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（英文版·第6版）

运筹学导论

Introduction to Operations Research

(SIXTH EDITION)

MBA 专业精品教材

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出版者的话

在全球经济一体化的激烈竞争格局中，中国正处于前所未有的经济与产业结构调整与转型的关键时期。飞速发展的社会与错综复杂的变革要求我们的经济与管理水平有一个飞跃。

为了能让读者系统地学习、借鉴国际上先进的管理理论、方法和手段，机械工业出版社从一些世界著名出版公司引进了一批一流品质的经济管理名著，组成了这套《世界经济管理文库》。其中所选图书均为当前国际上最为流行和权威的教材，大部分多次修订重版，有的多达十几版。作者都是哈佛、芝加哥、斯坦福等著名商学院的教授，使您足不出国，便可领略世界知名学府的文化精粹。

为了给中国的MBA教学提供一套完整的MBA系列教材，继与清华大学经管学院、加拿大毅伟管理学院合作共同策划出版的《国际通用MBA教材》与《国际通用MBA教材配套案例》丛书之后，近期，我社又和中国人民大学工商管理学院联手，共同策划本套《MBA专业精品教材》丛书。《国际通用MBA教材》涉及了所有的MBA核心课程，而本套《MBA专业精品教材》包括了MBA各个不同专业方向的全部课程及选修课程，它为各类工商管理学院培养更适

合社会需要的专门管理人才提供了丰富的教材资源库。全套丛书按专业分类，包括经济学、战略管理与组织、管理科学、财务与金融管理、会计、市场营销、商务技能等7大系列、60多个品种。

为了保持原作的原汁原味，这套丛书是以英文原版的形式出版的。这样可以避免因翻译而造成的歧义和出版时间的滞后，以便让读者能亲身体味原作者的精彩文风，并在第一时间洞悉经济管理学科各个领域的最新学术动态。

由于作者所处的社会、政治环境的不同，书中所述难免有不妥之处，请读者在阅读时注意比较和鉴别，真正消化吸收其中的精华，这也就达到了出版者出版本套丛书的目的。我们真诚地希望这套《世界经济管理文库》的出版，能为提高中国的MBA教学水平、推动中国的改革开放事业尽点绵薄之力。

机械工业出版社
1998年8月

序　言

当前，我国正处于知识经济初露端倪的时代,管理科学已经成为兴国之道，这给我国工商管理教育带来新的机遇与挑战。今年9月，又将有4000余名工商管理硕士生满怀着理想与希望进入各大学学习。一大批机关分流干部与经贸委系统的管理人员也要经过入学考试，在职学习并申请工商管理硕士学位。如何办好工商管理硕士（MBA）项目，为国家和社会培养出一批又一批符合市场需求的高质量的工商管理硕士，是全国可以授予工商管理硕士学位的56所院校所共同考虑与研究的问题。

在这里，MBA课程设计是成功的关键环节之一。记得在1984年的夏天，在加拿大国际开发总署的资助下，加拿大蒙特利尔大学、麦吉尔大学、康克迪亚大学以及魁北克大学蒙特利尔分校的教授们为中国人民大学的年轻教师讲授了管理经济学、会计学、管理学以及管理信息系统等MBA课程。在1985年夏天，加拿大的教授们又讲了另外4门MBA课程。当时，我并没有真正了解这些MBA课程与我过去所学的管理课程在实质上有多大的区别，也没有理解这些课程之间的内在联系，对于MBA核心课与选修课以及专业的主修与副修的区别与联系更是知之甚少，只是感

到加拿大教授的教学在内容和手段上与我们传统方式有较大的区别。1988年初，我到加拿大麦吉尔大学管理学院研修后，才真正对MBA的课程设计有所了解。此后，我先后到美国布法罗纽约州立大学管理学院与澳大利亚悉尼科技大学管理学院任教，又对MBA课程之间的内在联系有了更切身的体会。为了更好地了解美国MBA教育的新潮流，今年6月，我又随中国管理学院院长代表团考察了美国著名管理学院，出席了在芝加哥举办的"全球管理教育论坛会"。

