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Hugh J. Miser, Editor

BOOKS

Reviews

RONALD E. FRANK, ALFRED A. KUEHN, and WILLIAM F. MASSY, *Quantitative Techniques in Marketing Analysis: Text and Readings*, Richard D. Irwin, Inc., Homewood, Illinois, 1962, 556 pages, $10.60

OPERATIONS-research workers have maintained a steady interest in marketing problems, and so has this journal: There was a paper by JOHN MAGEE on the effect of promotional effort on sales in the second issue, and other papers have appeared from time to time since then; a number of them are to be found in *Mathematical Models and Methods in Marketing*, edited by FRANK M. BASS and others, and published also by Irwin [reviewed in this journal, **10**, 579–581 (1962)], a book which emphasizes mathematical models and contains relatively few instances of empirical work.

The present book is another collection, with the emphasis now on empirical studies and techniques of data analysis. About one third of the material is by the principal authors, either as reprints, review papers, or new articles, the other two thirds consisting of reprints by others. It is interesting to note that there are no papers from OPERATIONS RESEARCH, a fact that may be due in part to a culling by the Bass volume, but, more fundamentally, to there having been in this journal regrettably few marketing papers reporting empirical research and displaying data-analysis techniques. Other sources that were surprisingly unproductive for the authors were *Management Science*, with one reprint (and that not empirical), and the *Journal of Marketing*, with only two. Where, then, did the papers come from? The *Journal of Chronic Diseases*, *Public Opinion Quarterly*, *Journal of Applied Psychology*, and from less surprising sources, such as *Journal of Business*, *Journal of Advertising Research*, and *Applied Statistics*.

The truth is that good, published, empirical marketing studies are hard to find. Those in the best position to do decision-oriented research are inside companies, and for them the reasons for not publishing in a competitive area like marketing are fairly obvious. To put them somewhat facetiously: if a study does not come out well, it will not be published; if it does come out well, it certainly will not be published. Thus, we find that the best reported study of a promotional experiment is done by researchers at, of all places, the Department of Agriculture.

As a result of the lack of good papers from natural sources, the authors have

had to do some scrabbling around. The ideal paper might be one that (*a*) exhibited a technique of wide applicability in marketing, (*b*) made clear the fundamental model on which the analysis was based, and (*c*) used the technique to contribute directly to important marketing decisions. Such an ideal is only occasionally attained by these papers: Most of them do fairly well by (*a*), worse by (*b*), and still worse by (*c*). Yet this is a criticism more of the state of the field than of the book. The authors seem to have done a good job within the confines of existing material. In any case it is certainly a good service to collect together for marketing workers examples of relevant analytic techniques and discussions of their use.

A brief outline of the book's contents and a few remarks thereon may be helpful. The book is divided into five parts:

Part I is a paper by HARRY ROBERTS on the role of research in marketing management.

Part II consists of didactic papers by the three principals: one on research design (FRANK), one on statistical analysis (MASSY), and one on complex interactive models (KUEHN). Of these, Massy's gets into the most useful practical detail.

Part III contains readings on experimentation. The section on laboratory experimentation includes a shopping-game study done by the firm of ALDERSON AND SESSIONS, a jam-tasting study by GRIDGEMAN, PESSEMEIER'S technique for estimating demand, and SCHWERIN'S method for testing TV commercials. 'Laboratory' experiments like these are useful, but the discrepancies between laboratory and real world with respect to environment and measures of effectiveness loom large. As a result, the user of such research must supply considerable amounts of interpretation. The section on field experimentation contains the excellent paper of HENDERSON, HIND, AND BROWN (the Department of Agriculture group) on the sales effect of two campaign themes. BANKS reports a combined sales experiment and preference test in which the sales experiment is not sensitive enough to detect an effect. JESSEN has a methodological paper without data, and BELSON presents a rather careful before-and-after analysis of learning from a TV broadcast, but, strictly speaking, this study is not an experiment.

Part IV consists of readings on statistical analysis. A bright spot here is a paper by COLEMAN, MENZEL, AND KATZ on social processes in doctors' adoption of a new drug; it traces the effect of various communication networks among doctors on the time pattern of the drug's adoption. The work is not statistically sophisticated, at least in the sense of complicated technique, but is unquestionably interesting for the insight it offers into the seldom measured effects of word-of-mouth communication. Part IV continues with several papers that display the advantages of multiple regression and discriminant analyses and do it with varying degrees of convincingness. (One paper contains a regression with 6 variables, 9 data points, and an R^2 of 0.9997, a result that, in context, is not at all convincing.) Several papers take up the analysis of consumer brand loyalty. Here authors Frank and Kuehn get into a moderate hassle over learning models versus spurious contagion as possible explanations of certain consumer panel data. One is left with the impression that, although brand loyalty studies have developed rapidly, they still have a long way to go. Finally, there are three papers employing factor analysis.

