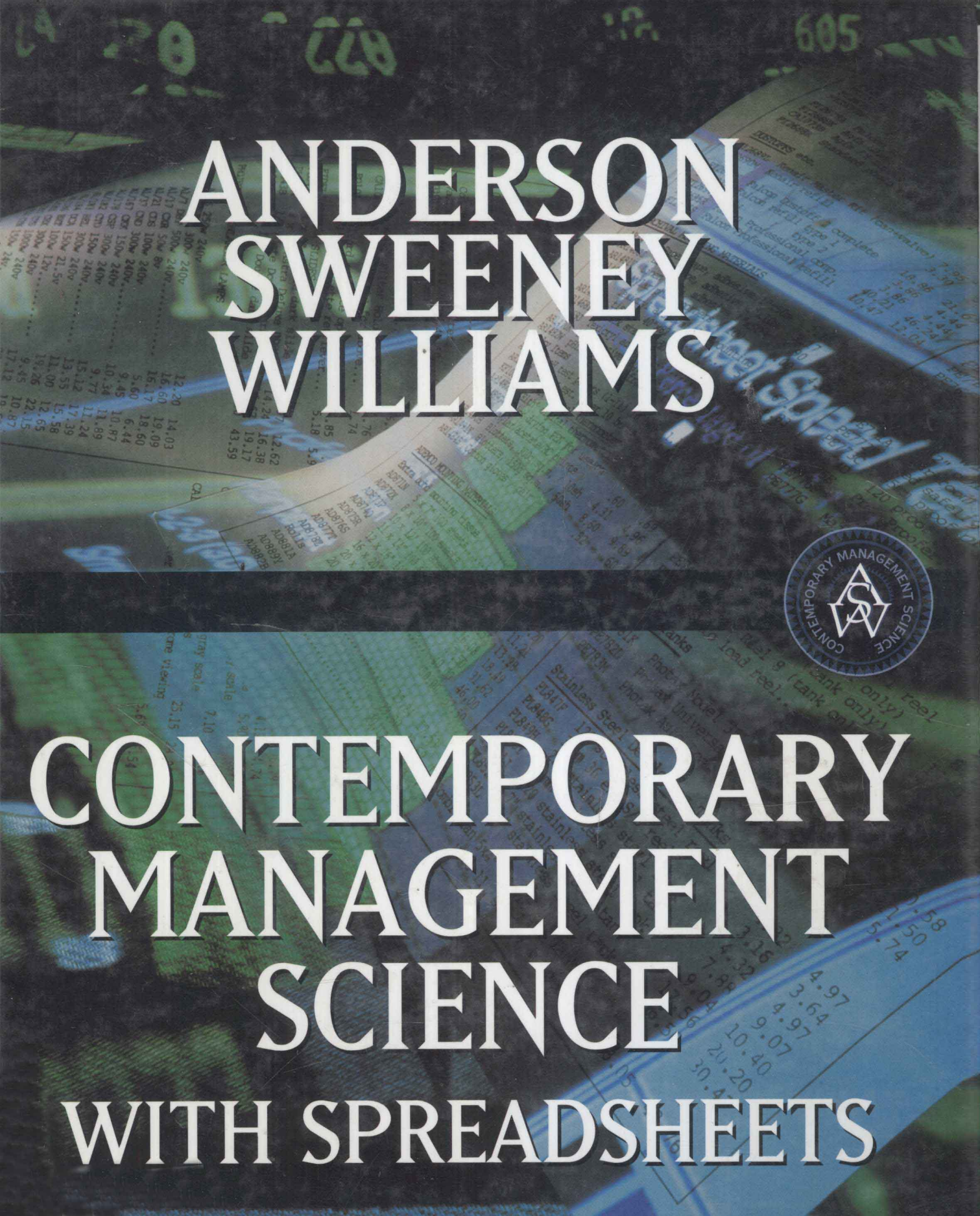
ANDERSON
SWEENEY
WILLIAMS
CONTEMPORARY MANAGEMENT SCIENCE
CONTEMPORARY MANAGEMENT
SCIENCE
WITH SPREADSHEETS

CONTEMPORARY MANAGEMENT SCIENCE

WITH SPREADSHEETS

David R. Anderson
University of Cincinnati

Dennis J. Sweeney
University of Cincinnati

Thomas A. Williams
Rochester Institute of Technology

SOUTH-WESTERN College Publishing
An International Thomson Publishing Company

Publishing Team Director: John Szilagy
Acquisitions Editor: Charles E. McCormick, Jr.
Developmental Editor: Alice C. Denny
Production Editor: Amy C. Hanson
Media Production Editor: Robin Browning
Production House: BookMasters, Inc.
Marketing Manager: Joseph A. Sabatino
Technology Coordinator: Kevin von Gillern
Manufacturing Coordinator: Sue Kirven
Internal and Cover Design: Michael H. Stratton
Cover Photo: FPG International

