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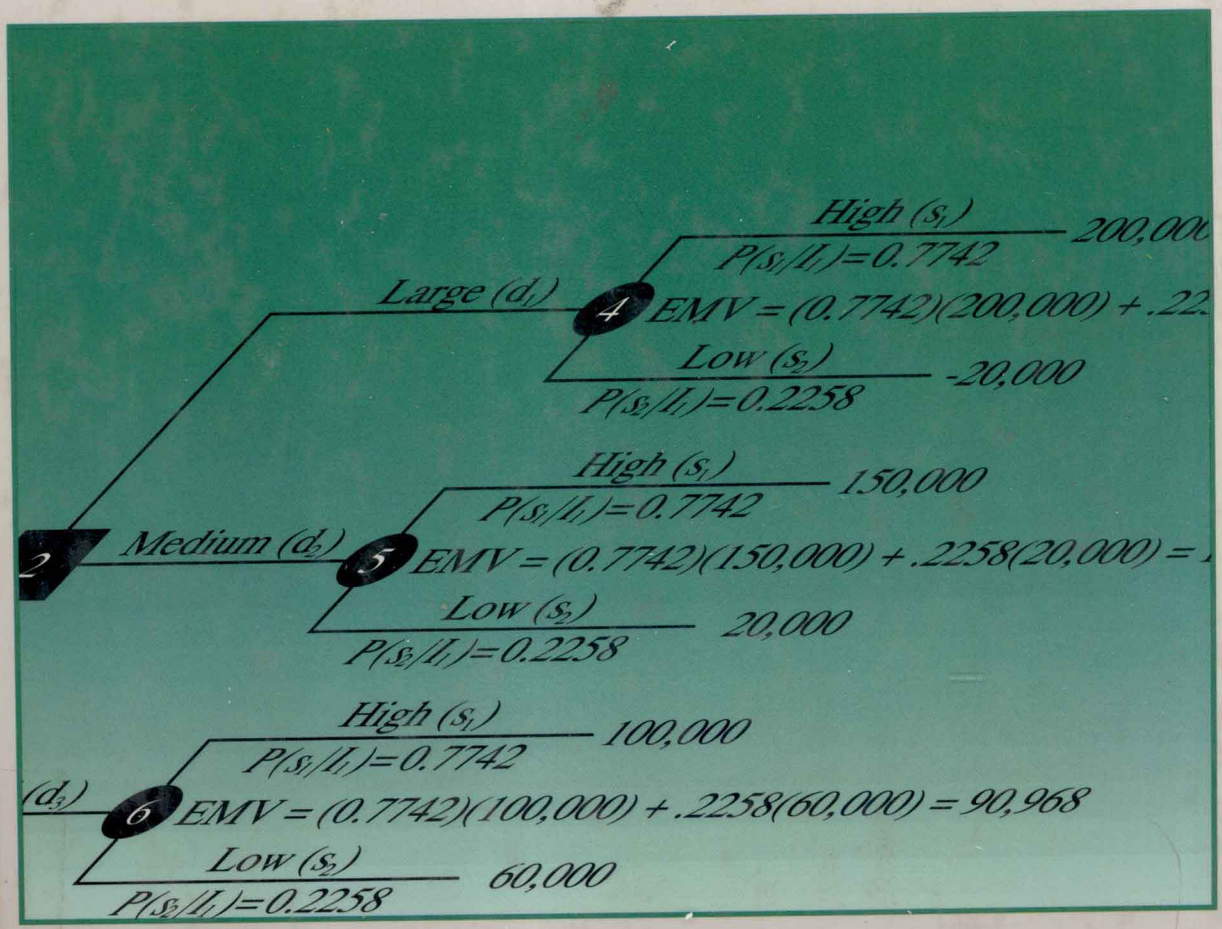
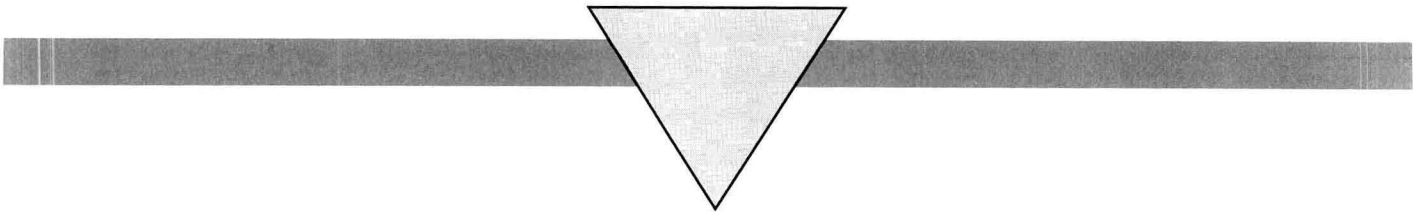
AN INTRODUCTION TO

