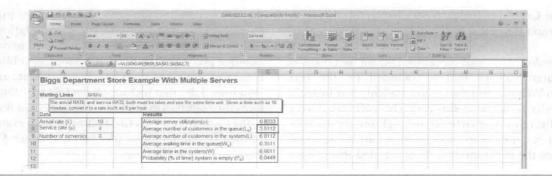
**Note to instructors:** An access code that permits students to download the full version of all packages is available as a free bundle with this text. To obtain ordering information, please contact your local sales rep, or visit the catalog page for this book at www.pearsonhighered.com.

Excel QM For some management science topics, the Excel formulas that are required for solution are lengthy and complex and thus are very tedious and time-consuming to type into a spreadsheet. In several of these instances in the book, including Chapter 6 on transportation and assignment problems, Chapter 12 on decision analysis, Chapter 13 on queuing, Chapter 15 on forecasting, and Chapter 16 on inventory

control, a spreadsheet "add-in" called Excel QM is demonstrated. These add-ins provide a generic spreadsheet setup with easy-to-use dialog boxes and all of the formulas already typed in for specific problem types. Unlike other "black box" software, these add-ins allow users to see the formulas used in each cell. The input, results, and the graphics are easily seen and can be easily changed, making this software ideal for classroom demonstrations and student explorations. Following on the next page is an example of an Excel QM file (from Chapter 13) that is on the Companion Web site that accompanies the text.

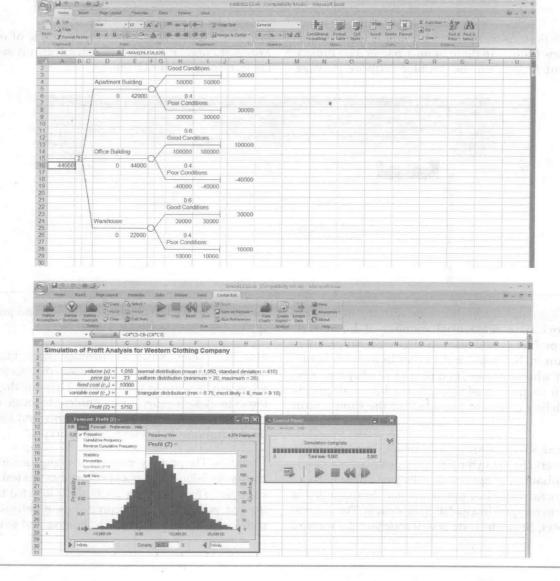
Premium Solver for Education This is an upgraded version of the standard Solver that comes with Excel. Complete information on how to download this upgraded version is available at www.pearsonhighed.com/Taylor.

TreePlan Another spreadsheet add-in program that is demonstrated in the text is TreePlan, a program that will set



up a generic spreadsheet for the solution of decision-tree problems in Chapter 12 on decision analysis. This is also available on the Companion Web site. Following is an example of one of the **TreePlan** files (from Chapter 12) that is on the text Companion Web site.

Crystal Ball Still another spreadsheet add-in program is available from Crystal Ball by Oracle. Crystal Ball is demonstrated in Chapter 14 on simulation and shows how to perform simulation analysis for certain types of risk analysis and forecasting problems. Following is an example

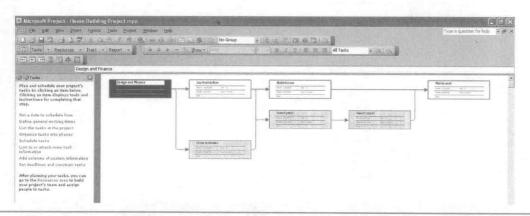


of one of the **Crystal Ball** files (from Chapter 14) that is on the Companion Web site.

QM for Windows Software Package QM for Windows is the computer package that is included on the text Companion Web site and that many students and instructors will prefer to use with this text. This software is very user-friendly, requiring virtually no preliminary instruction except for the "help" screens that can be accessed directly from the program. It is demonstrated throughout the text in conjunction with virtually every management science modeling technique, except simulation. The text includes 50 QM for Windows screens used to demonstrate example problems. Thus, for most topics problem solution is demonstrated via both Excel spreadsheets and QM for Windows. Files that include all the QM for Windows solutions for examples in the text are included on the accompanying Companion Web site. Following is an example of one of the QM for Windows files (from Chapter 4) that is on the Companion Web site.