The most interesting is TWEDT's study of advertising readership; he uses factor analysis to winnow down a long list of variables to a promising few, which are then put into a multiple regression.

Part V is on simulation, and so departs somewhat from data analysis into model synthesis, but this is completely desirable. Two of the papers are first class: The first is POOL AND ABELSON's report on the Simulmatics Project for the Democratic National Committee in 1960; it makes absorbing reading in this election year. The narrow overlap between the potential of the new tool as conceived by the scientists and the capacity of a fast-moving political operation to grasp and use some of this potential is painfully evident and painfully familiar to on-line operations researchers. The second paper is CYERT, MARCH, AND MOORE's model of retail ordering and pricing in a department store. It completely dispels the quaint notion, still occasionally found, that businessmen set prices by taking a derivative and putting it equal to zero. The model is descriptive, not normative, but it reveals the system an operations researcher would have to cope with should he start normative work in this area. The final paper of this part is also a good one, although it is not what is usually called simulation; in it KUEHN AND HAMBURGER apply heuristic programming to the problem of locating warehouses.

To summarize, the volume contains a variety of interesting and valuable papers gleaned from diverse sources. The reader cannot accept uncritically all the work here, for there are some poor examples as well as good ones. One can take the authors to task for this, but, at least in part, the fault lies with the whole field. Perhaps there is a wry virtue in the poor examples: They reveal the opportunities that exist for good quantitative work in marketing. I am sure that the authors aspire to do some of that work, and I hope a few of their readers will too

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RONALD E. MILLER, *Domestic Airline Efficiency, An Application of Linear Programming*, The M.I.T. Press, Cambridge, Massachusetts, 1963, 190 pages, $6.00

IT HAS become fashionable to deplore the activities of the Civil Aeronautics Board: some people claim that it is unnecessary, while others believe it incompetent. DR. MILLER's book describes an attempt to assess the respective merits of these positions.

His method is to examine a small sample of US city pairs, which he supposes to be reasonably representative, to determine whether the passenger traffic between them during 1957 could have been carried more cheaply if air service had been more rationally allocated than in fact it was under the conditions of CAB regulation. He also makes projections into the (then) future of 1963. The technique he uses is linear programming. He sets up a model to assign aircraft of different types (with different ranges, capacities, and operating costs) to the routes in such a way that all passenger demand is satisfied at least cost, and at a certain prespecified load factor.

If an econometric, or operations-research, study uses a model that is not realistic enough to satisfy the 'practical' man, he will ignore the results; if it is sufficiently

realistic to satisfy him, it will most likely be unusable. This dilemma is an occupational hazard that Dr. Miller views with equanimity. In order to formulate the problem of scheduling aircraft capacity in linear programming terms, Dr. Miller has to make many simplifications. For example, he treats the demand for travel between two points as occurring at one specific point in time per week. It is not true, as he goes on to suggest, that it is unimportant to consider passenger demand as a variable throughout the day, and throughout the week.

Again, Dr. Miller tends to think of passengers not as persons (with infuriating whims and fancies) but as load units. His model allocates aircraft to routes quite well according to operational and cost criteria, but it fails to allow for variable passenger preferences. These genuine preferences for certain departure times and certain types of equipment cannot be ignored by individual airlines when engaged in competitive scheduling, and the CAB with all its faults is not simple enough to think that they can. (The CAB document, *Analysis of Passenger Traffic Carried by Local Service Carriers in Competition with Trunk Carriers*, although full of inaccurate statistical analyses and computational errors, illustrates the CAB's realistic attitude.)

Dr. Miller's model also ignores the interests of the individual airlines providing services. While it is true that the transportation needs of the cities he considers might be provided efficiently by a pooling of individual carriers' flights at less cost than by the airlines acting without collusion, this would raise serious problems concerning the allocation of revenues. For example, how would one convince an airline that had been allocated unfavorable departure times and instructed to utilize unpopular equipment, that it should lose money for the common good? The individual carriers will tend to operate similar equipment on any given route at the same fare levels in order to ensure that their competitors do not take the whole market.

Too, Dr. Miller minimizes the importance of price structure. He quotes numerous authorities to support his view that fare differentials have little effect on traffic generation and traffic diversion. These are questionable in view of the recent experiences with fare differentials in the United States (e.g., Continential Airlines) and in Europe; and the responses of passengers to the fare reductions on the North Atlantic certainly indicate considerable elasticity.

