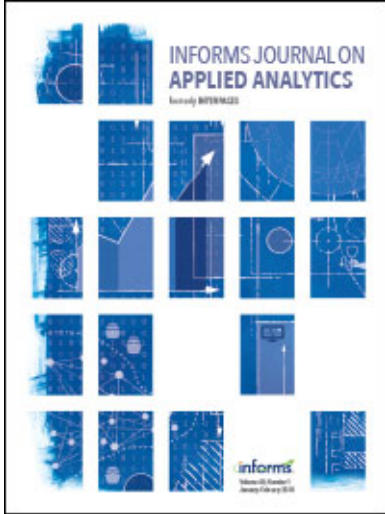




Interfaces

Publication details, including instructions for authors and subscription information:
<http://pubsonline.informs.org>

Abstracts

To cite this article:

(1971) Abstracts. Interfaces 1(5):29-86. <https://doi.org/10.1287/inte.1.5.29>

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ABSTRACTS

TA1.1 Roles for Business in Government Problem Solving, LEONARD NEWLAND, Ford Motor Company, Dearborn, Michigan.

There are reciprocal responsibilities in business dealings between a corporation and government. Both are stratified and bureaucratic. Both are suspicious as well as suspect. And yet their mutual survival and the necessity to compete demand that they work together on the increasingly complex problems which they share.

What well developed systems techniques can be used to bridge the bureaucratic gap? What systems are salable today that were unused ten years ago? Where do we look in government to find markets for matrix analysis, exponential smoothing and micro economics? The "blind men and elephant" syndrome is apparent in public problem definition. The management science approach might help if we could locate the problem.

TA1.2 Smoothing Techniques for State Government Financing, B.M. CONBOY, Director, Michigan Office of Economic Expansion.

State government is being whipsawed between the demands of local government and the guidelines of federal matching programs. Complicating this dilemma is a porpoising federal monetary policy which consistently overcorrects on both the upturns and the downturns.

Goaded by this fiscal harassment and inspired by its inherent challenge, state officials are turning to the most sophisticated management science techniques to anticipate emerging public problems, forecast the cost of coping with them, and analyze ratios of benefit to cost. Most exciting of all may be a new technique to capitalize on the program planning prerogatives accorded the states in the federal-state-local delivery system program. Here may be opportunities not only to smooth out the cost of solving problems but even to smooth the trends that create the problems.

Governments at all levels should be employers of last resort. Instead we are becoming the first to hit the layoff panic button. This deteriorating situation can be corrected and sophisticated mathematics can help.

TA1.3 Management Science in Local Government Projects, MARVIN L. ESCH, U.S. Congressman from the Second District of Michigan.

With the growing emphasis on placing more responsibility and decision-making with state and local units of government, there are major needs that must be established for the application of systems management techniques to local projects. A primary analysis will be made of the requirements in this area as well as potential sources of

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assistance available to local units of government through federal government programs. The paper will also explore the problems created by the duplication and parallelism of conflicting units of governmental jurisdiction on the local level by the townships, counties, cities, and regional associations and on the federal and state level by the departments and agencies with duplicating functions and overlapping categorical programs.

TA1.4 State of Michigan Management Information System Master Plan,
GLENN W. GOODMAN, Director, Management Sciences Group,
Executive Office of the Governor of Michigan, Lansing, Michigan.

A survey of state governments by the National Association for State Information Systems, completed late in 1970, concluded that a major difficulty of many states, insofar as the development of state information systems is concerned, stems from the "lack of a long range plan to assure coordinated development of state-wide systems rather than departmentally-oriented systems."

Recognizing this problem, the State of Michigan undertook early in 1970 the initial steps to overcome this difficulty through the development of a Management Information Systems Master Plan. The objectives of this plan are to guide the future development of management and management information systems and to insure the efficient and effective use of this State's automatic data processing resources. The Master Plan provides a blueprint--a program of action--for change in the total management process of Michigan State government.

TA1.5 Management Science in County and Municipal Government,
JOHN CARDEN, Ernst & Ernst, Cleveland, Ohio.

This paper is concerned with the application of management sciences to the special problems of county and municipal governments. It briefly reviews key problem areas where management science techniques have been successfully applied. This review is followed by a discussion of how management sciences can be more extensively used by local governments in the future, especially in the planning, funding, and evaluation of governmental programs.

TA3.1 Monte Carlo Simulation of Operating Room and Recovery Room Usage, HOMER H. SCHMITZ, Deaconess Hospital, St. Louis, Missouri; and N.K. KWAK, St. Louis University, 3674 Lindell Blvd., St. Louis, Missouri 63108.

The purpose of this paper is to provide Deaconess Hospital with an insight into the increased need for operating room and recovery room facilities, based on an increased bed complement of 144 medical-surgical beds. The problem is formulated into three primary questions: (1) How many more surgical procedures will Deaconess Hospital perform due to the increased bed capacity? (2) How much operating room time and space will the surgical procedures require? (3) How much recovery room time and space will the surgical procedures require?

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To answer these questions, a simulation model on the lengths of stay in the operating room and recovery room is constructed by the Monte Carlo method. The simulation model is statistically tested, and its results are interpreted. This simulation model can facilitate planning, decision making, and managerial control by providing management information.

TA3.2 A Prepaid Helicopter Usage Plan for Ambulatory and Other Medical Services, JOHN C. BAKER, Department of Pathology, Elyria Memorial Hospital, Elyria, Ohio 44035; and S. SUBBA RAO, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio 44106.

Air-mobility -- the use of helicopters -- has vast potentialities in rapid and efficient delivery of health care. Not being limited by the vicissitudes of ground transportation, especially in an urban set-up, and the antecedent delays and loss of precious time, a helicopter will be an invaluable mode of transportation in ambulatory services, in transporting doctors, nurses and other medical personnel. It will be uneconomical for a hospital to have its own fleet of helicopters since the utilization would be low. Economics of scale can be achieved if the usage is on a multi-purpose and inter-hospital (perhaps even inter-community) basis. It is advocated in this paper that such an approach be taken, and to meet the requirements a prepaid helicopter usage plan is suggested. Various aspects of the problem are discussed.

TA3.3 Management Science in the Design of an Ambulatory Care Information System, JOHN F. ROCKART, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, 50 Memorial Dr., Cambridge, Massachusetts 02139.

The development, implementation and evaluation of an effective information system to control the scheduling of patients in a multi-specialist medical group practice requires concepts from several areas of management science. In addition to the obvious area of information systems, models and theories from the areas of production management, behavioral science, and operations research are being extended and utilized in the implementation of this system. This paper reports on the conceptual multi-disciplinary approach to the design of this information system and some of the specific models being developed at the Lahey Clinic in Boston. The work, supported by both the Lahey Clinic Foundation and an HEW grant, draws heavily from theories, concepts, and methodologies which have been successfully applied in the industrial setting. Necessary extensions and accommodations to the medical setting are noted.

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TA3.4 Optimum Inventory Model for a Community Blood Bank, L. DEAN MAURER, American Hospital Supply Corporation, 1740 Ridge Ave., Evanston, Illinois 60201; JOE W. RIGBY, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas; and ROY D. HARRIS, Graduate School of Business, University of Texas, Austin, Texas 78712.

This paper presents a model designed to yield the optimum inventory of whole blood units of each type for normal operations of a community blood bank. The purpose of the model is to enable a blood bank to meet normal demand for whole blood while minimizing losses of whole blood units through deterioration. The model is based on a Poisson distributed demand for blood and a known carrying and shortage cost. The supply of blood is considered to be constant since an empirical study showed leadtime between order and receipt of whole blood units to be extremely small. The generalized model can be applied to most blood banks if demand follows a Poisson distribution.

TA3.5 and TA3.6. See Late Abstracts, page 85.

TA6.1 Executive Strategy in Managing Technological Innovations, DONALD M. ALSTADT, Lord Corporation.

Analysis of sequential stages of information collection, technological evaluation, economic assessment, and capital commitment decisions.

TA6.2 The Effects of Plant Size and Technological Change on the Cost of New Capital Facilities and Their Impact on Industry Investment Requirements, DAVID A. HUETTNER, School of Business Administration, Wayne State University, Detroit, Michigan 48202.

The effects of increased plant size and technological change on plant construction costs are analyzed using plant level data covering forty-five years in the electric power industry, twenty years in the cement industry, and forty years in the steel industry. The results contradict the belief that unit capacity costs decline with increased plant size and suggest that present construction cost indexes are blind to technological change and misleading for planning of future capital expenditures. These results also indicate that use of replacement costs instead of original costs as a basis for depreciation would make little difference. Analysis of the operating costs of electric generating plants shows no decline in operating costs for plant sizes above 300 megawatts and questions the present philosophy of building larger power plants, especially when an alternate strategy might be ecologically more desirable. The effects of diffusion of new technologies on capital requirements are also analyzed.

TA6.3 Technological Change and Scale Economies: Development and Application of a Model to Pig Iron Production: 1900 - 1965, MYLES C. BOYLAN, Department of Economics, The Ohio State University, Columbus, Ohio 43210.

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A model for analyzing changes in scale and in technology is developed which involves disaggregation of plant production processes into vertically- and horizontally-related sequences; examination of the general properties of typical manufacturing activities; and analysis of the interaction of capital investment decisions with activity and technological characteristics. The resulting framework is applied to pig iron production and related investments during 1900-1965.

TA6.4 Conceptual Problems in Measuring the Effects of Technological Change, BELA GOLD, Research Program in Industrial Economics, Case Western Reserve University, Cleveland, Ohio 44106.

A critical analysis of the potentials and limitations of efforts to measure the effects of technological changes through adjustments in productivity, unit costs, profits and prices--reflecting the results of extensive empirical studies.

TA6.5 Major Capital Decisions and Technological Change, RONALD W. SKEDDLE, PPG Industries, Inc., Pittsburgh, Pennsylvania.

A critical examination of the systematic procedures and analytical frameworks used in corporate assessments of prospective major technological innovations serves as the basis for suggesting improvements in such ex ante approaches and for designing more effective ex post evaluations. Illustrative material based on field research is provided.

TA6.6 A Measure of the Probability of Success for OR/MS Technological Innovations Due to Client Behavior, JOHN H. MANLEY, Air Force Institute of Technology, Wright-Patterson AFB, Ohio 45433; and DAVID I. CLELAND, Department of Systems Management Engineering and Operations Research, University of Pittsburgh, Pittsburgh, Pennsylvania 15213.

The behavioral response of individuals below the organizational level of decision-maker to proposed operations research/management science (OR/MS) technological innovations is investigated. The OR/MS implementation process is defined to contain three active groups of participants: researchers, managers, and clients. The normal psychological phenomenon of client resistance to change is described. However, in this study, the change threat stems directly from OR/MS projects being presented to clients for implementation. Using the analogy of a rotatable spring-weight mechanism, a quantitative model of the client resistance phenomenon is developed which is claimed to be useful for measuring this type of behavior. The effectiveness of the model as an indicator of project success under these circumstances was evaluated through field experimentation and the results are reported.

TA8.1 Routinization and Automation of Managerial Processes: A Systems Design Approach, JULES BELLASCHI, U.S. Department of the Navy, Naval Ordnance Systems Command.

A conceptual design approach will be presented. The first step in this approach requires the development of a simple model of the management functions and operational functions. A planning and control system will be conceptualized in terms of a process, decision making system, and information system (including information communication and feedback). The decision making system will reflect the behavioral attributes of the environment, and the firm including the management and its peculiar management philosophy. The concepts utilized in the routinization of the decision making system are rules, pattern creation and recognition, risk-taking thresholds, meta rules, algorithmic/heuristic methods, and adaptive capability. The automation of the planning and control system will be established in terms of rationalization, on-line computer and closed-loop system. The overall design approach will be in terms of horizontal and vertical integration and a hierarchical and modular approach.

TA8.2 The Decision Maker in Decision Making: Implications of Cognitive Functioning For Using Men and Machines, HILLEL J. EINHORN, Graduate School of Business, University of Chicago, Chicago, Illinois 60637, and Graduate School of Industrial Administration, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213.

With the increased emphasis on formal mathematical and computer models in decision making, the role of the man in this process needs explication. Whether men are used as measuring instruments and/or combining devices, the question of man's efficiency becomes one of determining his information processing capacities under various conditions and situations. Men can be used in formal models since the man is often able to perform tasks that may be difficult to deal with formally. Some of these tasks might involve sequential decision strategies, complex interactive strategies, and sensitivity to changing probabilistic generating functions in the environment. Men can also be used to provide input data for a formal model since they have accumulated information with regard to the past, present and future (e.g., expectations of future conditions could be used as input data). A methodology is introduced to deal with men and machines in an optimal fashion, taking into account the limitations and advantages of both. This approach is then extended to deal with the causes of disagreements between men utilizing a matrix approach to Brunswik's "lens model."