Original Problem w/ans								
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Shipping capacity (boxes)	3	3	1	1	<##	1,200	22.2222	
Budget (\$)	36	48	25	35	<=	25,000	0	
Blank sweats (dozens)	1	1.	0	.0	408	500	0	
Blank T's (dozens)	0	0	1	- 1	<==	500	4.1111	
Solution->	175.5556	57.7778	500	0	Optimal Z->	45,522.22	X3 + X4 <= 500	

Microsoft Project As we indicated previously when talking about the new features in this edition, Chapter 8 on Project Management focuses on the popular software package Microsoft Project. Following is an example of one of the Microsoft Project files (from Chapter 8) that is available on the text Companion Web site.



New Problems and Cases Previous editions of the text always provided a substantial number of homework questions, problems, and cases to offer students practice. This edition includes more than 750 homework problems, 30 of which are new, and 62 end-of-chapter cases, 10 of which are new. In addition, four additional spreadsheet modeling cases are provided on the Companion Web site.

Management Science Applications Boxes These boxes are located in every chapter in the text. They describe how a company, organization, or agency uses the particular management science technique being presented and demonstrated in the chapter to compete in a global environment. There are 50 of these boxes, 20 of which are new, throughout the text and

they encompass a broad range of business and public sector applications, both foreign and domestic.

Marginal Notes Notes are included in the margins that serve the same basic function as notes that students themselves might write in the margin. They highlight certain topics to make it easier for the student to locate them, they summarize topics and important points, and they provide brief definitions of key terms and concepts.

Examples The primary means of teaching the various quantitative modeling techniques presented in this text is through examples. Thus, examples are liberally inserted throughout the text, primarily to demonstrate how problems are solved with the different quantitative techniques and to make them

easier to understand. These examples are organized in a logical step-by-step solution approach that the student can subsequently apply to the homework problems.

Solved Example Problems At the end of each chapter, just prior to the homework questions and problems, there is a section with solved examples to serve as a guide for doing the homework problems. These examples are solved in a detailed, step-by-step fashion.

## Instructors' and Students' Supplements

#### For the Instructor:

Excel Homework Solutions—In addition to the printed Instructor's Solutions Manual, almost every end-of-chapter homework and case problem in this text has a corresponding Excel solution file for the instructor. This new edition includes 750 end-of-chapter homework problems and Excel solutions are provided for all but a few of them. Excel solutions are also provided for most of the 62 end-of-chapter case problems. These solution files can be accessed from the Instructor's Resource Center at www.pearsonhighered.com/Taylor, as shown in the illustration below. These Excel files also

include those homework and case problem solutions using *TreePlan* (from Chapter 12) and those using *Crystal Ball* (from Chapter 14). In addition, *Microsoft Project* solution files are available for homework problems in Chapter 8.

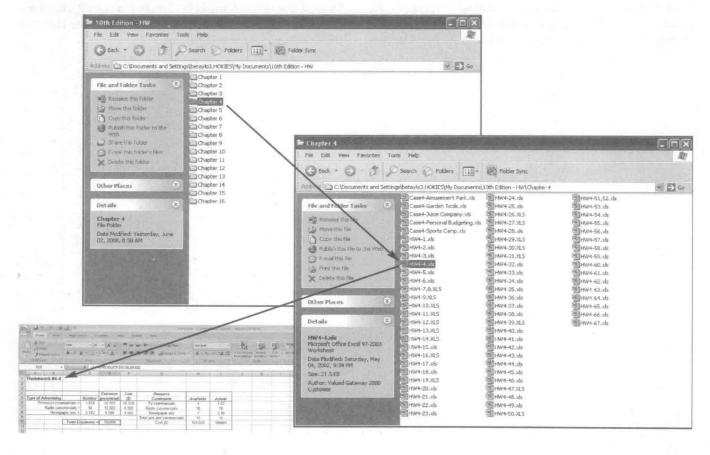
PowerPoint Presentations—PowerPoint presentations are available for every chapter to enhance lectures. They feature figures, tables, Excel, and main points from the text. They are available for instructor download at www.pearsonhighered.com/Taylor.

