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Reviews

ARTHUR I. SIEGEL and J. JAY WOLF, *Man-Machine Simulation Models—Psychosocial and Performance Interaction*, John Wiley & Sons, New York, N.Y., 1969, 175 pages, $9.95

THIS RATHER interesting monograph is challenging to a reviewer since few persons are simultaneously competent in the psychology of individual behavior, the psychosocial theories of group interaction and the techniques of digital computer simulation. This reviewer readily admits to claim competence only in the last area. Unfortunately, the last area proves to offer the least concern to the authors and that may be a proper decision on their part.

The organization of the text begins with a brief discussion of modeling and simulation techniques. This introduction seems extremely brief (eight pages), but does include consideration of when simulation is an appropriate research or problem-solving technique. In the second chapter the authors present a general model of single operator or dual operator and machine interaction. The parameters used as input to the model and the means by which their values are estimated are discussed. Variables calculated to indicate the state of the system are explained (stress, cohesiveness, task success or failure, and individual operator descriptors). Description of initial conditions includes a sketchy and confusing description of the process of pseudorandom number generation and consequent transformation of the uniform values.

The third chapter presents several different applications of the general model. The authors use these studies (carrier landing of fighter aircraft, missile launching, inflight refueling, and air to air intercept) to validate the usefulness of the general model. Statistical validation criteria are not well specified, and the test procedure is not clear. For example, no indication is given that the data used to estimate parameter values for the simulation model were separate from those used to compare the model results with the actual values.

Three chapters deal with the group simulation model. Chapter IV is devoted to the conceptual consideration—the variables of interest (system efficiency, crew morale, task completion time, individual proficiency, and manpower requirements). The authors develop their assumptions with careful references to the theories of group interaction and organizational behavior. Qualitative factors such as cohesiveness, morale, group pressure, group communication, and environmental stress are supported by numerous references.

Quantitative considerations are discussed in Chapter V. Data and assumptions on group duties, equipment, and personnel are presented. Equations for determining qualitative measures (cohesiveness, morale, and communications efficiency) are developed. Measures for psychological efficiency (performance in terms of the psychological factors) and environmental efficiency are offered together with a total

efficiency formula and individual proficiency values. Testing of the group simulation in Chapter VI involves the hypothetical operation of a submarine (or submerged craft). While the form of the generated output can be demonstrated, the hypothetical application enables no real validation of the simulation model.

In summary, the book should be more appealing to those in psychology and sociology interested in judging the usefulness of digital computer simulation as an empirical technique. Although the general models have been around for quite some time (the first was originally programmed for an IBM 650), they still present an interesting approach to solving difficult problems. The book falls short of specifying *how* to do simulation studies on man-machine studies, but certainly provides insights into *what* can be done.

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LEON COOPER and DAVID STEINBERG, *Introduction to Methods of Optimization*, W. B. Saunder Co., Philadelphia, Pa., 1970, 381 pages, $12.50

THIS IS AN excellent and fairly comprehensive book dealing with the basic methods available for solving optimization problems. The only prerequisite assumed is a first year college course in calculus. Even topics like matrices, vectors, and determinants are developed fully in this book. Hence this text can be easily used by practicing engineers, undergraduate students, economists, and social scientists.

In the introductory chapter, the authors introduce the linear and nonlinear optimization problems. No discussion on formulation of practical problems is given. It is assumed that the reader has the problem and is interested in techniques of solving it.

In the next two chapters, the authors develop the necessary and sufficient mathematical background. They provide an excellent review of topics like matrices, determinants, vector spaces, hyperplanes, convex sets, and convex polyhedra. Another nice feature in their treatment is that they do not dwell unnecessarily on complicated theorems and proofs. Instead the authors very freely use pictorial illustrations and intuition to prove important theorems.

Chapter 4 introduces the classical optimization techniques through the use of differential calculus. Necessary and sufficient conditions for the existence of optimum, global optimum of convex and concave functions, constrained optimization and use of Lagrange multiplier are discussed very nicely.

In the next chapter the authors discuss the modern search techniques for unconstrained optimization problems. One finds good discussions on Fibonacci search, method of steepest descent, Fletcher-Powell method, and pattern search. For each search technique, the authors give a step-by-step flow chart that would be very useful for anyone interested in programming it for solving some problem. The authors also give the number of functional evaluations necessary for each search method. This gives an idea about the relative efficiencies of various methods.

