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THE INSTITUTE OF MANAGEMENT SCIENCES REPORT OF THE AMERICAN NATIONAL MEETING

June 4–6, 1959, Chicago

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Opening General Session: *Chairman:* LEONARD SWANSON, *Arthur Andersen & Company, Chicago.*

Keynote Speaker: "The Partnership of the University and the Business Community in the Development of Management Science," JAMES H. LORIE, *Associate Dean, Graduate School of Business, University of Chicago.*

A. Organization Theory. *Chairman:* THOMAS MARSCHAK, *Economist, The RAND Corporation.*

1. "Team Theory Problems in a Hypothetical Sales Organization," C. B. MCGUIRE, *Yale University and The RAND Corporation.* Abstract not received.
2. "Problems in the Simulation of Organizational Behavior," SIDNEY SCHOEFFLER, *General Electric Company.* Abstract not received.
3. "A Centroid Method for Estimating Cohesiveness in (Small) Groups," V. B. CERVIN, *Imperial Oil Company.*

Social groups are viewed as associations of individuals interacting with respect to a common goal. The group structure is described by a goal vector with components representing individual involvements with the common goal. The cosines of the angles of separation between these components represent group solidarity. Variations in time of the vector constitutes the dynamics of groups. As an illustration, the model is applied to analyse and describe a seminar group run at University of Toronto. The group's performance is compared with the analytical results post factum.

B. Computer Systems. *Chairman:* W. ROBERT HYDEMAN, *Touche, Niven, Bailey and Smart.*

Problems in system design and implementation concerned with business data processing systems were discussed by a panel. Participants were:

1. W. ROBERT HYDEMAN, *Manager, Computer Systems, Executive Office, Touche, Niven, Bailey & Smart, Detroit.* Abstract not received.
2. H. N. LADEN, *Chief of New Systems Development, Chesapeake & Ohio Railroad.* Abstract not received.
3. GOMER H. REDMOND, *Manager, Corporate System & Procedures, Chrysler Corporation.* Abstract not received.
4. RICHARD A. SPRAGUE, *Manager of Field and Airline Sales, Teleregister Corporation;* a charter member of TIMS.

The College of Business Computer and Data Systems of The Institute of Management Sciences will undoubtedly concern itself with the use of Data Processing systems and devices as tools of Scientific Management. Three specific areas are recommended for attention:

1. Use of existing or proposed data processing installations on an overall, organization-wide basis. The attention of top management will be required here because of the crossing of departmental lines.
2. Use of existing or proposed installations for the job of overall planning, including evaluation and assistance in making risk taking, risk making decisions.
3. Re-examination for future data processing installations of overall, organization-wide, requirements and use of systems approach to mechanizing the whole or a majority of the whole, rather than a piece-by-piece mechanization.

Examples or recent programs in the third category are given. A summary of possible objectives of TIMS and specifically the College of Business Computer and Data Systems is included.

Luncheon Speaker: MELVIN SALVESON, *President of TIMS; President, Center for Advanced Management*

C. Simulation. THEME; "Simulation as a Technique for Developing Theory in Management Science and for Predicting the Results of Implementation

of the Theory." *Chairman:* W. E. BARNES, *Operations Research and Synthesis, General Electric Co., Schenectady, New York.*

1. "Compatible Systems Simulation," JOHN M. ALLDERIGE, *Industrial Engineering Division, Eastman Kodak Co.*

The problem of overly-complex models becomes a more pressing one as simulation potential becomes greater. Such complexity is expensive and blocks insight. Compatible simulation seeks to have the model fit the decision-making needs. This paper discusses two examples of compatibility in action and sketches some game theory aspects as well as the outline of a general theory. The latter is sought as a basis for methodological guides to engineers and analysts in their routine operational model building.

DISCUSSANT: B. BRYTON, *Home Laundry Division, General Electric Co., Louisville, Kentucky.*

This paper introduces a most suitable problem. The introduction formalizes a problem which we tend to accept as an art. Namely—compatibility of "description" to specific "needs."

While one is solving specific problems, let us not forget that *description* provides the opportunity for studying many kinds of system changes. Thus we see that any strict adherence to a matching of detail of description and specific need may economize the solution of a well-defined problem, but it also limits the opportunity for innovation by limiting the number of elements and connections possible to be studied.

John Allderidge gives us in his paper rather concrete examples and demonstrates an intuitive approach to matching the detail of description with the detail of specific need. His suggestion of "sequential sampling" of increasing detailed descriptions seem to suggest a new accent.

Here he provides a systematic approach to measuring the scientist's own risk. It opens up the role of the model-maker as a risk-taker himself. I hope we will accept the task of looking at risks in solutions as well as risks in overlooking solutions.

The paper suggested certain ideas that I wish to set forth.

Let us assume that "models" may be ranked by their degree of detail, and further, models of great detail can generate models of lesser detail.

If one starts with a model of greatest detail and generates models of less detail, the number of models of less detail increases almost without bound as the degree of detail is reduced. Then at some point in the processes, the degree of detail is so general that all we can say is "we have a model."

Thus I see an opportunity to invent a model generating function which traces out paths of "sufficient models" for specific purposes.