It is not surprising to learn that the discrepancies between the results of Dr. Miller's researches and those of real life were substantial. In comparison with the results of the linear programming model there is considerable over-scheduling in real life. Now Dr. Miller's simplifications about demand and passenger preferences go a long way to ensure a result of this nature, and it is supported by his simple attitude towards average system load factors. Furthermore, overscheduling is a well-known consequence of oligopolistic airline competition under conditions of governmental regulation of the CAB type [*see*, for example, A. A. SPROUL AND H. B. HUBBARD, "What is an Airline?" *Proc. Second AGIFORS Symposium* (1962), New York]. The linear programming model, alas, does not bring us a new vision of Truth. But Dr. Miller is no self-deceiver, and toward the end of his book he admits that his model may be over-simplified; he agrees that least cost may not be the aim of the airlines (a reasonable rate of return on investment is, odd as it may seem, a more likely aim), that the CAB's aim may be balanced competition and

not least-cost service (almost certainly true, as the failure of the Eastern-American merger showed), and so on. This honesty is commendable.

Dr. Miller has shown courage in tackling a big subject, competence in manipulating a technique, imagination in his interpretations, and honesty in admitting his work's failings. His book is fascinating; it is also unusually well written. For these reasons it ought to be read. The reader may be convinced by it that a regulatory agency for US civil aviation is necessary, but that the question of the CAB's competence is still unresolved. He may ask himself whether in such a complicated area *any* regulatory agency could be perfect.

The lesson of this book is that linear programming is not enough to save a transportation system.

ALEC M. LEE
Air Canada

EDWARD A. FEIGENBAUM and JULIAN FELDMAN (editors), *Computers and Thought*, McGraw-Hill Book Co. New York, N. Y., 1963, 549 pages, $7.95

THE subject of intelligence in machines has a history that traces back well before the realization of the first digital computer—chess-playing machines, for instance, date to at least the eighteenth century (albeit in fraudulent form). But the attention attracted by intelligent machines never before has been so sustained and widespread as it is in this age of automatic control, information processors, cybernetics, automation, cybernation, and cyberculture (or tomorrow's new permutation).

One way to assess the significance of this reawakened interest in an old subject is to consider the work of the recent breed of scientists most closely identified with it. First was ALAN TURING, a distinguished English mathematician and logician. His theoretical preoccupation with computing machines, before there really were computing machines, led him to consider analytically the question that many others before and since have considered only emotionally: Can a machine think? His answer, or more precisely, the experiment that he proposed as a way of permitting an answer, appeared in an article in *Mind* in October of 1950.

Turing's article, plus nineteen more recent papers by researchers who have programmed computers to behave in reasonably intelligent ways, are contained in this collection edited by two active investigators in the field.

What field? This is another tricky question worthy of a Turing to resolve. Several labels have been applied, including *artificial intelligence*, *heuristic programming*, and *simulation of cognitive processes*. The editors have adroitly sidestepped the problem by naming their book *Computers and Thought*—a general, noncommittal title.

The field is more than its name, however, and it is instructive to prod a little deeper. We may inquire, for example, about *how* intelligent machines are produced, and *why*.

One answer to the *how* is the self-organizing system: a large number of very simple (even crude) information processing elements that adapt continually to the environment. In the aggregate, such a system organizes itself and can exhibit a learning of sorts.

However, research in self-organizing systems is not represented in *Computers and Thought* because of its allegedly meager success and dismal prospects. The research that *is* represented constitutes an important alternate approach: cognitive models incorporating complex information processes, frequently referred to as heuristics. Simply stated, an heuristic is a time-saving rule that guides behavior: examples are limiting alternatives in chess or in making investments, and means-ends analysis in a general problem-solving context. The design of good heuristics is a primary goal of this second approach.

Why develop good heuristics? Why build intelligent machines? These questions bring different answers even from contributors to *Computers and Thought*. There are at least two schools. The first attempts to find mechanical ways of solving problems, making decisions, doing mathematics, or playing games, whether or not these ways resemble their human counterparts. A major success of this school is ARTHUR SAMUEL's checker-playing program which already beats checker experts and continues to improve its game.

The second school sees in the computer a powerful new tool for modeling psychological processes, and thereby better comprehending man and his actions. It shares the interest of the first school in heuristics, but for the purpose of understanding behavior, not improving upon it. Experimentation with human subjects and the analysis of protocols supplement theory and computer work.

The second school constitutes a new branch or development of psychology, and this fact is beginning to be generally recognized by psychologists—for example, HERBERT A. SIMON, a leader of the second school, gave the WILLIAM JAMES guest lectures in psychology at Harvard last year.

