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PROCEEDINGS OF THE CONFERENCE ON *WHAT IS OPERATIONS RESEARCH ACCOMPLISHING IN INDUSTRY?* APRIL 5–7, 1955
Case Institute of Technology, Cleveland, Ohio, 99 pp , $5 00

THIS CONFERENCE was attended by approximately 110 persons, chiefly middle management or staff personnel from various industrial organizations It was presumably organized for the purpose of answering the question raised in the title Admittedly this is a most difficult question to answer, if only because of the natural reluctance of many industrial organizations to talk about their accomplishments If the answer is based on this volume it is a disappointing one, even though several fine examples are provided It is evident from the proceedings that OR in industry is not yet started in any large way, despite an impressive listing of companies presumably interested in it There is still too much preoccupation with definition and problems of initiation to allow devotion of much attention to quality of effort, performance, or achievement A conference such as this is more of an effective means of introducing others to the subject than it is a means of appraisal, and few of the examples provided fulfill the many criteria outlined in early issues of this JOURNAL Yet progress is being made, and the evidence, although slight, is provided

DR CHURCHMAN of the Case group leads off with a report on the returns from a brief questionnaire evidently designed to turn up indications of interest and possible performance His comments demonstrate that confusion in industry as to what is and what is not operations research is still general Evidently the one solid conclusion that can be drawn from the returns is that interest still continues to build on a broad base

Following this report is a series of presentations of areas of study These vary, but in general involve a representative of the group performing the study and a representative of the firm studied Some of the presentations suffer from insufficient detail, impressive though the speakers may be in claims of complexity of the problems met Others are most illuminating in the demonstration of the degree of compromise necessary in order to produce an operable result It is dubious that those practicing in industry, who are well read, will find much that is new in the Proceedings On the other hand, the many individuals concerned with military operations research who hope ultimately to move into industrial areas should find the volume interesting and educational, not only in the six examples provided but also in the discussion of the problems met, many of which will sound very familiar

The individual examples include reports on allocation of sales effort, production scheduling and inventory control, a warehousing and distribution example, and some discussion of an application in the mining industry

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REPORT OF THE CONFERENCE ON LINEAR PROGRAMMING

Arranged by Ferranti, Ltd , London, May 1954

A CONFERENCE on linear programming, arranged by Ferranti, Ltd , was held in the Connaught Rooms, Great Queen Street, London, on May 4, 1954 Attending were approximately eighty representatives of military, political, commercial, and academic organizations MR W G WELCHMAN of Ferranti, Ltd , served as chairman

Six technical papers are contained in Report of the Conference, each of which is summarized below It is testimony to the rapid advance of linear-programming methods that these papers, presented less than two years ago, appear to be mainly of historical interest

Linear Programming of an Air-Lift—G P M HESELDEN AND S VAJDA The air-lift problem of this paper is one contrived to be instructive of the application of linear programming Specifically, it involves the air supply of a fixed quantity of material during a period of n successive weeks—the quantity n being a scheduling parameter The cost of this air transport is to be minimized subject to linear restrictions on the training and utilization of flying crews Solutions to the problem are shown for several special cases—in particular, for $n=5$ and $n=4$ Since these solutions exhibit an undesirable degree of fluctuation of traffic load from week to week, the examples are reworked with additional constraints on the amounts delivered in successive weeks, viz , that these deliveries must form a non-decreasing sequence (Dr Vajda recommends the practice of incorporating appropriate additional restraints also to reduce the instability of linear-programming solutions) The paper concludes with a technical appendix by E M L BEALE, who demonstrates the following point (which could be considered as a special consequence of the Dual relation) Suppose the functional being minimized represents a cost $C\ (=\Sigma\, c_i x_i)$, suppose further that one of the constraint equations represents a quantity $Q\ (=\Sigma\, d_i x_i)$ Then the set of $x_i\ (\geqq 0)$ that minimizes the cost C for a fixed value of Q also has the property that it maximizes Q for a fixed value of C, provided that the fixed Q with which one started lies between two extremes The lower extreme is the value of Q associated with a minimization of C when the original constraint on Q is omitted, and the upper extreme is the maximum value of Q obtainable under the original set of constraints, again omitting the original constraint on Q

