



# 运筹学

应用与解决方法

(第4版)

Operations Research

Applications and Algorithms

Forth Edition

(美) 韦恩·L. 温斯顿 (Wayne L. Winston) 著

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# 出版说明

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为了适应经济全球化的发展趋势,满足国内广大读者了解、学习和借鉴国外先进管理经验和掌握经济理论前沿动态的需要,清华大学出版社与国外著名出版公司合作影印出版一系列英文版经济管理方面的图书。我们所选择的图书,基本上是已再版多次、在国外深受欢迎、并被广泛采用的优秀教材,是该领域中具有权威性的经典之作。

温斯顿教授是运筹学领域的著名教授,其教材非常畅销,影响广泛。本书是作者根据多年的教学和研究经验所著,各章相对独立,注重理论和实践应用的结合,是一本国际上很受欢迎的教材,被众多院校采用。

感谢圣智学习出版公司(Cengage Learning) 授予清华大学出版社本书的影印版版权,使我们能够将这本深受读者喜爱的教科书奉献给更多的中国读者。根据我国的教学实际情况和外方出版公司的要求,我们删减了部分章节,主要是数学的基本知识和运筹学中深度较大的内容(简明目录后注明了所删的章节标题)。在保留原书页码的同时,我们还按顺序编排了新的页码,望读者注意。

在本书的审阅过程中,我们得到了天津大学杜纲教授的热心帮助和支持,在此表示感谢!

由于原作者所处国家的政治、经济和文化背景等与我国不同,对书中所持观点,敬请广大读者在阅读过程中注意加以分析和鉴别。

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# 英/双语教学的成功路径与商科英文原版教材的效用

(代序)

在我国高校,用英语或双语教授专业课程(以下简称:英/双语教学)始于改革开放引进热潮,历经30年,虽发展不快,仍在缓慢推进。20世纪80年代,改革开放后留学归来的教育界学者们不仅引进了各学科先进的研究成果,也随之引进了西方高校的教材。以清华大学出版社为领军的国内出版社适时地引进了西方优秀教材的影印版,推动了一些高校开始在专业课程中开展英/双语教学。2007年以来,国家教育质量工程专设的“国家高校双语教学示范课程建设点”的评定项目被视为政府教育发展的政策风向标,正有力地推动着高校英/双语教学的发展。

但对英/双语教学的必要性,我国高校内部一直争议不断。争议首先围绕着中国人用英语教学的必要性。在公认英语是目前世界通用语言的前提下,英/双语教学的必要性取决于我国高校师生是否有必要及时汲取世界最新的知识和研究成果。答案是不言而喻的。况且英/双语教学省却了翻译过程,可以避免常见的信息减损和曲解问题。不过,信息发布者——教师的英语演讲能力和信息接收者——学生的英语解读能力不足又成为开展英/双语教学的障碍。因而常见的反对意见是,开展英/双语教学,课堂教学内容就会缩水,因为讲授者和听众都得花费精力和时间解译内容。如此看来,我国开展英/双语教学的高校教师必须应对挑战,洞察在我国现有条件下用英文原版教材开展英/双语教学的利和弊,并找到可行的扬长避短的路径。

在经济开放和全球化的大趋势推动下,我国中小学英语教学分量加重,英语普及程度逐年提高,高校新生的英语基础愈益扎实;教师的英语能力也随着师资的新陈代谢而日见增强。这一趋势无疑在为英/双语教学营造越来越有利的条件。尽管如此,不同于以英语为主要语言或官方语言的一些国家,英语在我国的普及率仍较低。在青少年中,英语的普及程度和英语应用能力还仅处于初级水平;高校中能用英语演讲的教师尚属少数,且熟练程度还有待大幅提高。这样的师生英语基础,使得英/双语教学面临巨大的挑战。