Instructor's Solutions Manual—The instructor's Solutions Manual contains detailed solutions for all end-of-chapter exercises and cases. In addition to a printed solutions manual, these solutions are provided electronically on the text's Web site.

Test Item File—The test item file contains a variety of true/false, multiple choice, and problem-solving questions for each chapter.

questions for each chapter.

Instructor's Resource Center—The Instructor's Resource Center contains the electronic files for the complete Instructor's Solutions Manual, the Test Item File, TestGen software, and Power Point Slides. They are available for download at www.pearsonhighered.com/Taylor. This of course is open only to instructors who must register for use.



#### TestGen Software

The print Test Item Files are designed for use with the TestGen test generating software. This computerized package allows instructors to custom design, save, and generate classroom tests. This software allows for greater flexibility and ease of use. It provides many options for organizing and displaying tests, along with a search and sort feature.

#### For the Student:

Companion Web site—The student Web site contains all the files needed for use with this text as well as information on how to obtain various third party and companion software. Visit this site at www .pearsonhighered.com/Taylor for the most recent updates and information.

Acknowledgments

As with any large project, the revision of a textbook is not accomplished without the help of many people. The tenth edition of this book is no exception, and I would like to take this opportunity to thank those who have contributed to its preparation. First, I would like to thank my friend and colleague, Larry Moore, for his help in developing the organization and approach of the original edition of this book and for his many suggestions during its revisions. We spent many hours discussing what an introductory text in management science should contain, and his ideas appear

in these pages. Larry also served as a sounding board for many ideas regarding content, design, and preparation, and he read and edited many portions of the text, for which I am very grateful. I also thank the reviewers of this edition:

I remain indebted to the reviewers of the previous editions: Nagraj Balakrishnan, Edward M. Barrow, Ali Behnezhad, Weldon J. Bowling, Rod Carlson, Petros Christofi, Yar M. Ebadi, Richard Ehrhardt, Warren W. Fisher, James Flynn, Wade Furgeson, Soumen Ghosh, James C. Goodwin Jr., Richard Gunther, Ann Hughes, Shivaji Khade, Shao-ju Lee, Robert L. Ludke, Peter A. Lyew, Robert D. Lynch, Dinesh Manocha, Mildred Massey, Abdel-Aziz Mohamed, Thomas J. Nolan, Susan W. Palocsay, David W. Pentico, Cindy Randall, Roger Schoenfeldt, Charles H. Smith, Lisa Sokol, John Wang, and Barry Wray. Dr. B. S. Bal, Dewey Hemphill, David A. Larson, Sr., Christopher M. Rump, Dothang Truong, Hulya Julie Yazici, and Ding Zhang.

I am also very grateful to Tracy McCoy at Virginia Tech for her typing and editorial assistance. I would like to thank my production editor, Clara Bartunek at Pearson Prentice Hall, for her valuable assistance and patience. I very much appreciate the help and hard work of Heidi Allgair and all the folks at GGS Higher Education Resources, a Division of PreMedia Global, Inc., who produced this edition. Finally, I would like to thank my editor, Mark Pfaltzgraff, and assistant editor Susan Abraham, at Pearson Prentice Hall, for their continued help and patience.

# Contents

2

Model Formulation 28

Models 32

A Maximization Model Example 28

Time Out: for George B. Dantzig 29

Management Science Application:

Graphical Solutions of Linear Programming

Operational Cost Control at Kellogg 33

Preface i	Management Science Application:  Improving Customer Service at Amazon.com 44
1 Management Science 1	A Minimization Model Example 45 Management Science Application:
The Management Science Approach to Problem Solving 2 Time Out: for Pioneers in Management Science Management Science Application:	Determining Optimal Fertilizer Mixes at Soquimich (South America) 49 Irregular Types of Linear Programming Problems 51
Management Science at Taco Bell 6 Model Building: Break-Even Analysis 7 Computer Solution 12 Management Science Modeling Techniques 15 Business Usage of Management Science Techniques 18	3 Linear Programming: Computer Solution and Sensitivity Analysis 61
Management Science Application: Employ Scheduling with Management Science 19 Management Science Models in Decision Support Systems 20	Management Science Application: Optimizing
Management Science Application: A Decision Support System for Aluminum Can Production at Coors 21	Management Science Application: Grape Juice Management at Welch's 72
2 Linear Programming: Model Formulation and Graphical	4 Linear Programming: Modeling Examples 91
Solution 27	A Product Mix Example 92