TA8.3 Improving Time-Sharing System Performance with Adaptive Algorithms, FRANKLIN H. WESTERVELT, Director, Computing and Data Processing Center, Wayne State University, Detroit, Michigan 48202.

The contemporary time-shared computing system is an example of a fairly complex dynamically changing environment in which "good" and "bad" performance may be quite easily recognized but where it is much more difficult to specify the precise procedures to be followed to yield "good" performance. This class of problems has been shown to

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yield to adaptive algorithms in which a large collection of tentative "policies" may be chosen by the adaptive procedure and the resulting "performance" used to influence subsequent choices. An on-going investigation of this approach in a contemporary time-shared computing system is explored.

TA8.4 The Limits of Artificial Intelligence in Management, BENT STIDSEN, University of Pennsylvania, Philadelphia, Pennsylvania 19104.

It has been reasonably well established that even very complex processes can be patterned for machine execution, and the search goes on for even more ingenious ways of patterning executive processes for purposes of "artificial management." In this context: What are the crucial elements of management? What role is left for the human manager? The "machineness" of artificial intelligence notwithstanding, artificial intelligence is a purely human creation; what is man that he creates artificial intelligence and where does he go from here? What are people for?

TP1.1 Problems of Applying Aerospace Systems Analysis/Management Techniques to Nonaerospace Programs, HARRIS PLOTKIN, President, H.M. Plotkin & Associates, 3972 North Waterman Ave., San Bernardino, California 92401; and JAMES VAUGHAN, The Aerospace Corporation, 1111 East Mill St., San Bernardino, California 92408.

The paper will present problems encountered in applying aerospace industry developed systems engineering and management science techniques to nondefense projects. The areas covered will be medical systems, law enforcement, transportation, education and urban renewal. Specific problems encountered in various civil system projects will be presented, along with a discussion of some of the alternate means found for establishing better communication between the systems analyst/management consultant and the educators, medical doctors, law enforcement officers and other potential recipients of the benefits of science techniques. The purpose of the paper is to provide management scientists and consulting personnel with insight for more efficiently communicating and accomplishing their work with their clients.

TP1.2 A Framework for Characterizing Interdisciplinary Urban Task Teams, JURI PILL, Systems Research Group, 252 Bloor St. West, Toronto 5, Ontario, Canada.

Temporary ad hoc task teams, usually interdisciplinary in nature, have been used in military systems analysis and in industry with some success, and it appears that such projects could be useful in alleviating some of our urban and environmental problems, where flexibility and comprehensiveness are crucial. However, there are pitfalls as well as payoffs; some attempts have failed miserably. To understand the reasons

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for this, a systems framework is developed to characterize the components, the process, and the results of such a project. Through repeated application and modification of such a framework, perhaps some causality can be established for success or failure. To this end, the framework is used to compare two task team efforts, a downtown transportation study and a study of a system of social agencies. Certain differences between them are hypothesized as plausible reasons for the failure of one and the success of the other.

- TP1.3 A New Model for Implementation of "O.R." in Public Agencies,
A. FOUAD SHERIF, Inter-Regional Advisor to the Public Administration Division, U.N. Headquarters; and FAREED R. ELNAGGAR, New York Institute of Technology, 135 West 70th St., New York, New York 10023.

Field experiences related to the introduction and implementation of operations research models in several developing countries in Asia, Africa and Latin America point to a high rejection rate of operations research solutions. Our sample case studies show the need for changing the conventional approach of the O.R. practitioner, especially in reference to the implementability of such models. Certain insights into the implementation phase could be drawn from the findings of applied behavioral sciences and management sciences. This paper attempts to (a) present the problem in a case situation context; (b) pull out from these case situations certain weaknesses in the conventional approach and (c) present new O.R. implementation models that could bring about better results.

- TP1.4 A Systematic Approach to Consulting for City Administration,
YORAM ROSENBERG, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

In recent years there has been an increasing trend toward recruiting research organizations to help in the solution of the problems faced by city administrations. This paper deals with the question of how to view such a consulting process. It suggests a conceptual framework and discusses its implications and uses. This systematic view of consulting was employed in examining an actual case of an organization consulting various departments of a city administration, and the lessons drawn from this exercise are presented. Finally, the research and application potential of this approach is discussed.

- TP1.5 Optimization of Creative Behavior in Government Bureaucracy,
VEDANAND, Faculty of Commerce, University of Manitoba, Winnipeg 19, Canada.

The size and complexity of challenges facing modern government bureaucracies are stupendous. And, if the Victorian pattern of bureaucracy has become "obsolete" and is no longer in tune with contemporary

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realities, a new form of organizational structure will have to emerge to meet the needs of society. This calls for a new look at the organizational dynamics in government bureaucracies. While the situation requires greater commitment for organizational creativity and innovation, little may be done in that direction because of certain built-in constraints. It is also conceivable that bureaucracies working through "bureaucratic personalities" are best equipped to handle routine decision-making, and tend to optimize routine decision-making behavior. Nonroutine decision-making and creative behavior in general may involve too much of a risk in bureaucracies. The paper explains this dynamics through an optimization model.

TP2.1 Measuring the Quality of Housing Stock, ANDREW GOLD, Executive Assistant, Cleveland Community Development Improvement Program, Cleveland, Ohio.

A brief review of problems one program has had in defining (a) housing standards and (b) what housing is. A case will be made for the use of the concept of housing service. This will be followed by the preliminary findings of a household survey for the city of Cleveland which may bear on the questions raised above.

TP2.2 A Linear Decision Model to Evaluate Financing Alternatives for the Rehabilitation of Urban Housing, ERICH OBERSTEINER, Assistant Professor of Finance, Wayne State University, Detroit, Michigan 48202.

The paper is concerned with an attempt to develop a rational linear decision model for the evaluation of rehabilitation proposals of urban housing under the Federal Housing Administration's program, Section 236. The model assumes private initiative and ownership of the properties. The model will be based on the principle of the maximization of the net present value of investment and rehabilitation proposals for urban housing. The impact of various constraints such as limitations on investment returns, minimum equity contributions and other restrictions associated with FHA guaranteed financing under Section 236 will be examined.

TP2.3 A Hypothetical Case Study of the Use of the Interdisciplinary Task Force Approach to Develop an Interagency Policy on Housing in Urban Areas, LOIS DEAN, Comprehensive Planning Assistance Division, U.S. Department of Housing and Urban Development.

In inter-governmental relations, the pressure of events demands a far greater degree of coordinated action than has heretofore been accomplished. One such means for achieving coordinated action is the interdisciplinary task force approach. Where task forces or variants of the interdisciplinary task force approach have been tried, they have often been established without the corresponding management adjustments which would give them a better chance to be effective. The paper shows

how the techniques can be applied to government. A hypothetical case study will be presented, illustrating the application of the approach to housing policy problems common to two or more agencies.

TP2.4 Operation Breakthrough's Application of Management Science Control Techniques, BERT GREENGLASS, Director of Planning and Programs Control for the Office of Research and Technology, U.S. Department of Housing and Urban Development; and TOBIAS GOTTESMAN, Operation Breakthrough, U.S. Department of Housing and Urban Development.

Operation Breakthrough is a HUD research and operational program designed to demonstrate the feasibility of using a variety of mass produced industrialized houses as an effective means to increase the volume of new housing starts in this country. Thus, Breakthrough must simultaneously satisfy both research and operational program requirements. The unusual set of requirements combined with unusual complex relationships between industry, local communities, local governments, and various agencies of the federal government represents a formidable management challenge. This paper describes various management techniques and systems currently being used which allow a small HUD staff, working with industry and with local government, to achieve program goals.

TP3.1 Benefits of Variable Nurse Staffing Under Various Constraints, JOHN C. HERSHEY and NICHOLAS BALOFF, Stanford School of Medicine and Graduate School of Business, Stanford University, Stanford, California 94305.

Hospitals often staff nursing wards at nearly constant levels although considerable fluctuations in work load may occur daily. "Controlled variable staffing," a procedure for adjusting staff to meet work load, is discussed as a means of increasing manpower efficiency. Gains in productivity using this approach versus a constant staffing policy are estimated using Monte Carlo analysis. The sensitivity of the relative benefits of the two systems to constraints such as the dependence among work loads in different hospital wards, the distribution of work load variability among wards, the degree of flexibility provided, and the level of demand upon full time staff are examined. Several criteria which a hospital administrator might adopt for equating levels of patient care under alternative staffing schemes are studied.

TP3.2 A Model for the Optimal Scheduling of Nursing Personnel in a Hospital, DAVID M. WARNER, and JUAN PRAWDA, Graduate School of Business Administration, Tulane University, New Orleans, Louisiana 70118.

The objective of this paper is to develop a scheduling model for nursing personnel. The nursing personnel scheduling problem is defined as the identification of that staffing pattern which (1) specifies the num-

ber of nursing personnel of each skill-class to be scheduled among the wards and nursing shifts of a scheduling period, (2) satisfies total nursing personnel capacity, integral assignment, and other relevant constraints, (3) allows for substitution of nursing tasks among the skill classes, and (4) maximizes the amount of nursing care services provided for the scheduling period.

The problem is posed as a mixed-integer quadratic programming problem, which is decomposed by a primal resource-directive approach into a multiple choice programming master problem, with quadratic programming sub-problems. Initial results suggest that a linear programming formulation, with a post-optimal feasibility search scheme, may be substituted for the multiple-choice master problem. The model is tested on six wards of a 600-bed general hospital, and results are presented.

TP3.3 Bureauadaptability Versus Bureaupathology of Mental Hygiene Systems: A Multi-Satellite Operational Model for a State Psychiatric Hospital, FAREED R. ELNAGGAR, New York Institute of Technology, 135 West 70th St., New York, New York 10023.

A large number of health institutions face the problem of how to make the most rational medical care and treatment decisions for every type of patient. However, the problem in the case of mental hygiene institutions is more complicated since: (a) The mental hygiene patient has an array of characteristics that make him different from the other hygiene patients. (b) The mental hygiene service is, in turn, a multi-service. (c) The mental hygiene decision is a team decision and not an individualistic action. (d) The resources management must, then, provide an organizational design that makes the system function effectively. Since state and mental hygiene institutions face some levels of bureaucratic dysfunctionals, the survival of such systems within the bureaucratic crisis is a dilemma. A state mental hygiene system is empirically analyzed using Merton's, Selznick's and Gouldner's models. And an operational research multi-satellite system of action is proposed to meet the criteria mentioned above.

TP3.4 Health Manpower Management, JOSEPH T. NOCERINO, Technomix, Inc., 7405 Colshire Dr., McLean, Virginia 22101.

This paper focuses on the interrelationship of the inadequate supply and inoptimal utilization of professional and paramedical manpower in our national health system and the design for an in-depth solution to the problem. Job analysis is the technique chosen to manage and reorder the current manpower disarray. Technomix, Inc. is presently engaged in such a study for the Navy Bureau of Medicine and Surgery. Drawing upon a computer-based compiled bank of over 7,500 health occupation task statements, THOUT, (Technomix Health Occupation Universe of Tasks) task inventory packages are being designed and constructed to job analyze over 50 different medical occupations. The packages are designed to

generate data which will indicate the job incumbent's task frequency of performance, task criticality and difficulty. The analysis will provide information needed by manpower managers and planners to do job engineering, design career pathways and develop training curriculum.

TP3.5 Physician Supplied Discharge Estimates as an Integral Element of Hospital Information Systems, ALAN C. FOOSE and GALEN BRIGGS, Bureau of Hospital Administration, The University of Michigan, Ann Arbor, Michigan 48104.

As part of an on-going research project, physician supplied estimates of patient discharge dates are being used as a primary information source in an admission scheduling system. This report reviews the design, implementation, and preliminary evaluation of the discharge estimate reporting system as follows. (a) Collection and reporting of estimates: To assist in collection and reporting, computer programs have been developed which provide daily reports to the admitting office and each of the four medical-surgical units participating in the study. (b) Data analysis and feedback: Analysis of estimates provided in the initial study period supports our belief that discharge information can assist management in the decision-making process. A routine feedback reporting system is being used to provide information on performance to physicians and nursing unit personnel.

TP6.3 An Experiment in Developing R&D Project Selection Criteria, WILLIAM A. HETZNER and WILLIAM E. SOUDER, Department of Industrial Engineering and Management Sciences, The Technological Institute, Northwestern University, Evanston, Illinois 60201.

This paper describes an experiment on the effects of group interaction upon the development of effective and consistent decision criteria for research and development (R&D) project selection. Fifteen practicing engineers and managers were asked to develop and rank a set of decision criteria based on their experiences in their own organizations. They were then divided into two heterogeneous groups, representing different operating organizations affected by R&D, and asked to develop and rank a set of group decision criteria. There were three separate and three joint group decision sessions held to discuss their criteria. Criteria and their rankings were reported at six points in the experiment: three individual reportings and three group reportings. The reported criteria and rankings were analyzed in terms of the convergence of the groups and their individual members toward similar criteria and rankings, and the emergence of useful decision criteria during the experiment.