A Problem in Transportation—A LAND This paper is essentially a progress report on the application of the (Koopmans) transportation-problem method of linear programming The problem being studied is that of the distribution of coal from some 260 collieries to some 80 coke ovens—this having been the subject of an industry-wide survey by the British Coking Industry Association for a period of one month An objective of the study is to determine if savings would have occurred in the month of the survey if linear programming had been applied by the National Coal Board However, at the time of the conference (May, 1954), the computations were not sufficiently advanced to permit a quantitative comparison of the costs implied by the linear-programming solution and the cost actually incurred The paper also contains comments on the pricing policy of the National Coal Board

An Application of Dynamic Programming—G MORTON Dr Morton presents a brief exposition of dynamic programming from the point of view of its being a special species of linear programming (with no apology to R Bellman) He formu-

lates an artificial and considerably simplified problem of forestry management in dynamic-programming terms, but presents no quantitative solutions Dr Morton comments that, at the date of the conference, the theory of dynamic programming was not sufficiently advanced for a solution to be available for practical problems, but, at the same time, he observes that the techniques of dynamic programming would improve as a result of efforts to apply them to practical problems

An Experiment in Demand Analysis The Computation of the Diet Problem on the Manchester Computer—J A C Brown The possibility of explaining, by means of a linear-programming model, the behavior of customers in the market for foodstuffs receives the attention of Mr Brown His experimental data are the results of a survey of approximately 1,000 urban working-class households made by the Ministry of Food between July and September, 1950 These data serve to provide an average distribution of food purchases and expenditures for the sample as a whole, and of the quantities of nutritional factors derived from the diet For purposes of the analysis, the foods are classified into fifteen groups, the number of nutritional factors considered is twelve Mr Brown speculates as to whether the consumer may be thought of as having certain minimum (or maximum) objectives in terms of the nutritional factors supplied by his diet, and as choosing a selection of foods to meet these requirements at minimum expenditure (The requirements are, of course, not those which a nutritional expert would specify) His analysis then proceeds along the lines of calculating four diets the first is obtained by specifying that it should *at least* meet, at minimum costs, all the requirements observed to be met by the nutritional factors in the sample data, the second differs from the first in that additional requirements limit the excesses of calories and calcium, the third diet then adds still another constraint on the excess of vitamin B_1, finally, the fourth diet reverts to the conditions of the first, but requires additionally that bread and potatoes be consumed strictly in the amounts observed in the sample data For each of the four diets, a comparison is available of the expenditures for foodstuffs in the calculated diet and the expenditures for the same foodstuffs in the sample Although none of the four sets of diet requirements analyzed by Mr Brown provides an adequate explanation for the consumer behavior observed in the survey, he concludes that the linear-programming method has distinct possibilities as a new operational technique in the analysis of the demand for food—especially after such factors as food rationing, food grouping, and variation in requirements from individual to individual are more realistically treated in the model

Linear Programming by the Method of Leading Variables—E M L Beale The method of Leading Variables is a procedure for computing solutions to linear-programming problems It consists of finding an optimum solution when some of the constraints are ignored, and modifying this solution until the latter constraints are satisfied The method appears to be closely related to the Dual Simplex method Mr Beale comments that this method is not likely to revolutionize the art of linear programming, but it has interest in demonstrating that different approaches to the subject lead to similar computing techniques The method is illustrated by the computation of the solution of one of the air-lift problems of the Vajda and Heselden paper Mr Beale reports that he believed the computation time required to apply the method of leading variables to be of the same order as the Simplex method, but he had no experience in applying it to large-scale problems