Using a *simulation* description in the very detailed sense as the most detailed model, we should be able to generate models to suit many changing patterns of uses.

If this can be done, we can look forward to a class of descriptions and generation techniques that can extend the speed and meaning of contributions we can make.

2. "Statistical Interrogation of Data for Alternative Models," R. L. BASMANN AND L. G. WATERS, *General Electric Company, Richland, Washington.*

It is the object of this paper to describe very briefly a program of statistical interrogation of operating data as a form of investigation preliminary to the design and execution of experiment or of simulation models. This program makes use of statistical techniques recently developed in connection with econometrics. The techniques attempt to glean from past operating data some indication of the types of *causal-interdependent* model structures capable of "explaining" the functioning of a system that generates quantitative observations. The motivation for applying these techniques to quantitative operations research problems encountered in a business enterprise is described.

Our practical applicatory interest is in the use of these methods of estimation and hypothesis testing primarily as "data reduction" techniques or devices for the statistical interrogation of data in operations research studies. In this sense our intent differs from that often found in econometrics where the chief emphasis has been put on selecting the "best" method for estimating "true" theoretical parameters of economic models; rather we use these methods in much the same way as experimental psychologists use principal components methods and factor analysis as exploratory tools in the search for significant relationships among variables. The statistical methods are used to assist in the study and interpretation of historical (previously observed) states of systems prior to the design of experiments or construction of simulation models and are not directly involved in the extrapolative and predictive aspects of operations research, as experimentation and simulation properly are. Nor in using the methods are we seriously concerned with any conceptually "true" form of functional relations between variables, but rather with alternative hypothetical patterns of causal and interdependent relationships among variables held to be relevant to the system under investigation.

The use of these methods in operations research is illustrated by an example: A system (e.g., a business enterprise, a sector of the national economy, dissolvers in a chemical separations plant), is first modeled (loosely) in terms of a set of quantitative variables believed to be relevant and related to one another.

DISCUSSANT: R. L. CHAPMAN, *Ramo-Wooldridge Corp., Los Angeles, California.*

Dr. Basmann's presentation has provided a helpful context for the technique he has described in his written paper in more detail. The authors' approach to a very real problem is both imaginative and sophisticated and may very well have implications for a whole class of investigations.

I should like to raise the general question, apropos of exploring alternative models for organizational data, of where we expect stability. Implicit here is the notion that certain relations will be stable enough to be identified. Some studies of man-machine systems have indicated that stability is found in a description of man's adaptive process—that many internal relations remain in a state of flux as long as external environments change.

There is a good deal of empirical and theoretical work to be done—of various kinds before we model operating data effectively. This paper seems a promising beginning along one direction.

3. "Difficulties of Simulation," C. M. KELLOGG, *Home Laundry Division, General Electric Co., Louisville, Kentucky.*

Large scale simulation of business phenomena is still in its experimental stage and it was the purpose of this paper to crystallize some of the uneasiness about its use and to bring some of its drawbacks into focus. Among the drawbacks covered are the following: Simulation does not alleviate the need for the formulation of a problem, nor a well understood concept of what constitutes a solution. This is easily forgotten. There is a lack of properly convergent processes. Simulation is very expensive in time and money and tends to dominate the funds allocated for all research. Since it is costly it cannot be "turned off" before final results are obtained. Simulation has little generality and each problem must have its own particular model. There may be a tendency to over dis-aggregate when aggregation may be easily done. Simulation can easily be misused due to its simplicity.

DISCUSSANT: T. C. ROWAN, *Systems Development Corporation, Santa Monica, California.*

Mr. Kellogg appears to have made his task more difficult by finding fault with what I and at least a few others feel to be only one corner of the field of simulation. While I hesitate

to open up the problem of definition, apparently Kellogg is using simulation to mean the use of computer techniques as substitutes for analytic methods when the functions involved are too complicated for solution.

Mr. Kellogg's first main point is that simulation does not provide a solution. One can go further, as Kellogg does, and say that it does not even provide a problem. This is very important; to me simulation is a way of understanding a complex phenomenon generally. Its optimum contribution is in exploring a complex operation—as a way to seek hypotheses.

Mr. Kellogg's comments on cost were very appropriate. Simulation studies on a computer can be very expensive. In suggesting that each simulation model is a specific tool, he is addressing himself to one way to making simulation less expensive. Another area of potential savings is the manner in which the model is probed. We need to give more attention to making simulation more efficient in the statistical sense of the term. It is important both in formulating the question to be asked the model and in deciding what input parameters to use to approach the task in a way that will maximize the information obtained from the runs.

Mr. Kellogg described in closing an example of what I suppose he considers a misuse of the simulation approach. As I understand it, he had to develop a second model based on the first model in order to gain understanding. It seems to me that this is an excellent example of the usefulness of simulation in exploring a complex area that one does not understand.

4. "Progress and Plans of the College of Simulation's Project," WILLIAM DROZDA, *Computer Department, General Electric Co., Phoenix, Arizona.*

The objective of the project undertaken by the College of Simulation is to prepare a comprehensive, evaluative review of the literature on the use of simulation in the Management Science area. The ultimate product of this project will be a book containing, as chapters, some of the more significant papers on simulation. Some editorializing will be done for continuity purposes. As presently visualized, this book will begin with some elementary concepts of simulation and progress through rather detailed discussions of more complex simulations. Because more literature will be covered than that actually included in the text, an appendix will be prepared containing an annotated bibliography of all the material that was studied. In this way, all of the work done on the project will be put to good advantage.