While reading through this volume, it becomes clear that no sharp line divides the two schools. Heuristics developed for one purpose often serve the other, and investigators starting out with one set of objectives sometimes contribute significantly to the other set as well.

Evaluating the practical significance of the work on intelligent machines is an exercise that must be left to each individual reader, but one thing is clear: The ramifications for operations research are potentially great. For instance, the papers by FRED TONGE on line balancing and GEOFFREY CLARKSON on the trust investment process suggest the possibility of direct input, one day, to the study and practice of management.

Computers and Thought is the best presentation to date of the work in an important new field of research; it includes contributions by PAUL ARMER, CAROL CHOMSKY, GEOFFREY P. E. CLARKSON, H. GELERNTER, BERT F. GREEN, JOHN T. GULLAHORN, JEANNE E. GULLAHORN, J. R. HANSEN, CARL I. HOVLAND, EARL B. HUNT, KENNETH LAUGHERY, ROBERT K. LINDSAY, D. W. LOVELAND, MARVIN MINSKY, ULRIC NEISSER, ALLEN NEWELL, A. L. SAMUEL, OLIVER G. SELFRIDGE, J. C. SHAW, HERBERT A. SIMON, JAMES R. SLAGLE, FRED M. TONGE, A. M. TURING, LEONARD UHR, CHARLES VOSSLER, ALICE K. WOLF, and the editors. The editing is carefully done and very helpful. The volume concludes with a thorough survey and bibliography on artificial intelligence by MARVIN MINSKY.

MARTIN GREENBERGER
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SEYMOUR J. DEITCHMAN, *Limited War and American Defense Policy*, The M.I.T. Press, Cambridge, Massachusetts, 1964, 288 pages, $10.00

THIS IS a much-needed book on a topic important to all Americans written by a top-level Department of Defense scientist. Since it defines limited war as any military effort short of a total, or maximum one, the contents of the book are not as limited in scope as the title may suggest. Thus, it discusses a wide range of military policy and development matters short of those of all-out war, involving, for example, an exchange of ICBMs or hydrogen bombs.

Since the descriptions of the details of our military establishments and the workings of the Department of Defense in war and peace are lucid and accurate, the book is a valuable reference for any person wishing to understand our current national policy as implemented by the Department of Defense.

The importance of limited wars in the last twenty years is very well presented in the first chapter. Extensive tables are presented of the scopes, issues, resolutions, and third-party involvements of over thirty limited wars that have occurred since 1945, and classifications into conventional, unconventional, and deterred wars are given. This discussion of history and the introduction that precedes it provide a valuable perspective to an examination of current military activities.

The second chapter, "Something New: Unconventional Warfare as a Strategic Weapon," suffers because more space is not devoted to it. This reviewer would have liked to have seen a discussion of older types of unconventional warfare contrasted with new types; for instance, the historical use of US Marines as special forces and the partial support of Spanish Guerrilleros by the British in the war against Napoleon fit the usual definition of unconventional warfare. He believes, however, that the author is correct in pointing out that something new has happened in the field: Currently, rebels and guerrillas do not have to take advantage of just local politics and injustices to produce a conflict—in fact, a determined enemy can exploit the potential for a conflict by strategic agitation from within the enemy territory by unconventional warfare techniques. On the whole, this chapter is excellent. In it the author displays a clear appreciation of the dynamic interactions of the military, political economic, sociological, and ideological factors in unconventional warfare—he even presents a formula for a successful counterattack on unconventional warfare.

Chapters 3 and 4, "Nuclear Weapons, Limited War and Europe" and "The Future: What Kinds of Limited War?" are very good. One may note that the author's view of a European war is very modern and the place he gives to nuclear weapons in such a war is not the policy publicized a year or so ago— but this position, understandably, must be flexible enough to meet the changing world of today. Here a purist may quarrel with the author's choice of words: In discussing the dangers of unstable warfare situations and escalation to higher levels of force the author says that "escalation to higher levels of force within a nonnuclear conflict is inherently limited by the ultimate level, however high, of resources that can be applied. Such limits clearly were reached by both sides in World War II"; it is hard to see how this concept is compatible with the nonuse of poison gas in World War II. Too, the author says that we developed a nuclear capability in order to defend against the superior quantities of manpower and equipment in the Soviet and

Chinese Communist Forces, but he seems to agree with one of the references quoted to the effect that "... NATO powers can, without undue strain on their resources, build their ground forces to the point where the Soviets would not be able to accomplish aggressive designs against them." Finally, one can note that any discussion of a limited war using nuclear weapons must, of necessity, be pure conjecture. All in all, however, Chapter 3 presents a good discussion of possible conflict in Europe with or without nuclear weapons.