Some Experiences of the Manchester Computer with the Simplex Method—D G Prinz Dr Prinz's paper provides first a condensed version of the Simplex method

of linear programming—without, however, describing a procedure for the resolution of degeneracy, on the grounds that "in most practical cases this difficulty does not arise" He then reports that in the early applications of the Simplex method on the Manchester electronic computer, the process of solution (except for some very simple problems) refused to terminate, or terminated before the extreme of the functional was attained These difficulties are asserted to have arisen as a consequence of rounding errors that caused the computer to branch incorrectly on elements having spurious non-zero values To overcome these errors, Dr Prinz recommends the refinements developed by A Orden and others that is, omit the computation of unit vectors in favor of retaining only a record of the indices of the vectors in the basis, and maintain a testing procedure to determine when the artificial vectors have been completely removed from the basis, after which the row of coefficients of the arbitrarily large quantity M (one of the two rows comprising $\Sigma z-c$) need no longer be computed, but rather can be stored as a set of values identically zero or unity Dr Prinz concludes by reporting that the Manchester computer has performed matrix inversion by the Simplex procedure, essentially in the form published by A Orden, he observes that the Simplex method of matrix inversion is superior to more traditional methods mainly when the matrix is badly conditioned, i e , when the elements along the diagonal are relatively small

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THE JOURNAL OF INDUSTRIAL ENGINEERING

THE ATTENTION of readers interested in industrial problems is invited to this publication of The American Institute of Industrial Engineers It is a bimonthly publication, subscription rate $6 00 per year, the address of the business office is 225 North Avenue N W , Atlanta, Georgia The sixth volume was published in 1955

There are at least two reasons for operations analysts to become familiar with this publication One is the frequent appearance of articles that either are descriptive of the problems currently faced by engineers who are actively engaged in designing, planning, and controlling industrial operations, or that discuss the shortcomings of the models which form a basis for current practice Examples of such articles are "The Forecasting Problem—An Industrial Engineer's Viewpoint," by R E McGarrah, and "Industrial Investments and Engineering Economy," by Ernest H Weinwurm, both in the July-August, 1955 issue

A second reason lies in the appearance of articles devoted to presentation of some of the techniques frequently associated with operations research These articles also generally include some discussion of the potential pit-falls and shortcomings of these techniques if they are applied to industrial situations without proper background in industry, as well as comments that indicate in which directions further research or refinement of the methods is essential for broad applicability Examples of such articles are "The Industrial Engineering Application of Communication-Information Theory," by Allen B Rosenstein and "The Assignment of Operators to Service Automatic Machines," by Robert N Fetter, both in the September–October, 1955 issue of this journal

In addition, articles appear which describe research on industrial engineering problems and which furnish excellent examples of operations research One of these is "The Assembly Line Balancing Problem" by M E Salveson in the May–

June, 1955 issue This furnishes an example also of the type of industrial engineering problem which can be satisfactorily handled by competent engineers in a near-optimal fashion, but which can be handled more rapidly and in an optimal manner by large scale computers once the model has been developed

There apparently is a considerable overlapping of the membership of The Institute of Management Science, the Operations Research Society of America, and the American Institute of Industrial Engineers and undoubtedly as time passes the results of much of the fundamental work described in the *Journal of the Operations Research Society* and in *Management Science* will appear in the *Journal of Industrial Engineering*, which is published primarily for the large number of engineers in industry who design and control industrial operations and procedures It seems logical to assume that those interested in fundamental work that has a potential pay-off in this area would be interested in such a publication

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MANAGEMENT SCIENCE

THE April–July, 1955 issue of *Management Science* (vol 1, Nos 3–4) has the following table of contents

GEORGE B DANTZIG—*Linear Programming Under Uncertainty*
ANDREW VAZSONYI—*The Use of Mathematics in Production and Inventory Control—II*
HARRY V ROBERTS—*Statistics in Middle Management*
HAROLD GUETZKOW AND HERBERT SIMON—*The Impact of Certain Communication Nets in Task Oriented Groups*
IAN ROSS AND FRANK HARARY—*Identification of the Liaison Persons of an Organization*
PATRICK SUPPES AND MURIEL WINET—*An Axiomatization of Utility Based on the Notion of Utility Differences*
S SHERMAN—*Comment on "Smooth Patterns of Production"*