A literature search has been conducted to identify as many periodicals as possible that may contain papers on simulation. To date, a list of more than 45 periodicals has been prepared. It is planned to search the journals as far back as January, 1955 for any papers on simulation. In addition to the above periodicals, a survey is currently being conducted to identify any internal company periodicals that may contain papers on simulation. A literature search of the internal publications will also be conducted.

An abstract form has been developed for use by the reviewers. Accompanying the forms will be instructions to the reviewers concerning such things as style, particular terms, and concepts to look for and a discussion of what is meant by "Simulation" for the purposes of the literature survey.

In the near future, members of the College will be assigned the periodicals for review. The reviewers will submit their reviews on the standard abstract form. Based on this information, those papers most suitable for inclusion as chapters will be selected. The remainder of the reviews will be included in the annotated bibliography. The finished publication will then be submitted to The Institute of Management Sciences for distribution in whatever manner they choose. It is expected that the results of this project will be made available to all TIMS members.

The success of this program depends entirely upon the cooperation of each member of the College of Simulation. Without an adequate and timely response from each participant, it will be impossible to bring the project to a successful culmination.

D. Research and Development Management. WALTER GAILUS, Introduction and Orientation. *General Electric Co,*

1. "Rate of Organizational Change, Corporate Decentralization, and the Constraints on Research and Development in the Firm," ALBERT H. RUBENSTEIN, *School of Industrial Management, Massachusetts Institute of Technology.*

This is a progress report on one phase of a long-term study of Organization of Research and Development in Decentralized Companies. It is now in its second year in the School of Industrial Management, M.I.T. The study involves over 100 large decentralized manufacturing companies in six major industries. One phase traces the historical relationship between corporate decentralization and the deployment of research and development resources and activities in the firm. The organizing principle for operating divisions is examined, as well as the initiation and termination of operating divisions. A second phase examines the dynamics of the relationship between corporate headquarters and the operating divisions with respect to R and D policies and programs, in approximately 25 companies. A third phase concentrates on the measurement of idea flow within and between laboratories of three companies.

This paper, reporting primarily on the second phase, deals with: the relation of R and D deployment to company technology; the rate of change in organizational position of R and D within the firm; and the historical cycle of centralization-decentralization-centralization. Some problem areas are discussed: questions of efficiency and cost of R and D; coordination of the "current business" aspect of the R and D program; sources and support for specific changes in the current business; maintenance of technical competence; and relation of R and D to the Future Market Mission of the company.

The economic and organizational constraints on operating division managers and divisional laboratory directors are examined. Several ways of dealing with the problem areas are discussed: methods relating to deployment of R and D; methods relating to funding of R and D; and methods of exerting direct influence on the selection of projects and programs.

2. "A Model of the Discovery and Application of Knowledge," JAMES C. HETRICK, *Senior Member, Operations Research Staff, Arthur D. Little, Inc.* Abstract not received.
3. Panel Discussion. *Co-Chairmen:* WALTER GAILUS, *Consulting Engineer, General Electric Co.*, and PETER NORDEN, *Manager of Operations Research, IBM Corporation.* Participants were as follows:
   a. "A Method for Selecting Research and Development Projects," BURTON V. DEAN, *Case Institute of Technology.* Abstract not received.
   b. "Criteria for Evaluation of an Optimum National Research Effort," ROBERT L. FULLMAN, *General Electric Co., Schenectady, New York*

The need for an expanded national research effort has been abundantly expressed, particularly in the past few years. This paper is concerned with identifying the fundamental economic criteria that should be considered in determining the most appropriate level of research effort in a nation.

The amount of basic research that is worth supporting in anticipation of unpredictable future applied benefits is larger, the broader is the scope of applied interests of the enterprise concerned. Hence a nation can benefit from a larger amount of research than the sum of that which is profitably undertaken by all of the nation's industrial enterprises. The likelihood, magnitude, and probable timing of useful consequences of new knowledge is an important criterion for the basic research effort.

There is usually a long time interval between performance of research and the benefits

that ultimately accrue. Hence the discount rate that is used to express a willingness to exchange present benefits for later ones is an important determinant in evaluating research projects. This discount rate for a nation does not necessarily coincide with the mean value of those appropriate to the nation's individual enterprises.

Since a nation as a whole has essentially fixed total resources, it is not, in general, possible to maximize the present value of its activities by engaging in all projects with positive present value and no others. A method is presented for obtaining the maximum present value permitted with fixed total resources.

An important part of the national research activity implies possible consequences to the population's life expectancy and to other values that have no "market" in which a dollar value is determined. In order to compare research and other projects that have different degrees of potential influence on these values relative to other aims, it is necessary to assign a dollar value to them by a group of "market analyses."