同时,在多数的中国高校课堂里,教学任务多被视为逐章讲解某本教材的内容。本土中文教材通常是400~500页的32开本,含理论框架、主要知识点、计算方法和习题,但案例和故事不在其中,多由教师在讲解时添加,以演示和诠释理论要点。迄今仍然普遍盛行的“填鸭式”、“满堂灌”的传统教学法侧重于传授知识,从多数评教指标可见,只要学生感觉教师讲得精彩、有条理、能解惑,就算教学成功。

而引进的国外教材篇幅通常较长,16开大本,500~800页。习惯于上述传统教学法和评价标准的人们自然会产生一个疑问:在有限的课时内,这么厚的教材,怎么讲得完?其实,发达国家多数高校对学生阅读量的要求远远大于我国高校(即使是中文课本和资料),名校更是如此。它们的教材不仅涵盖理论框架和基本概念,而且富含长短不一、详简各异的演示性案例、故事和大量习题,总之它便于学生自学。课堂讲解只占一半课时,其余课时常被用于师生讨论和互动。于是,教师的讲解主要是勾勒理

论框架,阐释重点和难点,还需针对事先布置的阅读资料和讨论题,引导学生展开讨论。可见,大厚本的教材适合于能力培训教学法。两者相辅相成,致力于调动学生的主动性:他们必须大量阅读和思考,才能在课堂上有上好的表现,真正成为学习的主人。结果,他们的能力获得了必要和切实的磨炼。

由此可见,英/双语教学不只是教学语言的改变,它可以达到三重效用:传授专业知识;传授英语知识;同时训练专业方法和英语的应用技能。也因此,一些非英语国家的高校不惜成本,开展英/双语教学,使用与之相配的教材。对我国高校来说,要想成功开展英/双语教学,恐怕首先需要改变传统的教育思想和教学方法。换言之,如果高校想要使教育、教学接近世界先进水准,用英文原版影印教材开展英/双语教学是有效的途径。

迄今为止,原版英文教材的缺点也很明显。鉴于发达国家的作者是以其母国为背景,多数教材不涉及中国国情。教师必须在教学中紧密结合中国国情,提供相关案例、资料和思考讨论题,适时引导师生思辨现有理论的普适性,激励师生发现和创作适合我国国情的经济学、管理学、营销学规律。在我国作者编写和出版足量的优质英文教材之前,这些额外的工作必须由开展英/双语教学的教师来承担。

古今中外,成才之士都乐于阅读和探索,而这种氛围却在当今我国的大学校园里愈见淡化。加之中国学生相对薄弱的英语基础,目前英/双语教学仍面临很大的挑战:“填鸭式”的讲授与之相悖;仅靠课堂讲授和互动也很难奏效。但如能培养学生阅读和探索真理的兴趣,并营造一个全方位的孵化温床或生态环境,英/双语教学是有望成功的。根据能力培育过程的所需,这个生态环境包含师生对教育、教学的共识,好学求知的校风,富有挑战和师生互动的课堂教学,从课外讲座、项目操作到校园竞赛等第二课堂活动,便于师生交流的校园互联网等。

要做到这些,教师亟待与时俱进。随着师资的年轻化和高学历化,如年轻教师的英语基础更好。但逆水行舟,不进则退。英语能力的进退取决于使用频率的多寡,其实英/双语教学过程既是加强英语使用、提高英语能力,也是汲取世界新知的最佳机会。不过,这一过程通常比用汉语教学的付出大得多,且因学生也需成倍地付出,英/双语教学的课程不容易像汉语教学课程那样容易在短期内获得学生的好评。因此给予英/双语教学的教师足够的激励成为生态环境的首要组成部分;缺乏对教师的足够激励,上述英/双语教学的生态环境就无法营造。

诚然,在教育体制和环境不够理想的情况下,教师和学生仍然有个人自训和奋斗的条件。英语原版教材影印版在我国的出版和更新就是对英/双语教学的及时支持。清华大学出版社近期又有一批英文原版影印教材出版,相信必将更进一步推动英/双语教学的发展。如今,已有一些本土高校的教师与英语国家的教师合著英文教材;在可见的将来,还会有中国教师编写发行到世界各地的英文教材。总之,及时用好英文原版影印教材,编写优质的英文教材是我国高校教师的历史责任。

愿英/双语教学的师资队伍愈益壮大,愿英/双语教学更加有力地推动我国教学方法与国际接轨,愿我国高校各级学生在英/双语教学中受益良多,茁壮成长!

