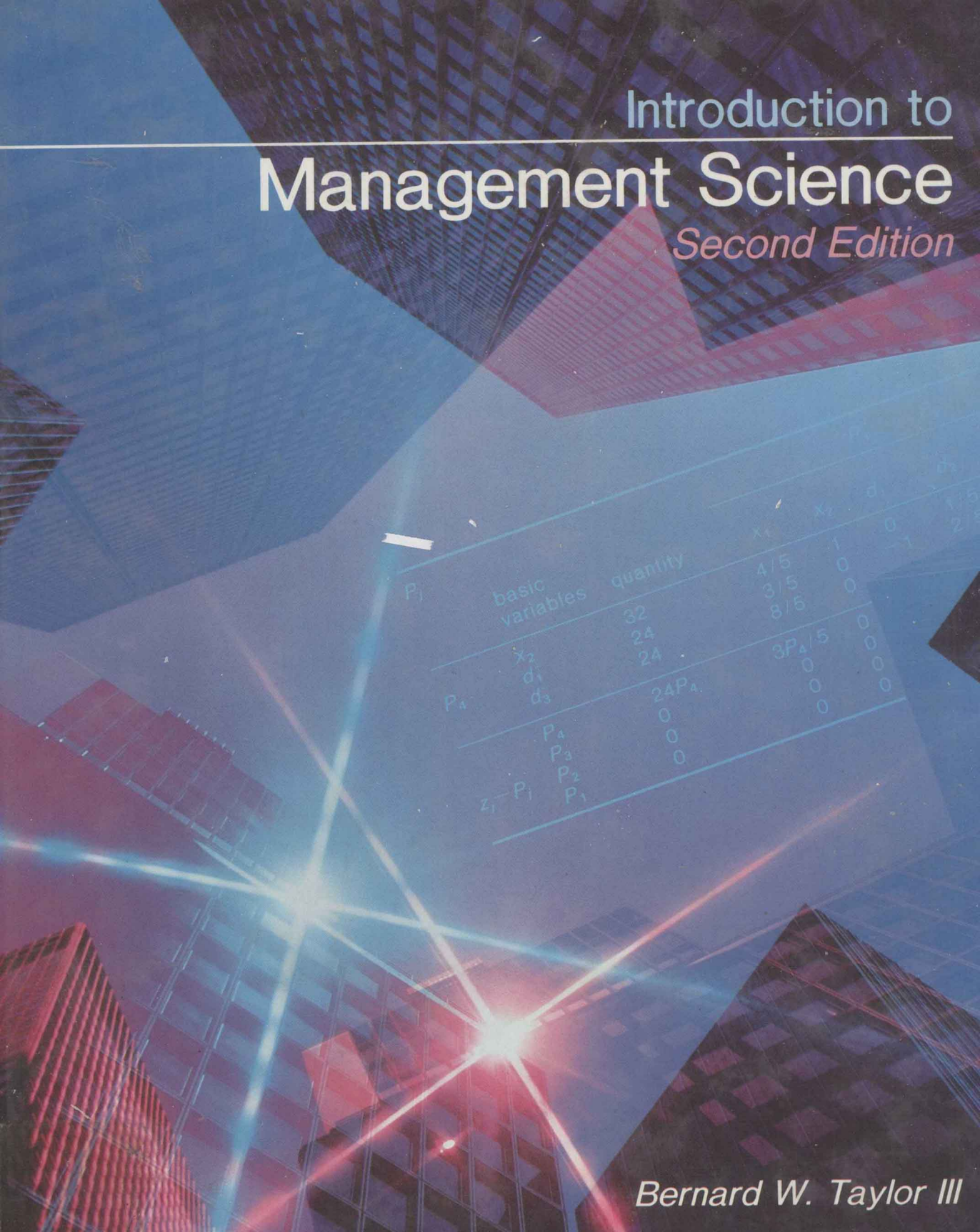
Introduction to Management Science

Second Edition



Bernard W. Taylor III

Introduction to Management Science

Second Edition

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To the memory of my grandfather,
Bernard W. Taylor, Sr.

Preface

A Note to the Student

Before writing this book I tried to recall the reasons I did not like many of the quantitatively oriented textbooks that I used when I was a student. One prominent reason was that many of the texts consisted of long, sprawling chapters that tried to explain everything about a quantitative technique without the benefit of very many examples. Therefore, I have written short, concise chapters that are centered around simple, straightforward examples that demonstrate in detail the fundamentals of the techniques. I have also presented these examples so that you can easily apply the same solution steps to homework and test problems.