Possible means for determining the national discount rate and the values of life extension and other social aims are discussed.

c. "Requirements for Research and Development Data Systems," MAX W. MUELLER, *Lockheed Aircraft Corporation, Burbank, California.* Abstract not received.

d. "Toward a More Quantitative Method of Research and Development Management," LOUIS A. SELOGIE, *U.C.L.A.* Abstract not received.

E. Measurements in Management. *Chairman:* DAVID B. HERTZ, *Arthur Andersen & Company, New York.*

1. "Measurement and Misrepresentation," RAY J. CHAMBERS, *Professor of Accounting, Department of Economics, University of Sydney, Australia.*

The possibility of measuring does not necessarily lead to the presentation of relevant information for decision-making in business. This is demonstrated by reference to accounting methods and to profit computation in particular. Accounting processes have become formalized to the point where they misrepresent financial results and position; the probability that resources will be used efficiently and that equity between parties of interest will be served is materially reduced by lack of care in the definition of significant concepts and the concurrent acceptance of procedures which have directly opposite justifications and consequences. As the speed of information processing increases and computational refinements develop, a corresponding effort is necessary to redefine in operationally relevant terms or to sharpen the definition of, such key concepts as profit, capital, cost. The history of the development of accounting and auxiliary calculations illustrates the consequences of permitting a measuring and communicating system to become institutionalized. Some suggestions for improving the relevance of accounting and similar information are made.

2. "The Theory of Technological Measurements," SEBASTIAN B. LITTAUER, *Professor of Operations Research and Statistical Quality Control, Columbia University.* Abstract not received.

3. "A Discounted Cash Flow Approach to Long Term Leasing Evaluations," WILLIAM D. MCEACHRON, *Head of Long-Range Planning Department, Standard Oil Company of Indiana.*

Many business enterprises evaluate internal operating investment opportunities by means of discounted cash flow or present value techniques. When such investment opportunities include long-term lease commitments, direct application of these techniques will generally give misleading results because the lease payment obligation is not recognized.

The paper proposes a method for adjusting the evaluation technique under this circumstance so that it will yield answers valid for decision making purposes. By equating the lease payment obligation to an equivalent sum of borrowed money, the method essentially substitutes in the cash flow schedule an initial lump sum payment in lieu of the obligated stream of lease payments. Tax effects are handled by auxiliary calculation. Application of this procedure indicates that a firm with adequate capital resources will generally find ownership of facilities economically preferable to long-term leasing.

F. Production and Inventory Management. *Co-Chairmen:* A. J. ROWE, *System Development Corporation, Santa Monica, California,* and NORMAN TENZER, *Lever Brothers Company, New York.*

1. "An Airline Provisioning Problem," VAN COURT HARE, JR., *Consultant in Operations Research, New York,* and JAMES A. SHAUNTY, *Trans World Airlines, Inc., Kansas City, Missouri.*

The authors describe a method of computing the number of spare parts of each kind to have at each field station in a maintenance system. One-at-a-time replenishment is used and the variables considered are: 1) the replenishment time from a central warehouse to field stations, 2) a specified protection level (maximum number of shortages per year), and 3) the predicted usage rate for each part-station combination. The method employs multi-channel queuing theory in a routine programmed for Univac 1. Of basic interest is the technique of predicting part-station usage from the *number of landings per time period,* rather than from hours flown, a modification of usual airline practice that allows usage predictions to be tied directly to a given station and, furthermore, allows allocations of parts to stations to be revised as schedules change. Thus, the procedure bases inventory levels at each station on *future* needs, rather than on past history—a poor predictor as plane types and schedules are revised. The method is also applicable to field inventory planning for non-airline use, particularly if part usage is low, if one-at-a-time replenishment is used, and if the number of part-station combinations serviced is large.

2. "Production Planning Through Inventory Control," W. C. HUGLI, JR., *Consultant in Operations Research, New Jersey.* Abstract not received.
3. "Ordering and Issuing Inventory with Known Demand," ARTHUR F. VEINOTT, JR., *Statistical Engineering Group, Columbia University.*

Simple economic lot size models often assume that the selling price of stock is a decreasing function of its age in storage, the decrease in the "price function" being accounted for in the cost of carrying inventory. In this paper the price function is introduced explicitly. Thus, in addition to the usual ordering problem (how much and when), a new question arises. That is in what order should the stocks of various ages be issued to satisfy demands for product?

The demands at equally spaced points in time are known with certainty and may be satisfied by issuing stock of any age. Although the cost of carrying inventory is dropped in this model, conditions on the carrying cost which enable it to be "included" in the price function are given. The ordering cost is proportional to the quantity ordered; and there is no cost of "setting up" an order.

This paper is concerned with finding policies which maximize discounted profits from ordering and issuing in each of the following situations: where the issuing policy is given, where the ordering policy is given, and where neither policy is given. For every price function the last two situations give rise to transportation type linear programming problems, for which standard solution techniques are available. The main work of the paper, however, is the characterization of several sets of conditions on the price function which guarantee the optimality of simple ordering policies and LIFO (last-in-first-out) or FIFO (first-in-

first-out) issuing policies. Such characterizations are justified by the enormous computational task of straightforward application of the simplex method to large problems, by the large class of price functions so characterized, and by the approximate optimality of the simple policies when the price function does not meet the required conditions (upper bounds on the loss in discounted profits incurred by approximation are provided). Finally, conditions on the price function are given which justify the assumption (often made in simple economic lot size models) that changes in the price function may be accounted for in the cost of carrying inventory.