TP7.1 Problems of Airport Management, JOHN E. FLEMING, Graduate School of Business, University of Southern California, University Park, Los Angeles, California 90007.

The airport manager is a key link in the national air transportation chain. This paper presents an overview of the functions and activities of

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airport managers and the problems which they confront. The research data comes from on-site interviews and studies at twenty airports in the western portion of the United States. It was found that the airport manager operates at a critical interface between the airport owner (often a municipality), the airlines, general aviation, various governmental agencies, local residents and environmentalists. His primary management functions require sophisticated technology in long-range planning, operational and financial control, organizing, and staffing. He administers revenue-generating activities and technical operations in the areas of maintenance, security and safety involving modern management techniques. Yet much of his time is also spent in external relations that necessitate great competency in behavioral and interpersonal skills.

TP7.2 A Transportation Scheduling Model, HUGO VANDERSYPEN, Transportation Center, Northwestern University, 1812 Hinman Ave., Evanston, Illinois 60204.

The objective of a transportation schedule is to provide an attractive service (capacity, frequency, timetable, travel time) over links of a given network, in such a way that the demand achievable at these service levels can be accommodated under optimal conditions. A conceptual model is developed which enables the transportation manager to simultaneously define such decision variables as fleet size, service frequencies, and dispatch policies (timetables). Both the passenger routing and the vehicle routing can be obtained from the solution through a post-analysis program. The model, couched in a mathematical programming format, has a linear objective function, with both linear and nonlinear constraints. Decision variables are either continuous or zero-one. Zero-one and mixed-integer solution algorithms are tested, concurrently with normal linear programming algorithms, in a search for "good" solution procedures for the scheduling model.

TP7.5 The Dow Rail Car Location System, CHARLES W. BASH, GORDON A. LANGE, and STEPHEN D. WHIPPLE, Business Information Services, The Dow Chemical Company, Midland, Michigan.

The rail car location system processes data provided by nearly all U. S. railroads and forty Dow shipping points to provide information to improve utilization of the Dow rail fleet. The collected data is processed by computer to create a file containing current status and location of every car in the Dow fleet at all times. Objectives of the system include maximum use of the fleet, improved customer service, and performance measurement.

Data collection methods will be discussed including track-side scanners, voice-grade and teletype communication, message switching and order entry system interface in a quasi-real-time environment. Presentation will be centered around the usage of data to improve capital performance, with topics such as car location reports, exception reports, detention billing, utility reports, recharge costs, history and carrier audit and performance reporting. Future applications to include

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on-line inquiry with teletype and CRT remote devices and/or COM. Problem areas are incomplete, missing, or out-of-sequence input; control; and user familiarization and education.

TP7.4 Dynamic Simulation Model for Total Logistics System Planning, OMAR KEITH HELFERICH, Department of Marketing, Michigan State University, East Lansing, Michigan 48823; ROBERT MONZCKA, Department of Management, Arizona State University, Tempe, Arizona 85281; and PETER GILMOUR, Department of Economics, Monash University, Melbourne, Australia.

The paper reviews the experience over the past eighteen months of the application of LREPS, Long Range Environmental Planning Simulator, to planning of corporate physical distribution systems. The concept of the LREPS model was developed to consider the strategic sequential decision problems of physical distribution systems. A partial list of variables modified in simulation experiments includes (1) sales forecast, (2) product line, (3) market areas, (4) warehouse and manufacturing plant size and location, (5) service level goals, and (6) cost factors. The paper also presents a progress report of continuing research which has as its goal the expansion of the model to a total corporate logistics simulator. The logistics model will have the capability to simulate the major components of materials management, production management, and physical distribution relevant to strategic, sequential decision making. The components modeled include (1) multi-echelon multi-item inventory control, (2) transportation, (3) warehouse and production operations, (4) multi-link communications network, (5) facility relocation, (6) purchasing, and (7) production and work force planning.

TP7.5 Truckload Motor Carrier Rates in a Normative Spatial Environment, JAMES P. HYNES, Naval Postgraduate School, Monterey, California 93940.

Very little analytical attention has been focused on directional and spatial effects in truckload freight rate structures. Directional effects in freight rates have been widely discussed in the literature, but a general mathematical resolution of the problem has not evolved. Directional effects are looked at here in terms of a profit maximizing motor carrier. Under normative assumptions, the characteristics of a rate structure which maximizes profit for the carrier are examined.

Rates on truckload freight traffic in an actual common motor carrier are examined for directional patterns which correspond with empty vehicle movement patterns prescribed by the normative model. The data indicate a positive statistically significant relationship. It is concluded that directional effects are significant and measurable factors in a motor carrier's rate structure, and therefore should not be ignored in contemporary rate studies.

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TP7.6 Operations Research Applications in Transportation, WENDELL M. STEWART, A. T. Kearney & Co., Inc., Chicago, Illinois.

Transportation is the largest individual cost element in most physical distribution systems. Rapidly increasing transportation costs have focused increased management attention on the problem of minimizing transportation costs within a framework of acceptable customer service. This paper will describe the manner in which OR/MS has been used to reduce costs and improve service in the following different types of key transportation problems: (1) optimizing (private and common) motor carrier line haul costs, (2) minimizing local delivery costs, (3) optimizing the use of in-transit credits (a grain industry example), (4) optimizing the mix of time and spot charters (a marine problem), and (5) simulating airport passenger moving operations.

TP8.1 The Automatic Factory: Possibility Versus Desirability, SUMER C. AGGARWAL, The Pennsylvania State University, University Park, Pennsylvania 16802.

This paper discusses two main aspects of the Automatic Factory: (i) its possibility and (ii) its desirability. Possibilities of automatizing production of goods and services are quite evident from the way sciences and technologies are progressing. Humans are slowly beginning to function as supervisors of machines. Computers have started taking over even the routine functions of human intelligence. Automation is always accompanied by compulsory interdependence between departments, and as a result, it promotes better coordination. Simon predicts that by 1985, the U. S. A. will have technical capabilities to manage corporations by machines. Therefore, it is high time that management scientists take a hard look at its desirability aspects. This paper highlights the favorable and unfavorable consequences of such a situation. The major resulting effects discussed are: (1) isolation of employees from executives, (2) need for managers with superior all round capabilities in the profession and human relations, (3) underutilization of equipments and their cost-effectiveness, (4) unemployment and retraining problems, (5) environments of uncertainty and fear, (6) possession of wealth and consequently of power by a few, and (7) inability to influence an individual's conditions of participation, resulting in lowering of self-esteem and his turning to illegitimate means.

TP8.2 Stochastic Line Balancing, HON-SHIANG LAU and JOHN F. KOTTAS, School of Business Administration, University of North Carolina, Chapel Hill, North Carolina 27514.

This paper deals with the paced line balancing problem in which task times are stochastic. Paced lines are those that allow only a limited amount of time to complete the tasks assigned to each work station. The usual procedure is to group tasks into work stations so that the sum of their expected times approximate some arbitrary level, e.g. 90% of the maximum available time. Optimal level of labor utilization is

achieved by developing relationships between the costs of staffing work stations and the costs of finishing tasks not completed on the line. This research has led to significant improvements for balancing paced lines.

TP8.3 Simulation as an Aid to Flexible Manufacturing System Design, JOHN J. HUGHES, Kearney & Trecker Corporation, 11000 Theodore Trecker Way, Milwaukee, Wisconsin 53214; and GEORGE K. HUTCHINSON, University of Wisconsin, Milwaukee, Wisconsin 53211.

This paper describes a generalized digital simulation model developed to aid in the design and operation of automatic factories, which are of the flexible manufacturing systems type. The factory is viewed as a closed transportation system serving work centers. Incorporated in the model are the detailed steps necessary to automatically move parts from one work center to another, including the assignment decisions and the choice of paths between work centers; the detailed movement of parts within the material handling system to and from the work centers, including shuttling, and priority based part sequencing decision rules; the processing of parts at the work centers; the introduction of raw materials into the system and intermediate storage of semi-finished parts; and the decision to add or remove workholding devices from the system. The entire system, including decision rules, is defined at model run time by input parameters. The model is intended to serve as a design aid in such areas as physical plant layout, choice of work centers (machine tools), choice of material handling systems, and evaluation of alternative control systems and process control strategies.

TP8.4 Log Sorting Yard Simulation, G. F. FINKE, Weyerhaeuser Company, Tacoma, Washington.

A rapidly expanding activity at Weyerhaeuser is dry-land sorting of logs. A dry-land log sorting yard involves an initial investment in excess of a million dollars in land, machinery and mobile equipment as well as substantial continuing operating costs. Simulation has been, and is being, used to assist in such capital budgeting decisions. Computer simulation models written in SIMSCRIPT have been used to answer the following questions: What is the most efficient yard layout? What is the best combination of equipment to service the yard? How will the yard perform under fluctuations in volume and average log size? What is the incremental cost of making additional sorts? Which are the critical or "bottleneck" activities? What efficiencies are possible through smoothing truck arrival patterns? Each simulation run, representing a complete day of activity, takes less than five minutes on a GE 635 computer and produces reports at a management level.

TP8.5 WORKSIM: A Work Flow Simulation Program, HENRI DE CROUY-CHANEL, THOMAS VICTOR, First National City Bank; and CHARLES R. McCLUNG, TMI, Cambridge, Massachusetts.

WORKSIM provides line managers with an evaluation of the economic

impact of alternative structural changes in transaction based processing systems. It has been successfully applied to model the unique production characteristics of check processing in banks. WORKSIM, driven by the input profiles of work entering the system, projects (1) work flows through a network of work centers, (2) queueing at individual work centers, (3) manpower and equipment utilization, (4) late completions, and (5) system costs. The individual work centers and their interrelations are defined separately via input data such as process rates and delays, priority and capacity allocation rules, and routing of completed work. Results are presented of an application which identified \$1 million annual savings in a bank check processing operation. A comparison of pilot versions coded in PLI, Dynamo and GPSS is included.

TP8.6 A Modular Approach to Computerized Material Balance Calculations, J. I. MORGAN, The Dow Chemical Company, Midland, Michigan; and A. I. JOHNSON, McMaster University, Hamilton, Ontario.

The problem of determining material requirements is an important one in any integrated manufacturing organization. This paper presents an approach to the computer calculation of material requirements and balances. The approach is particularly useful in planning applications where it is desired to evaluate numerous alternatives. It also forms a means of generating matrices for linear programming optimizations. The approach identifies particular types of calculations which can be written as subroutines in a computer program. Each subroutine can be represented by a particular name and symbol, thus becoming a module which can be used as a building block in a material balance calculation system. To model a particular material flow complex, an information flow diagram is drawn in which each calculation module is represented by a block. Directed lines connecting the blocks represent streams of information flow. The information flow diagram can be readily coded for computer case-study simulations using a unique application-oriented language.

TP9.1 Control of Random Fluctuations in Shop-Load, MOHAMED E. TAYMOUR, Technical Center, Owens-Illinois, Inc., P. O. Box 1035, Toledo, Ohio 43601.

In a shop-warehouse system, where orders to the shop are triggered through an order-point-order-quantity inventory control system, shop load fluctuations will occur even in the absence of a seasonal demand pattern. This is due to the chance element involved in triggering orders. In this paper an expression is derived for the mean and the variance of the shop load in the absence of seasonal demand patterns for the manufactured items. A model to describe the costs associated with random load fluctuations is presented and a method to control such fluctuations is suggested. This is based on the creation of a time buffer between the triggering of an order and its actual dispatch to the shop. An expression for the optimum length of this time buffer is derived.

TP9.2 Evaluation of Shortage Costs for Inventory Models: A Queueing-Theoretic Approach, MUHITTIN ORAL, Scientific and Technical Research Council of Turkey, Ankara, and Department of Operations Research, Case Western Reserve University; and S. SUBBA RAO, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio 44106.

Most of the objective functions of inventory control models have cost parameters, namely, set-up or order cost, inventory carrying cost, and shortage cost. Successful implementation of inventory models requires an accurate evaluation of these cost parameters. Of these costs, shortage costs are the hardest to handle.

This paper investigates and derives a model to evaluate shortage cost parameters utilizing a queueing-theoretic approach. The basic idea is to identify the measurable factors of shortage cost for which the associated costs are much simpler to obtain. The shortage cost can then be expressed in terms of these component costs.

When inventory level goes below zero, the backlogged demands form a queueing process. Shortage costs arise because of "defections" of the customers. In queueing terminology, the loss of customers can be due to balking and reneging. Various losses and times associated with customer impatience are evaluated using queueing theory methods. These in turn lead to the estimation of shortage costs.

TP9.3 Utility Program for Systematic Layout Planning, HAMED KAMAL ELDIN, Professor of Industrial Engineering and Management, Oklahoma State University, Stillwater, Oklahoma 74074.

