



## Interfaces

Publication details, including instructions for authors and subscription information:  
<http://pubsonline.informs.org>

## Book Reviews

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To cite this article:

Wenjing Shen (2016) Book Reviews. Interfaces 46(1):109-114. <https://doi.org/10.1287/inte.2015.0826>

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## Book Reviews

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In *Book Reviews*, we review an extensive and diverse range of books. They cover theory and applications in operations research, statistics, management science, econometrics, mathematics, computers, and information systems. In addition, we include books in other fields that emphasize technical applications. The editor will be pleased to receive an email from those willing to review a book, with an indication of specific areas of interest. If you are aware of a specific book that you would like to review, or that you think should be reviewed, please contact the editor.

The following books are reviewed in this issue of *Interfaces*, 46(1), January–February 2016: *Operations Planning: Mixed Integer Optimization Models*, Joseph Geunes; *Extension of Data Envelopment Analysis with Preference Information: Value Efficiency*, Tarja Joro and Pekka J. Korhonen; and *Rational Action: The Sciences of Policy in Britain and America, 1940–1960*, William Thomas.

GEUNES, JOSEPH. 2014. *Operations Planning: Mixed Integer Optimization Models*. CRC Press. 218 pp. \$99.95.

Deterministic optimization models with integer (binary) variables have been successfully employed to address a wide variety of important operations planning problems. Therefore, knowing how to model and solve problems facing operations managers is vital for students, whether they are training to be practitioners or researchers. By systematically introducing the key models that have emerged, carefully building them from small to large, and highlighting in each case the methods that may be used and their relative merits, Geunes' book provides students with a comprehensive, yet accessible, introduction to the area, while gently exposing them to the research literature.

Textbooks on optimization, in their zeal to be rigorous, often fall into the pedantic trap, resorting to long and dry descriptions that offer little by way of intuition and are difficult to follow. In contrast, this book offers intuition and is highly accessible without compromising on technical rigor. In particular, Geunes' gradual buildup of problem complexity, starting from simple problems and progressively generalizing to more complex problems, will allow students to ease into the technical material, while building their understanding of the fundamental concepts that are used later in the book. The well-constructed

numerical examples and the exercises at the end of each chapter will also be a great help to students.

A central theme of the book, and one that serves the reader well, is the emphasis on drawing out and highlighting the relationships between seemingly disparate problem classes. Geunes diligently points to the various connections, as special cases or generalizations, between the different problems and subsequently uses them in both model development and in developing solution approaches. For example, introducing the knapsack problem first (Chapter 2) allows the author to relate it to diverse applications, such as the lot-sizing and single-source facility-location problems that he describes in later chapters. The book's emphasis on identifying the interconnections among problem classes has several advantages. First, it can aid students in understanding problem complexity analysis. Additionally, this building-block approach offers students a mechanism for the development of methodologies for new problems by studying problem substructures.

The book considers a wide variety of operations topics spanning strategic (e.g., facility location), tactical (e.g., lot sizing), and operations (e.g., routing, machine scheduling) decision problems. As the author notes in his introduction to the book, the operations area is vast, especially when we consider its

extensions into supply chain management. By choosing to focus only on classical operations topics, and resisting the temptation to delve into the supply chain area, the author is able to provide in-depth coverage. Unfortunately, this does not allow room for covering some important contemporary applications of integer programming in areas such as procurement, and sales and operations planning. Perhaps Geunes will consider including such content in future editions. One minor point related to the topics: although the book covers deterministic models of inventory management (Chapter 7), a very important topic in operations, none of the chapter's titles uses the word inventory, which is initially somewhat unsettling.

As one might expect from the title, the book's primary focus is in introducing the various methodologies that have been developed to solve operations problems. The author covers both exact techniques and approximate methods, including recent developments for each problem class, and notes their relative merits for different classes of problem instances. For each problem class, rather than limit the discussion to one type of method, he summarizes the approaches that have proved successful for solving the problem. This provides the student with a well-rounded perspective on the appropriateness and fit of methodology with problem class. In particular, the book's in-depth discussion of approximation methods, their application, and analysis, is new, thorough, and enlightening. One fruitful way to expand the scope of the book that the author might wish to consider in a future edition is to complement student understanding of the various methodologies by integrating the theory covered in the book with aspects of implementation (perhaps with code samples).

The book, as the author notes in the introduction, is intended for graduate students who have an interest in operations research and how it applies to operations planning, and have taken a course on mathematical modeling that covers the basics of model formulation and linear programming. It is intended for use in a course that covers the mathematics of operations planning models and would be perfect for a foundational elective in operations planning. Researchers interested in this area are likely to find the up-to-date summaries of research in the various chapters useful as a reference.

