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Book Reviews

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BOOK REVIEWS

Introduction to Operations Research. C. WEST CHURCHMAN, RUSSELL L. ACKOFF, AND E. LEONARD ARNOFF. New York: John Wiley & Sons, Inc., 1957. Pp. x + 645. \$12.00.

This book is the first of what will probably turn into a long line of textbooks in the field of (non-military) Operations Research. Its authors have aggregated and connected a rather substantial number of lectures and papers prepared by more than a dozen individuals, most of whom were associated with the Operations Research Group at Case Institute of Technology. It was intended as a textbook for both prospective "consumers" and potential "practitioners" of Operations Research, even those without a high degree of mathematical sophistication. Its over-all aim is stated to be one of creating "an understanding of the application of scientific method to Operations Research, and not a listing of techniques."

The text is organized in ten parts. The first part presents a general overview of what Operations Research is all about, and then goes on to two illustrative cases. The second part treats certain concepts and techniques of problem formulation, beginning with an essay on organization theory and ending with a detailed procedure by which individuals can weight objectives. The next six parts, comprising about two-thirds of the book, are devoted to the subject of models in Operations Research. This middle section of the book contains a rather detailed catalogue of models relating to many general, as well as specific, types of inventory, allocation, waiting line, replacement, and competitive situations. To illustrate, the catalogue includes: an inventory model with more than two price breaks; a queueing model with three stations, n jobs and no passing; and a bidding model with closed bidding where the number of bidders is large but not known exactly. The final sections of the book are concerned with: (a) testing and implementing "solutions;" and, (b) selecting and training personnel for an OR team, and locating that team within the organization.

On the whole, this book will make a valuable addition to the OR bookshelf. A great deal of material which is scattered throughout the technical literature has been pulled together and organized in a coherent way. In addition to the intended instructional function, it should become a useful reference for those in practice. Technical details are well handled and easy to follow. Students should be able to master most of its content with a minimum of supplementary instruction. Such a text has been sorely needed and the authors are to be complimented on their courage in undertaking to produce the first one.

From a technical point of view, the first two parts of the book are by far the most vulnerable, for it is here that the authors deal explicitly with the underlying philosophy of OR. It is unfortunate that the introductory part of this introductory text emphasizes the so called "optimization" formulation of decision problems, for in attempting to bolster this formulation, which requires that a

single measure of effectiveness be produced, the authors have been forced into some rather absurd positions. For example:

“it is desirable to have each group of participants in the problem or a representative sample from each group, do the weighting of all the objectives,”

“set up a model in which an intangible objective appears, say, as a linear term.”

Such remarks suggest a fundamental sort of confusion about the basic nature of OR. There seems to exist a strong attachment to formally developed answers, exemplified by the belief that decision problems have universal “solutions” which are capable of being found by establishing some objective measure and finding a maximum through the application of formal method. The need for a single objective measure brings trouble, however, because it requires some means for identifying and weighting “objectives.” One might fairly conclude that the “science” of Operations Research has a soft core when so much elegance of technique seems to depend so heavily on this business of weighting objectives. It is only fair to observe, however, that this may be more of a commentary on the state of the art than on this book.

The longest and strongest treatment in the book is given to the development and study of mathematical models of idealized operations. The book serves very well the function of collecting together a large number of such models and, in this sense, should become a useful reference and catalogue for the practitioner. It is reasonable to conclude that the beginner will be helped in developing a feeling for the development of models. The less sophisticated, however, may well tend to conceive of OR as the art of selecting and fitting models—a conception which is already too firmly entrenched.

The omissions from this book are notable. The more difficult, time consuming, less formal aspects of OR are treated either casually or not at all. The general problems of identifying input and output variables and relationships, developing cost, performance and other models of operations, are just about mentioned in passing. The often crucial problems of forecasting sales, prices, future technologies, and so on, are glossed over. The treatment of an important class of OR problems, namely, investment decision problems, is ignored, although many of the operating problems dealt with are often virtually inconsequential by comparison. Although methodology is its stated theme, and although one of the stated aims of the book is to create an understanding of the application of *scientific* method to OR, that aim is not really pursued. Science, at least as many conceive of it—observation, hypothesis, experimentation, induction as well as deduction—never really gets into the plot. The critical problem of choosing between alternative models is given only casual attention. Although science surely involves the development of formal theories or models, this reviewer tends to feel that undue emphasis has been placed on illustrative models of possible operations for an introductory text in OR.

As a pioneer work in its field, this book possesses a special kind of authority and importance. With respect to training and education, this book cannot fail

to have an important influence on the development of Operations Research as a professional field. It must surely help to initiate would-be practitioners, and it may contribute importantly to the popularization and fashionability of OR. For the immediate future, at least, it will serve as the standard textbook for most OR, near-OR, short-OR, and similar courses operated by universities, institutes, consultants, and trade associations. The book may, in short, have a profound influence upon the direction which OR takes in the future, and it is for this reason that it behooves us to appraise the nature of that influence.