MANAGEMENT SCIENCE



QUANTITATIVE APPROACHES TO DECISION MAKING

David R. Anderson Dennis J. Sweeney Thomas A. Williams



An Introduction to Management Science

Quantitative Approaches to Decision Making

SIXTH EDITION

David R. Anderson
University of Cincinnati

Dennis J. Sweeney
University of Cincinnati

Thomas A. Williams
Rochester Institute of Technology

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Preface

The purpose of this sixth edition, as with previous editions, is to provide students with a sound conceptual understanding of the role that management science plays in the decision-making process. The focus is on the part of management science referred to as quantitative approaches to decision making. The text describes the many quantitative methods that have been developed over the years, explains how they work, and shows how they can be applied and interpreted by the decision maker.

We have written this book with the needs of the nonmathematician in mind; it is applications oriented. In each chapter a problem is described in conjunction with the quantitative procedure being introduced. The development of the quantitative technique or model includes applying it to the problem in order to generate a solution or recommendation. We have found that this approach helps to motivate the student by demonstrating not only how the procedure works, but also how it can contribute to the decision-making process.

Changes in the Sixth Edition

In preparing the sixth edition we have been careful to maintain the overall format and approach of the previous editions. However, based upon our own classroom experience and suggestions from users of previous editions, a number of significant changes have been made to enhance the content, managerial orientation, and readability of the text.

Notes and Comments Notes and comments have been added at the end of many sections of the text. In an introductory treatment of a subject such as management science it is not possible to provide a complete coverage of all managerial issues and technical details. The purpose of the notes and comments feature is to mention additional issues we think students should be aware of and/or to note a technical detail that could cause some difficulty in applying the material.

Linear Programming Applications A new section on data envelopment analysis has been added to Chapter 4. Data envelopment analysis is a linear programming based techique that is rapidly gaining in popularity for evaluating the efficiency of comparable organizations. It has been used extensively in franchise operations and in the not-for-profit sector. We believe the number of applications have reached the point where students can

benefit from being exposed to data envelopment analysis in an introductory course. A new case and new problems have also been added to this chapter.

Multicriteria Decision Making A new Chapter 15 on multicriteria decision making has been added. In recent years we have seen a growing recognition that methods for dealing with multiple, often noncommensurable, criteria are needed. An expanded treatment of goal programming is included in this chapter. We show that the philosophy of preemptive priorities is consistent with many decision making processes and how linear programming methodology can be employed to solve goal programming problems with preemptive priorities. The chapter also includes an introduction to the analytic hierarchy process and expert choice.

Waiting Line Models The material on waiting line models has been expanded considerably. Also, at the request of several users, we now treat waiting lines before computer simulation. The major change to the waiting lines chapter has been to extend coverage to additional situations that occur in practice. Even though the mathematics are sometimes difficult, the situations being modeled are easily understood by students. The Management Scientist software package has also been extended to handle the new models.

Transportation, Assignment, and Transshipment Problems The treatments of the transportation, assignment, and transshipment problems have been unified around the notion of a network flow model. In the first three sections of Chapter 7, we show the network flow models of these problems and how easy it is to develop a linear programming model from the graphical network representation. The fourth section shows the use of the transshipment model for a production and inventory scheduling problem. This emphasizes the fact that applications do not always involve shipment of goods from one point to another.

The last two sections of the chapter detail special purpose solution procedures for the transportation and assignment problems. The material on the transportation simplex algorithm has been completely rewritten to provide a more unified treatment. A phase I, phase II approach is employed. Phase I is described as the phase where heuristics are used to find a feasible solution; the minimum-cost method is demonstrated. Phase II is explained as an interative procedure for moving from the initial feasible solution to the optimal solution. The MODI method is used to find a route to bring into solution and the stepping-stone method is used to find the route leaving the solution and to adjust the flow over the transportation network.

The Management Scientist Software Package Revised Version 2.0 of The Management Scientist is available to adopters. It is also available shrinkwrapped with the text at a small additional charge. Version 2.0 includes a number of improvements. The most notable improvements are increased solution speed for transportation and assignment problems, the addition of several new waiting line models, and redesign of menus to enhance the user friendliness of all modules.

Other Changes A variety of other changes have been made throughout the text. All of them cannot be listed here, but we will mention a few.