Component ISBN: 0-538-87609-3
Text ISBN: 0-324-00054-5

4 5 7 8 9 C1 6 5 4 3 2 1
Printed in the United States of America

Library of Congress Cataloging-in-Publications Data:

Anderson, David Ray, 1941-
Contemporary management science : with spreadsheets / David R. Anderson, Dennis J. Sweeney, Thomas A. Williams.
p. cm.
Includes bibliographical references and index.
ISBN 0-538-87609-3
1. Management science. I. Sweeney, Dennis J. II. Williams, Thomas Arthur, 1944– . III. Title.
HD30.25.A527 1998
658—dc21 98-13629
CIP

I(T)P®

International Thomson Publishing
South-Western College Publishing is an ITP Company.
The trademark ITP is used under license.

To Our Students

PREFACE

CONTEMPORARY MANAGEMENT SCIENCE WITH SPREADSHEETS will provide both undergraduate and graduate students with a conceptual understanding of the role of management science in the decision-making process. We have written a text that covers what we believe to be the core topics in management science. The contemporary, or new, aspect of this text is an emphasis on how spreadsheet packages (we use Microsoft's Excel) can be used to implement the techniques of management science and bring timely decision-making information to the screen of a personal computer.

We have written the book with the non-mathematician in mind; it is applications oriented. A problem scenario approach is used to teach modeling and the proper managerial interpretation of the solution to a model. Our experience has shown that if we start with a challenging managerial problem, students are much more interested in learning how a particular management science technique can be used to provide useful decision-making information. Once a problem is introduced, we first formulate a mathematical model, and then develop a spreadsheet model of the problem. Solving the spreadsheet model transforms the data and mathematical description of the problem into easily interpreted decision-making information.

A big advantage of spreadsheets is that they offer a convenient means for dealing with both the data associated with a problem, and a model of the problem. Many students entering management science courses are already familiar with spreadsheets, and their use to organize data and solve problems is appreciated and well accepted. However, this text is written for the course in management science, not a course in spreadsheets. We do not feel that the use of spreadsheets has eliminated the need to understand the mathematical models that underlie management science. Researchers have made tremendous strides in the past 50 years developing mathematical models of practical problems. We seek to build on that work. Our focus is on developing a smooth interface between mathematical modeling and the use of spreadsheets in management science.

The mathematical prerequisite for this text is a course in algebra. In addition, it is assumed that the student has at least a beginning understanding of and the ability to use a spreadsheet package such as Microsoft® Excel. Although the text is ideally suited to a one-term introductory course, instructors will find that the wide variety of application exercises and case problems provide the flexibility for longer and more in-depth courses.

Throughout the text we utilize generally accepted notation for the topics being covered. Students who pursue study beyond the level of this text should have little difficulty reading more advanced material.

Excel Spreadsheet Files

The disks at the back of this text contain 100 spreadsheets in both Excel 97 and Excel 5.0 formats. These disks include every example spreadsheet presented in the text as well as all spreadsheets used to solve the self-test problems. Students may use these disks to review the cell formulas and details of the spreadsheet models.

Some instructors may choose to use the example spreadsheets to demonstrate the flexibility of spreadsheets in analyzing a problem. Student assignments might involve using these existing spreadsheets as templates. Input data and other parameters can be varied to show how changes impact the solution and decision recommendations. For more emphasis

on the development of spreadsheet models for new problems, the instructor may use the spreadsheets in the text for illustration purposes and then make class assignments which ask students to develop their own spreadsheet models for the problems and/or cases at the end of the chapters.

Ancillary Teaching Materials

The following support materials are available from the ITP Academic Resource Center at 800-423-0563 or through *www.swcollege.com*:

- **Solutions Manual with Solutions Disks** The *Solutions Manual* (ISBN: 0-538-87610-7), prepared by the authors, includes solutions for all problems in the text. In addition, the *Solutions Manual* includes disks containing 125 spreadsheets which were developed to solve the text problems.

- **Instructor's Manual with Case Solutions Disk** The *Instructor's Manual* (ISBN: 0-538-87613-1), also prepared by the authors, contains solutions to all case problems presented in this text. A disk containing the spreadsheets used to solve the case problems is included with the *Instructor's Manual*. The manual also provides brief annotations for each problem in the text. These annotations will help instructors select homework problems designed to meet their course objectives.

- **PowerPoint Presentation Slides** Prepared by John Loucks, the presentation slides (ISBN: 0-538-87614-X) contain a teaching outline that incorporates graphics to help instructors create even more stimulating lectures. The PowerPoint 7.0 slides may be adapted using PowerPoint software to facilitate classroom use.