4. "An Independent Sequence Gantt Chart Scheduling Problem," L. G. MITTEN, *Industrial Engineering Department, Northwestern University.*

The Gantt Chart (or Job Shop) scheduling problem involves establishing the sequence(s) in which a specified set of activities are to be performed using a given set of facilities. The paper treats a problem in which the activities may be undertaken in different sequences on each of the n ($\geqq 2$) facilities; the measure of merit is minimum idle time for the facilities, and start and stop lags are incorporated in the model.

A graphical procedure is presented for improving some arbitrary initial schedule. Iteration of the procedure yields successively better solutions, but an optimal final solution is not guaranteed. Further, the efficacy of the method depends to some extent on the ingenuity of the problem-solver. Nonetheless, the method is simple and rapid enough (and its skill demands small enough) to give it considerable practical utility.

G. Management Games. *Chairman:* MERRILL FLOOD, *University of Michigan.*

This session consisted of two parts: 1) A general description of a new interacting Management Game, developed by the Management Services Division of Remington Rand, and 2) A briefing for those participating in the game itself on Saturday at the Operations Analysis Laboratory at the University of Chicago.

Luncheon speaker: JAMES JACKSON, *TIMS, President-Elect, UCLA.*

H. Long-Range Planning.[1] *Chairman:* WALTER B. SCHAFFIR, *Management Engineer, Office of Executive Vice President, Sperry Gyroscope Company, Great Neck, New York.*

1. "The State of the Art in *Making* Long-Range Plans," H. IGOR ANSOFF, *Director, Diversification Task Force, Lockheed Aircraft Corporation.*

The development of a plan requires (1) formulation and solution of the planning problem, resulting in the selection of a preferred strategy, and (2) translation of this solution into a time-phased schedule of action. This second aspect is well understood and not treated any further here. The first aspect has been approached in the past in two ways:

I. *The Operations Research Approach* has been successful largely with problems which
   a. Are at levels below top management
   b. Involve suboptimization in terms of an objective function reflecting performance of less than the enterprise as a whole
   c. Are concerned primarily with the arrangement and utilization of internal resources
   d. Involve relatively short lead times

[1] A report of this session is contained in the "First Symposium on Corporate Long-Range Planning" published by the College of Planning of The Institute of Management Sciences. Copies may be obtained from The Institute of Management Sciences, P.O. Box 273, Pleasantville, New York.

e. Involve a large number of controlled (and a small number of uncontrolled) variables.
f. Allow quantification of relevant variables
g. Allow the solution to be stated in numerical terms
h. Are based on well understood underlying theory (with past relationships likely to continue into the future)
i. Allow ready reduction to systematic, computational routines
j. Are generally "well-structured".

Operations research has been less successful with "strategic" business problems, such as those concerned with product, market and research policy, diversification, allocation of corporate resources, etc. These problems generally

a. Are of concern to top management
b. Require over-all optimization
c. Have their major impact in the long-range future
d. Are greatly influenced by environmental factors, external to the business
e. Are not readily quantifiable
f. Require judgment in arriving at a solution
g. Lack an over-all criterion of effectiveness ("Profit maximization" is not an adequate criterion of business performance)
h. Are generally "ill-structured".

II. *The Heuristic Approach* has been traditionally employed in tackling this second class of problems. It draws on individual experience, training and intuition. There is no generally applicable methodology. Each problem is tackled and solved on its own merits. The problem is "unstructured". The "careful" approach to business problems abstains from general principles and evaluates competing conclusions by logical reasoning and the passage of time in the real-life situation.

III. *The New Quasi-Analytic Method*, suggested by the author, is a compromise between the above two approaches. It may be characterized as follows:

a. It is process-, rather than goal-oriented. Rather than comparing the likely outcomes of various alternative strategies, it emphasizes comparison of their characteristics (thus inferring likely outcomes)
b. It utilizes qualitative judgments, imbedded within the problem structure
c. It maintains continuous feedback between analysis and problem formulation, thus constructing a self-correcting theory of the business, as it proceeds. (The model of the whole cannot be made explicit in advance of the solution, but only in terms of symbolic relations between variables)
d. It treats several (often mutually exclusive) business objectives simultaneously until a set of dominant alternatives is found
e. It divides strategic business problems into (1) external (concerned with the firm's opportunities in its environment) and (2) internal (concerned with the firm's strengths and weaknesses); it divides each such problem further into its quantitative and qualitative subproblems
f. It arrives at a family of solutions by successive narrowing the field of alternatives by means of elimination criteria
g. It arrives at a final solution by applying some weighting procedure to the residual set of alternatives
h. It emphasizes comprehensiveness and validity in abstracting the real-life situation (rather than precision and mathematical formulation)
i. It is neither well-structured (as the operations research approach), nor unstructured (as the heuristic approach), but rather ill-structured. It is thus methodical, without being mathematically rigorous.