Thoughtful Operations Researchers have recognized for some time that there was no ready niche for them in the world of intellectual activities. This difficulty has had many sources: OR has had to compete with, and yet depend upon, many of the traditional scientific disciplines (for example, economics); it has had to compete with some of the well established applied fields traditionally devoted to similar problems (for example, production engineering, cost accounting, market research); it has been divided by important internal differences as to its true nature and role; and, most important, it has been entrapped by the need to establish itself as a "science" and, at the same time, to establish itself as "useful."

What is to be the outcome of this complex set of forces? Is Operations Research to become just another kind of "scientific management" and, if so, can it avoid the fate which befell "scientific management" a generation ago? Or, on the other hand, is OR to become a true "management science?" Is the Operations Researcher to become a subordinate, management decision maker, or is he to become a scientist? Is he to become an applier of formulas, or a student of the fundamental processes which govern the operation of our physical and social environment? The issue is drawn too strongly, and yet this is its fundamental nature. All generally recognized fields of science have their practitioners, their routine "appliers," but they also have scientists, their members who have had more interest in the establishment of general laws than in specific applications. And it is more or less true that while Operations Research has been established by scientists who matured in other fields, it has not yet, in this sense, brought forth its own scientists. It is the view of this reviewer that Operations Research must produce such men, must maintain an emphasis upon its "pure science" aspects rather than its applied aspects or it will surely perish as a research field. Operations Research will become a routine job, to be practised by anyone with a sufficiently large handbook.

From this long run point of view, it must be said that the book under review is likely to perform a disservice. The most important positive contribution of this book is that it emphasizes the supremacy of formal methodology over informal argument, of principle over how-to-do-it, rule-of-thumb. Yet, paradoxically, because the book is based upon a superficially objective, pseudo-scientific (because indefensible) view of the basic nature of decision making and the decision process, it paves the way for the formula appliers and the handbook preparers. In this book the Operations Researcher can always determine what is "best," and it is but a step—a short step—from this book to the preparation of, say, a catalogue of inventory models, with a statement as to the circumstances under which each

is applicable. And from this, in turn, it is but an easy step to the preparation of numerical tables or detailed computational procedures which give "solutions" for each of the models. And at this point the Operations Researcher is neither scientist nor research man: he is simply another management functionary, a crank-turner, distinguishable from his "scientific management" predecessor only because of the computer at his side. And, like his forebear, he will frequently do more harm than good in the name of science.

To its everlasting credit, a large part of management is rightfully suspicious of all this going-on. In part because of an innate distrust of anything which cannot be spelled out in two-syllable words, but, more interestingly, because of a native intuition which recognizes (better than the OR knights advancing behind the shield of science) that decision problems are fundamentally not "solvable" by formulas.

There are some in Operations Research (this reviewer is one) who believe that Operations Research cannot survive as an identifiable professional activity unless it really remains a research activity and represents research of a kind which is not suggested by this book. The plain and obvious fact is that Operations Research can be an aid to, but not a substitute for, the decision maker. No science ever has, and perhaps none ever will, approach in complexity the reality of decision making.

But perhaps, after all, it is too early to say. Perhaps there is too little experience to support generalizations, and perhaps there are bound to be many points of disagreement between early practitioners in any emerging field. Perhaps one ought not to ask more of a pioneer book than that it be a pioneer.

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Office Work and Automation. HOWARD S. LEVIN. New York: John Wiley & Sons, Inc., 1956. Pp. x + 203. \$4.50.

Electronic Data Processing for Business and Industry. RICHARD G. CANNING. New York: John Wiley & Sons, Inc., 1956. Pp. x + 332. \$7.00.

Despite differences in title, both books have the same purpose—to interest and guide business management in the application of electronic data processing equipment. They have much in common; both are written from the standpoint of enthusiastic advocacy and follow a parallel structure and development. There are, of course, significant differences.

Office Work and Automation is written at a more general level, principally useful to top management. The arguments for office mechanization are marshalled, followed by a discussion of common language, general characteristics of alternative computers, a chapter on operations research, and concludes with a discussion of social and economic implications. In a sense, the book is a primer of terms and concepts which management is thought to find useful in dealing with the systems engineer.

Electronic Data Processing for Business and Industry, although similarly di-

rected to management, is perhaps even more useful to the systems engineer; i.e., towards training the group responsible for the system "internal design." There are chapters on programming, initial and detail design, equipment characteristics, and other points that are beyond the "decision" phase of the problem. It continues with a chapter on Operations Research and concludes: "Electronic data processing is a thing of the present. It deserves management's attention now." An appendix thoughtfully provides advice on "Overcoming Barriers to the Acceptance of New Ideas and Methods."

