管理科学与工程经典教材

MANAGEMENT SCIENCE AND ENGINEERING CLASSICS

McGraw Hill Education

管理科学

英文版

威廉·史蒂文森 (William J. Stevenson)
锡汉·奥兹古 (Ceyhun Ozgur) 著
李勇建 张建勇 改编

INTRODUCTION TO MANAGEMENT SCIENCE WITH SPREADSHEETS

全新版

中国人民大学出版社

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总 序

随着我国加入WTO，越来越多的国内企业参与到国际竞争中来，用国际上通用的语言思考、工作、交流的能力也越来越受到重视。这样一种能力也成为我国各类人才参与竞争的一种有效工具。国家教育机构、各类院校以及一些主要的教材出版单位一直在思考，如何顺应这一发展潮流，推动各层次人员通过学习来获取这种能力。双语教学就是这种背景下的一种尝试。

双语教学在我国主要指汉语和国际通用的英语教学。事实上，双语教学在我国教育界已经不是一个陌生的词汇了，以双语教学为主的科研课题也已列入国家"十五"规划的重点课题。但从另一方面来看，双语教学从其诞生的那天起就被包围在人们的赞成与反对声中。如今，依然是有人赞成有人反对，但不论是赞成居多还是反对占上，双语教学的规模和影响都在原有的基础上不断扩大，且呈大发展之势。一些率先进行双语教学的院校在实践中积累了经验，不断加以改进；一些待进入者也在模仿中学习，并静待时机成熟时加入这一行列。由于我国长期缺乏讲第二语言（包括英语）的环境，开展双语教学面临特殊的困难，因此，选用合适的教材就成为双语教学成功与否的一个重要问题。我们认为，双语教学从一开始就应该使用原版的各类学科的教材，而不是由本土教师自编的教材，从而可以避免中国式英语问题，保证语言的原汁原味。各院校除应执行国家颁布的教学大纲和课程标准外，还应根据双语教学的特点和需要，适当调整教学课时的设置，合理选择优秀的、合适的双语教材。

顺应这样一种大的教育发展趋势，中国人民大学出版社同众多国际知名的大出版公司，如麦格劳-希尔出版公司、培生教育出版公司等合作，面向大学本科生层次，遴选了一批国外最优秀的管理类原版教材，涉及专业基础课，人力资源管理、市场营销及国际化管理等专业方向课，并广泛听取有着丰富的双语一线教学经验的教师的建议和意见，对原版教材进行了适当的改编，删减了一些不适合我国国情和不适合教学的内容；另一方面，根据教育部对双语教学教材篇幅合理、定价低的要求，我们更是努力区别于目前市场上形形色色的各类英文版、英文影印版的大部头，将目标受众锁定在大学本科生层次。本套教材尤其突出了以下一些特点：

- 保持英文原版教材的特色。本套双语教材根据国内教学实际需要，对原书进行了一定的改编，主要是删减了一些不适合教学以及不符合我国国情的内容，但在体系结构和内容特色方面都保持了原版教材的风貌。专家们的认真改编和审定，使本套教材既保持了学术上的完整性，又贴近中国实际；既方便教师教学，又方便学生理解和掌握。

● 突出管理类专业教材的实用性。本套教材既强调学术的基础性，又兼顾应用的广泛性；既侧重让学生掌握基本的理论知识、专业术语和专业表达方式，又考虑到教材和管理实践的紧密结合，有助于学生形成专业的思维能力，培养实际的管理技能。

● 体系经过精心组织。本套教材在体系架构上充分考虑到当前我国在本科教育阶段推广双语教学的进度安排，首先针对那些课程内容国际化程度较高的学科进行双语教材开发，在其专业模块内精心选择各专业教材。这种安排既有利于我国教师摸索双语教学的经验，使得双语教学贴近现实教学的需要；也有利于我们收集关于双语教学教材的建议，更好地推出后续的双语教材及教辅材料。