To summarize, although many textbooks are available on integer programming techniques and include several references for research in the area, Geunes' book artfully covers the area in between to help students advance their study of operations models, while accessing it in the context of current research.

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JORO, TARJA, PEKKA J. KORHONEN. 2015. *Extension of Data Envelopment Analysis with Preference Information: Value Efficiency*. Springer Science + Business Media. 191 pp. \$99.00.

Data Envelopment Analysis (DEA) is a widely used methodology for the performance evaluation of various units, which are usually called decision-making units (DMUs), operating in similar conditions, especially where a finance-based evaluation is not applicable. Such situations are typical for the evaluation of public sector institutions (e.g., hospitals, schools). If the pricing of the relevant products or services is not an appropriate evaluation method, then the production process should be analyzed to evaluate the technical efficiency of the considered DMU. The main concept of DEA is to evaluate relative technical efficiency considering inputs and outputs of the production processes that comparable DMUs use. DEA terminology and methods are similar to those of multiple-criteria decision making and multiobjective optimization; however, the former is an evaluation approach, whereas the latter are methods to support planning and design.

The literature on DEA is rich and diverse. For the classical theory of DEA, we refer the reader to Cooper et al. (2007). The real beneficiaries of Joro and Korhonen's book will be the readers who understand theory and have some experience in applying DEA methods. Although a modest mathematical education—an education that includes elements of linear algebra and optimization theory—is sufficient to understand the propositions and their proofs, some maturity in operations research methodology is desirable to understand the real advantages of the methods proposed.

*Extension of Data Envelopment Analysis with Preference Information: Value Efficiency* has 12 chapters, most of which consist of only about 10 pages. The first

five chapters (64 pages) contain introductory material, including definitions, notation, basic concepts of multiobjective optimization, several models of DEA with different returns to scale, and basics of multiobjective linear programming. Chapter 6 presents a review and classification of preference-based approaches to DEA. Chapters 7–10 present the results of value efficiency analysis, and include important results of analysis by the authors and their collaborators. Chapter 11 discusses practical applications of value efficiency analysis, and Chapter 12, a one-page chapter, presents conclusions.

The objective of classical DEA methods is to construct an empirical efficiency frontier for the relevant DMUs, and to assess the inefficiency of the DMUs that do not belong to the efficiency frontier. Technically, a DMU can be efficient as a result of one extreme output, even if its other inputs and outputs are inefficient; however, different inputs and (or) outputs are normally of a different value than the subject requesting the evaluation. The main part of this book addresses problems in which value-free consideration is not appropriate, and methods that consider some preference information. A standard method to incorporate preference information is via the constraints for weights of inputs and (or) outputs. Allen et al. (1997) provide details.

The review in Chapter 6 covers DEA methods that include various requirements for weights: examples include upper and lower bounds, ordinal relationships, and restrictions of the assurance region of cone ratio type. The chapter also includes a discussion of methods that are based on artificial DMUs (e.g., setting targets based on preferences). Illustrations and comparisons complement the theoretical presentation of the methods reviewed.

The value efficiency analysis aims to complement the selection of a nondominated DMU with some preference information where simple restrictions for weights do not work. In Chapter 7, the authors present the most preferred unit-based approach, whereby a decision maker expresses his (her) preferences by identifying a target or ideal point. The methodology describes the selection of a realistic target—the most preferred solution (MPS). Theoretically, the MPS corresponds to the point at which the

value function of the decision maker reaches its optimum. The value function is assumed to be pseudo-convex for inputs and pseudo-concave for outputs. However, the proposed methodology for the computation of efficiency scores does not require the explicit knowledge of the value function, and uses its theoretical properties in combination with the information on the MPS. The main difference between the proposed method and the target-setting approach, which is familiar to readers of operations research (OR) literature, is that a decision maker selects an MPS on the efficient frontier in the target-setting method; in the proposed method, the selection is supported by an interactive procedure. For potential users of value efficiency analysis, Chapter 8, which discusses practical applications of these methods, is particularly important. In Chapter 9, the authors discuss extensions that focus on the hybridization of the information in the MPS, including price information of inputs and outputs.