综观北美的工商管理教育，在全球化、信息化与整合化的挑战下，实在是强调其实用性。纵然有的教授学者看重自己的象牙宝塔，勾画着纯理论的模型与理论。但在MBA的教育上，美国现有的750余所管理学院，特别是为美国管理学院联合会（The American Assembly of Collegiate School of Business, AACSB）所承认的300余所管理学院，培养目标明确，课程设计体现出其为社会需求与市场服务的宗旨，没有半点的含糊。美国著名的管理院校明确自己的教育使命，把视野放在全球与创新上，不断地迎接新的挑战，将所授的知识与社会的实际需求密切地结合起来，期望培养出真正的高质量的管理人才。例如，哈佛商学院明确地提出，该院的使命是"影响企业的实践"，培养全面的管理者（general managers），指出"我们要对企业的领导人在如何完成他们的工作上，即在他们如何提出与解决问题、确定战略方向和采取行动上施加重大的影响。同时，我们鼓励从实践中获得反馈，以便了解这些领导人如何在实践中应用我们的思想与知识，从而进一步发展与提炼我们的理论与知识。"麻省理工学院斯隆管理学院的使命"尊重有用的工作"，"为产业提供服务"，提出"作为管理教育与研究的世界领导者，麻省理工学院斯隆管理学院要培养能在快速发展与高度竞争的全球企业环境中获得成功的管理者。当前持续不断的技术创新已成为每个产业各个方面生产力和增长的关键，因此，这正是我们的时机。"伯克利加利福尼亚大学商学院从学院的成立始，就将教育的重点放在国际与企业家的舞台上，研究迅速发展的全球经济，为学生提供创新的学习机会。

根据上述的使命，美国著名的管理学院教育模式基本上有三大流派：一是以哈佛商学院为代表的培养全面管理人员的模式。斯坦福商学院的培养方式也是属于这种模式。他们培养的是全面的MBA，而不是专业化的MBA，通过

为学生提供必要的专业知识，使之毕业以后成为企业或其他组织中高层的有效的全面管理者，而不是职能部门的管理人员。二是以芝加哥大学管理学院为代表的培养专业管理人员的模式，其方向是为企业和组织培养专业的管理人员。斯隆商学院亦属于这种类型。三是介于两者之间的模式。美国多数管理院校采用的是这种培养目标，如伯克利商学院、西北大学的凯洛格商学院、洛杉矶加州大学、康乃尔大学管理学院以及杜克大学管理学院等。因此，各个管理学院在其课程设计上有着不同的战略重点。

哈佛商学院MBA课程设计的思路是"在日益增长的全球商务环境中，提高学生进行战略性与关键性思考的能力。"斯坦福商学院MBA课程设计的思路是"确保学生获得管理运行的知识，了解企业运行的经济、政治和社会环境，以及掌握作为管理者所必须的行为技能。"同时，"MBA项目也要设计成为一种可以终身学习的模式。这样，今天的学生将在今后贯穿其事业的复杂而快速变化的管理世界中有能力自如地作出调整。"斯隆管理学院MBA课程设计的思路是"对日益增长的市场全球化和密集的竞争正在改变工作性质的这一事实作出反映。"哥伦比亚商学院MBA课程设计的思路是"让学生掌握作为管理者能够在全球经济中进行有效竞争所需的基本学科与应用的职能领域。"

总之，这些学院在设计MBA课程时，首先，考虑的是学生要了解全球的竞争环境。其次，考虑学院所在的地域和环境。例如，哥伦比亚商学院极其强调该院处于纽约这个金融中心，其战略重点是国际、金融和纽约，培养出的学生要适合在国际大城市从事金融工作。因此，该学院在课程设计上就对财务与金融等相关课程有所侧重。再次，考虑学院自身资源的特点，如斯隆管理学院在技术管理上设置较多的课程，而哈佛商学院则在全面管理与竞争战略课程上有所突出。最后，要使学生获得相关的专业知识，了解研究与实践的前沿，如企业伦理、领导精神、创新、以及企业与政府关系等。

在课程设计的内容上，美国管理学院根据自己的情况，多按传统划分为核心课程与选修课程。课程内容上并不划一，门数上也多少不等。在学习核心课之前，学生要预先学习计算机应用和技能、商务沟通以及基本数量分析方法等课程。在核心课上，各学院基本上开设了经济学、统计或数据分析、会计、财务、市场营销、运作管理、组织行