A Diet Example 97

An Investment Example 100

A Marketing Example 105

A Blend Example 112

A Transportation Example 108

Management Science Application: A Linear

Programming Model for Optimal Portfolio

Selection at Prudential Securities, Inc. 105

A Multiperiod Scheduling Example 117

Management Science Application:
Gasoline Blending at Texaco 118

A Data Envelopment Analysis Example 121

Management Science Application: Analyzing
Bank Branch Efficiency by Using DEA 122

# 5 Integer Programming 146

Integer Programming Models 147

Management Science Application: Allocating Operating Room Time at Toronto's Mount Sinai Hospital 150

Integer Programming Graphical Solution 151

Computer Solution of Integer Programming

Problems with Excel and QM for Windows 153

Time Out: for Ralph E. Gomory 154

Management Science Application: College of Business Class Scheduling at Ohio University 156

Management Science Application:
Forming Business Case Student Teams at
Indiana University 160
0-1 Integer Programming Modeling Examples 161
Management Science Application: Planning
Next-Day Air Shipments at UPS 168

# 6 Transportation, Transshipment, and Assignment Problems 183

The Transportation Model 184

Time Out: for Frank L. Hitchcock and Tjalling C. Koopmans 186

Management Science Application: Transportation Models at Nu-kote International 187

Computer Solution of a Transportation Problem 187

Management Science Application: Matching Wineries with Distributors 192

The Transshipment Model 192

Management Science Application:
Transporting Mail at the U.S. Postal Service 196
The Assignment Model 197

Computer Solution of an Assignment Problem 197

Management Science Application: Supplying Empty Freight Cars at Union Pacific Railroad 200

Management Science Application:
Assigning Umpire Crews at Professional
Tennis Tournaments 201

## 7 Network Flow Models 223

Network Components 224
The Shortest Route Problem 225
The Minimal Spanning Tree Problem 232

Management Science Application: Reducing Travel Costs at the Defense Contract Management Agency 233

The Maximal Flow Problem 237

Time Out: for E. W. Dijkstra, L. R. Ford, Jr., and D. R. Fulkerson 238

Management Science Application: Improving Service for Yellow Freight System's Terminal Network 239

# 8 Project Management 259

The Elements of Project Management 260

Management Science Application: Managing Projects in China 262

Time Out: for Henry Gantt 266

Management Science Application: An Air Flight Safety and Efficiency Project at the FAA 268

CPM/PERT 269

Time Out: for Morgan R. Walker, James E. Kelley, Jr., and D. G. Malcolm 270

Probabilistic Activity Times 278

Management Science Application: A Drug Development Project to Combat Malaria 284

Microsoft Project 285

Project Crashing and Time-Cost Trade-Off 292

Management Science Application:

Reconstructing the Pentagon After 9/11 296

Formulating the CPM/PERT Network as a Linear Programming Model 297

### 9 Multicriteria Decision Making 315

Goal Programming 316

Graphical Interpretation of Goal Programming 320 Computer Solution of Goal Programming Problems with QM for Windows and Excel 323

Management Science Application: Developing Television Advertising Sales Plans at NBC 324

Time Out: for Abraham Charnes and William W. Cooper 327

The Analytical Hierarchy Process 330

Management Science Application: Selecting Students for Graduate Studies Abroad at Dar Al-Hekma Women's College 331

Management Science Application: Analyzing Advanced-Technology Projects at

Management Science Application: Ranking Twentieth-Century Army Generals 339 Scoring Models 342

Management Science Application: A Scoring Model for Determining U.S. Army Installation Regions 343