2. "The State of the Art in *Using* Long-Range Plans," GEORGE A. STEINER, *Director, Division of Research, Graduate School of Business Administration, University of California, Los Angeles.*

This paper assumes, of course, that long-range plans have been formulated and are ready for use. The study of uses of long-range plans has two principal aspects. First is the procedural execution of formulated plans. In mind here are the usual actions to insure that what is done is in conformance with plans. Second are the development of new uses for plans, other than those now generally perceived, together with improvement in presently recognized ancillary uses of long-range plans. There is a rather large body of information on control techniques concerning the procedural execution of plans. Literature is almost silent on the second aspect of long-range planning noted here. For this reason the paper emphasizes gaps in our knowledge in this area.

Improved use of long-range plans will, of course, flow from close meshing of the actual making and using of plans. Suggested steps for improving this coordination are: develop needed sub-plans; assure proper synchronization with other plans; actuate plans by having competent officers to administer the plans, allocate necessary funds and authority, and assure proper timing of decisions when multiple decisions are involved; assure that proper standards and procedures for control are ready for use.

Problems in the execution of long-range plans vary tremendously depending upon a variety of circumstances. First, types of long-range plans require different techniques for most effective execution or, at least, different emphases on standard methods. In mind, for example, are quantitative vs. qualitative plans, narrow vs. broad plans, short vs. very long-range plans, realistic vs. unrealistic, simple vs. comprehensive, and so on. Second, characteristics of the enterprise in which execution takes place has a bearing upon use problems. Third, effective execution depends upon the extent to which the steps given above for meshing preparation and use are planned and followed. Finally, execution depends upon the control tool-kit that is available and ready for use.

A great deal is known about methodology for using plans. The state of the art is rather sophisticated on such matters as budgets, the development of control standards, and certain types of evaluations. There are, however, a number of big holes in existing knowledge.

Among the major gaps I would list methods: to relate better short- and long-range plans; to coordinate long-range planning at top management levels with respect to timing, incompatabilities among goals, and preferred methods to execute different types of plans; to assure appropriate flexibility in long-range planning; to understand and improve the role of individual participation in implementing plans; to quantify more planning objectives; to evaluate better the results of long-range plans; and to measure better costs of planning in relation to benefits. In addition, we do not know what is an ideal long-range planning structure for different sized companies in different industries. If we knew this the problems of execution would be easier. Finally, of course, the clearer, more complete and coordinated are actual plans the more complete and efficient can be control. Hence, the gaps that Dr. Ansoff noted have important implications for the improved use of plans.

There are even larger holes in our knowledge about ancillary benefits or uses of long-range plans. There are two categories here. One is completely new uses. The other is improvement in presently recognized uses. In the first class is use of long-range plans for understanding and taking advantage of projected periodicity of a firm's life. In the second category, we need to do much to increase knowledge about using long-range planning as a prime system of communication; as a major force to center top management's attention more on the long rather than the short-range problem; to give individuals a greater sense of participation in the decision-making process; to get at the problems which are of major concern to the life of an enterprise; and to provide a facile framework for better background studies and forecasts.

In dealing with the state of the art in using long-range plans it seems worthwhile to note a few major dangers to avoid. The following are illustrative: assuming planning decisions will be carried out without adequate machinery for execution; costs greater than the value of implementation; failing to provide for and permit flexibility; assuming too much precision of goals and plans for the very long-range future; ignoring uncontrollable factors important to executing the plan; confusing background studies and forecasts with

well-developed plans; failing to coordinate length of the planning period with time of commitments.

Long-range planning is growing rapidly in use. It will expand even more rapidly and have much greater benefit to users when we learn how better to make and use long-range plans.

3. Panel Discussion: Three experts engaged in a critical round table discussion of their presentations.
   a. WILLIAM HILL, *President, William Hill & Co.* Abstract not received.
   b. WILLIAM J. PLATT, *Deputy Director, Economics Division, Stanford Research Institute.*

My comments and questions fall in the crack between making plans (Ansoff) and using plans (Steiner).

These remarks must be prefaced by congratulating Chairman Schaffir on his selection of the word "Art" in the title of this session. Indeed, making, testing, and using plans are still art more than science. Ansoff has recognized that the making of plans is at best only quasi-analytical. Steiner has pointed to gaps in knowledge for implementing plans. It is as though we were navigating into the future with only a cloudy rear-view mirror to guide us. Nearly every paper heard during this convention emphasizes the need for humility on our part in viewing management as a science.

Yet business and government operations move on apace, the movement being unplanned, opportunistic and planned. This progress, we must confess, is largely in the hands of the management artist, not the management scientist. And until a new generation of managers is in control who have been trained better in the science of solving business problems, as was described by Dean Lorie yesterday, we who attempt to practice management science had better find a way to join and help the manager-artist. As such his approaches may be more visceral than cerebral.

The behavioral scientists remind us that company goals are not the only goals that motivate a company team: individual aspirations and drives are of great importance.

To come to the "crack" between making and using plans, it appears that a key factor is how to bridge from making to using plans in such a way as to assure a fair trial of planning. To get the strength of a whole organization behind it, a plan should be like a magnetic field (or lines of force) that properly orients all the component motivations and tendencies of the people in an organization. The lines of force will be effective only if the plan has been communicated to those who have authority to carry it out and only if they have confidence in it.