为、人力资源管理、战略管理以及公共管理等课程。当然，也有例外。芝加哥大学管理学院就不设置核心课。在选修课程上，除哈佛商学院外，各学院基本上设置了专业，如管理经济学（Managerial Economics）、会计（Accounting）、财务管理（Financial Management）、税收（Taxation）、管理科学（Management Science）、信息系统（Information Systems）、市场营销（Marketing）、组织行为学（Organization Behavior）、人力资源管理（Human Resource Management）、国际商务（International Business）、战略管理(Strategic Management)以及公共管理(Public Management)等。最具特色的是斯隆管理学院的课程设计。该学院除了设计出体现管理基础原理和技能的六门核心课以外，根据学生今后所要从事的工作方向，创造性地设计自我管理模块(Self Managed Track)与管理模块（Management Track）。自我管理模块包括应用宏观与国际经济学、财务管理或财务理论、信息技术、产业关系与人力资源管理、运作管理导论和市场营销导论等六门课。如果学生希望将来从事较为全面的管理工作，则可以选择自我管理模块。而学生希望成为更专业的管理人员，则可以选修管理模块。在这个模块中，有六个分模块，即战略管理与咨询（Strategic Management and Consulting）、新产品与风险开发(Product and Venture Development)、信息技术与企业变革(Information Technology and Business Transformation)、金融工程(Financial Engineering)、财务管理(Financial Management)以及制造与运作(Manufacturing and Operations)。这种设计打破传统职能性课程的框架，切实反映市场的声音，力图符合具体职业领域的要求，使学生能在今后的工作中更快地进入某个具体的管理角色。

我国工商管理硕士教育总体来说，还处在试点阶段之中。在课程设计上，全国工商管理硕士教育指导委员会规定了核心课的指导大纲。经过多年的建设，MBA核心课的教材已经初步满足教学的需求。当然，在质量上还有待进一步完善。随着MBA教学的深入发展，一些院校在培养全面管理人员的基础上，进一步根据自己院校的区域环境和办学条件，探索开设专业方向，以便培养出更适合社会需要的专门管理人才。这就对课程设计提出了新的要求，希望有更专门化的课程支持不同的专业方向。这不仅对教师的科研提出了更高的要求，而且对教材的建设也提出新的

需求。教材不足便是当前工商管理教育中最大的困惑之一。

为了满足工商管理专业方向的发展以及相应的课程设计，在中国人民大学工商管理学院的策划下，机械工业出版社推出了英文版的《MBA专业精品教材》，填补教学用书中空白，力图缓解MBA各专业教学上的急需。在这套丛书中，我们精心选择了北美在经济学、战略管理与组织、管理科学、财务与金融管理、会计、市场营销以及商务技能等7个专业的英文版教材，期望对国内各管理学院所开设的管理专业有所帮助。同时，有志于学好MBA某个专业的管理人员、研究生甚至本科生也可以通过系统地学习该专业所列的教材，掌握个中三味。

当然，在学习西方的管理理论与经验时，需要认真对待其内在的文化底蕴。正如同样是绘画，西方的绘画注重光线与颜色，体现出一种形象思维，而中国画则注重线条，体现出内在的逻辑思维，从而表现出中国文化与西方文化的差异。本世纪初以来，我国知识分子一直在研究与吸收西方文化，力图西学中用。正如有人所讲，学习的方法有三种形式，一是鸟瞰的方法，二是仰视的方法，三是平视的方法。鸟瞰者，持才傲物，看不起其他民族的文化，更看不起其他民族的管理理念与方法。仰视者，自卑自弃，看不起自己民族的文化，盲目追求其他民族的管理理念与方法。要真正作到西学中用，而不是仅仅学到一些皮毛的话，则需要运用平视的方法，拉开距离，去观察与学习世界上一切优秀的管理理念与方法。今天，我们利用西方的管理理论与实践，是为了更合理地推动中国的管理教学与科研，促进中国的管理实践，切不可邯郸学步，而是真正做到"以我为主、博采众长、融合提炼、自成一家"。

徐二明 博士

中国人民大学管理学教授
中国人民大学工商管理学院院长
全国MBA教育指导委员会委员
1998年盛夏于北京

About the Authors

Frederick S. Hillier was born and raised in Aberdeen, Washington, where he was an award winner in statewide high school contests in essay writing, mathematics, debate, and music. As an undergraduate at Stanford University, he ranked first in his engineering class, won the McKinsey Prize for technical writing, and won the Hamilton Award for combining excellence in engineering with notable achievements in the humanities and social sciences. Upon his graduation with a B.S. degree in Industrial Engineering, he was awarded three national fellowships (National Science Foundation, Tau Beta Pi, and Danforth) for graduate study at Stanford with specialization in operations research. After receiving his Ph.D. degree, he joined the faculty of Stanford University, where he is now Professor of Operations Research.