# 10 Nonlinear Programming

Nonlinear Profit Analysis 366

Constrained Optimization 369

Solution of Nonlinear Programming Problems with Excel 372

A Nonlinear Programming Model with Multiple Constraints 375

Nonlinear Model Examples 377

Management Science Application: Gas Production in Australia 380

#### 11 Decision Analysis 387

Components of Decision Making 388 Decision Making without Probabilities 389

Management Science Application: Decision Analysis at DuPont 391

Decision Making with Probabilities 396

Management Science Application: Evaluating Electric Generator Maintenance Schedules Using Decision Tree Analysis 407

Decision Analysis with Additional Information 411

Management Science Application: Decision Analysis in the Electric Power Industry 412

Management Science Application: Discount Fare Allocation at American Airlines 414

Management Science Application: Scheduling Refueling at the Indian Point 3 Nuclear Power Plant 418 Utility 418

#### 12 Queuing Analysis 435

Elements of Waiting Line Analysis 436 The Single-Server Waiting Line System

Time Out: for Agner Krarup Erlang 438

Management Science Application: Reducing Perceived Waiting Time at Bank of America 446 Undefined and Constant Service Times 447 Finite Queue Length 450

Management Science Application: Providing Telephone Order Service in the Retail Catalog Business 452

Finite Calling Population 453 The Multiple-Server Waiting Line 456

Management Science Application: Making Sure 911 Calls Get Through at AT&T 460 Additional Types of Queuing Systems 462

## 13 Simulation

The Monte Carlo Process 472

Time Out: for John Von Neumann 477 Computer Simulation with Excel Spreadsheets 477 Simulation of a Queuing System 483

Management Science Application: Planning for Health Emergencies Created by Terrorist Attacks 486

Continuous Probability Distributions 487 Statistical Analysis of Simulation Results 492 Crystal Ball 494

Verification of the Simulation Model 502
Areas of Simulation Application 502
Management Science Application:
Simulating a 10-km Race in Boulder,
Colorado 504

# 14 Forecasting 516

Forecasting Components 517 Management Science Application: Forecasting Advertising Demand at NBC 519 Time Series Methods 520 Management Science Application: Forecasting at Goodyear Tire and Rubber Company 524 Management Science Application: Forecasting Customer Demand at Taco Bell 525 Management Science Application: Seasonal Forecasting at Dell 530 Management Science Application: Developing Joint Forecasts at Boeing and Alcoa 533 Forecast Accuracy 534 Management Science Application: Forecasting at Bayer Consumer Care 537 Time Series Forecasting Using Excel 538 Time Series Forecasting Using QM for Windows 540 Regression Methods 541 Management Science Application: An Airline Passenger Forecasting Model 544

# 15 Inventory Management 563

Elements of Inventory Management 564
Management Science Application:
Evaluating Inventory Costs at HewlettPackard 566

Inventory Control Systems 567 Time Out: for Ford Harris 568 Economic Order Quantity Models The Basic EOQ Model 569 The EOO Model with Noninstantaneous Receipt 575 The EOQ Model with Shortages 577 Management Science Application: Determining Inventory Ordering Policy at Dell 580 EOQ Analysis with QM for Windows 581 EOQ Analysis with Excel and Excel QM 581 Quantity Discounts 582 Management Science Application: Quantity Discount Orders at Mars 585 Reorder Point 587 Determining Safety Stock by Using Service Levels 589 Management Science Application: **Establishing Inventory Safety Stocks at** Kellogg's 592 Order Quantity for a Periodic Inventory

Appendix A
Normal Table 601
Chi-square Table 602

Glossarv 617

System 593

Appendix B
Setting Up and Editing a Spreadsheet 603
Appendix C
The Poisson and Exponential Distributions 607
Solutions to Selected Odd-Numbered Problems 609

Chapter 1

# Management Science

anagement science is the application of a scientific approach to solving management problems in order to help managers make better decisions. As implied by this definition, management science encompasses a number of mathematically oriented techniques that have either been developed within the field of management science or been adapted from other disciplines, such as the natural sciences, mathematics, statistics, and engineering. This text provides an introduction to the techniques that make up management science and demonstrates their applications to management problems.