1. The introduction provides a more in depth discussion of the problem solving and decision making processes.
2. The inventory chapter now includes a section on periodic review models. The chapter ending application details how SuperX, Inc. uses this approach. A new section on just-in-time is also included.

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3. The Management Scientist computer printouts are used in the linear programming chapters. An appendix to Chapter 3 also shows how LINDO/PC is used. LINDO/PC continues to be used in the integer programming chapter.

Prerequisite

The mathematical prerequisite for this text is a course in algebra. An introductory knowledge of probability and statistics would be desirable, but not necessary, for Chapters 10–14 and 16, 17. Only Chapter 19, which discusses calculus-based solution procedures and which we consider optional, requires a knowledge of differential calculus.

Throughout the text we have utilized generally accepted notation for the topic being covered. Thus students who pursue study beyond the level of this text should find the difficulties of reading more advanced material minimized. To assist in further study, a bibliography is included in the backmatter of the book.

Course Outline Flexibility

The text has been designed to enhance the instructor's flexibility in selecting topics to meet specific course needs. The single-quarter and single-semester outlines that follow are a sampling of the many options available.

One-quarter outline stressing linear programming, model development, and applications.

Introduction (Chapter 1)
Introduction to Linear Programming (Chapters 2 and 3)
Linear Programming Applications (selected portions of Chapters 4 and 7)
Project Management: PERT/CPM (Chapter 10)
Waiting Lines (Chapter 12)
Computer Simulation (Chapter 13)
Decision Analysis (Chapter 14)

The instructor in a one-semester course who wants to focus on model development and other applications could either spend more time on the applications in Chapter 4 or cover additional topics. One possible outline, stressing linear programming, model development, and applications, would be

Introduction (Chapter 1)
Introduction to Linear Programming (Chapters 2 and 3)
Linear Programming Applications (Chapter 4)
Simplex Method (Chapters 5 and 6)
Transportation, Assignment, and Transshipment Models (Chapter 7)
Project Management: PERT/CPM (Chapter 10)
Inventory Models (Chapter 11)
Waiting Lines (Chapter 12)
Computer Simulation (Chapter 13)
Decision Analysis (Chapter 14)
Multicriteria Decision Making (Chapter 15)

Ancillaries

A complete package of support materials accompanies the text: a Solutions Manual; a Study Guide, coauthored by John A. Lawrence and Barry Alan Pasternack, California State University at Fullerton; a Test Bank, prepared by Constance McLaren, Indiana State University; transparency masters; and *The Management Scientist*™ Version 2.0, an IBM-compatible software package capable of solving a variety of management science problems. This menu-driven software package has been revised for the sixth edition and has been designed to provide a high degree of user flexibility, including the ability to easily save and modify problems. We believe that the applications orientation of the text, combined with this package of support materials, provides a solid framework for introducing students to management science.

Acknowledgments

We owe a debt to many of our colleagues and friends for their helpful comments and suggestions during the development of this and previous editions. Among these are Robert L. Armacost, E. Leonard Arnoff, Uttarayan Bagchi, Edward Baker, Norman Baker, James Bartos, Richard Beckwith, Stanley Brooking, Jeffrey Camm, Thomas Case, John Eatman, Ron Ebert, Don Edwards, Peter Ellis, Lawrence Ettkin, Jim Evans, Robert Garfinkel, Damodar Golhar, Stephen Goodman, Jack Goodwin, Richard Gunther, Nicholas G. Hall, David Hott, Raymond Jackson, Muhannad Khawaja, Bharat Kolluri, Darlene Lanier, John Lawrence, Jr., Phillip Lowery, Prem Mann, Kamlesh Mathur, Joseph Mazzola, Richard McCready, Patrick McKeown, Constance McLaren, Edward Minieka, Richard C. Morey, Alan Neebe, Brian F. O'Neil, David Pentico, Gary Pickett, B. Madhusudan Rao, Handanhal V. Ravinder, Douglas V. Rippy, Richard Rosenthal, Carol Stamm, Willban Terpening, William Truscott, James Vigen, Ed Winkofsky, Bruce Woodworth, M. Zafer Yakin, and Cathleen Zucco.

Our associates from organizations who supplied the Management Science in Practice applications made a major contribution to the text. These individuals are cited in a credit line on the first page of each application.

We are also indebted to our editor, Mary Schiller, production editor, Tad Bornhoft, and others at West Publishing Company for their editorial counsel and support during the preparation of this text.

David R. Anderson
Dennis J. Sweeney
Thomas A. Williams

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