I have attempted to write this book so it can be understood by individuals with limited mathematical background or those who haven't had a math course for several quarters (or semesters). Thus, when I begin to cover a particular quantitative technique, I do not automatically assume that students understand the mathematical underpinnings of the technique. And this consideration is not limited to just the easier topics in this text. I have followed the same policy in chapters dealing with what are often perceived as more complex management science techniques—integer programming and dynamic programming. As you read those chapters dealing with topics you thought would be very hard, you will find they are presented in such a way that they are not that difficult.

Students often find difficulty perceiving the usefulness of quantitative courses in general, like the one for which you will be using this text. When I was a student I did not always foresee how I would use such material in any job I might pursue. (One reason for this feeling is that the examples used in texts often do not appear to be realistic. However, it must be remembered that simple examples are used to facilitate the learning process. More realistic examples reflecting actual applications would be so complex that they would not be very helpful in learning a technique.) Let me assure you, though, that the techniques presented in this text are already used extensively in the real world and their use is increasing rapidly. Therefore, the chances of using the techniques you learn from this text in a future course or job are very high. To demonstrate the usefulness of these techniques in the real world I have included in many chapters an "Applications" section that documents actual applications of management science.

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However, even if you do not use these techniques when you get a job, you should understand that management science consists of more than just a collection of techniques; it also involves a philosophy of approaching a problem in a logical manner, as does any science. This logical approach to problem solving embodied in management science or quantitative methods is valuable for all types of jobs in all types of organizations. Thus, this text does not only teach you specific techniques; it also provides a method for approaching problems that will be very useful in your future endeavors.

A Note to the Instructor

I had two primary objectives in mind when I originally wrote this text, neither of which has been altered during the preparation of this second edition. First, I wanted the text to be thoroughly comprehensive, containing all of the topics normally attributed to the field of management science. Second, I wanted the text to be readable.

Regarding the first objective, this text contains twenty-five chapters that encompass the major topics in the field of management science. As such, it can be employed in a variety of course structures. The organization of the various techniques presented in this text is shown in the front endpaper.

The second objective, readability, has been accomplished primarily by creating direct and succinct chapters that avoid rambling discussions of the subleties and nuances of a technique. I have concentrated on the fundamentals of one topic, or several closely related topics, in a chapter rather than combining several areas of coverage in a single chapter. In addition, the techniques presented in each chapter are explained within the context of straightforward examples that avoid lengthy written explanations. These examples are organized in a logical step-by-step solution approach that the student can subsequently apply to homework problems. An attempt has been made to avoid complex mathematical notation and formulas wherever possible. The combined effect of these various factors helps to ensure student assimilation of the material.

To facilitate the learning process and to update the text, I have made two major additions to this second edition. First, I have added a section on real world applications to most of the chapters in the text. It is hoped that this will help students visualize and understand how management science is used in the process of decision making in the real world. Second, I have demonstrated the use of computer software packages for a number of the techniques in these chapters, and have increased the emphasis in the text on computerized solutions.

Introduction to Management Science provides many pedagogical aids for the student. Each chapter begins with a *chapter outline,* which gives a brief overview of topics covered in the chapter. *Marginal notes* are used to help the student quickly locate specific topics. As an additional aid

to the student, a complete *glossary* of all the key terms is included at the end of the text. In addition, the *solutions* to all of the odd-numbered homework problems have been added at the end of the text.

Many quantitative methods or management science texts are criticized because they contain a limited number of homework problems. The number of homework problems in this second edition has been increased by over 10 percent. There are now over 550 end-of-chapter problems in this text, many with multiple parts. These problems are organized to coincide with the order of presentation of the material in the chapter. In addition, the problems range from very easy to very challenging. The Instructor's Manual that accompanies this text contains the detailed solutions of all homework problems, as well as 40 transparency masters of figures and tables from the text.

Also accompanying this text is a revised Study Guide (authored by Connie and Bruce McLaren of Indiana State University), which contains a corresponding chapter for every chapter in the text. These study chapters consist of an outline of the text chapter, quizzes (answers are given in the back of the study guide), problems (different from those in the text) that are solved in detail, and cases (solutions are contained in a separate case solutions manual). An additional accompaniment prepared for this edition of the text is a Test Bank, which contains over 800 short answer questions, true/false questions, multiple-choice questions, and problems and their solutions.

wcb StudyPak is a computerized study guide that will help your students master the material presented in *Introduction to Management Science,* Second Edition. It includes guided reviews and quizzes. The easy-to-use program includes a built-in diagnostic scoring system that identifies the learning objectives students need to review further. StudyPak is available for the IBM® PC, Apple® *II*e, and *II*c.

The text and its accompaniments comprise a comprehensive package that is flexible enough to accommodate a broad range of management science course structures. The textual material in this package should provide the student with a thorough understanding of the individual management science techniques and an overall comprehension of the management science process.