This is a Monte Carlo simulation program using GPSS. This program is used to determine the number of loading facilities required for dispatching goods. The parameters of the model are: number of truck arrivals, times of arrivals, size of truck loads, loading times appropriate to these loads. For a chosen number of loading bays, the program simulates the truck arrivals. The reduction in waiting time of trucks is balanced against the increased waiting time of servicing facilities. The resultant truck waiting time/loading facility utilization determines the appropriate number of loading bays.

TP9.4 Some Joint Order Inventory Models, HARISH L. VERMA, School of Business Administration, Wayne State University, Detroit, Michigan 48202.

In the last twenty years considerable attention has been focused on the subject of inventory control. The inventory control systems that are generally discussed in the literature are the fixed order quantity system, the periodic review system, and the (s, S) system where s is the reorder point and S the maximum inventory level (also known as the two bin inventory control system). A basic but limiting assumption of these inventory models is that all sets of item decisions are independent of one another. The models assume that the inventory level of each item is con-

trolled separately and that each item in inventory is ordered independently from all others. This approach often leads to higher total costs. Moreover, one supplier is the source of a variety of related items, and savings are achieved by ordering the items jointly, i.e., by including a number of such items in one purchase order.

This paper examines some of the limitations of "independent" ordering rules and the advantages of joint orders. Some joint order inventory models are analyzed and one is proposed. The proposed joint order model is more general and incorporates within itself both the independent ordering rules and joint ordering rules. Some applications of the proposed model are discussed and results are reported.

FA1.1 The Systematic Use of Expert Judgement in Manpower Planning, G. T. MILKOVICH, A. J. ANNONI, and T. A. MAHONEY, Industrial Relations Center, University of Minnesota, Minneapolis, Minnesota 55455.

Manpower planning, defined simply as the process of determining how the organization should move from its current manpower position to its future desired manpower position, encompasses most elements of manpower management. Forecasts of manpower requirements, supplies and deficits and surpluses are the typical outputs of these planning efforts. Manpower forecasting functions to provide the framework for planning efforts and to enable any organization, industry, education, or government to achieve its goals. Most conventional manpower planning models rely upon historical relationships among parameters and upon the expectation that these historical relationships and rates of change will persist into the future. When decision makers do recognize that future conditions may be unique, few systematic procedures have been developed and, more importantly, tested to incorporate rapidly changing environments.

We report here a case study in the development, implementation and evaluation of the delphi technique, which systematically makes use of expert judgment in generating manpower forecasts. This case study was conducted in a large national retail organization on professional manpower. The results of the delphi technique using an expert and a naive panel are compared with results generated by a conventional regression based model and the actual experience of the organization, which serves as the criterion. The expert judgments generated using the delphi technique are analyzed in an attempt to formulate an improved forecasting model, i.e., the delphi experience is used in developing a model incorporating elements used by the expert judges. The use of the delphi in generating manpower forecasting models in diverse fields such as educational and health organizations is also discussed.

FA1.2 Some Manpower Planning Models Based on Levels of Educational Attainment, WARREN L. BALINSKY, School of Management, Crosby Hall, State University of New York at Buffalo, Buffalo, New York 14214 and ARNOLD REISMAN, OR Department, School of Management, Case Western Reserve University, Cleveland, Ohio 44106.

A number of manpower planning models are developed and optimized.

The models are dynamic feed forward models, and treat people as the only flow variable. The flow originates by considering a particular population of eligible persons, and then traces them through the educational and economic sectors of the model. The flow is driven by selecting the optimal number of entrants into the educational (training) program each period. The objective function is composed of educational and manpower "inventory" costs. The manpower costs are for having an undersupply or oversupply of trained manpower, and can be related to unemployment, educational or other societal costs.

FA1.3 Prediction of Job Choice from Respondent's Discrimination Net of Decision Process, ROBERT L. SWINTH, School of Business, University of Kansas, Lawrence, Kansas 66044.

The decision process of an investment trust officer selecting among alternative stocks for a portfolio can be characterized as a discrimination net. Gaumnitz, Sherr, Swinth and Tollefson demonstrated that this technique could be used as the basis for obtaining and describing the choice behavior of a large number of people. In the present study the job selection decision processes of MBA students at the University of Kansas were obtained.

The subjects formed discrimination nets that incorporated the factors of employment that were important to them (location, salary, type of work, etc.) and the substitutions they were willing to make between factors. These nets were then used to predict which jobs the subjects would take from among those offered. The predictive correctness was highly significant. The data also revealed which factors are important (out of 82 available) and what substitutions people are willing to make (substitute location for salary, etc.).

A second wave is in progress such that it also will be possible to compare the nets of this year's class with last year's to see if the changes in the job market are reflected in the nets of these two sets of subjects.

FA1.4 A Case Study in Program Evaluation and Optimum Organization Design, GEORGE P. HUBER, Graduate School of Business, University of Wisconsin, Madison, Wisconsin 53706; and JOSEPH C. ULLMAN, Krannert Graduate School of Industrial Administration, Purdue University, Lafayette, Indiana 47907.

The Job Bank Program is a principal component of the government's efforts to fight the unemployment problem and to bring minority groups into the nation's workforce. Among its unique organizational-technological features is its use of computers to maintain and communicate information on job openings to work applicants. The study reported here had two purposes. The first was to determine the optimum organizational-technological configurations for the job banks. The second was to determine if and how the feedback, to the Job Bank Program administrators, of program performance data affected the administration and direction of the program. Operations research and organization theory concepts

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were used, but the principal analytic techniques were multivariate analyses of monthly performance data from the job banks of 46 metropolitan areas. Comparisons were made between particular organizational-technological configurations and various performance measures in order to identify and communicate the optimum technological and organizational design.

FA1.5. See Late Abstracts, page 85.

FA2.1 The Market for Private Housing and the Market for Management Sciences, KARL G. PEARSON, Professor of Business Administration and Director of Real Estate Education, University of Michigan.

The market for private housing has many dimensions, all of which indicate an increasing demand. This demand, and the associated industry to fulfill it, creates a secondary demand for the application of the management sciences to the problems of the industry. This paper will explore the dimensions of demand for housing and suggest the nature of the problems of this industry to which management scientists should be addressing themselves.

FA2.2 Management Science Approach to Land Development, FOSTER M. BURTON and RICHARD L. SMITH, Arizona State University, Tempe, Arizona 85281.

A nine-step approach was developed for selecting the best development scheme for a given parcel of land. The steps are grouped into four phases: (1) market analysis, (2) construction engineering evaluation, (3) mathematical optimization model, and (4) financial and risk analysis. The mathematical model involves both general and integer linear programming. The risk analysis uses some of the PERT probabilistic concepts.

FA2.3 A Multidimensional Analysis of a Family Decision-Making Unit's House-Buying Decision Process, THOMAS W. WHIPPLE, Assistant Professor of Administrative Studies, York University, Murray G. Ross Building, 4700 Keele St., Downview 463, Ontario, Canada.

Past housing research has included feature preference and decision process studies in addition to traditional demand analyses. Unfortunately, the analyses performed have been limited to bivariate techniques with findings summarized in frequency response tables. This study differed considerably in that:

- (1) it was a case study based on pre-purchase and post-purchase dissimilarity and preference data;
- (2) disaggregated data were used to study house-buying behavior at the family decision-making unit level; and
- (3) psychometric techniques were utilized extensively.

The most significant result was the development of a useful procedure for the scientific solicitation, analysis, determination, and segmentation of home-buyers' preference structures with respect to housing dimensions, features, and identifiable tradeoffs. In addition,

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multidimensional perceptual maps of house descriptions enabled housing decisions to be predictable. The analysis procedure extracted differing family-level housing dimensions besides suggesting useful relationships among purchase time, the degree of congruence of house descriptions, the number of housing feature disparities, and the amount of house-buying experience.

FA2.4 Low and Moderate Income Housing Management - An Important Component in Creating and Maintaining Environmental Quality for Residence, GERALD MADER, Assistant Director, Community Systems Foundation, Ann Arbor Office, 2200 Fuller Rd., Ann Arbor, Michigan 48105.

When housing is provided for low and moderate income families, consideration must be given to forming a sense of community in the housing developments so that quality of living as well as shelter is provided. The history of public housing indicates a failure of management to provide a standard of living conducive to maintaining a good physical and psychological environment.

This paper will present an effort conducted by the Community Systems Foundation and the Institute for Social Research, University of Michigan, in analyzing management systems and designing and conducting management training programs which have had as a major goal an attempt to reduce failure by increasing the ecological awareness and problem solving skills of the manager.

FA3.1 An Aggregative Budget Planning Model for Health Care Clinics, SANG M. LEE, College of Business, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

One of the most pressing social problems in the United States today is the delivery of adequate health care services to every American. The total health care expenditure for Americans has reached \$60.5 billion a year, which is approximately 6.7 percent of the Gross National Product, and it has been increasing at an average annual rate of 7 percent. In recent years, a very popular organizational structure of health care service has been medical clinics. This "group practice" is a system of cooperative practice of medicine by physicians for the purpose of providing efficient service at low costs. Yet, systematic analysis of health care clinic operation has been almost totally neglected by physicians, management scientists, and economists. This paper applies goal programming to design an aggregative budget planning model for an optimum resource allocation in medical clinic operation.

FA3.2 Information Systems for Health Care Delivery in an Ambulatory Care Facility, DAVID J. WERNER, Assistant Professor of Management Science, Southern Illinois University, Edwardsville, Illinois 62025; MARTIN GOLDBERG, Instructor of Industrial Engineering, Illinois Institute of Technology, Chicago, Illinois; and A. GERSON GREENBURG, Resident in Surgery, Michael Reese Hospital, Chicago, Illinois.

An ambulatory care facility is composed of diverse decision makers including physicians, administrators, and paramedical personnel. These decision makers have diverse information requirements; however, the bulk of these requirements involve data derived from patients in a variety of ways. This paper is concerned with identifying the decisions and information requirements of these individuals and the problems in structuring an information system to serve these multiple users. The system must be capable of providing the inputs for planning and evaluation decisions as well as that for routine, specific-patient problems. Furthermore, the present state of knowledge about decision making in this environment dictates that the information system be dynamic and capable of providing a means for the study of the decision-making process so that the system can continually be improved. The results of a pilot project will be presented.

FA3.3 A Population Clustering Technique for Primary Health Care Services Planning, WILLIAM J. ABERNATHY and JOHN R. MOORE, JR., Graduate School of Business, Stanford University, Stanford, California 94305.

A central problem in planning primary health care services for a specific target population is to anticipate how that population will react to the mix of services provided and the way in which the delivery system is organized. An ability to determine the factors influencing an individual's decision to seek care would be an important contribution to the management of primary care facilities and the removal of barriers that deny certain portions of a population access to care. Recent studies attempting to explain health services utilization in terms of population characteristics have demonstrated shortcomings in two areas: (1) The basic data used in much of this research reflects attitudes and not utilization per se; and (2) the analytical methods employed are frequently too weak to permit the drawing of predictive relationships or valuable insights. This paper discusses an approach whereby local census data and other readily available information can be used to describe the primary care utilization practices of all major segments of a community. An example based on a census of 3,000 families illustrates the feasibility of this technique for health services planning, and suggests that population clustering provides a powerful base upon which to construct meaningful predictors of primary care utilization.

FA3.4. See Late Abstracts, page 86.

FA3.5 A Spatial Allocation Model for Regional Health Services Planning, WILLIAM J. ABERNATHY and JOHN C. HERSHEY, Graduate School of Business, Stanford University, Stanford, California 94805.

In planning for health services, the need arises to determine the location, capacity and number of health centers for a geographically

defined region. This paper presents a model which can assist in making such allocations. The planning region is assumed to consist of geographically defined subareas or census blocks of known location. The region is stratified in such a way that each stratum exhibits relatively homogeneous patterns of health care utilization. The model characterizes the effects of center locations upon aggregate utilization and utilization of individual centers, and gives optimal locations of centers with respect to several alternative criteria. An example illustrating computational feasibility and the implications of various criteria is presented.

FA3.6 Design of a Target Health Care System, JOHN HUTCHINS and GERALD NADLER, College of Engineering, University of Wisconsin, Madison, Wisconsin 53706.

There is a demand for change to improve cost effectiveness and equitability in health care from both consumers and providers of health care. Current attempts to improve the health care system (HCS) are often fragmented and piecemeal and thus probably capable of only marginal improvement. Rational change requires the availability of a formally designed Target Health Care System (THCS) whose implications have been thoroughly explored as a guide toward which changes can be directed. Given a target, action alternatives can be more intelligently decided upon, redundancies and duplications avoided, resources more intelligently allocated, and more comprehensive, longer range plans made to implement a more cost/effective and equitable HCS.