The analytical analysis of the value efficiency considered in the previous chapters is facilitated by the assumption that the production-possibility set and the decision maker's value function are convex. However, such an assumption is not always applicable. In Chapter 10, the authors describe a model that enables a user to find the most preferable solution and to compute the efficiency score of a DMU in the case of relaxed convexity assumption. Finally, in Chapter 11, they present and discuss several real-world problems and their solutions. This chapter is based on the results that the authors and their collaborators found by using the methods they describe in this book. The value efficiency analysis of academic research is an interesting but difficult task. The objective of the evaluation in the book was to establish the extent to which the research units correspond to the following characterization: "A research unit whose members continuously produce high quality, innovative and internationally recognized research, and who actively supervise doctoral students and actively take part in various activities of the scientific community" (p. 162). Five groups of criteria that correspond to this description were selected; examples include articles published in international refereed journals, citations, conference presentations, invited and plenary presentations from international conferences, and doctoral degrees produced. An efficiency analysis of the

18 research units at the Helsinki School of Economics was performed using both a standard DEA method and a method oriented to the value efficiency analysis. The differences in the results highlighted the advantages of the proposed methodology. The authors claim that: “At the Helsinki School of Economics, the decision makers—while expressing their original reservation about the usability of OR models in this context—viewed results useful” (p. 169). The wider promotion of this methodology seems reasonable in view of the prevalent simplified evaluation of the research units, which is based on an impact factor and the number of publications in journals identified as the top journals. The results of a performance analysis of the bank branches of Helsinki’s OP Financial Group has also demonstrated advantages of the new methodology with respect to the previously applied standard methods of DEA. At first glance, the third problem considered would seem to be an unusual one: quantitative assessment of the religious parishes of the heterogeneous areas of a metropolitan city; however, it is especially interesting because it demonstrates the applicability of a nonconvex value efficiency analysis to nonhomogeneous DMUs.

The book presents an introduction in an interesting topic—the development of DEA when it is combined with available preference information. Researchers and managers who are interested in applications of DEA would seem to be the primary beneficiaries of reading it; professors and instructors might select some themes from the book to complement their DEA courses for OR students. In addition, the theoretician of decision making might be interested in the further development of the nonconvex approach in value efficiency analysis initiated in the book.

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THOMAS, WILLIAM. 2015. *Rational Action: The Sciences of Policy in Britain and America, 1940–1960*. The MIT Press. 416 pp. \$38.00.

This remarkable book began as William Thomas’ undergraduate senior thesis at Northwestern University, where he majored in physics and minored in history. He went on to obtain a doctorate in the history of science at Harvard University in 2007. From 2010 to 2013, he held a junior research fellowship at Imperial College in London. Dr. Thomas is now a senior historian at History Associates, Inc., based in Rockville, Maryland.

As befits the author’s impressive educational and professional background, *Rational Action* is scholarly, elegantly written, and well organized. To emphasize the thematic diversity involved in his subject, Thomas has divided the 300-page body of the work into 30 chapters and grouped them into seven parts. The back matter (approximately 100 pages) is comprised of endnotes (50 pages), a bibliography (33 pages), and a combination name and subject index (17 pages). The relative brevity of the chapters contributes to the book’s readability as does its attractive printing.

This book belongs within the history of science literature, and its subject and historical period are clearly declared in its subtitle, *The Sciences of Policy in Britain and America, 1940–1960*. In truth, however, the book does not strictly observe these time boundaries at either end of the interval. Author William Thomas uses the term sciences of policy for convenience to represent a host of disciplines, some of which emerged during the period under study. Among the most prominent of these are operational research (in Britain) and operations research (in America), both long known the world over as OR. Readers familiar with the terms *science policy* and *policy science* may need to find a way to distinguish them from the *sciences of policy*, which Thomas broadly conceives of as “science, mathematics, philosophy, engineering, computation, expert advice, and executive decision making” (p. 3). In addition to being primarily historical in nature, this work is variously concerned with organizations—military, governmental, professional, academic, and industrial—and with philosophy as represented by the views of the major participants in the field, social scientists, and academic philosophers. In reading this volume, it helps to be

comfortable with words such as epistemology and historiography.

Curiously, one might even say fortunately, the neologism *sciences of policy* is used almost exclusively at the beginning and at the end of the book. These parts reflect the author's interest in clarifying the overall significance of the work. The heart of the book relates the story of how World War II and the postwar era (including the Cold War) created a demand that led to the rise to OR and systems analysis, the latter represented primarily by work done in the United States by the RAND Corporation and its affiliates. This development involved many people on both sides of the Atlantic. In this respect, it resembles two publications (Arjang and Gass 2011, Gass and Arjang 2005) that may be familiar to *Interfaces* readers. *Rational Action* contains 11 tables, three boxes, and 29 illustrations (i.e., figures). The latter is a mix of diagrams, cartoons, and photographs (some portraits, some snapshots), only some of which illustrate people. Thus, the number of photographs of people is but a small fraction of the more than 200 individuals named in the book.