Management science is a scientific approach to solving management problems. Management science is a recognized and established discipline in business. The applications of management science techniques are widespread, and they have been frequently credited with increasing the efficiency and productivity of business firms. In various surveys of businesses, many indicate that they use management science techniques, and most rate the results to be very good. Management science (also referred to as operations research, quantitative methods, quantitative analysis, and decision sciences) is part of the fundamental curriculum of most programs in business.

Management science can be used in a variety of organizations to solve many different types of problems. As you proceed through the various management science models and techniques contained in this text, you should remember several things. First, most of the examples presented in this text are for business organizations because businesses represent the main users of management science. However, management science techniques can be applied to solve problems in different types of organizations, including services, government, military, business and industry, and health care.

Second, in this text all of the modeling techniques and solution methods are mathematically based. In some instances the manual, mathematical solution approach is shown because it helps one understand how the modeling techniques are applied to different problems. However, a computer solution is possible for each of the modeling techniques in this text, and in many cases the computer solution is emphasized. The more detailed mathematical solution procedures for many of the modeling techniques are included as supplemental modules on the companion Web site for this text.

Management science encompasses a logical approach to problem solving. Finally, as the various management science techniques are presented, keep in mind that management science is more than just a collection of techniques. Management science also involves the philosophy of approaching a problem in a logical manner (i.e., a scientific approach). The logical, consistent, and systematic approach to problem solving can be as useful (and valuable) as the knowledge of the mechanics of the mathematical techniques themselves. This understanding is especially important for those readers who do not always see the immediate benefit of studying mathematically oriented disciplines such as management science.

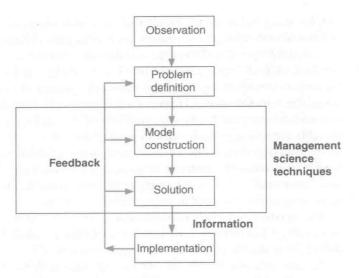
## The Management Science Approach to Problem Solving

The steps of the scientific method are (1) observation, (2) problem definition, (3) model construction, (4) model solution, and (5) implementation. As indicated in the previous section, management science encompasses a logical, systematic approach to problem solving, which closely parallels what is known as the scientific method for attacking problems. This approach, as shown in Figure 1.1, follows a generally recognized and ordered series of steps: (1) observation, (2) definition of the problem, (3) model construction, (4) model solution, and (5) implementation of solution results. We will analyze each of these steps individually.

#### Observation

The first step in the management science process is the identification of a problem that exists in the system (organization). The system must be continuously and closely observed

Figure 1.1
The management science process



A management scientist is a person skilled in the application of management science techniques. so that problems can be identified as soon as they occur or are anticipated. Problems are not always the result of a crisis that must be reacted to but, instead, frequently involve an anticipatory or planning situation. The person who normally identifies a problem is the manager because managers work in places where problems might occur. However, problems can often be identified by a management scientist, a person skilled in the techniques of management science and trained to identify problems, who has been hired specifically to solve problems using management science techniques.

#### Definition of the Problem

Once it has been determined that a problem exists, the problem must be clearly and concisely *defined*. Improperly defining a problem can easily result in no solution or an inappropriate solution. Therefore, the limits of the problem and the degree to which it pervades other units of the organization must be included in the problem definition. Because the existence of a problem implies that the objectives of the firm are not being met in some way, the goals (or objectives) of the organization must also be clearly defined. A stated objective helps to focus attention on what the problem actually is.

#### Model Construction

A model is an abstract mathematical representation of a problem situation. A management science model is an abstract representation of an existing problem situation. It can be in the form of a graph or chart, but most frequently a management science model consists of a set of mathematical relationships. These mathematical relationships are made up of numbers and symbols.

As an example, consider a business firm that sells a product. The product costs \$5 to produce and sells for \$20. A model that computes the total profit that will accrue from the items sold is

$$Z = \$20x - 5x$$

In this equation x represents the number of units of the product that are sold, and Z represents the total profit that results from the sale of the product. The *symbols* x and Z are *variables*. The term variable is used because no set numeric value has been specified for these items. The number of units sold, x, and the profit, Z, can be any amount (within limits); they can vary. These two variables can be further distinguished. Z is a *dependent variable* because

A variable is a symbol used to represent an item that can take on any value.