The formal design of a THCS would use definitions of HCS goals and objectives developed by an interdisciplinary panel of health experts to develop functional models from which four separate interdisciplinary teams would each design a health care system concept. Each team would be chaired by an experienced systems engineer.

A system concept, embodying the best parts of each of the competing system concepts, would be chosen for detailed design of a health care system. The most cost/effective design solutions for each component would be assembled into alternative systems and evaluated. The best system solutions would be selected and synthesized into a THCS.

FA4.1 Methodological Problems in Management Science Education, LAURENCE J. MOORE, College of Business Administration, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

Management science educators have long dealt with methodology as it relates to scientific inquiry, general model building concepts, and the various specific models of selected problem areas. The problem is that methodology in management science education has, however, remained relatively undeveloped. Students continue to come away from a first course in management science with the impression that they have studied a group of independent and, in many cases, unrelated topics. A cursory examination of any half dozen texts on the subject will generally yield chapter titles of various solution techniques. There is a need for an inte-

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grative framework (model) of management science which would provide an overview of the interrelationships of the various topical areas to one another and to real-world problems. The purpose of this paper is to address itself to the problem and to present a proposed methodology for the teaching of management science.

FA4.2 A General Systems Paradigm for Management Science Education, ROBBIN R. HOUGH, School of Economics and Management, Oakland University, Rochester, Michigan 48063.

The success or failure of a program in management science education may be described in terms of the ability of its graduates to respond analytically to a variety of economic, social, political and ecological scenarios. The paper discusses the nature of a successful response, and several barriers to the production of graduates capable of making such responses are discussed. A restatement of the methodological foundations of management science along general systems lines is shown to provide the basis for a solution to the problems identified. Finally certain results which have followed from use of the paradigm in the classroom are presented and discussed.

FA4.3 Futurism: A New Direction in Management Science Education, HARVEY NUSSBAUM, Bureau of Business Research, Wayne State University, Detroit, Michigan 48202.

Recent writers (Kahn, Toffler, Bennis, etc.) have alerted the public to the significance of our rapidly changing cultural environment. Business organizations are becoming increasingly aware of these future changes and are beginning to establish and utilize groups devoted to planning for this new environment. This paper will discuss a course sequence in "corporate futurism" which the author has developed in conjunction with an ongoing management science education program.

FA4.4 Education for Management Science: A Graduate Student Post-mortem, JOHN B. KENNEDY, Owens-Illinois, Toledo, Ohio.

The author, a recently graduated management science M.B.A. (Wayne State University), will discuss his educational experience from the standpoint of both a former graduate student and a currently employed practitioner. This paper will attempt to serve as a suggestion generator for curriculum planners, deans, and corporate recruiters.

FA6.1 The Emergence of Consensus Decision Criteria in Heterogeneous Groups, WILLIAM A. HETZNER and WILLIAM E. SOUDER, Department of Industrial Engineering and Management Sciences, The Technological Institute, Northwestern University, Evanston, Illinois 60201.

Many resource allocation and planning decision situations require the cooperation of individuals or groups not directly involved in the decision process in order to achieve successful implementation of the

decision. This paper proposes a methodology for determining the needs and objectives of these individuals and groups, and for including their needs and objectives as part of the decision criteria. The resolution of possible conflict between the needs and objectives of the decision maker(s) and the needs and objectives of these other individuals and groups is discussed, and the results of an experiment on developing consensus decision criteria in heterogeneous groups (individual members of the groups having disparate backgrounds and experiences) are reported.

FA6.2 A Study of the Errors Obtained When Aggregating Expert Judgments with the Delphi Technique or Other Quasi-Nominal Decision Making Processes, GEORGE P. HUBER, Graduate School of Business, University of Wisconsin, Madison, Wisconsin 53706.

This paper is concerned with the problem of obtaining judgments from experts and combining them into a single "group-representative" value in a way that will minimize the error, the difference between this value and the "true" value being sought. Although the analysis was conducted using computer simulation, the results were congruent with the published experimental studies on this subject. The effects on the error of all combinations of the following variables were determined:

- (1) The accuracy of judgments of the individual group members,
- (2) The number of group members,
- (3) The aggregation rule used to transform individual judgments into the group-representative judgment, e.g. the mean, or majority rule,
- (4) The number of intervals on the rating scale used by the judges,
- (5) The distribution of the true value being estimated.

Guidelines for the practicing administrator wishing to structure decision making or group-estimation processes are suggested based on the study results.

FA6.3 Stochastic Analysis of Personnel Systems, RICHARD L. SMITH, Arizona State University, Tempe, Arizona 85281.

The flow of personnel through formal organization hierarchies is considered as a stochastic process. Both simulation and GERT models are developed and compared. Measures of performance involving transition probabilities from one position in the organization to another as a function of time are identified and discussed. An interesting feature of the work is the interpretation and utilization of very low order transitional probabilities associated with success in a given organization. The work is a by-product of the Ph.D. dissertation written by the author.

FA6.4 Optimal Command Structure as Viewed Through the Budget Process, PAUL M. CARRICK, Department of Management and Economics, Code 62, Naval Postgraduate School, Monterey, California 93940.

One performance criterion for defining the optimal command structure of a large organization is the efficiency with which the struc-

ture facilitates the formulation and execution of maximally feasible budgets. For example, the recent 6% unemployment rate can be regarded as a measure of the efficiency with which the highly decentralized command structure of the United States economy is able to solve a short run gross output estimation problem. Formally, within the class of linear programming decomposition models, there is a subset where prices are continually fixed, i.e. current costs are used as a basis of planning. This is a very simple estimation problem, but it is descriptive of the actual budgeting process in many large organizations, where optimization is accomplished as a conceptually separate administrative problem. Thus, variation in the partitioning of the technology matrix is equivalent to a change in an organization's command structure. Consequently, it is possible to specify a command structure that identifies a maximally feasible gross output through a minimum cost estimation process.

FA9.1 Multi-Dimensional Forecasting, PAUL D. GOODWIN and BURNHAM S. GOULD, JR., CPC International, Inc., International Plaza, Englewood Cliffs, New Jersey 07632.

CPC International, Inc. has developed a forecasting system to serve various functions (e.g., production planning, market and sales analysis) in different divisions (e.g., industrial, consumer). Adaptive smoothing techniques are used to generate independent monthly projections at three levels of detail--simultaneously. Marketing analysts have the opportunity to modify these projections at any level of detail. As a result, the analysts are able to apply sound business judgment to the projections of a large number of related items in a timely and effective manner. This is accomplished through the use of a hierarchical tree structure accessed with a pointer system which allows modifications made at one level of detail to be efficiently extended to related items at the other levels of detail.

FA9.2 Industrial Profitability: A Long-Term, Firm-Level Study of Cost Behavior in the Steel Industry, ROBERT W. MITCHELL, School of Business Administration, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.

The object of this paper is to study the long-term (1933-1969) profitability of sixteen of the larger steel firms, and of the industry, in order to assess the following: (1) the relative contributions to changes in profit rates of: (a) unit profit margins and investment turnover defined on physical output and (b) profit margins on sales and investment turnover defined on sales and (2) the relative contributions to changes in unit profit margins of changes in unit price and of changes in several categories of unit costs including unit materials cost, unit labor cost and unit depreciation cost. The present profitability of the firm is viewed as a result of its prior adjustments, and these adjustments are appraised within the above framework. In addition, the paper comments on the existence of trends and other consistent patterns in the long-term behavior of the various costs and the corresponding cost proportions.

FA9.3 The Implications and Implementation of Explanatory Modeling in Corporate Planning, WILLIAM K. HALL, University of Michigan.

A major problem in the development of corporate planning models is the determination of structural relationships which quantitatively relate planning decisions to measures of future organizational performance. In a large number of contemporary planning models, these relationships are estimated by conducting statistical analyses on data obtained from the firm's accounting information system. The intent in this paper is to illustrate some problems which can arise in using such an approach and to propose some alternative model-building methodologies. Methodologies are developed for situations where the underlying causal associations between decisions and performance measures are known, in which case time series analysis techniques can be utilized to estimate the desired structural relationships. In addition, methodologies are developed for situations where the underlying causal associations are unknown. In this case structural decomposition techniques and analyses of data obtained from special-purpose information systems can be utilized to make inferences on the relationships of interest. The techniques are applied to operation cost analysis and revenue forecasting to illustrate the underlying concepts in developing structural relationships for strategic corporate planning models.

FA9.4 The Corporate Model: The Long-Range Planning and Monitoring Tool, M.N. BARTAKKE and J.P. POPINO, Sperry-Rand Corporation.

This paper describes a computer model which has been implemented to aid the decision-maker both in planning corporate activities in the future and in monitoring certain current activities.

Its interactive nature enables the user to easily manipulate this deterministic model to consider a wide range of assumptions. Each product manager, within a division, can develop a plan which is consistent with the firm's previously stated objectives. Functional considerations can easily be evaluated across product and division lines by a central planner as he interfaces with the model and its subsets.

The novel graphic approach employed by the authors in building the model and in gaining user acceptance will be illustrated.

FA9.5 Production Functions and Management Decisions, P.T. LELE and J.W. O'LEARY, Research Staff, Western Electric Engineering Research Center, P.O. Box 900, Princeton, New Jersey 08540.

The process of planning future utilization is one of the management's basic functions. Quantitative models that define the relationship between resources and output can help management supplement intuition and experience necessary to make good decisions.

Production functions are econometric models of historic relationships between output and the factors of production. Most of the research in production functions has been on the macro-level with aggregated inputs and outputs. This paper develops production functions on product

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lines, for which accurate and detailed data are available. Production functions for various product lines in an economic entity can be combined into an econometric model for the entity.

This model can be viewed as a corporate planning model, which can be used to forecast costs, productivities and returns on investment, not only for the entire corporation but for each product line. Furthermore, it can be used to plan and allocate resources among various product lines to achieve the management's objectives.

FA9.6 The Problem Formulation Process: We Need a Strategy!

MICHAEL E. ECHOLS, School of Business Administration, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.

The thesis of the paper is that strategic considerations dominate the economic return of the problem formulation process. This is demonstrated by a simulated problem solution process constructed from the models and concepts familiar to every management scientist. The key decision of selecting the problem-model combination prior to the gathering of data and the familiar solution process is examined in terms of the constraints on the formulation process as a whole. The role of the budget is examined, and shown to be a fundamental piece of information having strong implications for the types of strategies feasible for the management scientist to use. The paper ends with a brief discussion of the necessary conditions for defining a problem formulation strategy.

FP1.1 Models for Law Enforcement Effectiveness, E. I. GOLDING and

P. CHEILIK, National Institute of Law Enforcement and Criminal Justice, LEAA, Department of Justice, Washington, D. C.

An illustrative example - the use of indices to predict the utilities of law enforcement strategies or new equipments to reduce criminal activity. An example of a specific case history will be used to describe the initial calibration of the index.

FP1.2 The Use of Management Information Systems for Police Operations, N. NISSENOFF, Computer Command and Control Company,

Washington, D.C.

A definition of police operations, based upon a concept of the management structure which supports a police commissioner, is presented. This structure clearly relates police objectives, positions, and decisions with data elements in such a way as to identify areas of overlap and omission in operations. The result is a more efficient and responsive system. Finally, a brief discussion of a method for monitoring a community's changing goals will be discussed in the foregoing context.

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- FP1.3 "Robustness" of Random Patrol Scheduling, JAMES EVANS and MATTHEW ROSENSHINE, The Pennsylvania State University, 207 Hammond Building, University Park, Pennsylvania 16802.

A theoretical method of random patrol scheduling is modified to allow the consideration of operational requirements in deriving the patrol routes and schedules. The departure of the schedules from purely random schedules is considered by comparing the distribution of patrol inter-arrival times on road network links with the exponential distribution obtained under random patrol scheduling. The results obtained in this investigation indicate that the maintenance of a constant number of patrol cars in the network adversely affects the random character of the patrols, but that these effects are mitigated by superposition on the patrol of duty-caused delays. It is concluded that random patrol of street networks can be effected under operational constraints.

- FP1.4 Management Science and the Crime Laboratory, E. S. KRENDEL, R. M. DUMMER and L. FREIFELDER, University of Pennsylvania, Philadelphia, Pennsylvania 19104.

A study of the crime laboratory's role in the law enforcement and criminal justice systems has been conducted. The requirements imposed on the laboratory by its clients are defined, and a scheme to support laboratory planning and budgeting is presented.

- FP1.5 The Utilization of "Calls for Police Assistance" in the Police and Municipal Policy Making Processes, THOMAS E. BERCAL, Southeast Michigan Council of Governments, Detroit, Michigan 48231.