Steiner suggests an important means of bridging this gap and of orienting motivations when he describes the use of planning as a "system of communication." A well organized planning structure embracing appropriate staff and line officers is in itself a way of getting purposeful drive and movement, if for no other reason than that these officers are communicating in a *planning* network.

Another possibility for the problem of motivation and solidarity between planners and implementers is the use of a business game. In its ability to compress time and to demonstrate the interdependence of decisions, it is a powerful tool for training line and staff officers in the art and in the coming science of planning. The literature on business games is growing; several references are contained in Ansoff's and Steiner's paper.

I heartily recommend one of the generalized games such as have been developed by UCLA, IBM, Remington-Rand or American Management Association as a useful exercise in training those associated with planning. Even more useful would be tailoring of a game structure to the problem of the individual industry. While reality has not been fully captured in game models, there may be useful statistical inference that can be gained from many plays of a well designed game.

c. ROBERT B. SINGLETON, *Consultant, Operations Research and Synthesis Services, General Electric Co.* Abstract not received.

I. Managerial Economics. *Chairman:* PHILIP FAUCETT, *Director of Research and Senior Economist, Wolf Management Engineering Company, Chicago; Lecturer in Economics, School of Business Administration, Northwestern University.*

1. "Economic Analysis and Business Decisions," GEORGE CLOOS, *Senior Economist, Federal Reserve Bank, Chicago.* Abstract not received.
2. "Forecasting Demand in the Petroleum Industry," CLARENCE JUNG, *Section Director of Economic Research, Commercial Research Division, Standard Oil Company of Indiana.*

Forecasting petroleum demand requires an analysis and forecast of the energy market.

The energy market, in total and with respect to the shares contributed by each energy source, is mainly affected by income and price relationships. These must be taken into account in forecasting petroleum demand.

Petroleum demand can also be projected by traditional time series analysis or by the concoction of structural equations.

Forecasts are a part of the day-to-day living of modern business and must be evaluated as to their accuracy and worth and, most importantly, must be looked upon as guides to the most economic use of the firm's capital.

3. Panel Discussion.

a. GUENTHER BAUMGART, *President, American Home Laundry Manufacturers Association*

Top executives in business have far greater ability to understand and comprehend technical principles and information than most practitioners seem to feel. To this extent I respectfully disagree with Mr. Cloos' implication that business men tend to be "sucker" for pseudo-technicians, even though I have seen it happen time and again. Most executives of the top management and officer levels, especially in medium and large size corporations, are able and willing to study to the point of understanding the statistics and economic data necessary for making their respective business decisions.

The problem is for highly developed technical people in the fields of Economics, Statistics, Operations Research, and Quality Control to provide simple reports, charts, and tables, and other presentations of their findings, in the language, yes, even the jargon, of the executive and officer level, rather than in the relatively occult language of the technical science itself. For example:

A. I believe it is the responsibility of the business statistician to teach notions of accuracy, standard deviations, correlations, variance, and especially probability usually without mentioning the words themselves. It is my belief and it has been my experience that these ideas can be conveyed in simple lay language and they will be understood, yes, gobbled up, by fact-hungry top management teams. It takes hard work and substantial ingenuity on the part of the technical man, however. He must not expect the busy executive to come over to his ground.

B. I am certain it is the responsibility of the business economists to convey the full flavor, meaning, and business significance of the elasticity of demand as it relates to applied price policy. Marginal producers and buyers should be recognized and dealt with, even if they are never called that. I think it is important also that ideas related to hedging be used more than now and that business men be made conscious of the fact that they are speculating in almost every decision they make, even though they think they are conservatively "standing pat".

C. All of the mathematics-based scientists should use the ideas of change, rate of change, and change in rate of change because they exist, however clouded, in the many time series on which business decisions are based. Similarly, the ideas of maxima, minima, and inflection points, and even in some instances the significance of areas between curves, occur regularly in the business but are seldom called that. (One general sales manager whom I knew well developed for himself because he needed it, a system of elementary calculus, graphically applied, in order to control some 20 or 30 salesmen and relate their work to their respective share of industry in their territories. This man's mathematics education stopped in second year high school, thirty years before he did this!)

I believe I disagree in part with the preceding speakers that technical management services should be staff or advisory in nature. I do not like the idea of a well informed technician presenting the facts as he sees them and then abrogating his responsibility to think toward the best decision to be made on the basis of the facts he has gathered. I think the technician, be he economist or otherwise, should recommend, should argue his position, and face up to the consequences of making a wrong decision.

It is, of course, inherent in the business system that top management and officer level people must make the final decision. I think the technicians should participate in it, however.

I agree with Brother Cloos that forecasting sciences and techniques are sadly wanting. Like the weather man, if you forecast the going trend or seasonal average, you will be right. You will, however, be contributing really nothing. I call upon all of the technical scientists there are to work toward economic analysis which can actually identify in advance, times at which and quantities by which deviations from the expected norm or trend will occur.