- **Test Bank** and **World Class Test** Prepared by Jack B. Jensen and Sener Erdem of the University of South Maine, the *Test Bank* (ISBN: 0-538-87611-5) includes true/false, multiple choice, short answers, and problems for each chapter. *World Class Test* (ISBN: 0-324-00048-0) computerized testing software allows instructors to create, edit, store and print exams.

Acknowledgments

We would like to say thanks to the colleagues who provided helpful comments and suggestions during the development of this manuscript. These reviewers include Phillip C. Fry, Boise State University; Robert E. Johnson, Greenville College; Sameer Kumar, University of St. Thomas; Ruth A. Maurer, Walden University; Charlene Robert, Louisiana State University; Marie Yetimyan, San Jose State University; Mustafa R. Yilmaz, Northeastern University; and Zhiwei Zhu, University of Southwestern Louisiana.

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

We are also indebted to our acquisitions editor, Charles McCormick, Jr., our developmental editor, Alice Denny, our production editor, Amy Hanson, and others at South-Western College Publishing for their counsel and support during the preparation of this product.

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

ABOUT THE AUTHORS

David R. Anderson. David R. Anderson is Professor of Quantitative Analysis in the College of Business Administration at the University of Cincinnati. Born in Grand Forks, North Dakota, he earned his B.S., M.S., and Ph.D. degrees from Purdue University. Professor Anderson has served as Associate Dean of the College of Business Administration. In addition, he was the coordinator of the College's first Executive Program.

At the University of Cincinnati, Professor Anderson has taught introductory statistics for business students as well as graduate level courses in regression analysis, multivariate analysis, and management science. He has also taught statistical courses at the Department of Labor in Washington, D.C. He has been honored with nominations and awards for excellence in teaching and excellence in service to student organizations.

Professor Anderson has coauthored six textbooks in the areas of statistics, management science, linear programming, and production and operations management. He is an active consultant in the field of sampling and statistical methods.

Dennis J. Sweeney. Dennis J. Sweeney is Professor of Quantitative Analysis at the University of Cincinnati. Born in Des Moines, Iowa, he earned a B.S.B.A. degree from Drake University, graduating summa cum laude. He received his M.B.A. and D.B.A. degrees from Indiana University where he was an NDEA Fellow. Since receiving his doctorate in 1971, Professor Sweeney has spent all but 2 years at the University of Cincinnati. During 1978–79, he spent a year working in the management science group at Procter & Gamble; during 1981–82, he was a visiting professor at Duke University. Professor Sweeney served 5 years as Head of the Department of Quantitative Analysis and 4 years as Associate Dean at the University of Cincinnati.

Professor Sweeney has published over 30 articles in the general area of management science. The National Science Foundation, IBM, Procter & Gamble, Federated Department Stores, and Cincinnati Gas & Electric have funded his research, which has been published in *Management Science, Operations Research, Mathematical Programming, Decision Sciences,* and other journals.

Professor Sweeney has coauthored six textbooks in the areas of statistics, management science, linear programming, and production and operations management.

Thomas A. Williams. Thomas A. Williams is Professor of Management Science in the College of Business at Rochester Institute of Technology. Born in Elmira, New York, he earned his B.S. degree at Clarkson University. He did his graduate work at Rensselaer Polytechnic Institute, where he received his M.S. and Ph.D. degrees.

Before joining the College of Business at RIT, Professor Williams served for 7 years as a faculty member in the College of Business Administration at the University of Cincinnati, where he developed the undergraduate program in Information Systems and then served as its coordinator. At RIT he was the first chairman of the Decision Sciences Department. He teaches courses in management science and statistics, as well as more advanced courses in regression and decision analysis.

Professor Williams is the coauthor of seven textbooks in the areas of management science, statistics, production and operations management, and mathematics. He has been a consultant for numerous Fortune 500 companies and has worked on projects ranging from the use of elementary data analysis to the development of large-scale regression models.

CONTENTS IN BRIEF

CONTENTS

I

INTRODUCTION

This book is concerned with the use of quantitative methods in the decision-making process. The emphasis is not on the methods themselves, but rather on how they can contribute to better decision making. A variety of names exists for this body of knowledge, including Management Science (MS), Operations Research (OR), and Decision Science. All are concerned with rational approaches to decision making based on the scientific method.

The scientific management revolution of the early 1900s, initiated by Frederic W. Taylor, provided the foundation for the use of quantitative methods in management. But modern usage of quantitative methods is generally considered to have originated during the World War II period, when teams were formed to deal with strategic and tactical problems faced by the military. These teams, which often consisted of people with diverse specialties (e.g., mathematicians, engineers, and behavioral scientists), joined together to solve a common problem through the use of the scientific method. After the war, many of these team members continued their research in the field of management science.