Dr. Hillier's research has extended into a variety of areas, including integer programming, queueing theory and its application, statistical quality control, and the application of operations research to the design of production systems and to capital budgeting. He has published widely, and his seminal papers have been selected for republication in books of selected readings at least ten times. He was the first-prize winner of a research contest on "Capital Budgeting of Interrelated Projects" sponsored by The Institute of Management Sciences and the U.S. Office of Naval Research. He also has served as Treasurer of the Operations Research Society of America, Vice President for Meetings of The Institute of Management Sciences (TIMS), and Co-General Chairman of the 1989 TIMS International Meeting in Osaka, Japan.

In addition to *Introduction to Operations Research* and the two companion volumes, *Introduction to Mathematical Programming* and *Introduction to Stochastic Models in Operations Research,* his books are *The Evaluation of Risky Interrelated Investments* (North-Holland, 1969) and *Queueing Tables and Graphs* (Elsevier North-Holland, 1981, co-authored by O. S. Yu, with D. M. Avis, L. D. Fossett, F. D. Lo, and M. I. Reiman).

Gerald J. Lieberman is Professor Emeritus of Operations Research and Statistics at Stanford University. He has served as Vice Provost and Dean of Graduate Studies and Research, as well as Provost, at Stanford, and was the founding chair of the Department of Operations Research. He is both an engineer (having received an undergraduate degree in mechanical engineering from Cooper Union) and an operations research statistician (with an A. M. from Columbia University in mathematical statistics, and a Ph.D. from Stanford University in statistics).

His research interests have been in the stochastic areas of operations research, often at the interface of applied probability and statistics. He has published extensively

in the areas of reliability and quality control, and in the modeling of complex systems, including their optimal design, when resources are limited.

Dr. Lieberman's professional honors include being elected to the National Academy of Engineering, receiving the Shewhart Medal of the American Society for Quality Control, receiving the Cuthbertson Award for exceptional service to Stanford University, and serving as a fellow at the Center for Advanced Study in the Behavioral Sciences. He also served as president of The Institute of Management Sciences.

In addition to *Introduction to Operations Research* and the two companion volumes, *Introduction to Mathematical Programming* and *Introduction to Stochastic Models in Operations Research*, his books are *Handbook of Industrial Statistics* (Prentice-Hall, 1955, co-authored by A. H. Bowker), *Tables of the Non-Central t-Distribution* (Stanford University Press, 1957, co-authored by G. J. Resnikoff), *Tables of the Hypergeometric Probability Distribution* (Stanford University Press, 1961, co-authored by D. Owen), and *Engineering Statistics,* Second Edition (Prentice-Hall, 1972, co-authored by A. H. Bowker).

Preface

Over the past 27 years, we have been deeply gratified by the widespread response to our first five editions. At the outset, we never dreamed that we now would have had the privilege of helping to introduce several hundred thousand students around the world to our field. It has been a heavy responsibility, but we have enjoyed the challenge of meeting the needs of new generations of students. As always, our goal for the current edition has been to help define the modern approach to teaching operations research effectively at an introductory level.

One key element of a modern approach now is the use of the computer. We believe that our OR Courseware accompanying the book is helping to usher in a new era for making effective use of the computer in a modern introductory course. This innovative tutorial software—featuring demonstration examples, interactive routines, and automatic routines—has been expanded, improved (much larger problems now can be solved), and fully integrated with the text and problems (including a guided tour at the end of Chap. 1 and documentation in Appendix 1). Many new routines have been added, including some for the network analysis and simulation chapters, so now *every* chapter after the first two introductory chapters has useful routines for aiding the learning process.

The software now has 17 demonstration examples, thereby supplementing the book with 17 additional examples for those who need them without adding many more pages for those who do not. Furthermore, these demos vividly demonstrate the evolution of an algorithm in ways that cannot be duplicated on the printed page. A new enhancement is the ability to backtrack in each demo to enable quickly referring back to a preceding screen.

The interactive routines also are a key tutorial feature of the software. Each one enables the student to interactively execute one of the algorithms of operations research, making the needed decision at each step while the computer does the needed arithmetic. To get the student started properly, the computer also points out any mistake made on the first iteration (where possible). By enabling the student to focus on concepts rather than mindless number crunching when doing homework to learn an algorithm, we have found that these interactive routines make the learning process *far* more efficient and effective as well as more stimulating. Our students say that they cannot imagine having to do this homework by hand instead.