The use of more than 400 electronic computers in business data processing (including over 50 large machines) and numerous conferences and symposia on this subject are ample evidence of the effectiveness of such interest. Certainly, complexity due to Government regulations, increased size and scope of operations imply the handling of large amounts of data. A similar gradient, therefore, acts in favor of any means of lowering the cost of paper work as exists in the physical production analogue when, say, individual lathe operations are replaced by automatic turret lathes and transfer machines. The same characteristics also apply: the machines must be sufficiently flexible to cope with possible changes in the nature of the product, must not show undue sensitivity to the scale of production, and must be amortized within the period of such stable quantity and configuration of product.

They imply the requirement for staffs capable of intelligent management, operation and maintenance of the machine capability, hence, creation of the new occupations of analyst, programmer and coder replacing the general-purpose clerk. Moreover, management must be able to structure the evolving organization, communicate with its designers and operators, exploit its capabilities and recognize its limitations. Levin's book is more useful for the latter purpose, and that of Canning is applicable to both.

In so active and growing a field, data specific to particular equipments, costs, and performance capabilities are "outflanked" by events. This is natural and to be expected; hence, specific calculations should be based on current catalogues and manufacturer's data. The form for structuring and comprehending such data is, however, adequately presented.

Canning (page 246) suggests that "for the most effective installation of electronic data processing in a company, an operations research study should be made in parallel with the system study." The advice is given that if the parallel study is not made, that the systems engineer assume that present methods will be programmed for machine solution. However, the balance of uses of the machine determines the required relative capacity and performance of important features, e.g., the memory unit and computational capability. Clerical and inventory machines have, as their primary function, data manipulation and only little computation, in comparison with machines that involve engineering computation or mathematical model studies. It might be concluded that the feedback relations among the management purposes, operating conditions, and environment, be thoroughly investigated before settling on a specific piece of hardware.

The statement, "Mathematical programming and scientific programming are synonyms for the process of determining the best among many courses of administrative action," (Levin, page 140) is optimistic at the present state of the art. In practical business activity, constraints and functional relationships have an excessive number of degrees of freedom and discontinuities for currently available technique. The conservation goals of a company may involve, discontinuously in time and quantity of production, such diverse elements as the elimination of competition or its diametric opposite (for the purpose of avoiding anti-trust action), maintenance of earnings, "long term industry position," to cite only a few. The changing welter of goals and the fluctuation of uncontrolled elements combine to make major management decisions by computer, a research topic rather than a resource for present use by management.

Canning suggests that operations research concentrate on optimum methods for (1) management decision-making and (2) management controls. The decision-making process, as we have seen, does not yield to a simple-minded approach—at least, not for important decisions, which are beyond day-to-day operations. Management control is considerably more susceptible to the capabilities of high-speed digital computation. Production control, especially, has been a proven fruitful area. The General Electric Appliance Parts Plant requires a 20-week production schedule, involving 30 models, 1,000 purchased parts, and 350 raw material items. Before computer operation, there was at least one shut-down per month due to materials shortages; during five months of computer operation, no shut-down of assembly lines occurred for this reason.

The electronic computer's utility to the operations analyst arises because it permits the performance of a large number of "paper experiments" and the use of numerical methods that would otherwise be prohibitively expensive. But the computer is a tool, and only one tool. And if bemused by his computer, the analyst may investigate the properties of his model unperturbed by messy realities.

And then there is a problem of who is to do the operations analysis: Canning (page 241) suggests that an O.R. study might begin by turning a Ph.D. in Mathematics loose in the company, or "a little better", hiring an engineer who has good training in mathematics. Or secondly, to build an O.R. team consisting of an engineer, a mathematician, a methods man, and someone who knows the company operations very intimately. Third, to hire a consulting firm. This advice, at least the last two-thirds of it, suggests the realization of the inter-disciplinary nature of the management sciences. However, it is not clear why an intelligent ecologist, physician or biologist, well grounded in quantitative methods might not do equally well.

Both works are recommended for those interested in electronic data handling applied to business operations: Levin for a relatively brief, bird's eye view; Canning for details and material suitable for use in training programs.

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BOOKS RECEIVED

(Inclusion of books in this list does not preclude their subsequent review.)

Communication, Organization and Science. JEROME ROTHSTEIN. Foreword by C. A. MUSES. Indian Hills, Colorado: Falcon's Wing Press, 1958. xevi + 110. \$3.50.

Motion and Time Study. BENJAMIN W. NEIBEL. Homewood, Ill.: Richard D. Irwin, Inc., 1958. Revised edition. xii + 494. College price \$7.25.

Proceedings of the First International Conference on Operational Research. Baltimore: Operations Research Society of America, 1957. Pp. 526. \$7.50.

Studies in the Mathematical Theory of Inventory and Production. KENNETH J. ARROW, SAMUEL KARLIN AND HERBERT SCARF. Standord: Stanford University Press, 1958. Pp. 340. \$8.75.

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