Acknowledgments

As with any large project, the completion or revision of a textbook is not achieved without the help of many people. The second edition of this book is no exception, and I would like to take this opportunity to thank those individuals 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 revision. We spent many hours discussing what

an introductory text in management science should consist of, 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 would also like to thank my colleagues at Virginia Tech, Loren Rees, Allen Greenwood, Ernie Houck, and Robin Russell, for their valued assistance and many helpful suggestions. I would like to thank the reviewers of this second edition including, James C. Goodwin, Jr. (University of Richmond), Robert L. Ludke (University of Iowa), and Robert D. Lynch (Glassboro State College). Their suggestions and comments markedly improved many chapters of this new edition. I am also very grateful to Carol Ann Bowman at Virginia Tech for her typing and editorial assistance. Finally, I would like to thank my editor at Wm. C. Brown, Linda Galarowicz, whose patience and encouragement, and the organization she lent to the project are greatly appreciated, and, my production editor, Gloria Schiesl, whose conscientious editing greatly improved this revision.

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1

Management Science

The Management Science Approach to Problem Solving

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Linear Mathematical Programming Techniques
Probabilistic Techniques
Inventory Techniques
Network Techniques
Other Linear and Nonlinear Techniques
Business Usage of Management Science Techniques

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A scientific approach to management

Management 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 adapted from other disciplines, such as the natural sciences, mathematics, statistics, and engineering. This text attempts to provide an introduction to the techniques comprising management science and to demonstrate their applications to management problems.

Management science, although rather young, is a recognized and established discipline in the field of business administration. The applications of management science techniques are widespread, and they have been frequently credited with increasing the efficiency and productivity of business firms. In a 1975 survey responded to by 275 firms, approximately 50% indicated that they used management science techniques, and 80% rated the results to be very good.[1] In a more recent 1982 survey of corporate executives, over two-thirds of the respondents indicated that the effectiveness of management science in their firm was good or excellent, and none assigned a poor rating.[2] The increasing popularity of management science is reflected in the number of colleges and universities offering undergraduate courses and degree programs in management science. Management science (also referred to as *operations research, quantitative methods, quantitative analysis,* and *decision sciences*) is now part of the fundamental curriculum of most programs in business administration.

Management science can be used in a variety of organizations

As we proceed through the presentations of the various management science models and techniques contained in this text, several items should be remembered. First, management science techniques can be applied to solve problems in a variety of different types of organizations including government, military, business and industry, and health care. However, the predominant number of examples presented in this text will be for business organizations, since businesses represent the main users of management science. Second, for the mathematical techniques presented, manual solution will be emphasized since the purpose of this text is to teach techniques and how they are applied to problems in order to assist managers

1. N. Gaither, "The Adoption of Operations Research Techniques by Manufacturing Organizations," *Decision Sciences* 6, no. 4 (October 1975): 797–813.

2. G. Forgionne, "Corporate Management Science Activities: An Update," *Interfaces* 13, no. 3. (June 1983): 20–23.

in making decisions. However, *computerized solution* is possible in every case, and when feasible and conducive to the presentation, computerized solutions will be demonstrated.

Computerized solution

Finally, as the various management science techniques are presented, keep in mind that management science consists of 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 is an especially important thought to keep in mind for those readers who do not always see the immediate benefit of studying mathematically oriented disciplines such as management science.

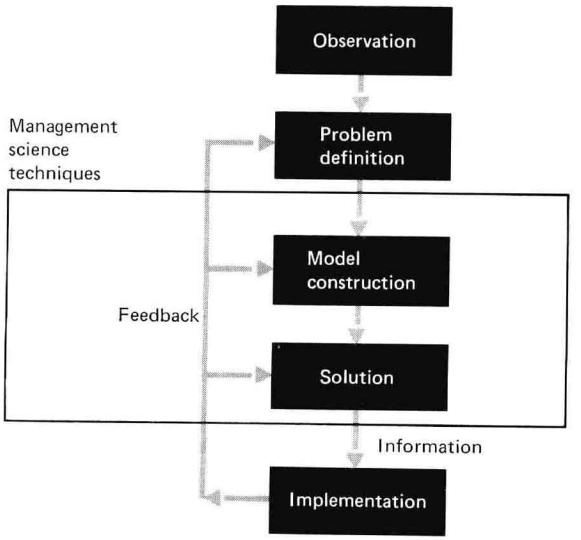
Management science encompasses a logical approach to problem solving

The Management Science Approach to Problem Solving

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, ordered set 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.

The scientific method

Figure 1.1 The management science process.



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