● 篇幅合理，价格相对较低。为适应国内双语教学内容和课时上的实际需要，本套教材进行了一定的删减和改编，使总体篇幅更为合理；而采取低定价，则充分考虑到了学生实际的购买能力，从而使本套教材得以真正走近广大读者。

● 提供强大的教学支持。依托国际大出版公司的力量，本套教材为教师提供了配套的教辅材料，如教师手册、PowerPoint 讲义、试题库等，并配有内容极为丰富的网络资源，从而使教学更为便利。

本套教材是在双语教学教材出版方面的一种尝试。我们在选书、改编及出版的过程中得到了国内许多高校的专家、教师的支持和指导，在此深表谢意。同时，为使我们后续推出的教材更适于教学，我们也真诚地期待广大读者提出宝贵的意见和建议。需要说明的是，尽管我们在改编的过程中已加以注意，但由于各教材的作者所处的政治、经济和文化背景不同，书中内容仍可能有不妥之处，望读者在阅读时注意比较和甄别。

徐二明
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改编者的话

由威廉·史蒂文森和锡汉·奥兹古所著的《管理科学》一书，既反映了这门学科的新进展，又深入浅出地阐明了管理科学的基本概念、理论和方法，各类模型的结构特征、经济含义及其在管理中的应用。该书内容丰富，逻辑严密，并提供了大量实例，非常适合作为经济管理专业的本科生、研究生学习管理科学课程的入门教材，同时也可作为相关工作人员的参考用书。

本书不同于以往一些严肃刻板的管理科学著作，借助大量生动有趣的实例及案例，把原本枯燥的技术性强的理论融入其中，让定量模型变得浅显易懂，将形象化思维和逻辑化思维有机地结合起来，使定量化理论及方法变得生动有趣。

本书充分体现了学以致用的特色，一切以学生为中心，目的是帮助学生掌握原理和方法。各章都配有大量案例和课后练习，读者可以在作者的引导下，通过学习和分析具体案例，找出问题的根源，并根据自己对管理科学的理解及对管理科学方法的掌握，尝试提出一些解决方案。所以本书的目的不仅是介绍管理科学方法的数学背景及原理，而且通过引用一些反映现实问题的案例来指导读者采取各种解决方案，可以说，这是一本问题导向型而非数学模型导向型的教材。

本书体系完整，教学资料丰富，反映了管理科学领域的最新进展，所以特别引进我国并加以改编，以惠及广大中国学子。读者可配合本书中文改编版一起阅读，便于理解和掌握其中内容。

由于原著篇幅较长，本书做了改编，对部分章节结构做了调整。从突出实用性和教学实际需求出发，整体删除了非线性规划和马尔柯夫分析两章内容；将原书第 3 章（线性规划：基本概念和图解法）和第 4 章（线性规划应用）合并为一章（线性规划：基本概念、解法及应用）；Excel 求解过程部分重复较多，故做了删减，但是并不影响整体知识结构。其他删改包括：删减了各章末小结、术语表和讨论题等；删减了部分习题。

李勇建　张建勇

Preface*

The material covered in this book is intended as an introduction to the field of management science. The subject matter covers the mainstream management science topics, along with the many practical applications of management science concepts. We include discussion and explanation of the concepts, formulation of problems, and their associated manual and Excel solutions.

The book describes both manual and computer solutions for a variety of management science tools. The purpose of manual solutions is to foster a conceptual understanding of each technique while presenting computer solutions to provide a practical approach to solving real-world problems.

The key areas of application for each topic is described, and appropriate techniques are explained in simple terms, with step-by-step procedures for both manual and computer solutions. There are ample discussions of how to interpret solutions.

Every effort has been made to develop a textbook that is readable and interesting. The writing style is light and informal and assumes that readers have no prior knowledge of the subject matter. The concepts are developed in a logical format, usually beginning with an overview so that readers can immediately see what the discussion will be. Explanations are clear and simple and often intuitive and examples are sprinkled liberally throughout the text.