Perhaps the biggest improvement in the software over the preceding edition has been in the automatic routines. Several new ones have been added, and they have been made considerably more powerful to enable solving essentially any textbook problem or problem encountered in a student project in an introductory course. For example, the automatic simplex method routine now can handle up to 50 functional constraints and

50 decision variables (not counting slack, surplus, and artificial variables), whereas it previously was limited to only 6 functional constraints and 10 variables of all kinds. The output also has been redesigned to resemble that in popular software packages such as LINDO in order to better demonstrate what can be done with commercial software. An open option then is to next introduce the students to a commercial software package as a supplement to our tutorial software. With this option, whenever a problem indicates that an automatic routine from the OR Courseware should be used, the corresponding routine (when available) from the commercial software package can be used instead.

One key change for this edition has been the addition of more than 250 new problems. Some of these have been adapted from previous operations research examinations given by the Society of Actuaries, which has provided a rich and diverse source of interesting problems. Included are some sets of true–false questions to enable students to test their understanding of key concepts. All problems now are organized and numbered by section at the end of each chapter. The problems also are coded to indicate when to use a helpful routine in the OR Courseware.

The new problems include six larger *case problems* that have been added at the ends of Chaps. 3, 4, 6, 12, 15, and 21. In contrast to the usual textbook problems, these case problems develop relatively elaborate and realistic problem scenarios and then require relatively challenging and comprehensive analyses with substantial use of the computer (using automatic routines in the OR Courseware). Therefore, they are suitable for student projects, working either individually or in teams, and can then lead to class discussion of the analysis.

Another key change has been the addition of some dramatic case studies of real applications. We begin in Chap. 1 with a tabular summary of 15 award-winning studies and the great impact that they had on their organizations. We then expand on some of these studies throughout Chap. 2 to illustrate the operations research approach. Problems at the end of Chap. 2 involve further investigation of these studies, which can provide the basis for class discussion. Section 3.5 then presents three case studies in substantial detail, including the factors that contributed to the success of the studies. These case studies should excite students about the importance and relevance of operations research.

Another important enhancement for the current edition has been a considerable increase in the number of formulation examples, including especially some in the first linear programming chapter (Chap. 3) and the integer programming chapter (Chap. 12). In fact, the latter chapter includes a new section devoted entirely to interesting formulation examples.

Other additions include a greatly expanded section on recent algorithmic developments in integer programming and a new section on utility theory (from an applied viewpoint).

As always, we have provided enough material to give the instructor some flexibility in picking and choosing what to cover. However, we do not believe that it is appropriate for an introductory textbook to be encyclopedic in length and coverage. Therefore, with all the additions described above, we felt that it was important to make some difficult choices of old material to eliminate. In addition to trimming the verbiage in a number of places, we have deleted the following material that was in the fifth edition: the chapter on formulating linear programming models (except for moving the goal programming section, one formulation example, and most of the formulation problems to other chapters), the chapter on reliability, and several sections, including

those on the transshipment problem (now treated briefly as a special case of the minimum cost flow problem), multidivisional problems, and evaluating travel time for designing queueing systems, along with the appendix on simultaneous linear equations and tables for the chi-square and Poisson distributions.

Another option available for instructors who want to focus on linear programming is to take advantage of the other Hillier-Lieberman book published by McGraw-Hill: *Introduction to Mathematical Programming* (2d ed., 1995). This book is virtually identical to Chaps. 1 to 13 (plus appendixes) of this book with the one exception that Chap. 8 here (The Transportation and Assignment Problems) has been replaced by a much longer Chap. 8 (Special Types of Linear Programming Problems) that also includes sections on the transshipment problem, multidivisional problems, the decomposition principle, multitime period problems, multidivisional multitime period problems, stochastic programming, and chance-constrained programming.

Outside the changes, additions, and deletions already described for this book, the organization remains almost the same as in the fifth edition. One small change is that the section on the dual simplex method (formerly Sec. 9.2, but now Sec. 7.1) has been moved next to the related chapter on duality theory and sensitivity analysis (Chap. 6). Another is that the chapter on the transportation and assignment problems (now Chap. 8) has been moved next to the chapter on network analysis (Chap. 9), with increased emphasis on the network representations of these problems.