The principal thesis of this paper is that police operational data are not only useful to the policy-making body of the department, but are also of significant value in the overall structuring and evaluation of municipal services. In presenting this thesis, examples of data collected, but not now generally used by police departments, will be discussed; an example of the use of this data in police resource allocation and patrol response evaluation will be presented; a possible redefinition of the police department within the urban "service" mix will be submitted, and the use of the data in defining and evaluating "service" other than police will be explored. In closing, the development of law enforcement management information centers and their integration with other municipal information systems will be discussed.

- FP2.1 Urban Recreation: Demand Analysis and Site Selection, NORBERT DEE, Senior Environmental Planner/Economist, Battelle Memorial Institute, 505 King Ave., Columbus, Ohio 43201; and JON C. LIEBMAN, The Johns Hopkins University, 513 Ames Hall, Baltimore, Maryland 21218.

Location of public recreation facilities is an important consideration in the management of today's urban places. In this paper the demand for urban playgrounds, a particular type of urban recreation, is

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determined and analyzed for the city of Baltimore. Information obtained from this analysis is used to formulate the location of playgrounds into an optimal location model. This formulation is verified on a study area in Baltimore City, and is used to compare alternative recreation development.

FP2.2 A DESIM Simulation of President's Family Assistance Plan, STEPHEN PATER and MADHUKAR JOSHI, Applied Human Service Systems, Florence Heller Graduate School, Brandeis University, Waltham, Massachusetts 02154.

A description of the Family Assistance Plan (FAP) is available from the VISTA Information Service Bulletin of November 15, 1970. Briefly, the plan creates a work requirement: physically fit heads of families are required to participate in manpower and job training programs. Child care services are expanded to support the children of trainees and workers. Conceivably, this acts as incentive and means to reduce dependence on local welfare programs. DESIM (managerial decision simulator) model based on the data from Macon County of Illinois is used to simulate this plan for four years. Except for the beneficial effects on child care, parental anxiety and related problems, no significant differences are noticeable between FAP and Macon County base run. Similar lack of effect is postulated throughout the northern United States where the welfare clients receive substantial benefits from state financial aid programs. In contrast, FAP may be more beneficial in the southern United States.

FP2.3 The Implementation of Decision Analysis in the Planning and Evaluation of Model Cities Programs, JOHN B. WALLACE, JR., 109 Matherly Hall, University of Florida, Gainesville, Florida 32601.

The objective of this project is to improve the effectiveness of the project planning and control decisions within an urban planning agency. The investigator found that the effectiveness of the agency could be improved by a greater emphasis on measuring output variables of projects and programs and training the agency personnel to make more accurate assessments of inputs and outputs. Consequently, a set of time-sharing programs was implemented, and the agency was encouraged to modify its decision processes to more completely quantify the analysis of each critical project. The paper discusses the behavioral and organizational changes and the types of improvements in resource allocation and project control which were observed.

FP2.4 Application of Modeling Techniques to Community Shelter Planning, J.W. DICKEY and ROBERT R. MCDONALD, Division of Environmental and Urban Systems, College of Architecture, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061.

Because of its lifesaving potential in the damage limitation structure of national defense, the development of a nationwide fallout shelter

system (the Community Shelter Plan--CSP) is at the core of Civil Defense. The primary aim of the CSP process is to balance such factors as movement times, shelter resources and physical barriers to arrive at the best and most workable plan for the community. To achieve this aim, a computer allocation model has been developed to help produce a plan which considers the entire system of the community and optimizes the allocation of its shelter resources. The results in testing the model have illustrated that some of the normal procedures and assumptions currently used in the CSP process are subject to serious question. This model currently is operational for rural county shelter allocation.

FP3.1 Pharmaceutical Innovation and the National Health Care System,
JOHN P. CURRAN, Pfizer, Inc., 235 East 42nd St., New York,
New York 10017; and JEROME E. SCHNEE, Graduate School of
Business, Columbia University, New York, New York 10027.

Our national system for the delivery of health care services has come under increasing scrutiny in recent years. Several studies of the economics of health and organized medicine have emerged. Yet, surprisingly little systematic study has been given to the relationship between our system for discovering, producing, and distributing drugs, and the total health care system. The purpose of this paper is to outline a program of research on pharmaceutical economics which will eliminate this gap in our existing knowledge.

In particular, we are concerned with the economics of pharmaceutical innovation and its implications for public policy. A number of studies will be discussed in this regard. Data will be presented regarding the relationship between pharmaceutical innovation and size of firm, and the sources of pharmaceutical innovation during the 1935-62 period. A current study updating these findings for the vital 1962-72 period will be reviewed. Implications for public policy in the areas of patents, compulsory licensing, and government support of inventive effort will be explored.

FP3.2 Government and Industry Errors in the Unsafe Drug Controversy,
WILLIAM H. GRUBER, President, Research and Planning Institute,
Inc., 50 Shaw St., West Newton, Massachusetts 02165.

Standards of drug safety have not been defined, and the statistical monitoring of the drug delivery system is functioning at a level far below the requirements implicit in the potency of pharmaceutical products delivered for health care of humans. The history of poor practice by the government and by industry is reviewed, statistical problems involved in the design of a statistically adequate testing system are considered, and a proposal for new standards of drug safety is suggested.

FP3.3 Problems in Hospital Pharmacy Operations, WENDELL HILL,
Pharmaceutical Services, Detroit General Hospital, and Associate
Professor of Pharmacy, Wayne State University, Detroit, Michigan.

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The paper will contain the following: (1) a discussion of the problems encountered by a pharmacy director in obtaining adequate funding for pharmacy operations in a tax-supported hospital; (2) a discussion of techniques for relating the medication services to overall hospital objectives as well as to those objectives adopted by the various major departments within the hospital; (3) a discussion of the problems encountered in reassigning medication service functions in a manner not necessarily fitting the traditional division of labor within the hospital.

The discussion will be illustrated from experiences acquired at a 700-bed county tax-supported hospital and a 500-bed city tax-supported hospital.

FP3.4 The Building of Scientific Evidence as Affected by Alpha and Beta Error Levels, A.J. MELCHER, B.L. MYERS and N.L. ENRICK, Department of Management, Kent State University, Kent, Ohio 44242.

We develop the thesis that under some conditions, a low alpha level will most contribute to building of scientific evidence, but with other conditions, this practice contributes to rejecting new evidence in favor of protection of the status quo in science. We first discuss and critically assess the reasons that apparently underlie the present practice of setting alpha error levels. We then propose several factors that if used in establishing error levels could contribute to development of science. Specific reference will be made with regard to pharmaceutical and related testing.

FP4.1 A Linear Model for the Allocation of Instructional Resources, RONALD BESEL, Southwest Regional Laboratory for Educational Research and Development, 11300 La Cienega Blvd., Inglewood, California 90304.

An allocation model is proposed for instructional systems having: (a) instructional programs which can be structured in terms of behavioral objectives, instructional activities, and required achievement levels; and (b) instructional activities for which the resources needed can be estimated. John Carroll's "model for school learning" is used to justify a linear model. Carroll's model hypothesizes that a learner will achieve an objective to the extent that he spends the time he needs. Student performance on program objectives is represented by "degree of learning." As a first approximation, degree of learning is the ratio of the time actually spent on learning to the time required. The Dantzig-Wolfe Decomposition Method is used to obtain an initial solution; a heuristic procedure is then employed to adjust parameters and improve the solution. The model can be used for econometric studies of instructional systems and to compare resource allocation strategies.

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- FP4.2 Delphi Decision Methods in Higher Education Administration,
ROBERT C. JUDD, Professor and Chairman, Department of
Operations Analysis, University of Toledo, Toledo, Ohio 43606.

Administration in higher education requires strategies that avoid confrontation and polarization. Methods of consensus formation have been utilized by futurists and by forecast oriented think tank assignments. They can be and are now being used to achieve consensus on academic planning, campus structure and utilization, and curriculum decisions. Delphi, focus Delphi, and several alternative approaches are examined and compared in both a time and dollar cost matrix.

- FP4.3 Planning Faculty Hiring, Promotion, and Tenure Policies,
PAUL V. TEPLITZ, Analytical Studies Group, Massachusetts
Institute of Technology, Cambridge, Massachusetts 02139.

Academic departments in many universities have hired new faculty on the basis of teaching needs and balance of specialties within the department, but have made their promotion and tenure decisions solely on the basis of professional quality. Yet, the two decisions interact, and in a period of limited growth or contraction, the practices of the recent past can lead to significant imbalances in the distribution of faculty ranks. In the development of a five-year staffing plan for one institution, a simulation model was used to make explicit the future consequences of current staffing decisions and of alternative decision rules. The model has been fitted to data for the university as a whole as well as to several schools within it. In these applications, direct appointments from outside the institution into the higher faculty ranks and sponsored research support have emerged as significant determinants of future faculty composition and costs. Furthermore, it is apparent that the rapid growth in some departments during the 1960's will pose unusual problems in the years immediately ahead.

- FP4.4 Information Constructs as Measures of Scientific Output,
WILLIAM E. SOUDER, Department of Industrial Engineering and
Management Sciences, Northwestern University, Evanston, Illinois
60201.

Definitions and techniques normally used to measure productivity in factory situations are not readily adaptable to scientific work. Surrogate productivity measures, such as the number of scientific publications per time period, inherently neglect the quality of the scientific output. Furthermore, the nature of the task can be a motivating variable for a scientist. In this research, a model of heuristic problem solving behavior is proposed, and information theoretic constructs are used to track both the quantity and quality of information outputs accruing over time. Applications to date indicate that the information quantity and quality constructs used are highly effective measures of scientific output.

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FP4.5 A Probabilistic Model of Educational Buyer Behavior, GURRAM-KONDA M. NAIDU, Michigan State University, East Lansing, Michigan 48823.

Administrators of higher education often confront the problem of predicting the number and quality of incoming students into their programs during any academic year. The uncertainty in prediction increases with increasing constraints on internal resource allocation, and the problem boils down to maximizing the enrollment and/or attracting the quality students into the programs which in part is necessary to attract and maintain quality faculty. In an effort to answer this problem, an empirical study covering both the populations of Shows (who accepted the Michigan State University's product package) and No-Shows (who rejected the MSU's product package) has been conducted at the Michigan State University during 1968-1969 and using this as a data base, a probabilistic model describing the educational purchase behavior has been developed. Treating financial aid as a control variable the model predicts the probability of accepting or rejecting the MSU's educational product package given certain academic and demographic information of the applicant. The developed model demonstrates how the graduate enrollment and incoming student quality varies with different administrative policies of financial aid allocation.

FP4.6 Program Planning in Community Colleges: The State of the Art, RICHARD S. WEBSTER, Executive Office of the Governor of Michigan, Lansing, Michigan.

Community colleges are under constant pressure to adapt to demands for growth and change by offering new programs. What are the planning strategies used and how might the management scientist contribute to this process? Is there a disparity between these two approaches, and if so, how can this disparity be reduced?

FP6.1 An Approach to the Investigation of Task-Communication Structures, GERALD W. STILES and MICHAEL A. NAHMIAS, The Graduate School of Management, University of Rochester, Rochester, New York 14627.

This paper assesses the feasibility of utilizing an information processing model of human behavior to describe the structure of decision-making and communication in a task-specific research and development organization. The organization studied (a small division of a large international firm) has reached a critical juncture in its attempt to develop markets. It is scheduled to move from pilot production to additional capacity from which greater and more varied output will be demanded. The situation reaches crisis proportions as the pilot line is unreliable and its output must be graded and allocated to present customers. Thus, market development through additional usage and new applications is severely constrained by the uncertain quality and volume of output. The need for a designed problem-solving and information

processing system which integrates production and marketing is apparent. The approach requires measuring the complexity of the decision tasks, the capacity of decision-making units for information processing, and the division's present organizational structure.

FP6.2 PERT/Performance: The PERT Methods Extended to Assure the Expected Product Performance, RONALD A. SCHNEPPER, Department of the Navy, Washington, D.C.

Proper management of a new product or an evolving program requires planning for and control of the desired objectives throughout the development period. The technology is available to assist the manager, but the techniques must be tailored to the particular problems and needs. In many situations powerful planning and control tools are available in the methods of networking and PERT (Program Evaluation and Review Technique), and specific applications can be innovated.

This extension to the PERT methods is such an application. It addresses a product's desired operational capability and the problems associated with planning and monitoring the performance aspects during a typical development program. Throughout a research and development effort the product is being reevaluated in terms of components, schedules, and costs, with the expected capability assumed to remain about as specified. Many a product's performance is not being guaranteed, and often unknowingly sacrificed for other considerations. As the desired product capability is the reason for the development, it is appropriate to assure this performance.

Mr. Schnepfer was the plans and programs staff assistant in the Navy Special Projects Office (Polaris/Poseidon) and raised the question --Why not PERT our performance? Attempting the positive answer to this question and later to fulfill his thesis needs, he developed this extension. The methodology was evolved from many considerations, including the rationale of the original PERT approach, and with a sound working knowledge of PERT and management tolerances of such techniques. This solution is identified as a PERT/Performance scheme for planning and control.