Chapter 6 introduces the most important topic—linear programming and simplex method. In my opinion, the authors could have simplified the discussion on simplex method by using the tableau approach rather than the abstract vector space approach. This would have also been consistent with the level of mathematical rigor used in the previous chapters. There is a seemingly facetious section entitled "How not to solve a linear programming problem"! Here the authors exhibit the inefficiency of the Lagrange multiplier approach to solve linear programs!

In the next chapter the authors discuss some advanced topics in linear programming. They include such important topics as duality theory, sensitivity analysis, transportation problems, and maximal flow in networks. But I fail to see the reason behind their inclusion of such topics as dual simplex method, primal-dual algorithm, revised simplex method, and decomposition principle. The discussion on these topics is very brief, without any illustrative examples. I doubt very much whether anyone will follow them during the first reading.

Chapter 8 introduces nonlinear programming. After developing the Kuhn-Tucker conditions, the authors discuss quadratic and separable programming. The basic principle behind the modern gradient projection methods are given without explicitly presenting any algorithm. No discussion of such penalty function techniques as SUMT is given. The method of GRIFFITH AND STEWART is fully illustrated for solving nonlinear programming problems.

The last chapter discusses integer programming. GOMORY's algorithm is discussed nicely. The illustration of branch-and-bound technique through an assignment problem is very well done. Dynamic programming is discussed briefly in the end.

On the whole the book is very well written and fairly comprehensive. This will be an ideal text for a two-semester course in optimization theory for undergraduates or first-year graduate students. Almost anybody who solves optimization problems can read this book comfortably without encountering any difficulty.

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A. O. CONVERSE, *Optimization*, Holt, Rinehart, and Winston, New York, N.Y., 1970, 295 pages, $13.25

THIS TEXT addresses the undergraduate engineering student. It is intended to provide a simple but effective introduction to applied optimization. The only mathematical prerequisite is calculus, though vector and matrix notation is used. If continuous time problems are taught (Chapter 6), then familiarization with elementary differential equations is assumed.

The book contains nine chapters with suitable exercises and some computer programs. The first three chapters comprise Part I: Problem Formulation, and the last six chapters comprise Part II: Problem Solution.

Beginning with Lagrange multipliers, PROFESSOR CONVERSE sets the stage for

his central theme. In a zealous effort to achieve clarity, the author oversimplifies his introduction. The student may be misled, unless the instructor embellishes—and to some extent departs from—the material presented. The algorithm in section four is at best incomplete. It would have been an improvement to present a simple procedure to change the Lagrange multiplier for the case of one constraint.

Chapter 2 is entitled, "The Objective Function." It is a brief introduction to formulating a measure of value and brings cognizance to interest rates. Chapter 3 presents some simplified models in water resource management, data compression, electric power dispatching, and operation of a catalytic reformer.

Professor Converse next introduces some methods to solve unconstrained—or simply constrained (e.g., an interval)—problems. The case of the univariate problem is solved by Fibonacci search. It would seem more consistent with the stated goals of the text to present a more effective method such as quadratic approximation. He also mentions how a constrained problem may be reduced to solving a sequence of unconstrained problems. He avoids rigor even to the point of not stating that the penalty problem is also constrained. The student could be misled into some false impressions, and may, for example, think that the HOOKE-JEEVES method of pattern search can be applied to the penalty problem. This seems to be a consistent shortcoming of each chapter: the student receives little insight and may even be misled.

Next the author introduces discrete time, sequential problems. Again, the coverage is sparse, but the presentation is good. Chapter 6 then describes continuous sequential problems. The only criticism I have of the combined coverage of discrete and continuous time models is that no comparison is made between them. However, the instructor can expound their differences and similarities.

Chapter 7 presents the ABC's of linear programming. In keeping with the overall manner of presentation, very little is said about many things. His first section is a motivating blending problem followed by another example to illustrate problem formulation. The description of the simplex method (4 pages) leaves much to be desired, as well as the use of the term, 'basis vector.' The remainder of Chapter 7 provides some appreciation for—as distinct from a working knowledge of—sensitivity analysis and decomposition.