Throughout history, scientific and engineering knowledge has been used in warfare for both offensive and defensive purposes. One need only point to the catapult and the fortress for examples. The book under review here largely ignores this familiar tradition, although it does recall the important studies and practice of gunnery conducted well before the two decades that it addresses. Shortly prior to and during World War II, advances in science and technology made the argument for their use in military planning more compelling than ever before. This brought about a significant role for scientists alongside the military and political leadership in Britain and America (and no doubt elsewhere). This arrangement was not always comfortable. C.P. Snow's famous lecture on the "two cultures" prevailing in Britain (Snow 1993) comes to mind. Issues relating to lines of authority loomed large in this urgent collaboration, as did debates about rationality.

To a large extent, the science that Thomas discusses in this book is what came to be called OR. The introduction of such analysis was initially accompanied by acceptance or nonacceptance in military and

governmental decision-making circles. In this regard, Thomas identifies two narratives present in the historical literature pertaining to this subject. The first is "the halting, eternally incomplete progress of 'science' as a force of economic and political enrichment" (p. 4). The second relates 'science' to technology and rationality. This, he says, "deals with the rising dominance, rather than the struggle, of technology and rationality in social and political life" (pp. 4–5). Yet, he says, "it does not suppose rationality to be an unalloyed virtue in policy." (p. 5). Thomas remarks that "within both narratives, an emphasis on failure—and the tacit role of the narrator as a diagnostician of failure—plays a crucial role in the selection and description of the episodes populating the stories." (p. 5). As far as I can tell, the meaning of the term rational—as in rational policy—is never precisely pinned down in this book, although it must surely be based on reason (another slippery word). The kind of reasoning that 'science' brought to bear on certain military and civilian problems was of a mathematical and statistical nature with a strong emphasis on empirical data.

This book is pretty light on mathematical details; however, to Thomas's credit, he does a fine job of explaining diverse technical material for a lay audience. Nevertheless, as occasionally happens in doing this, a simple, intelligible statement distorts the truth. The following is a case in point. Recounting some of the very early history of linear programming and (two-person, zero-sum) game theory, Thomas says "Research on the fundamental mathematical aspects of linear programming moved almost immediately into what was called the 'duality' between it and game theory..." (p. 183).

This statement on the "duality" relationship—between linear programming and game theory—either suggests a misunderstanding of where duality fits in, or it is supposed to represent a bit of playful poetic license. The quoted passage then goes on to say "...as well as into what Tucker and Kuhn (sic) called 'nonlinear programming' in their 1951 paper introducing the subject" (p. 183).

The entire discussion of nonlinear programming is relegated to this one sentence and the associated endnote citing a paper (Kjeldsen 2000) by the mathematical historian Tinne Hoff Kjeldsen. Thomas makes

no further explicit reference to nonlinear programming, although in the 1950s, it could be found in journals such as *Naval Research Logistics Quarterly*. With rare exceptions, Thomas seems to equate operations research with optimization—and optimization with linear programming. This equivalence may have been largely, although by no means entirely, valid in the era covered by this study.

In a chapter called “Rationality and Decision: Varieties of Theory,” Thomas observes that “systems analysis, logistical analysis, operations research, and closely associated branches of statistics, mathematics, and economics all combined in the 1950s to form an intellectual matrix in which new theories of decision making developed” (p. 211). He stresses the major role played by procurement on behalf of the military services. For example, the creation and selection of sophisticated weapons systems brought together a multitude of issues including military mission, fighting strategy, design of components, and man-machine interactions. The perceived political and defense objectives and sheer scale of the procurement process called for a comprehensive approach to decision making.

The author’s choice of words is sometimes rather different and, to be frank, annoying. For example, he refers to “an existing *intellectual economy* populated by officers and personnel in combat roles, intelligence officers, engineers, technical specialists, and others” (p. 85). (The italics are mine.) Another is his frequent

use of the word “theorization” as in this opaque sentence speaking about the goals of decision theory: “The ultimate—and, it was admitted, unachievable—objective of this line of theorization was to define the rationality of a decision in such a way that it would be impossible for the decision maker to object that a formulation did not truly define a rational decision on account of its failure to account for some hidden meta-calculative criterion that bore upon how a decision had to be made in view of all relevant practical exigencies” (pp. 218–219).

But these are minor quibbles. I believe that anyone interested in the history and philosophy of our field—from its inception and through its first two decades—will be rewarded by reading this generally masterful publication.

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