对外经济贸易大学  
傅慧芬

# Preface

In recent years, operations research software has become widely available. Its use is illustrated throughout this book. Like most tools, however, it is of little value unless the user understands its application and purpose. Users must ensure that the mathematical input accurately reflects the real-life problems to be solved and that the numerical results are correctly applied to solve them. With this in mind, this book emphasizes model formulation and model building as well as the interpretation of software output.

## Intended Audience and Prerequisites

This book is intended as an advanced beginning or intermediate text in operations research or management science. The following groups can benefit from using it.

- Undergraduate majors in information systems or decision sciences in business, operations research, management science, industrial engineering, mathematics, or agricultural/resource economics.
- MBA students or masters students in public administration enrolled in an applications-oriented operations research or management science course.
- Graduate students who need an overview of the major topics in operations research and management science.
- Practitioners who need a comprehensive reference.

For courses specializing in deterministic models or in probabilistic models of operations research, or for those wishing to cover state-of-the-art methods of operations research (OR), the publisher offers split volumes of this text that feature additional coverage.

*Introduction to Mathematical Programming (Operations Research: Volume One—ISBN 0-534-35964-7)* includes Chapters 1 through 10, 11, and 14 of *Operations Research*, along with three unique chapters covering recent developments in mathematical programming. Unique topics include heuristic methods,

artificial intelligence, genetic algorithms, simulated annealing, Tabu search, and neural networks.

*Introduction to Probability Models (Operations Research: Volume Two—ISBN 0-534-40572-X)* includes OR Chapters 12, 13, and 15 through 24, plus three additional chapters on financial engineering topics. Topics include option pricing, real options, the scenario approach to portfolio optimization, stochastic calculus, and stochastic control.

*Operations Research* is designed for students who have had some calculus, matrix algebra, and an introductory statistics course. A formal course in probability theory is not required. Chapter 2 provides a review of matrix algebra, and Chapter 12 reviews the probability and calculus required for the rest of the book.

## Features

The following features help to make this text reader-friendly.

- The book is completely self-contained, with all the necessary mathematical background reviewed in Chapters 2 and 12. Each chapter is designed to be modular, so the book can be tailored to the needs of a course. Additionally, each section of the book is written to be as self-contained as possible; instructors can be extremely flexible in designing a course. The Instructor's Notes identify which portions of the book must be covered as prerequisites to each section.
- To provide immediate feedback to students, problems are placed at the end of sections, and most chapters conclude with review problems. There are approximately 1,500 problems, grouped by level of difficulty: Group A for practice of basic techniques, Group B for underlying concepts, and Group C for mastering the theory independently.
- The book avoids excessive theoretical exercises in favor of applied word problems. Many problems



are based on published applications. The exposition takes great pains, by means of several examples in each chapter, to guide the student step by step through even the most complex topics.

- To help students review for exams, most chapters have a summary of concepts and formulas. Answers to selected problems appear in an appendix. A *Student Solutions Manual* is available, providing worked-out solutions to selected problems. The *Student Solutions Manual* may be purchased separately or packaged with the text at a nominal additional price.
- Instructors who adopt this text in their courses may receive the *Instructor's Suite CD-ROM*. This CD contains complete solutions to every problem in the text, PowerPoint slides, and Instructor's Notes.
- The book is accompanied by a CD containing special versions of LINDO, LINGO, Premium Solver, Process Model, and @Risk.
- The text contains instruction for using the software contained on the CD. All of the files needed for examples and exercises are also included on the CD.

