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Book Reviews

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BOOK REVIEWS

HALL, ARTHUR D. *A methodology for systems engineering*. Princeton, New Jersey: D. Van Nostrand and Company, January 1962, 478 pp., \$12.00.

The present book is a very welcome contribution not only to the field of systems engineering, which is a discipline in its own right, but also to teachers and workers in industrial engineering, management science, and operations research. This is the first treatment of systems engineering that has come to this reviewer's attention which gives a unified presentation of the subject as a whole and is not just an artificially pieced-together set of segments of a variety of other disciplines which necessarily contribute to the making of systems engineering. On the other hand, many writers on operations research and management science also seem to limit themselves to putting together a number of existing disciplines, with some applications to certain problems, and calling the result a treatise on operations research or management engineering or management science, *et al.* This is not to say that operations research and management science are equivalent to systems engineering, as has been proposed by some writers, nor that management science and operations research are interchangeable concepts or interchangeable names for a common discipline. In fact, the author carefully spells out this notion by consideration of the relations among and the differences between the three fields. The author very wisely recognizes that the field of systems engineering is substantiated and founded on fundamental methodology rather than on a specified and self-contained set of techniques. He also recognizes that systems engineering can be so broad as to include almost every field of activity and, therefore, to defy tight formulation and exposition within any reasonable limitation of space. He has, therefore, drawn his conceptualization, his methodological formulation, from his extensive experience in communications systems in his work with the Bell Telephone Laboratories. This organization, undoubtedly more than any other, has devoted itself to creative and applied work in systems engineering.

This book is the result of some eight years of steady and consistent work both in the preparation of the manuscript and in the teaching of an advanced course in systems engineering for personnel of the Bell Telephone Laboratories. Some parts of the book have been contributed to by persons other than the author and his grateful acknowledgements are made therefore. This is an especially valuable feature of the book since it has permitted extensive critical treatment of the material that was to be included, and provided contributions by specialists where their particular competence was most helpful. The work is also selective, as it has to be (and as the author has indicated), since to attempt any kind of all inclusive statement of systems engineering would be an endless, if not a confused task.

The author has fortunately unified the subject in terms of four phases, each of which allows for a somewhat self-contained and unified treatment but yet as an integral part of the single objective of evolving an approach to effective

development, design and implementation of a comprehensive engineering system. This task has been done so well that the merits of this fine book can be presented systematically by considering its four main divisions: (1) philosophical foundations, (2) problem definition, (3) decision making, and (4) systems synthesis and analysis. The breakdown, of course, is not unusual but it does lend itself to a unified and connected presentation of essential subject matter. It is good to find an engineer admitting to the importance of the philosophical foundations of his work and attempting to set them off explicitly, or at least with some degree of conscious recognition of the significance of the underlying attitudes of the engineer and the underlying requirements of the job that he has set for himself. The meaningfulness of the first part of the book is attested to directly by the principal topics which are: first, What is Systems Engineering? Here a genuine attempt to characterize systems and systems engineering in operational terms is undertaken. And a genuinely reasonable comparison with related fields such as operations research and management science is offered. The second topic, namely a case history, The TD-2 Radio Relay System, definitely sets the perspective of this work in terms of communications engineering and does offer, as background for those who have not had experience in systems engineering, some of the operational material essential to an understanding of the methodology, as well as some of the techniques that are subsequently offered. Furthermore, the presence of the material on an actual systems engineering activity provides a center of focus as well as the means for unifying the subsequent treatment and development which the author gives and which is needed for the future practitioner of systems engineering. With this background the reader is better able to appreciate the next chapter dealing with some fundamental concepts of systems engineering. Finally, this first section closes with a discussion on An Operations Analysis of the Systems Engineering Process, dealing with problem definitions, choosing objectives, systems synthesis and analysis, selection of the optimum systems, as well as some of the practical aspects of management planning and systems development which provide a practically sound theoretical basis for building up a unified methodology.

The second part is quite naturally devoted to problem definition which deals with two broad topics, namely, environmental research and needs research. Environmental research is quite logically divided into the physical and technical, the economic and business, and the social environments. It is refreshing to find a successful engineer treating his concept of a discipline and its problems in these terms. Then again, in part as background for subsequent consideration of procedure on decision making the author takes up aspects of economic theory of individual demand, static market demand functions and dynamic market demand functions. This research, fundamental to any effective systems engineering planning and design, is an aspect of the subject hardly found in attempted compendia or synthetic treatments of the subject of systems engineering.