As a concluding thought, I would point out, however, the phenomenon which I am sure everyone has observed. This is the fact that in business application, a successful forecast frequently leads to decisions and actions which affect and sometimes even reverse the outcome of the forecast itself. For instance, if a sound and accurate forecast is for a marked decline in the sale of the widgets that I manufacture, the actions I take to minimize or reverse the decline, if successful, can make my forecast a bad one, even though it was valid at the time I made it.

b. JOHN DILLINGER, *Statistics Department, School of Business Administration, Northwestern University.* Abstract not received.

c. MYRON UMBREIT, *Chairman, Department of Business Economics, Northwestern University.*

The primary role of a business economist is to act as a consultant to top management as to the economic implications of its policies and practices and to point out various alternative courses of action from which management can choose those which best suit its purposes. The economist must not be a member of any department, nor have a large staff. He works with various departments. He is concerned with over-all problems as they affect the firm. It is hoped that more firms will recognize the real role of the economist, for in such a role the economist can make his maximum contribution.

J. Management Implication of Electronic Controls. *Chairman:* BASIL REGIONE, *Arthur Andersen & Company, Chicago.*

The implications of numerically controlled machine tools and other electronic controls as they relate to productivity, costs, profits and the manager's very job were discussed by the following panelists:

DAVID M. COX, *Senior Partner, Cox & Cox, Consultants, Chicago*

GEORGE KOZMETSKY, *Litton Industries, Beverly Hills, California*

H. CLIFTON MORSE, *Cox & Cox, Consultants, Chicago*

MELVIN SALVESON, *President TIMS; President, Center for Advanced Management, New Canaan, Connecticut.*

Dinner Speaker: "Improving the Management of the Federal Government," JOHN A. BECKETT, *Assistant Director, Bureau of the Budget.*

K. Contributed Papers.

1. "An Integer Linear Programming Model for Machine Scheduling," HARVEY M. WAGNER, *Department of Economics, Stanford University.*

Several authors have previously considered versions of the following machine scheduling or sequencing problem: Given n items, each to be processed on one or more of m machines, the order of processing for an item being partially or entirely specified, find the sequencing of items on the machines which minimizes the total elapsed time to complete the manufacture of all items. It is assumed that the manufacturing time of an item on a machine is specified (i.e., non-stochastic) and that in-process inventory is allowable. For the sake of expositional simplicity, we postulate that an item is processed no more than once (if at all) on any one machine; a trivial modification of the model may be made to allow for multiple processing.

In this paper we offer an integer linear programming model which is capable of characterizing the problem. We feel it is of interest to present the model as (i) it exhibits there is a single model that encompasses a wide variety of machine scheduling situations, (ii) the linear format establishes the existence of a finite algorithm which monotonically seeks an optimum solution to such sequencing problems, (iii) although the model is now of very limited computational interest, future developments in integer linear programming and methods for efficiently handling "secondary constraints" may make numerical solutions of particular problems possible, and (iv) there is an indication of the possibility of constructing special algorithms to exploit the structure of certain of the "classical" scheduling problems. Needless to say, the major justification for considering such an approach is that Gomory and others have recently discovered promising methods for solving integer linear programming problems; a related justification is that Dantzig, Fulkerson, and Johnson have achieved noteworthy success in using secondary constraint techniques for solving a problem which *a priori* contains a mammoth number of restrictions. As will be evident below, the model in its present form is computationally unwieldy except perhaps for situations with a very few machines and a limited number of items; in such cases, a frequently recurring sequencing problem or one involving a considerable financial sum might profitably be solved by the method herein. We are more hopeful that this presentation might serve as a link to a more computationally feasible formulation.

2. "Computer Simulated Production Control for a Cable Plant," J. W. JESKE, JR. *Western Electric Co.* Abstract not received.
3. "Optimization of Professional Personnel Recruitment Expenditures," HERBERT HALBRECHT, *Herbert Halbrecht Associates*

The sharp increase in costs of professional recruitment, particularly in a market which will continue to be increasingly tight in the foreseeable future, requires that careful analysis be given to methods of reducing such costs. Quantitative evaluations of recruitment techniques are possible and necessary. This paper presents an objective approach illustrating how, at a given point in time, a company can quantitatively determine whether it is cheaper to utilize the services of a professional recruitment firm, or to not do so, but continue searching on its own. A probability analysis is involved in the determination of optimum allocation of professional personnel recruitment expenditures.

4. "The Effect of Biasing Parameter Estimates," SHIV K. GUPTA, *Case Institute of Technology* and SIDNEY HESS, *Atlas Powder Company, Wilmington, Delaware.*

Exact values for the parameters appearing in decision making models are seldom known. Often the costs of errors of estimation are ignored. They should be included in the model whenever the costs associated with an underestimate or overestimate of a parameter's value are asymmetric.

In this paper it is shown that for models with one parameter and one control variable, deliberately biasing the parameter estimate will reduce the cost of error of estimation and hence reduce the total expected cost. Essentially, biasing changes the asymmetric cost function into a more nearly symmetric one. A procedure for determining improved parameter estimates and the resulting savings is developed.

The procedure is illustrated and numerical results are given for the economic lot size model. From these numerical results it is noted that not only the expected total cost, but also the variance of the total cost is reduced when the estimate of the parameter is appropriately biased.