The chapters just described comprise Part I of the book; Parts II and III, "The Military Background" and "The Problems of Planning," describe the workings of the Department of Defense. These Parts include chapters devoted to "The Forces Available," "Where They Fight: The Environment," "How They Fight: The Battlefield," "The Logic of Multifarious Requirements," "The Planning Process," "Resource Allocation: Levels of Decision and Constraint," and "The Impact of Technology." The author shows his operations-research background in these chapters by presenting a matrix of the kinds of limited wars and an attempt to categorize the types of geographical regions in which such conflicts may occur. Here again the book becomes most interesting when it discusses guerrilla warfare. In the past the weapons used by guerrillas have been always relatively simple; but what will this type of warfare be like when weapons such as the man-launched antiaircraft guided missile Redeye and the jeep-carried nuclear-rocket Davy Crockett can be 'purchased at the corner drugstore?'

Although the research and development planning process is accurately described, the readers of this journal will object to the single reference to operations research. Also, it would have been interesting to have had more discussion of the controversial B-70, Skybolt, and TFX decisions.

It is interesting to note that the current budget breakdown among major phases of military activity now shows over 40 per cent devoted to limited war forces. This reviewer recalls a similar breakdown during the era of the popularity of the 'massive strategic deterrent' only a few years ago that showed less than 5 per cent for limited war forces. One wonders whether the administration has truly accomplished a major reemphasis, or if accounting miracles have been produced: undoubtedly the allocation of the Navy carrier fleet and the Tactical Air Command has been involved in a juggling act.

Modern military operations research (although the author seems to go out of his way to not call it by that name) is discussed in Part IV, "The Structure of the Regular Forces," with chapters entitled "Battlefield Ballistic Missiles," "Battlefield Mobility: By Land or by Air?" "Tactical Air Warfare: Some Critical Problems," "Communications, Command and Control," and "Getting There: Strategic Response." Topics covered here such as the delivery capability of aircraft vs aircraft fleet cost, and tons per day of close-support ammunition delivered vs aircraft fleet size are normally discussed in detail in Navy-OEG or USAF-OA reports, and such topics as the mobility of a modern army, resupply by air, and the cost of air mobility would naturally be developed fully in Army-sponsored RAC studies. This part gives, however, an interesting overview of these operations-research activities.

The remainder of the book is devoted to Part V, "Unconventional Warfare:

Some Special Problems," which contains chapters on "Working With Allies," "Force Ratios and Organization," "Military Assistance and Specialization," "The Human Problems of Unconventional War," "Who's in Charge?" "What About a Turnabout?" "Legality and Morality," and "Conclusion: Where do We Stand?" Here the author discusses the possibility of positive action in the world and brings up some of our difficulties in carrying it out. Unfortunately, entire volumes should be devoted to the topics of this Part; but they are highly relevant to our daily international problems, and one therefore hopes that the leaders of our government will take time out to read the summary of them in this part of the book. If they had done so earlier, perhaps we would not have heard such optimistic statements as this one of eighteen months ago: "If you give us the time and money the war in South Viet Nam will be over in two years." Did this spokesman mean that we would give up in two years, or that we would be driven out before a two-year period expired? A colleague (MR. H. A. WHEELER) has made a more realistic statement about the general cold war: "We are in a war and we are not winning." We can take some comfort from the fact that apparently the administration is beginning to realize the depths of the problems in this area. The creation of the new post of Special Assistant for Counter Insurgency in the Office of the Director of Defense Research and Engineering, and the appointment of the author of this book to it, is certainly a good start in this direction.

T. E. CAYWOOD
Peat, Marwick, Caywood, Schiller & Co.

K. D. TOCHER, *The Art of Simulation*, D. Van Nostrand Co., Princeton, N. J., 1963, 194 pages, $5.95

THIS moderate-sized volume deals with many interesting and important techniques and methods used in simulation studies and Monte Carlo computations. It covers a lot of ground within its covers, but there is, in the reviewer's opinion, a disappointing balance from the point of view of the most interested American readers. Approximately 45 per cent of the text is taken up with methods of producing some of the basic inputs to simulation studies and Monte Carlo computations, e.g., methods of sampling from a specified probability distribution, methods of producing random and pseudo-random numbers, etc.; there is a broad survey of these matters, and in some cases an historical review. Approximately another 30 per cent of the volume is taken up with a description of computer programs for simulating queuing problems and various industrial processes, the emphasis here being on how to model these processes and produce simulations, things to watch for in programming the simulation, and how to save computer time here and there. Thus approximately 75 per cent of the volume is taken up with material that most people interested or engaged in simulation studies are relatively familiar with, or for which there exists an extensive literature. TOCHER's review of this material, however, is often very well done, and therefore persons new to the field may find this part of the book quite useful.