FP6.3 Multi-Product Program Component Testing and Acceptance Strategy Information System, R.W. SHRADER, Xerox Corporation, Business Products Group, Research & Engineering, Bldg. 833, 800 Phillips Road, Webster, New York 14580.

This paper is concerned with the design, implementation, and functioning of a complex technical information system required to provide technical and planning data for both administrative and technical decision making. The information system provides for a meaningful evaluation of a unique component at any point within the typical testing cycle. The parameters of the evaluation consist of reliability design, quality, and physical characteristic requirements as they affect the subsystem design within a specified machine or machines, these machines being in a

specific phase within the machine development life cycle. The system provides for the reporting, coordination, and feedback of information between the functional levels, i.e., design engineer, laboratory personnel, and component engineering, and the vertical decision-making administrative hierarchy.

FP6.4 Risk Analysis in Military R&D Projects, A.K. VARNELL, JOHN McGRATH, D. SALVANO, and W. HOLMES, U.S. Army Combat Developments Command, Communications-Electronics Agency, Plans & Operations Division, Fort Monmouth, New Jersey 07703.

This paper describes a method of formally assessing risk in major military Research and Development projects through quantitative analysis at predefined milestones. The answers to a series of questions concerning the many uncertainties associated with time, cost, and performance goals at key decision points identified in the Army Life Cycle Model provide the basis for ranking of alternatives. Each question is scored according to its ability to determine risk, its relevance and one's confidence in the response. The resulting pessimistic, best and optimistic risk estimates for each alternative may then be evaluated through standard statistical analysis.

FP6.5 Some Issues Concerning the Effectiveness of Parallel Strategies in R&D Management and Procurement, WILLIAM J. ABERNATHY, Graduate School of Business, Stanford University, Stanford, California 94305.

The decision making process in a research and development (R D) project is one of sequential choice under conditions of substantial uncertainty. The decision maker, starting from conditions of broad uncertainty, makes a stream of choices to: (a) gain increasingly better information about appropriate outcomes, (b) avoid excessive risks of unfortunate choices along the way, and (c) achieve progress toward a timely completion. The progress that is made over the course of a project in reducing uncertainty and sharpening and improving objectives is a form of learning. The rate with which this learning takes place is an important characteristic of an R&D project that influences the way the project can be managed.

This paper explores the effect of learning on the use of one particular strategy that a manager can use to deal with uncertainty in R&D projects--a strategy of parallel approaches. The broad usefulness of this strategy depends upon a rapid rate of learning, and previous studies have assumed such a condition in concluding that it should receive greater use. The pattern of choice and outcome in twenty-one actual projects using a strategy of parallel approaches is analyzed in the present study to test alternative assumptions about the rate of learning. Results show that a slow rate of learning, rather than a rapid one, best explains outcomes realized in these projects. Although the findings are tentative, they suggest the need for further research on this issue and establish a method-

ology that can be used for this purpose. The issue is particularly worthy of study because of the implications for R&D procurement in federal and industrial organizations where large amounts of resources are involved.

FP6.6 A Model for the Evaluation of R&D Laboratories and Some Preliminary Results, EDWARD S. ESBECK, N. M. BALWALLY, S. SRINIVASAN, A. REISMAN, B. V. DEAN and S. SUBBA RAO, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio 44106.

This paper describes a methodology for evaluating the effectiveness of R&D laboratories and the preliminary results of applying it to the eleven laboratories involved in the Project REFLEX (Resource Flexibility) experiment being conducted by the Department of Defense as well as the NASA Lewis Research Center. The methods are applied to (1) determining the input and output variables and (2) weighing and measuring the subjective variables. The results of the study indicate that laboratory effectiveness can be meaningfully quantified, thus providing a basis for evaluating the effects of changes in personnel, structure, and/or process.

FP7.1 An Economic Analysis of Use of a Management Science Technique, LEONARD S. SIMON, Community Savings Bank, Rochester, and Graduate School of Management, University of Rochester, Rochester, New York 14627; CHARLES LAMAR, Scott Paper Company, Philadelphia, Pennsylvania; and GEORGE H. HAINES, JR., Graduate School of Management, University of Rochester, Rochester, New York 14627.

The uses of management science models in organizations are assessed. A classification of models according to the type of problem for which the model is intended to be applied is developed. The economic benefits derived from use of such models are shown to be dependent upon the problem class for which the model was developed.

Application of linear programming to media allocation for a small budget advertiser is evaluated as an illustration. It is shown in this case that the use of formal models cannot be justified. A discussion is presented which focusses on the interrelationship between the model taxonomy, economic benefits, and problem scope.

FP7.2 Market Forecasting Using Input-Output Analysis: A Concept for Industrial Companies, JAGDISH KHANNA and ELLIOT RANARD, C-E Cermatec, Division of Combustion Engineering, Inc., Management Information Systems Department, Valley Forge, Pennsylvania 19481.

This paper outlines the use of the powerful technique of input-output analysis in forecasting the product markets of three of the industrial divisions of a large multi-division company. Forecasts were generated at the company product and geographical district level of detail as

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compared to the traditional I-O use in forecasting the demands for major producing sectors of the total economy. Forecasting accuracy has been enhanced because: (1) a product forecast is quantitatively related to forecasts of all consuming industries and the latter to a forecast of general economic activity. This ensures consideration of all effects on product demand and the consistency of product forecasts to an overall forecast of the economy; (2) changes in the forecasted product markets are identified as resulting from technological changes versus growth in the level of activity. Therefore, forecasts using the I-O approach have provided market insights substantially improving long-range planning in the company.

FP7.3 Choosing Product Characteristics, ROBERT C. BUSHNELL, Associate Professor of Economics and Operations Research, Wayne State University, Detroit, Michigan 48202.

Linear programs are used to model the preference (utility) functions with respect to a class of products of each of a large number of market segment (consumer) prototypes. This is a particular implementation of a scheme by Lancaster wherein such functions are considered a result of two mappings: consumers responding to characteristics and products giving rise to characteristics. The weighted sum of the solutions of the various prototype models yields a verifiable market prediction. The model framework is shown to have two virtues: First, it provides a framework into which existing market data can be fit or, if missing, specified. Second, it permits developing results for hypothetical circumstances, in particular for evaluating the competitiveness of projected with existing products.

FP7.4 An Interactional Model of Market Behavior: Computer Simulation, TANNIRU R. RAO, School of Business Administration, University of Wisconsin-Milwaukee, Milwaukee, Wisconsin 53201.

A typical produce purchase involves decisions on brand, store, size, and purchase timing, the outcomes of which are not independent of each other because of such factors as: the extent of product distribution, different product sizes, stockouts, and the degree of competitive activity, etc. The study tests via computer simulation, a model that incorporates the different response variables and their interactions. Using one half of the panel data (the first year purchases) the a priori distributions of the relevant response variables and the model parameters are estimated, while the other half (the second year purchases) is used for validating the model output. The model answers sequentially the following questions for each consumer: (a) When will the consumer make his next purchase? (b) In which store? (c) What brand? and (d) What size? The model, called Realistic Evaluation of Consumer's Interaction with the Purchase Environment, is tested for its ability to predict aggregate market behavior. The model treats the brand outcomes as a binary choice situation (purchase of a specific brand versus all other brands). The

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performance of the model in predicting brand sales is compared with the heterogeneous linear learning model adopted by Kuehn and Massy.

FP7.5 Product Modifications for New Multi-National Markets, TIM SHAFTEL, Department of Management, College of Business and Public Administration, University of Arizona, Tucson, Arizona 85721.

An international corporation has several product-market strategies available to it. One such strategy is that of moving existing products or minor modifications of existing products into new foreign markets. The chief difficulties of such a move are to determine which modifications should be used in a market and the associated optimum prices. The costs include fixed costs of producing new product modifications, shipping, inventory, and tariff costs, as well as advertising and distribution costs. Legal, cultural and environmental considerations must also be examined. This paper presents a model which develops an optimum marketing strategy. A solution procedure is presented which can solve large problems and which can be modified to allow other factors (such as cross elasticity of demand) to be considered.

FP8.1 MIS: Models and Information Systems, RICHARD L. ANDERSON and DAVID S. HIRSHFELD, Management Science Systems, 1530 East Jefferson St., Rockville, Maryland 20852.

An efficient, flexible information system is essential to the success of any large-scale optimization or simulation model. A frequent cause for the failure of a model building project is that it does not involve the development of a sound information system to support and process the model. The authors discuss the integration of management science and information systems technology. An effective approach to the design and implementation of systems for management science applications is presented, along with examples of recent, successful, large-scale applications in industry.

FP8.2 A Computerized Graphical Approach to a Production Information Reporting System, CAROLE E. ADAMS, JACK M. BROWN, and THOMAS G. EICHINGER, The Dow Chemical Company, Midland, Michigan 48640.

A flexible system has been developed which accepts standard accounting data on production units, and provides production management with "pictures" of their operations. A description of the interactions necessary between managers and management scientists to accomplish this task will be included. The manager is able to spend less time on considering what is happening and more time on what to do about it. In addition some basic techniques in implementation of such a system will be discussed.

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FP8.3 Survey of Methods for Determining Management Information Requirements, PETER SALOMONE, Northwest Computer Services, P.O. Box B-1397, Minneapolis, Minnesota 55480.

Determination of management information is the most pressing problem in MIS according to a 1969 survey. Practitioners in three management fields (management science, analysis of decision making processes, and MIS development) treat the topic of management information. Some management scientists, who model decision makers, have considered the information needed by such decision makers and have incorporated it into their models. Generally, however, they have ignored information concentrating instead on data, its collection, and its analysis. Analysts of decision making processes have emphasized the importance of information by including it in their models. They have attempted to define methods for determining management information. MIS developers in striving to fulfill management's demands claim to have implemented systems which supply management information, although few do. Of these few, some have defined methods for determining management information. Despite their work, today's methods are still relatively ill-defined and untested.

FP8.4 Learning Patterns, Decision Time, Decision Approach, Information Structure, and Value of Information in the Information Structure Experiments, THEODORE J. MOCK, TEVIAH L. ESTRIN, and MIKLOS A. VASARHELYI, Accounting and Information Systems Research Program, Graduate School of Business Administration, University of California, Los Angeles, California 90024.

This paper discusses the role of several information and decision variables including learning, decision approach and information structure in decision-making. In an experimental, business-game setting, evidence has been collected on performance and learning differences between heuristic and analytic decision-makers and also between decision-makers operating with information structures which differ in terms of timeliness of information. Performance is measured in terms of the economic variables of profits attained, costs incurred and decision time required. Learning is measured by the rate of change of the above variables and also by their logarithmic transformations. The results of the experiment indicate that there were significant performance differences between analytic and heuristic decision-makers. However, significant differences in learning patterns were not discernible between analytic and heuristic decision-makers or between decision-makers subjected to the alternative information structures.

FP8.5 Sensitivity of Optimal Management Reporting Schedules to Imperfect Control Information, WILLIAM H. HANNUM, Syracuse University, Syracuse, New York 13210.

Optimal timing of recurrent management control information requires balancing (1) opportunity losses incurred through failing to obtain

timely control information and (2) costs of obtaining control information required to reduce such losses. Control information is often imperfect, and thus the probability that the user will take incorrect action on the basis of the report is nonzero. This paper presents an explicit model for determining optimal reporting schedules and analyzing the sensitivity of relationships among costs of information, degree of imperfection in information, costs of corrective action, operating losses which may occur with a shift in process performance, and timing of control information. In this approach the time of a shift in the process to an unsatisfactory state is treated as a random variable with considerable flexibility available for specifying the probability distribution of this event. The lack of models permitting this sort of analysis prompted this research.

FP8.6 The Impact of Government Regulation on Management Goal Priorities as Reflected by Management Control Data, G.D. FOSTER, The Pacific Telephone & Telegraph Company, 740 South Olive St., Room 1218, Los Angeles, California 90055.

This paper examines the differences and similarities encountered when comparing the types of management control information used in a governmentally-regulated utility to those used in a nonregulated enterprise. Also, based on this examination, an attempt is made to postulate a generalized statement regarding the existence of disparate organizational goals in each of the respective types of business. The study was approached through the following steps:

- (1) The development of a qualitative, descriptive representation of the management control information likely to be found in the typical large nonregulated business;
- (2) The examination of the development of regulation as a quasi-economic constraint upon managerial decision-making;
- (3) The analytical presentation of the type of management control information that has developed in a selected public utility; and
- (4) The evaluation of the differences encountered in the two types of control systems, and some inferences relating to the resulting effects upon the organizational objectives of each.

FP9.1 A Simulation Model for Studying the Performance of the Markowitz Portfolio Selection Model under Realistic Conditions, GEORGE M. FRANKFURTER, Assistant Professor, Syracuse University, Syracuse, New York 13210; HERBERT E. PHILLIPS and JOHN P. SEAGLE, State University of New York at Buffalo, Buffalo, New York 14222.