The part on decision making is perhaps the most interesting part of the book. This part is rather insightfully devoted first to partitioning of the field of decision making, and then to questions of measurement, economic theory of value,

psychological theory of value, statistical decision making, theory of games, casuistic theory of value, and finally some remarks on setting of good objectives. This part, consisting of seven chapters, is closest to the interest of management scientists and operations researchers. It could very well be read and studied by anyone in this field. Interestingly enough, this is one of the few books that gives some significant consideration to economic theory and to concepts of value and utility in outspoken terms, and which is concerned with the very realistic and practical problem of the design of extensive communication engineering systems.

While it might be expected that it is unlikely that one author can give authoritative treatment to the variety of material covered in this part, so far as the reviewer is competent to judge the treatment of measurement and the various aspects of value as well as of decision making is handled with exceptional competence. To be sure the author availed himself of the good offices of a number of persons expert in certain of these branches, which is all to his credit and to the advantage of the reader. This reviewer will not pretend to be authoritative in each of the fields covered in this section, but he has availed himself of the opinions of others to supplement his own views as to the merit of this part. In any case, it certainly is of value to anyone concerned with systems, management science and operations research, who is not expert in—say—theory of measurement, or various theories of value, and in decision making and the theory of games to find the present treatment in connection with systems engineering and to have this treatment as a basis for further study which is advisedly suggested by a very extensive and substantial bibliography. The special merit of this part of the book is that it gives to the student of systems engineering, perhaps a mature person with considerable experience and advanced scientific training, a review of economic theory and decision making in the light of the subject of his personal interest and competence and not as a separate arbitrary and abstract discipline which may or may not be connected with his own field of application.

The concluding part of the book entitled System Synthesis and Analysis is best characterized (in the opinion of a reviewer who is not an expert in communications engineering) by an excerpt from the author's forward to this part which is worth quoting here:

"The material of the preceding chapters applies to any kind of system.

To achieve a useful depth in studying synthesis and analysis, it becomes necessary to trade general applicability for concreteness in a particular area of systems engineering.

"The trade that permits the smallest loss of generality is implied by Norbert Wiener's remarkable book, *Cybernetics*. He says that all systems are information systems and that they are also feedback systems. If this is true, the best techniques for studying systems are information theory (or communication theory) and feedback theory.

"In Sec. 4.4.4 all system inputs and outputs were classified according to whether they carried information, energy, or materials. The main consequence of Wiener's statement is that systems can best be understood, and hence designed, by focusing only upon the information inputs and outputs.

The system itself is thus conceived of as an information processor, with the energy and material conversions playing distinctly subsidiary roles.

"There is no proof for Wiener's proposition. One can only study large system examples of any kind: automatic control of a machine tool, factory organization, computers, etc., to be convinced of the essential soundness of the viewpoint. In a sense the material of the next three chapters is evidence to support the viewpoint."

The merit of this phase of the present treatment of systems engineering is obvious. The effectiveness of this treatment can be attested to by the achievements of the author of the text and his associate, Mr. W. G. Bender, who prepared chapter 14 on the Language of Systems Structure and Graphical Models, and also cooperated with the author in the teaching of some of the sections of systems engineering. This chapter and the next one on Input-Output Functional Design contain the most specifically technical material related to systems engineering and, in particular, concerned with information-handling systems. As indicated in the author's forward to this part, eminent justice is done to substantiating the thesis that systems can best be understood and designed by focusing on the information processing aspect and relegating the transformation of energy and materials to a subsidiary, although necessarily supporting role.

The closing chapter on psychological aspects of synthesis is highly interesting and yet, however, one's individual biases may produce reactions not fully in agreement with the views of the author. These views are certainly stimulating and of considerable value to anyone who essays such a comprehensive task as the design of a large industrial or other system. Closing the book with some consideration of psychological aspects of synthesis (and a great part of systems engineering entails the act of synthesis) is indeed evidence of the author's wisdom. For the broad subject of systems engineering is only in part technical, in considerable part economic, and perhaps in greater part a matter of problem recognition, conceptualization, and formulation. These three aspects of the problem have been treated in separate sections of the book, although interdependently and finally drawn together with some speculations about the psychological aspects of creative activity in such an extensive and comprehensive enterprise.

The book has two other features which commend it very highly to those who wish a comprehensive and enlightening text for teaching. Each chapter closes with a summary which is very helpful in bringing together any loose ends that may have developed in the reader's mind, and a section of problems which are quite interesting and stimulating. In fact, one of the concerns of this reviewer about how one could devise problems in such a field has been handled by the author in a manner which will relieve the teacher of many burdens. There is also, following each chapter, a very comprehensive set of references to both research and expository papers as well as to treatises.

The author is to be highly commended for his efforts and for bringing to his colleagues a work which will make the teaching of systems engineering a possible task, a unified and well formulated task which previously consisted largely in

groping for sporadically related topics. This reviewer plans to devote a good part of his seminar on operations research to the study of systems engineering based on this treatise. This book belongs in the library of every reader of this journal.