The remainder of the book deals with the sort of problems that the reviewer would regard as the most important, and neglected, part of the art of simulation: the systematic use of methods of improving the accuracy of estimates derived from

simulations, for fixed sample size, and the general problem of the design of simulation experiments broadly conceived. It is one of the major values of this book that it discusses these problems at all, since the easily available public literature on these matters is very thin, but the treatment is by no means extensive, even though the author covers a lot of ground in the relatively few pages he devotes to this subject. Happily, he clearly is aware of the need for what might be broadly called a design-of-experiments approach.

One defect of his discussion of the various variance-reducing techniques is that he seldom indicates which methods are likely to work best in specific cases—for example, it would have been worthwhile to mention that the antithetic variate and related devices are especially useful in the case of queuing problems where other methods do not work well at all. Also, Tocher discusses the problem of choosing appropriate initial starting conditions and suggests the technique of allowing the simulation to run until abnormal transient behavior can be ignored one way or another. He fails, however, to mention that experience has shown that very high serial correlation often exists in the processes simulated, a phenomenon especially prevalent in systems that involve queuing processes (which occur in many of the systems for which simulations have actually been undertaken). What to do about this high-serial-correlation situation is one of today's outstanding design problems.

A reviewer is always in a delicate position in indicating that he wishes the author had written a somewhat different book than he has; however, that is the case here. The reasons are that a book on the major problems of designing simulations and Monte Carlo calculations is needed badly, and Tocher has shown in part of his current book that he has a lot of useful things to say about this most important part of the art of simulation.

ANDREW W. MARSHALL
The Rand Corporation

ROBERT E. MACHOL and PAUL GRAY (editors), *Recent Developments in Information and Decision Processes*, The Macmillan Co., New York, N. Y., 1962, 197 pages, $8.00

THIS collection of papers is the proceedings of a symposium held at Purdue University in April, 1961. Like almost all reports on meetings on such general subjects, this volume varies considerably in the topics it covers and in the depth to which it covers them. However, the eminence of the authors of the papers is such that we would be interested in their presentations in any form.

The book begins with a paper by NORBERT WIENER on "The Mathematics of Self-Organizing Systems." Professor Wiener discusses the two problems of self-reproducing and learning machines and indicates that they have much in common. His method is to consider any nonlinear transducer as a linear combination of orthogonal nonlinear operators. The coefficients in the linear combination are found by applying the same random input to the original system and to its model, multiplying their outputs, and averaging in time. The degree of approximation of the two systems depends on the time allowed for the averaging process. Professor Wiener points out that genetic machines and translating machines should be considered as learning machines. He suggests that the self-organization of electrical

power systems by frequency locking provides a valuable model for biological self-organization. An appendix warns of the social danger inherent in building learning machines because of the dualism between the two qualities we expect of our machines: subservience and intelligence. All of the observations in this paper are thought-provoking.

The next paper is by RICHARD BELLMAN on "The Basic Concepts of Dynamic Programming." This reviewer cannot bring himself to say ill of a subject that has been good to him, but he can hardly see that this paper merits inclusion under the title of this symposium in 1961. However, anyone who has not yet heard about dynamic programming could learn about its mathematical structure from this paper. Yet, he would be better advised to consult any of Doctor Bellman's books for a much more complete introduction.

"Axioms for Persistent Preference," by P. A. DIAMOND, T. C. KOOPMANS, AND R. WILLIAMSON, presents an axiomatic system and its implications. The most interesting implication is that even though the axioms do not explicitly express a time preference for different outcomes, a time preference is, in fact, implicit. Unfortunately the proofs of this result are not contained in the paper.

On first reading, "Further Results in the Theory of Numerical Convergence" by SIGEITI MORIGUTI makes it appear that the author went to the wrong symposium by mistake. A second reading confirms this conclusion, but indicates that his paper would be a fine contribution to a conference on numerical computation. He shows, for example, that the problem of rounding error in solving difference equations can be effectively treated by the theory of Markov chains.

"Some Numerical Results on a Compound Decision Problem" by HERBERT ROBBINS and "Testing Statistical Hypotheses—The 'Compound' Approach" by HERBERT ROBBINS AND ESTER SAMUEL are attempts to solve repeated decision problems by classical methods. The authors go out of their way to avoid the type of reasoning espoused by GOODE, RAIFFA, TRIBUS, AND SAVAGE in later papers in this volume. Since the reviewer belongs to this latter school he can say of the Robbins and Samuel papers only that they are consistent with the best of classical statistical thinking.