MANAGEMENT'S OPERATIONS RESEARCH DIGEST

THE FIRST ISSUE of a new quarterly publication with the above title has been received (Volume I, Number 1, October 1955) This quarterly is published by the Operations Research Institute Inc , Princeton, New Jersey, at $5 00 a year, $1 50 a copy

According to the editorial preface, "the objective of the Digest is to provide for *managers*, briefly and in non-technical language, the best in *Operations Research* literature "

This first issue is a small 14-page pamphlet It contains three short articles prepared in a very readable conversational style The first article, "They Harnessed the Dragline," is a description of the work by Dunlap and Jacobs on increasing the output of walking drag-lines that was first published in the February 1955 issue of this JOURNAL The second article, "How to Balance a Line," describes the work of Salveson on balancing the assembly-line operations in the General Electric Appliance Division in order to increase line productivity This work was published in the *Journal of Industrial Engineering*, May–June 1955 The third article is a description of the work of the Westinghouse Air Brake Operations

Research Group It is based on an article by Crane, Brown, and Blanchard in the August 1955 issue of this JOURNAL and a paper presented by Crane at the Case Institute Conference of April 5–7, 1955

These articles are followed by a two-page discussion, "Bottleneck in Operations Research," pointing out the shortage of training facilities and describing the training seminars of the Operations Research Institute The last page of the pamphlet contains a 'sales appeal' to management entitled "Where Operations Research Can Help You"

G S

DAVID BLACKWELL and M A GIRSHICK, *Theory of Games and Statistical Decisions*, John Wiley & Sons, Inc , New York, 1954, 355 pp., $7 50

THIS book is designed as a text for a graduate course in mathematical statistics It is rigorous, carefully written, and relatively free from errors, however, the highly formal presentation makes it difficult reading for a non-mathematician The treatment is somewhat simpler than Wald's pioneering 1950 book (*Statistical Decision Functions*) but the price for this simplification is a drastic reduction in mathematical generality caused by a restriction to discrete distributions The chapter headings are 1 Games in Normal Form, 2 Values and Optimal Strategies in Games, 3 General Structure of Statistical Games, 4 Utility and Principles of Choice, 5 Classes of Optimal Strategies, 6 Fixed Sample-Size Games with Finite Ω, 7 Fixed Sample-Size Games with Finite A, 8 Sufficient Statistics and the Invariance Principle in Statistical Games, 9 Sequential Games, 10 Bayes and Minimax Sequential Procedures When Both Ω and A Are Finite, 11 Estimation, 12 Comparison of Experiments

The first two chapters form a self-contained unit on game theory and have value as such entirely independent from their role in decision theory In the third chapter the basic concepts of statistical decision making are introduced as a special case of game theory This chapter serves as a general introduction to the rest of the book Chapter 4 gives an axiomatic development of utility theory in the spirit of von Neumann and Morgenstern This chapter also includes a theorem which shows the great importance and broad applicability of Bayes' solutions The remaining eight chapters are devoted to study of Bayes' solutions in various cases For a more technical discussion of the contents of this book the reader is referred to the excellent review by J WOLFOWITZ in the *Bulletin of the American Mathematical Society* (vol 6, pp 247–253, 1955)

There are numerous illustrative examples and a good selection of exercises The reader who proceeds slowly and carefully through the book with pencil and paper at hand will find that once he has mastered the basic notation, concepts, and framework, the rest comes more easily

The subject of *decision making under conditions of uncertainty* is clearly of central importance in operations research The reviewer feels that it is neither necessary nor feasible for every operations-research analyst to reach the level of technique-proficiency in this area that is represented by the present book However, each OR team should include at least one member who can work at this level, and it would be desirable for most OR workers to have some comprehension of the topic This book is clearly a 'must' for the bookshelf of each OR team

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