## Coverage and Organization

The linear programming section of the book is completely self-contained; all necessary mathematical background is given in Chapter 2. Students who are familiar with matrix multiplication should have no problems with Chapters 2–11. Portions of the remaining chapters require rudimentary knowledge of calculus and probability equivalent to that obtained from a one-semester calculus course and a one-semester statistics course. All topics in calculus and probability used in Chapters 13–24 are reviewed in Chapter 12.

Since not all students need a full-blown theoretical treatment of sensitivity analysis, there are two chapters on the topic. Chapter 5 is an applied approach to sensitivity analysis, emphasizing the interpretation of computer output. Chapter 6 contains a full discussion of sensitivity analysis, duality, and the dual simplex method. The instructor should cover Chapter 5 or Chapter 6, but not both. Classes emphasizing model building and model formulation skills should cover Chapter 5. Those paying close attention to the algorithms of mathematical programming (particularly classes in which students will go on to further study in operations research) should study Chapter 6. If Chapter 5 rather than Chapter 6 is covered, then Chapter 2 may be omitted.

## Changes to the Fourth Edition

The fourth edition of *Operations Research* contains many substantial changes. Most significant is the inclusion of Process Model (Chapter 22) to perform queuing simulations and @Risk (Chapter 23) to perform spreadsheet-based simulations. Other major changes include the following.

- Over 200 new problems have been added.
- Microsoft Excel is featured. All Lotus spreadsheets appearing in the previous edition have been converted to Excel.
- There is more discussion of optimization with spreadsheets. The method of solving optimization problems with spreadsheets has been changed from What's Best to the Excel Solver.
- Discussion of important Excel functions such as MMULT, OFFSET, MINVERSE, and NPV has been added.
- Chapter 4 includes more extensive instruction in the use of LINDO and LINGO.
- Chapter 4 includes more discussion of the geometry of LPs.
- Chapter 11 contains new applications of nonlinear programming to pricing problems.
- Eleven new cases involving mathematical programming are included. Professor Jeff Goldberg of the University of Arizona wrote the cases.
- Chapter 12 contains a discussion of Excel's normal distribution functions and z-transforms.
- Chapter 13 covers the applications of prospect theory and framing effects in decision making.
- Chapter 15 discusses power-of-two inventory policies and multiple-product EOQ models.
- Chapter 20 now covers computing Poisson and exponential probabilities with Excel, Buzen's method for closed queuing networks, approximations for  $G/G/s$  queuing systems, the use of data tables in queuing optimization, and computing transient probabilities for queuing systems.
- Chapter 22 shows how to use the powerful, user-friendly simulation package Process Model to simulate queuing systems.
- Chapter 23 deals with the Excel add-in @Risk, for Monte Carlo simulation. Application areas include capital budgeting, project management, and reliability.
- In Chapter 24, Excel data tables and the OFFSET

function are used to optimize the number of periods in a moving-average forecast.

## Use of the Computer

In deference to the virtually universal usage of Excel, this software is featured throughout the book when appropriate. When Excel's native capabilities are limited, the text discusses add-in software that builds on the capabilities of Excel, or uses stand-alone software.

The CD accompanying the book contains several valuable software packages.

- **LINDO and LINGO.** These easy-to-use linear and nonlinear programming software packages are provided by Lindo Systems, Inc.
- **Premium Solver for Education.** Generously provided by Frontline Systems (the developers of Microsoft Excel's Solver), Premium Solver provides evolutionary solving techniques utilized in nonlinear optimization problems.
- **@Risk.** A professional Monte Carlo simulation add-in for Excel by Palisade Corporation.
- **Process Model.** This discrete-event simulation software is easy to learn and use. It is illustrated in Chapter 22. Process Model is provided by Process Model Inc.

Software illustrations, with all the necessary step-by-step instructions, appear at the ends of sections, to provide maximum flexibility to instructors who wish to employ different software packages in their courses.

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I retain responsibility for all errors and would love to hear from users of the book. I can be reached at

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Wayne enjoys swimming and basketball, and his passion for trivia won him an appearance several years ago on the television game show *Jeopardy*, where he won two games. He is married to the lovely and talented Vivian. They have two children, Gregory and Jennifer.

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