Solved problems are provided at the end of all chapters . Students use them as a guide for solving the end of chapter problems. Answers are given to most odd numbered problems in the answer appendix.

Prerequisites for being able to understand the material in this book are basic algebra and introductory statistics.

Pedagogical Features

Much attention has been devoted to pedagogy. This book has a number of features designed to enhance learning, including:

1. Every chapter begins with a chapter outline and a list of behavioral objectives. These provide the reader with a topical overview of the chapter and a guide as to what to expect from the chapter. Every chapter includes a summary.
2. There are numerous examples throughout the chapter and a set of solved problems at the end of each chapter that serves as a resource guide for solving problems.
3. The end-of-chapter problems are plentiful. The answers to most odd numbered problems are given in the answer appendix.
4. The writing style is a key feature of this book. It is light and informal and concentrates primarily on key concepts and ideas; it does not spend a lot of time with fine points and minor details. Every effort has been made to present an interesting, readable book.
5. A glossary of key terms is provided at the end of every chapter.

* 为保留原书概貌，未对前言做删减。——改编者注

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William J. Stevenson
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Part 1

Introduction to Management Science

Part Outline

Chapter 1 Introduction to Management Science, Modeling, and Excel Spreadsheets

Introduction to Management Science, Modeling, and Excel Spreadsheets

Chapter 1

Learning Objectives

After completing this chapter, you should be able to:

1. Describe the importance of management science.
2. Describe the advantages of a quantitative approach to problem solving.
3. List some of the applications and use of management science models.
4. Discuss the types of models most useful in management science.
5. Demonstrate the basic building blocks and components of Excel.
6. Describe the basic nature and usefulness of break-even analysis.
7. List and briefly explain each of the components of break-even analysis.
8. Solve typical break-even problems manually and with Excel.

Management science is the discipline of applying advanced analytical methods to help make better decisions. It is a discipline devoted to solving managerial-type problems using quantitative models. This quantitative approach is widely employed in business. Areas of application include forecasting, capital budgeting, portfolio analysis, capacity planning, scheduling, marketing, inventory management, project management, and production planning.

In this first chapter, some of the basics of management science are covered, including the answers to such questions as: What is management science? Who uses it? Why use a quantitative approach? What are models, and why are they used? What are the different types of models? How are models used? Why are computers important in management science?

Introduction

Management science uses a logical approach to problem solving. The problem is viewed as the focal point of analysis, and quantitative models are the vehicles by which solutions are obtained.

A Problem Focus

By adopting a problem focus, a decision maker has the advantage of directing attention to the essence of an analysis: to solve a specific problem. The problem in question may pertain to a current condition or it may relate more to the future. An example of a current condition would be customers complaining to the manager of a bank about the amount of time they have to wait in line for a teller. It is hoped that these kinds of problems can be kept to a minimum; a manger cannot be productive if he or she spends very much time putting out fires.

Often, problems result from inadequate planning. Hence, an ideal use of a manager's time, and of management science models, is to plan for the future. An example of that kind of problem would be deciding where to locate a warehouse to minimize future shipping costs. Another example would be choosing a plan for assigning jobs to machines that will minimize the total time needed to complete the jobs. Still other examples include predicting future demand so that intelligent decisions can be made about production levels, workforce levels, capacity, and inventory; selecting the combination of product output quantities that will maximize profits; and identifying appropriate levels of inventory.

Use of a Quantitative Approach

Problem solving can be either qualitative or quantitative. In qualitative problem solving, intuition and subjective judgment are used. Past experience with similar problems is often an important factor in choosing a qualitative approach, as are the complexity and importance of a problem. Managers tend to use a qualitative approach to problem solving when:

1. The problem is fairly simple.
2. The problem is familiar.
3. The costs involved are not great.

Conversely, managers tend to use a quantitative approach when one or more of the following conditions exist

1. The problem is complex.
2. The problem is not familiar.

3. The costs involved are substantial.
4. Enough time is available to analyze the problem.

Generally speaking, decisions based on quantitative analysis tend to be more objective than those based on a purely qualitative analysis. On the other hand, a purely quantitative analysis will include only information that can be quantified. Therefore, the results of models should be followed routinely only for the simplest and best-understood cases; otherwise, the results should be questioned and analyzed. As a general rule, the results of a mathematical analysis should be reviewed by management for reasonableness and feasibility.