Two developments that occurred during the post–World War II period led to the growth and use of management science in nonmilitary applications. First, continued research resulted in numerous methodological developments. Probably the most significant development was the discovery by George Dantzig, in 1947, of the simplex method for solving linear programming problems. Many more methodological developments followed, and in 1957 the first book on operations research was published by Churchman, Ackoff, and Arnoff.[1]

Concurrently with these methodological developments, a virtual explosion in computing power was made available through digital computers. Computers enabled practitioners to use methodological advances to solve successfully a large variety of problems. The computer technology explosion continues; personal computers are now more powerful than earlier mainframe computers. Today, variants of the post–World War II methodological developments are being used on personal computers to solve problems larger than those solved on mainframe computers in the early 1990s.

NOTES and Comments

1. Operations research analyst is listed by the Bureau of Labor Statistics as one of the fastest growing occupations for careers requiring a bachelor's degree; they predict a growth from 57,000 jobs in 1990 to 100,000 jobs in 2005, an increase of 73%.
2. The Institute for Operations Research and the Management Sciences (INFORMS) and the Decision Sciences Institute (DSI) are two professional societies that publish journals and newsletters dealing with current research and applications of quantitative methods.

1.1 PROBLEM SOLVING AND DECISION MAKING

Problem solving can be defined as the process of identifying a difference between the actual and the desired state of affairs and then taking action to resolve the difference. For problems important enough to justify the time and effort of careful analysis, the problem-solving process involves the following seven steps:

1. Identify and define the problem.
2. Determine the set of alternative solutions.
3. Determine the criterion or criteria that will be used to evaluate the alternatives.
4. Evaluate the alternatives.
5. Choose an alternative.
6. Implement the selected alternative (the decision).
7. Evaluate the results and determine if a satisfactory solution has been obtained.

Decision making is the term generally associated with the first five steps of the problem-solving process. Thus, the first step of decision making is to identify and define the problem. Decision making ends with the choosing of an alternative, which is the act of making the decision.

Let us consider the following example of a decision-making process. For the moment, assume that you are currently unemployed and would like a position that will lead to a satisfying career. Suppose that your job search has resulted in offers from companies located in Rochester, New York; Dallas, Texas; Greensboro, North Carolina; and Pittsburgh, Pennsylvania. Thus, the alternatives for your decision problem can be stated as follows:

1. C. W. Churchman, R. L. Ackoff, and E. L. Arnoff, *Introduction to Operations Research* (New York: Wiley, 1957).

1. Accept the position in Rochester.
2. Accept the position in Dallas.
3. Accept the position in Greensboro.
4. Accept the position in Pittsburgh.

The next step of the decision-making process involves determining the criteria that will be used to evaluate the four alternatives. Obviously, the starting salary is going to be a factor of some importance. If salary were the only criterion of importance to you, the alternative selected as "best" would be the one with the highest starting salary. Problems in which the objective is to find the best solution with respect to one criterion are referred to as **single-criterion decision problems.**

Suppose that you have also concluded that the potential for advancement and the location of the job are two other criteria of major importance. Thus, the three criteria in your decision problem are starting salary, potential for advancement, and location. Problems that involve more than one criterion are referred to as **multicriteria decision problems.**

The next step of the decision-making process is to evaluate each alternative with respect to each criterion. For example, evaluating each alternative relative to the starting salary criterion is done simply by recording the starting salary for each job alternative. Evaluating each alternative with respect to the potential for advancement and the location of the job is more difficult to do, however, since these evaluations are based primarily on subjective factors that are often difficult to quantify. Suppose that for now you have decided to measure potential for advancement and job location by rating each of these criteria as poor, fair, average, good, or excellent and that the data you have compiled are shown in Table 1.1.

You are now ready to make a choice from the available alternatives. What makes this choice so difficult is that the criteria are probably not all equally important, and no one alternative is "best" with regard to all criteria. Although a method for dealing with situations like this is presented later in the text, for now let us suppose that after a careful evaluation of the data in Table 1.1, you have decided to select alternative 3 (Greensboro); alternative 3 is thus referred to as the **decision.**

At this point in time, the decision-making process is complete. In summary, we see that this process involved five steps:

1. Define the problem.
2. Identify the alternatives.
3. Determine the criteria.
4. Evaluate the alternatives.
5. Choose an alternative.

Note that missing from this list are the last two steps in the problem-solving process: implementing the selected alternative and evaluating the results to determine whether a

Table 1.1 DATA FOR THE JOB EVALUATION DECISION-MAKING PROBLEM

Alternative	Starting Salary	Potential Advancement	Job Location
Rochester	$38,500	Average	Average
Dallas	$36,000	Excellent	Good
Greensboro	$36,000	Good	Excellent
Pittsburgh	$37,000	Average	Good