Every chapter has received significant revision and updating, ranging from modest refining to extensive rewriting. Some areas receiving a major revision include the chapters on the simplex method (giving more emphasis to geometric insight), decision analysis, and Markov decision processes, as well as the sections on primal-dual forms and continuous-time Markov chains.

The overall thrust of all the revision efforts has been to build upon the strengths of previous editions while thoroughly updating the material and integrating the software to fully meet the needs of students preparing for a career in the twenty-first century. We think that the net effect has been to make this edition even more of a "student's book"—clear, interesting, and well-organized with lots of helpful examples and illustrations, good motivation and perspective, easy-to-find important material, and enjoyable homework, and without too much notation, terminology, and dense mathematics. We believe and trust that the numerous instructors who have used previous editions will agree that this is the best edition yet.

The prerequisites for a course using this book can be relatively modest. As with previous editions, the mathematics has been kept at a relatively elementary level. Most of Chaps. 1 to 13 (introduction, linear programming, and mathematical programming) require no mathematics beyond high school algebra. Calculus is used only in Chap. 13 (Nonlinear Programming) and in one example in Chap. 10 (Dynamic Programming). Matrix notation is used in Chap. 5 (The Theory of the Simplex Method), Chap. 6 (Duality Theory and Sensitivity Analysis), Sec. 7.4 (An Interior-Point Algorithm), and Chap. 13, but the only background needed for this is presented in Appendix 4. For Chaps. 14 to 21 (probabilistic models), a previous introduction to probability theory is assumed, and calculus is used in a few places. In general terms, the mathematical maturity that a student achieves through taking an elementary calculus course is useful throughout Chaps. 14 to 21 and for the more advanced material in the preceding chapters.

The content of the book is aimed largely at the upper-division undergraduate level (including well-prepared sophomores) and at first-year (master's level) graduate

students. Because of the book's great flexibility, there are many ways to package the material into a course. Chapters 1 and 2 give an introduction to the subject of operations research. Chapters 3 to 13 (on linear programming and on mathematical programming) may essentially be covered independently of Chaps. 14 to 21 (on probabilistic models), and vice versa. Furthermore, the individual chapters among Chaps. 3 to 13 are almost independent, except that they all use basic material presented in Chap. 3 and perhaps in Chap. 4. Chapter 6 and Sec. 7.2 also draw upon Chap. 5. Sections 7.1 and 7.2 use parts of Chap. 6. Section 9.6 assumes an acquaintance with the problem formulations in Secs. 8.1, and 8.3, while prior exposure to Secs. 7.3 and 8.2 is helpful (but not essential) in Sec. 9.7. Within Chaps. 14 to 21, there is considerable flexibility of coverage, although some integration of the material is available.

An elementary survey course covering linear programming, mathematical programming, and some probabilistic models can be presented in a quarter (40 hours) or semester by selectively drawing from material throughout the book. For example, a good survey of the field can be obtained from Chaps. 1, 2, 3, 4, 15, 17, 18, 20, and 21, along with parts of Chaps. 9, 10, 12, and 13. A more extensive elementary survey course can be completed in two quarters (60 to 80 hours) by excluding just a few chapters, for example, Chaps. 7, 11, and 19. Chapters 1 to 8 (and perhaps part of Chap. 9) form an excellent basis for a (one-quarter) course in linear programming. The material in Chaps. 9 to 13 covers topics for another (one-quarter) course in other deterministic models. Finally, the material in Chaps. 14 to 21 covers the probabilistic (stochastic) models of operations research suitable for presentation in a (one-quarter) course. In fact, these latter three courses (the material in the entire text) can be viewed as a basic one-year sequence in the techniques of operations research, forming the core of a master's degree program. Each course outlined has been presented at either the undergraduate or graduate level at Stanford University, and this text has been used in the manner suggested.

Again, as in previous editions, we thank our wives, Ann and Helen, for their encouragement and support during the long process of preparing this sixth edition. Our children, David, John, and Mark Hillier, Janet Lieberman Argyres, and Joanne, Michael, and Diana Lieberman have literally grown up with the book and our periodic hibernations to prepare a new edition. Now, most of them have used the book as a text in their own college courses, given considerable advice, and even (in the case of Mark Hillier) become a full-fledged collaborator. It is a joy to see them and (we trust) the book reach maturity together.

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