In Chapter 8 Professor Converse considers the quadratic program via Lagrange multipliers. In the final chapter entitled, "Geometric Programming," the elementary dual is presented with an example. It would seem more consistent to include a simplification of any of the real engineering problems that have been solved by geometric programming.

Overall, the text may serve as a guide for a course intended to survey elements of applied optimization in the spirit of appreciation rather than to impart a working knowledge of the subject. The instructor is obliged to supplement the material and correct any false inferences the student is likely to draw. The industrial engineering student should consider another text that includes production scheduling, inventory control, and combinatorial optimization. Other engineering students may find this book helpful, and it should not be difficult to read.

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JOHN G. RAU, *Optimization and Probability in Systems Engineering*, Van Nostrand Reinhold Company, New York, N.Y., 1970, 414 pages, $15.00

EVEN THOUGH operations research provides some of the most effective tools of system analysis, many such tools are yet to find acceptance in the day-to-day work of the practicing systems engineer. This book makes a laudable attempt in this direction and discusses some operations-research topics usable in the practice of systems engineering. These topics include optimization through calculus of variations and linear and dynamic programming techniques, Markov and renewal processes, recursion techniques, generating functions, reliability and queuing theory. The book aims to cover the mathematical aspects of these topics in a manner that can be understood by an engineer. Mathematical theorems are not proved all the time, but introduced through informal discussion and examples. Pedagogically these attempts are significant and welcome. (In the presentation of such results, it would have been helpful to the reader if the major results were to be separated from the discussion.)

The contents of the book are organized as follows: Systems engineering process (Chap. 1); optimization techniques and applications (Chaps. 2–4); stochastic models of reliability (Chaps. 5–8); Markov process (Chap. 9); and queuing systems (Chap. 10).

A major drawback of the book is its lack of a theme. In spite of the fact that the author develops the characteristics of the systems engineering process (*see below* for some specific comments), it is not fully developed in the rest of the book. One possible theme could have been the theory of reliability itself. Topics on reliability cover almost half the book, but as a book on reliability it does not contain discussion on the statistical aspects of reliability—such as estimation problems and characterization of failure rates. Markov models for queuing systems are discussed with no relation to the probabilistic models of reliability. Another possible theme could have been the use of optimization techniques in probabilistic models of systems engineering as suggested by the title of the book. The treatment is not complete even from this viewpoint. For instance, optimization techniques on queuing models have not been mentioned. There is a brief mention of dynamic programming, but not of dynamic programming and Markov processes. As a result, the book gives the impression of a collection of related and unrelated topics in optimization and probability models in systems engineering that are of interest to the author.

Another weakness in the book is its inadequate treatment of the foundations of probability theory as related to the probability models discussed in the book. For instance, in Chap. 5, sec. 2, the probability of an event is defined as the ratio of the number of favorable outcomes to the total number of outcomes—without mentioning the basic assumptions under which such a definition is valid. Even introductory textbooks of probability do not give such a conceptually deficient definition these days. Worse still is the derivation of an expression of the reliability function $R(t)$ based on the definition given above. A better approach would seem to be to derive $R(t)$ from the life distribution of the system and use the ratio of the number of working components to the total number of components as providing an estimate of such a reliability function.

A second example is the study of Markov models of reliability (Chaps. 5–8) without any mention of Markov processes, which is discussed later in a separate chapter (Chap. 9); at the conclusion of this chapter there is only a mention that the models studied earlier are in fact Markov processes. A discussion of Markov and renewal processes earlier as analysis techniques could have been used to unify the models used for the reliability studies as well as queuing analysis.

Finally a few comments about the definition of a systems engineering process. The author characterizes three phases of this process: definition, development, and evaluation. Looking at the detailed description of these phases (pages 3 and 4), a certain amount of confusion would seem to be inevitable regarding the distinction between development and evaluation. We feel that evaluation of the process is an integral part of development and the process is not complete without the inclusion of the phase signifying the operation of the system. Control problems can be grouped under the operation phase.

On the whole, in spite of the reservations expressed above, this reviewer feels that this book would be more appealing to the practicing engineer than many of the other books that cover theoretical aspects of the topics discussed here. In addition, it contains one of the most complete treatments of the stochastic models in reliability—and application of optimization techniques on them. Depending on the objectives of the course, it can be used as a text or a useful reference.

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