The use of quantitative analysis is not new. Quantitative methods of problem solving can be traced back to ancient times. Who would doubt that the great pyramids of Egypt were designed and built using quantitative methods? In similar fashion, the movements and supply requirements of Roman armies, the construction of ancient canals and waterways, and the ancient shipbuilding processes undoubtedly benefited from the use of quantitative methods.

Many of the early uses involved engineering applications. However, there were very few *managerial* applications of mathematical analysis before the Industrial Revolution, particularly with respect to problem solving. Even then, management science as we now know it did not exist.

A key period in the development of the use of the quantitative approach to problem solving came during World War II when teams of scientists were brought together to help solve complex military problems on deploying troops, searching the seas, supplying troops, and so on. These developments were given the name of operations research (OR) because scientists were doing research on managing military operations. The abbreviation for operations research is often used in conjunction with the abbreviation for management science, referring to the discipline as OR/MS. The following two societies publish journals and newsletters dealing with news and the state-of-the-art research and applications of operations research and management science techniques: The Institute for Operations Research and the Management Sciences (**INFORMS**), http://www.informs.org, and Decision Sciences Institute (**DSI**), http://www.decisionsciences.org. After the war, many of the techniques used by the operations researchers were adapted to business applications, and management science began to emerge as a discipline. Previously developed quantitative techniques were added along with newly developed techniques to form an expanding body of knowledge that had important business applications.

One difficulty that early practitioners faced was the burdensome computational requirements that often were required to solve even fairly simple problems. It is not surprising, then, that increasing use of management science has accompanied advances in computer technology, both in hardware and software. Today, access to computers, both mainframe and personal, puts the power of management science within the reach of virtually all managers.

The combination of access to computers and computer codes for solving management problems, continuing developments in management science models, and successful applications have contributed to the respectability of management science as a discipline. Successful applications of management science and new developments in this field are reported regularly in such journals as *Management Science, Decision Sciences, Interfaces,* and *Operations Research.*

Finally, it should be noted that although the field of management science is not entirely quantitative, the preponderance of management science applications fall under the heading of quantitative analysis. For that reason, this book emphasizes applications involving quantitative models.

Models

A **model** is an abstraction of reality. It is a simplified, and often idealized, representation of reality. An equation, an outline, a diagram, and a map are each an example of a model. By its very nature a model is incomplete: A good model will capture the important details of reality without including innumerable minor details that would obscure rather than illuminate. You could think of a model as a selective abstraction because only those details that are considered to be important for the problem at hand are included in the model. For example, suppose the problem involved aerodynamic properties of a new automotive design. Important details that come to mind are weight, shape, size, and height. Unimportant details include color, interior design, type of radio, and so on. Thus, it is important to carefully decide which aspects of reality to include in a model.

Models provide a manager or analyst with an alternative to working directly with reality. This allows the person using the model greater freedom in terms of experimenting with different ideas, controlling certain aspects of the situation, and investigating alternative solutions. It also reduces the cost of mistakes if mistakes can be corrected within the realm of the model.

In practice, models are employed in a variety of ways. **Symbolic models** incorporate numbers and algebraic symbols to represent important aspects of a problem, often in equation form. These numbers and symbols are then manipulated to solve for unknown values of key variables. Moreover, **mathematical models** lend themselves to the computational power inherent in calculators and computers.