The paper by H. H. GOODE on "Deferred Decision Theory" is a study of whether or not to delay making a decision to gain further evidence. The flavor is Bayesian, the presentation is clear, and the results are interesting. An example shows how the decision rule depends on the number of future observations that can be made. One wonders whether a dynamic programming formulation would not have indicated the generality of the problem more clearly.

"Bayesian Decision Theory" by HOWARD RAIFFA is a report on the Bayesian activities of the RAIFFA-SCHLAIFFER group at the Harvard Business School. The report shows succinctly in the clear but complicated Raiffa-Schlaiffer notation all a young man has to know to tell the difference between a prior and a posterior. It concludes with a description of the interesting research problems now being investigated by the group.

MYRON TRIBUS's "The Use of Maximum Entropy in the Estimation of Reliability" is a Bayesian investigation of reliability from what Savage would call the 'necessarist' department of the Bayesian school. A necessarist believes that there are definite mathematical principles for the construction of prior distributions in

inference problems. The mathematical principle in this case is the maximum entropy principle of E. T. JAYNES; namely, a prior distribution ought to be the distribution that has maximum entropy over the interval in question, subject to whatever information we have about the random variable. Professor Tribus discusses a number of inference problems involving the analysis of test data from the maximum entropy point of view. Tribus's work is as thought-provoking to the Bayesians in general as the Bayesians' work is to the classical statisticians.

"The Ergodic Theorem of Information Theory" by KAI LAI CHUNG proves that MCMILLAN's theorem on the convergence of the entropy function is convergence with probability one. Most interesting to the general reader are Chung's remarks that convergence with probability one, or almost sure convergence, is the only type of convergence that has a truly intuitive appeal. He writes, "Such other notions as weak convergence are only make-do half-measures which one adopts only when one does not know better!"

"Exploratory Mathematics by Machine" by B. DUNHAM, R. FRIDSHALL, AND J. H. NORTH presents "a way for testing the validity of an expanding truth-functional formula in alternational form," or, how to have a computer tell you whether a symbolic logic expression is correct. The results are of limited interest to a general audience.

Perhaps "Bayesian Statistics" by LEONARD J. SAVAGE appears at the end of the volume because it is the most readable paper and so leaves the reader with a satisfied state of mind; if so, it deserves its position. Professor Savage presents in a conversational tone both how to argue for Bayesian statistics and how to argue using Bayesian statistics. He points out that the real power of the rediscovered methods comes not from Bayes's theorem, but from the concept of personal probability. His views on why personal probability has attained respectability, at least in some quarters, are particularly well stated. He discusses the problems of analyzing a simple dichotomy, the concept of stable estimation, and the value of utilizing the likelihood principle. This paper is certainly one of the best introductions available to the value and method of Bayesian thinking.

Although one can find many faults with the unevenness of this book, it overcomes all of them because it is, in a word, stimulating. The main thoughts one has on finishing it are that Norbert Wiener was a brilliant and far-ranging man and that Bayesian statistics is here to stay. *Recent Developments in Information and Decision Processes* provides a rich diet of thought for a rainy evening.

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LUDWIG VON BERTALANFFY and ANATOL RAPOPORT (editors), *General Systems: Yearbook of the Society for General Systems Research*, Volume VIII, Society for General Systems Research, c/o Milton D. Rubin, Secretary-Treasurer, The MITRE Corporation, Bedford, Mass., 1963, 251 pages, $7.50 (paper)

THIS volume of *General Systems* follows much the same pattern as that of Volume VII [for a review, see this journal, **12**, 641–2, (1964)]. It is interesting to note that the Society for General Systems Research has flourished in the intervening year; it is now formally affiliated with the American Association for the Ad-

vancement of Science, and has increased in membership to a point where the list of members is too large to incorporate in the Yearbook. It may also be of interest that all back issues of the Yearbook are reported to be in demand and are available from the Business Office of the Society.

The Yearbook again contains a majority of reprinted papers (twelve out of nineteen). These are both valuable in themselves and gain added interest from being assembled in one publication. Four of the papers that appear here for the first time are speeches; three of these were delivered to sessions of the Society, reinforcing the picture of growth indicated above.