S. B. LITTAUER
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OWEN, DONALD B. *Handbook of statistical tables*. Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1962, 580 pp., \$12.50.

This book is a welcome addition to the literature on statistical tables. It contains a number of the classical tables, such as the normal distribution, Student's *t*, Chi square, the *F* distribution, etc. It also brings together in a convenient form a number of tables dealing with nonparametric and distribution free statistics, some of them being of the more familiar variety such as Wilcoxon's test and tests of signs, runs, and quadrants, and rank correlation coefficients. The book also brings together in a convenient collection several multivariate tables, including multi-normal and bivariate *t*-distribution tests, and it also includes several tables dealing with Kolmogorov-Smirnov statistics that are not available in other books of statistical tables. The book also identifies original sources for many of the tables and indicates where the author has had special calculations made to extend the tables or give finer detail. Thus, the book does add significantly to the collections of statistical tables that have been published in the past.

At some point it may prove useful to publish a book of tables more directly developed for applications in management science. Such a book would include several of the tables contained in Owen's book, such as the Poisson and binomial distributions, but it would also include queuing tables and statistical distributions that are finding greater usefulness in management science applications, such as the negative binomial distribution, the gamma distribution, the log normal distribution, and the Weibull distribution. Tables could also be given for statistical tests based on auto-correlated data. Also tables containing experimental designs, particularly those involving incomplete factorials, such as the Greco-Latin designs, would be useful to management scientists. Also, since most management scientists work for organizations which have computing facilities, it would be good if this would give computing methods or references for available computer programs so that the analyst could have tables made for his special needs.

To conclude, this book by Owen is highly recommended, and it does represent a forward step in providing tables which have special applicability to management science, but we are already developing needs for collections of tables which are even more particularly oriented toward the kinds of problems that characterize applications in management science.

MURRAY A. GEISLER
The Rand Corporation

BOOKS RECEIVED

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

- APOSTOL, TOM M. *Calculus, Vol. II*. New York: Blaisdell Publishing Company, 1962. 525 pp.
- CYERT, RICHARD M. AND DAVIDSON, H. JUSTIN. *Statistical sampling for accounting information*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962, 224 pp., \$7.95.
- INTERNATIONAL UNIVERSITY CONTACT FOR MANAGEMENT EDUCATION. *A critical review of the university approach to management education held in Melbourne, March 4, 1960*. Secretariat: Rietveldse Toorn, Oosterstraat 94, Delft, The Netherlands, 22 pp.
- INTERNATIONAL UNIVERSITY CONTACT FOR MANAGEMENT EDUCATION. *New programs in management education in Sweden held in Stockholm May 4-9, 1959*. Secretariat: Rietveldse Toorn, Oosterstraat 94, Delft, The Netherlands, 47 pp.
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- JONES, MANLEY HOWE. *Executive decision making*. Homewood, Illinois: Richard D. Irwin, Inc., 1962, 560 pp., \$10.00.
- KEMENY, J. G., SCHLEIFER, A., JR., SNELL, J. LAURIE AND THOMPSON, G. L. *Finite mathematics with business applications*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962, 482 pp., \$10.60.
- KUHN, TILLO E. *Public enterprise economics & transport problems*. Berkeley: University of California Press, August 13, 1962, 243 pp., \$5.00.
- MARGULIES, STUART AND EIGEN, LEWIS D. *Applied programmed instruction*. New York: John Wiley & Sons, Inc., 1962, 387 pp., \$6.95.
- PARZEN, EMANUEL. *Stochastic Processes*. San Francisco: Holden-Day, Inc., 1962, 324 pp., \$10.50.
- Programmed instruction in PERT/CPM*. Newburyport, Massachusetts: Entelek, Inc., 1962, 202 pp., \$27.50.
- REICHARD, SUZANNE, LIVSON, FLORINE AND PETERSEN, PAUL G. *Aging and personality*. New York: John Wiley & Sons, Inc., 1962, 237 pp., \$7.95.
- ROBERTS, ARTHUR L. *Production management workbook*. New York: John Wiley & Sons, Inc., 1962, 126 pp., \$2.95.
- ROY, BERNARD. *Cheminement et connexité dans les graphes application aux problèmes d'ordonnancement, Metra. Série Spéciale, No. 1*, 1962, 15 N.F.
- STARR, MARTIN K. AND MILLER, DAVID W. *Inventory control: theory and practice*. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962, 354 pp., \$10.00.
- UNITED NATIONS. *The United Nations development decade*. New York: United Nations, 1962, 125 pp., \$1.25.
- UNITED NATIONS. *Yearbook of national accounts statistics, 1961*. New York: Statistical Office of the United Nations, 1962, 305 pp.