Consider this simple mathematical model:

$$\text{Profit} = 5x$$

where

x = pounds of material sold

The number 5 represents the profit per unit of material, and the symbol x represents the quantity of a certain material; profit is the product of the profit per unit and the number of units sold. Thus, if 15 units are sold, the profit is 5(15) = \$75.

A slightly more complex version of this model is the following:

$$\text{Profit} = 5x_1 + 8x_2 + 4x_3$$

where

x_1 = pounds of material 1 sold
x_2 = pounds of material 2 sold
x_3 = pounds of material 3 sold

Thus, if $x_1 = 10$, $x_2 = 20$, and $x_3 = 30$, the total profit would be

$$5(10) + 8(20) + 4(30) = \$330$$

Mathematical models are made up of constants and variables; constants are fixed or known quantities not subject to variation, whereas **variables** can take on different values and can be either probabilistic or deterministic. Constants generally are represented by numbers and the variables by letters.

Thus, in the model Profit $= 5x_1 + 8x_2 + 4x_3$, the unit profits (5, 8, and 4) are the constants and the quantities of materials 1, 2, and 3 (i.e., x_1, x_2, and x_3) are the variables. In this example, the variables are **decision variables.** The manager or analyst would want to know what values to set these at (i.e., how much of each material to produce) in order to obtain the highest profit. Decision variables, therefore, are under the control of a decision maker and can be set at a desired level. Another kind of variable that is often encountered is an **uncontrollable variable.** An example would be the weather: Although it is beyond the control of a manager, weather sometimes is a factor that can have some bearing on profits. For instance, a mild, rainy winter can substantially reduce profits at ski resorts. Similarly, rainy weather and flooding can slow down a construction project. Other examples of uncontrollable variables include government decisions (for example, revision of the tax code, pollution regulations), competitors' decisions (e.g., product design, advertising, pricing), and consumer decisions.

Thus, models that are used for problem solving include constants, decision variables, and uncontrollable variables. The challenge for the manager or analyst who is developing a model is to determine the levels of the decision variables that will best serve the goals of the manager, given the constants and uncontrollable variables.

The models used in this book will be a blend of graphical, mathematical, and spreadsheet models: The graphical models will help to illustrate important concepts and help you to develop an intuitive understanding of various models, whereas the mathematical models will enable you to determine solutions for a wide range of problems. The spreadsheet models translate mathematical models to a spreadsheet.

Benefits and Risks of Using Models

Models have numerous benefits for problem solvers, but there also are certain risks for the users. Obviously, the benefits generally must tend to outweigh the risks, or models would not be used.

An important benefit of using a model is that it allows an analyst to strip away many unimportant details of reality and thereby focus attention on a small number of important aspects of a problem. The risk in doing this is that one or more of the important aspects of a problem may be inadvertently left out. If this happens, it is highly unlikely that the analyst will be able to successfully solve the real-world problem using the model.

Another benefit of using quantitative models is that they force the analyst to quantify information. The risk is that nonquantitative information may be down-played or ignored because it is difficult or impossible to include that type of information in a quantitative model.

The third benefit of models is the structure they provide for analyzing a problem in terms of what information is needed and how to organize information. One risk is that an inexperienced analyst may attempt to force a problem to fit the model. In effect, chances of obtaining a good solution would be diminished.

The process of developing a model can generate tremendous insight about reality. Care must be taken, however, so that modeling does not become an end in itself. In fact, it is easy to get carried away with modeling and to end up with a model that is more complex and powerful than what is needed to solve the problem.

Another benefit of models is that they compress time. They usually are also less costly than a real-life situation would be, and they permit users the luxury of experimentation without dangers that would be inherent in a real-life setting. However, due to their abstract nature, models sometimes do not adequately portray relationships that exist in reality. A consequence of this kind of error is that solutions obtained from the model fail under the harsh light of reality. One way to reduce this risk is to give careful consideration to the assumptions on which the model is based.

Assumptions of Models

All models are based on assumptions (that is, conditions that are assumed to exist). Some of these will be technical, such as "the relationship is linear"; others will be operational, such