The volume is divided into four main sections. Part I, "After Richardson," presents six papers dealing with mathematical studies of conflict behavior in terms inspired by the pioneer work of LEWIS F. RICHARDSON. Such attempts to quantify various aspects of international tensions are of great topical interest for many operations-research workers. In the present climate of limitations on the initiation of new weapon systems it is increasingly clear that the social sciences have much to contribute to the formulation of appropriate tasks for weapon systems at all levels of conflict; the Navy, for example, has sponsored a rather intensive effort in this area (Project Michelson) in connection with its examination of future sea-based deterrent systems. The papers of Part I consider conflict behavior (R. J. RUMMEL), aspects of the arms race (PAUL SMOKER), and of arms control (R. H. DAVIS, et al.), and stochastic models of war alliances (W. J. HORVATH AND C. C. FOSTER).

In Part II, "General," the emphasis is on "General Systems Theory" in six more papers. C. A. LAWSON discusses "Language, Communication and Biological Organization," ranging from genetic coding through the emergence of communication systems in social organizations, human as well as animal. W. H. HUGGINS, in "An Algebra for Signal Representation," has some thought-provoking remarks on the processes of engineering measurement in the light of the logical fallacy of confusing an object and its name—in this context, the physical quantity measured and the number which results. G. M. WEINBERG, in "Systems Research Potential Using Digital Computers," discusses the possibility of symbiosis between systems research and digital computers, which he compares with that between classical mechanics and calculus.

In Part III, "Social Systems," the major contribution is a continuation of J. W. THOMPSON's exploration of "Meteorological Models in the Social Sciences" of which an earlier section was noted in the review of Volume VII. The basic thesis continues to be that meteorology, as a study of large-scale turbulent processes in the physical world, offers tempting descriptive similarities and methodological tools for the use of the social scientist. The other paper in this section deals with a game for examining intercity competition; its structure and rules are given in some detail. The authors (R. F. EDWARDS AND D. E. FRANCIS) appeal for additional relevant statistical data to refine the input data for the game. The whole of Part III receives first publication here.

Part IV, "Cybernetics and Communication Theory," contains five papers, including two reprints of papers by W. R. ASHBY. A general thesis of all of this section is the role of the intelligent machine and its impact upon human affairs.

In Volume VIII, as in Volume VII, it is true that the entire contents will be un-

likely to appeal to any one individual, but the papers in Part I and in Part IV are certainly of general interest to the operations-research profession, and it is a real service to have them collected in a single volume. The insights acquired by browsing in Parts II and III may be regarded as bonuses for the operations analyst in search of wider horizons.

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ROBERT L. GRAVES and PHILIP WOLFE (editors), *Recent Advances in Mathematical Programming*, McGraw-Hill Book Co., Inc., New York, N. Y., 1963, 359 pages, $11.95

THIS book contains twenty-three of the forty-three papers presented in Chicago at the Fourth Symposium on Mathematical Programming of June 18–22, 1962. Included among them are four survey papers, *Combinatorial Theory Underlying Linear Programs* by A. W. TUCKER, *Methods of Nonlinear Programming* by PHILIP WOLFE, *Linear Programming under Uncertainty* by ALBERT MADANSKY, and *Flows in Networks* by D. R. FULKERSON. Abstracts of the twenty remaining papers are given.

The papers present many of the latest thoughts in mathematical programming, and their content amply justifies the title of the volume. In particular, one should note the work on large systems described in the papers by DANTZIG, BEALE, ABADIE AND WILLIAMS, and ROSEN. Coupled with previous and current work on decomposition and partitioning, these papers reveal the remarkable advances that have been made in this difficult problem area. As it had been out of print, the editors have wisely included, as a substitute for the paper given by GOMORY at the conference, his basic paper *An Algorithm for Integer Solutions to Linear Programs*, originally published as Princeton-IBM Mathematics Research Project Technical Report Number 1, November 17, 1958.

The editors are to be congratulated for putting together a fine volume that has already proved to be a valuable source document.

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Books Received

RUTH F. BLAISDELL AND OTHERS, *Sources of Information in Transportation*, The Transportation Center, Northwestern University, 1818 Hinman Ave., Evanston, Illinois 60204, 1964, 272 pages, $5.00 (paper).

CHARLES P. BONINI, ROBERT K. JAEDICKE, AND HARVEY M. WAGNER (editors), *Management Controls: New Directions in Basic Research*, McGraw-Hill Book Co., New York, N. Y., 1964, 361 pages, $8.50. A collection of 17 papers from a seminar on *Basic Research in Management Controls* at the Graduate School of Business, Stanford University.

Committee on Utilization of Scientific and Engineering Manpower, *Toward Better Utilization of Scientific and Engineering Talent: A Program for Action*, Publication No. 1191, Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Ave., Washington, D. C., 1964, 163 pages, no price (paper).