A number of portfolio selection procedures have been developed to enable an investor to achieve his desired balance between risk and return. The risk of a portfolio depends upon a full variance-covariance matrix of returns on individual securities. The elements of such a matrix are typically based on estimates, which are subject to uncertainty. A major shortcoming of present portfolio selection procedures is that the

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variance and covariances are treated as if they were known parameter values. A model is presented for simulating observations of means variances and covariances in accord with a multivariate normal data generating process and for incorporating the resulting estimates in an application of the full Markowitz portfolio selection model. The sensitivity of the composition of efficient sets of portfolios to error in estimating the required parameters is studied.

FP9.2 Determining a Preferred Financial Operating Structure in an Embryonic Firm, ROBERT E. MARKLAND, School of Business, University of Missouri, St. Louis, Missouri 63121.

Digital simulation is employed as an analytical mechanism to measure the cash flow attenuation which results from alternative financial operating structures. The data used in the study are taken from an actual large retailing firm, which must appraise several possible financial operating structures during its embryonic life stage. Simulation is utilized to determine risk-return profiles for the various alternatives, and efficiency frontiers are then computed for several measures of profitability, over a time adjusted horizon. A preferred operating structure, in terms of minimal cash flow attenuation, is then selected by analyzing the efficiency frontiers of the various alternatives.

FP9.3 A Financial Model in Acquisitions and Mergers Strategies, MANOHAR BARTAKKE, Univac, Blue Bell, Pennsylvania; SATISH DESAI and SHIVA SARDA, Jos. Schlitz Brewing Co., 235 West Galena St., Milwaukee, Wisconsin 53201.

The paper discusses various acquisition criteria for companies interested in diversification. A model using various financial parameters is developed for optimizing the rate of return on the company's investment in acquisitions. The model takes into consideration assets, market value of stock, earnings, debt and growth rate, etc. of the seller-company in view of corporate objectives of the buyer-company. Predictions on sales, earnings, stock-price, etc. are used to develop the future outlook on financial position of the seller-company. A sensitivity analysis is employed to solidify the confidence in the conclusions derived from the model. The sensitivity analysis approach also points out predominant parameters affecting the seller-company's financial situation.

FP9.4 A Markovian Analysis of the Longevity of Demand Deposit Accounts, ROBERT D. LEIDIG, Division of Business Administration, University of Michigan, Dearborn, Michigan 48128.

This paper presents a study in the application of some statistical theory, and a mathematical model, to a commercial banking problem. The problem is to determine the pattern of mortality of demand deposit accounts in a commercial bank, and thereby to ascertain certain longevity characteristics of such accounts. The method of solution involved the collection of data from a probability sample of demand deposit accounts

in a large midwestern commercial bank and the use of these data to construct an absorbing Markov chain wherein the absorbing state represents the closing of an account. Subsequent to the formulation of the model, a mortality table summarizing certain longevity characteristics is presented.

FP9.5 BANKMOD I: A Bank Asset and Liability Management Model, KENNETH B. GRAY, JR. and KENNETH E. REICH, Bank Administration Institute, 303 South Northwest Highway, Park Ridge, Illinois 60068.

BANKMOD I is a deterministic simulation model designed to aid the bank investment officer in managing discretionary assets and liabilities. Within the context of forecasted loan, deposit and interest levels, the model shows the impact on net income, liquidity and capital adequacy of shifts in the bank's security portfolio and in the use of purchased funds such as money market CD's. The model computes net gains or losses on security sales to forecast net income after security transactions as well as net operating income. Market value income incorporating the effect of changes in the market value of the security portfolio is furnished as an additional measure of performance. Sensitivity analysis is provided by software design which enables a set of user decisions to be tested under different assumptions about the economic environment. The model can be used to show the impact of various strategies: (1) straightforward management of fund excesses or deficits, (2) aggressive management of the portfolio for appreciation as well as income, and (3) aggressive expansion of the bank relative to its capital base.

SA1.1 The Design and Evaluation of Experimental Court Reforms, JOHN B. JENNINGS, New York City-Rand Institute, 545 Madison Avenue, New York, New York 10022.

As new ideas are generated (and old ideas regenerated) for dealing with court congestion and other criminal justice problems, those that appear to be the most promising must eventually be tested in practice. However, it is generally far from straightforward to determine whether there is in fact any resulting improvement. Accordingly, this paper is addressed to considerations of experimental design, the selection of evaluation criteria, the measurement of court performance, and the assessment of the results of such a test. The principles introduced will be discussed in terms of an ongoing evaluation of a major internal reorganization of the New York City Criminal Court.

SA1.2 Automated Scheduling of Court Cases, SAMUEL S. SHAPIRO, Programming Methods, Inc., New York, New York.

This talk describes a scheduling algorithm which was developed to calendar cases for the New York City Criminal Court. The algorithm took into account the status of the defendant and the availability of attorneys and policemen as well as the availability of court room facili-

ties. In addition, a court day simulator is described. The simulator was developed to determine what combination of judges, assistant district attorneys, and Legal Aid Society lawyers were necessary in a new proposed court structure in order to maximize the throughput of cases. The simulator was also used to evaluate the scheduling algorithm.

SA1.3 Court Management Science: An Overview, JEAN G. TAYLOR, Systems Evaluation Division, IDA, Arlington, Virginia.

This paper provides an overview of court management (with emphasis on criminal courts) and identifies some of the major problem areas and potential approaches for their reduction. Some pertinent court management studies are summarized; however, the main focus is on techniques and evaluation procedures for court management problems. A major problem is case management; this is used to illustrate the application of management techniques. From the variety of approaches for monitoring and evaluating management techniques both before and after their introduction in the court, the applicability of simulation for selection among techniques and for evaluation is emphasized.

SA1.4 A Total Management Analysis of a Michigan Juvenile Court, MAX C. SCHNOOR, JR., School of Business, Western Michigan University, Kalamazoo, Michigan 49001.

This paper summarizes as Model I one court's existing job descriptions; procedures; procedure flow charts; organization chart; organization consideration charts; master flow charts of detention, probation, and administration; and the cost and budget system. Model II is a proposed revision incorporating all recommendations with attendant restructured job descriptions; procedures; procedure flow charts; organization chart; organization consideration charts; master flow charts of detention, probation, and administration; forms; and a revised cost and budget system.

SA2.2 On Determining Optimum Size of New Cities, MANFRED KOCHEN, Professor of Information Science, Urban-Regional Planning and Research Mathematician, University of Michigan, Ann Arbor, Michigan 48104.

Starting with a search for a rationale underlying the population ceilings that are specified when new towns are planned, we found that no single, simple optimization criterion has theoretical validity. We explored the implications of population bounds imposed by finite "portal" capacity of a growing city, of minimizing the response time for services to citizens, and of central place theory. After analyzing a number of such criteria and methods for calculating optimal size, we investigated trade-offs between them. We found that if there is an overriding criterion it is maximizing that aspect of quality of life which derives from social culture, of which cities are the main source and site. The growth of social culture necessitates face-to-face contacts, the creation of I - Thou

relations which can in principle not be reproduced by the most sophisticated telemedia reproduction of remotely located communicants; and that is a major reason why people flock together in cities. To ensure at least the survival of cultural man, we urge the creation of new cities with an economic base in the knowledge industry - new "four-year college" towns - with the primary purpose of providing test vehicles of in vivo social-political innovation, fostering the development of the idea of a "learning" plan in place of master plans, and of a stronger underlying theoretical foundation, including a deeper scientific yet humanistic conceptualization of the concept of a "city."

SA2.3 On a Forecast of the Distribution of Population, JOHN C. PAPAGEORGIOU, School of Business Administration, Wayne State University, Detroit, Michigan 48202.

A wide range of empirical data regarding sociological, biological, and economic phenomena have been subjected to scientific analysis to discover models which would describe the distribution of the respective universes. In this paper the results of research in progress are discussed relevant to the forecast of the distribution of the world population among nations, and also of the national population among the various size cities. To this end, (a) the underlying causal relationships which govern the behavior of universes from various diversified areas are discussed; (b) use is made of a general model which seems to adequately describe such distributions; and (c) this general model is used to describe and forecast the distribution of population nationally and internationally.

SA2.5 On The Development of New Communities, RICHARD L. HEROUX, Research Associate, and WILLIAM A. WALLACE, Director, Urban-Environmental Studies, and Associate Professor of Management, Rensselaer Polytechnic Institute, Troy, New York 12181.

Linear programming is used to explore the relationship between a planned community and a planned development. Also, its usefulness to the developer in formulating land use plans is evaluated.

The objective of a planned community is maximization of social welfare, whereas the objective of a planned development is maximization of economic gain. It is shown through the use of duality theory that a planned community and a planned development are on a continuum, thereby (1) de-emphasizing the need to formulate a social welfare function, and (2) revealing the close relationship between the two.

SA3.1 Environment: An All-Encompassing Phenomenon, STANLEY A. CAIN, Director, Institute for Environmental Quality, The University of Michigan, Ann Arbor, Michigan 48104.

Environment has become commonly equated with pollution whereas it is half of the ecology equation: the interrelations between life and environment. Pollution, in turn, is being applied to almost anything that anyone doesn't like - not just the fouling of air and water and land but

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"sound pollution," "sight pollution" or uglification, mucking up the language, etc. Beyond any negative aspects of physical environmental deterioration, there are also positive environmental conditions that need management consideration if all ecological parameters are to be considered, as they should and must be.

SA3.2 Decision-Making Criteria for Environmental Protection and Control, DAVID S. ALBERTS, School of Commerce, New York University, Washington Square, New York, New York 10003; and JOHN MARSHALL DAVIS, New York City Planning Commission, Urban Design Group, 2 Lafayette St., New York, New York 10007.

As our recognition of the deterioration of the environment increases, a large number of scattered and uncoordinated programs will be undertaken in an attempt to arrest this deterioration and restore the environment. A general set of decision criteria for environmental protection programs is needed to best allocate the available resources. Protection and control is a two-way street. Just as the environment must be protected from man, man must be protected from the environment. This requires a set of decision criteria with special properties. This paper presents an approach to developing such a set of criteria.

SA3.3 An Efficient Water Quality Control, ANTHONY C. TAYLOR, Systems Research Group, 252 Bloor St. West, Toronto, Canada.

The effluent charge has been supported in water quality management as a control which provides waste dischargers with an incentive to be efficient in their waste abatement practices and to seek to improve their technology. In addition, a "basin efficient" attainment of water quality standards is possible if the effluent charge in each zone of a river basin is properly set. Unfortunately no satisfactory procedure has been proposed for setting these charges in the absence of complete cost information at the center. Sequential adjustment over time and the use of the Wolfe-Dantzig decomposition algorithm for planning are two suggestions that are found wanting. A bargaining process between the central agency and waste dischargers for reaching an agreement on effluent charges and allotments is proposed. It is shown that each decision-maker assumes the role of a player in an n-person prisoner's dilemma, and, by consequence, that strong forces exist to ensure the game terminates in efficient agreements.

SA3.4 Developing a National Data Network for Solid Waste Management, ROBERT M. CLARK, DANIEL GREATHOUSE, and JOHNSWEETEN, Solid Waste Management Office, U. S. Environmental Protection Agency, 5555 Ridge Ave., Cincinnati, Ohio.

Solid waste management is typified by fragmented collection and disposal systems, which may involve both public and private operations

for each function. Within a given set of political boundaries, one or more of these combinations frequently operates simultaneously. This complex tangle of public and private involvement in providing solid waste management systems for various political jurisdictions has resulted in a lack of uniform and reliable operational data relating to solid waste systems. To fill this need, the solid waste management program of the U. S. Environmental Protection Agency has initiated a pilot study to develop a national data network for solid waste management. The pilot study derives data from selected collection routes and disposal sites and facilities within three Standard Metropolitan Statistical Areas. Results from the current system are presented and plans for expansion to a national system are discussed.

SA3.5 Pollution Control and its Effect on Three Types of Organization, BARRY SHORE, Department of Management, College of Business Administration, Northeastern University, Boston, Massachusetts 02115.

The objective in designing a pollution control program can be expressed as the selection of that strategy which minimizes the sum of pollution prevention and pollution costs. The specification of this cost function, however, is quite difficult if not altogether impossible. For example, the welfare element of pollution costs is difficult to assess. Even if the function can be specified, the transition from theoretical solution to implementation is not without its problems. In this paper these problems will be considered and the consequences of the selected strategies will be examined for three organizations. The first is a power generating plant which is located in a large city. The second is a milk processor who is discharging a substantial quantity of effluent into a river. Finally, a municipality is considered whose major problem is the deterioration of its shellfish industry in the waters adjacent to the town.

SA3.6 The Management of Environmental Information: A Machine for Adapting a System to its Environment, ASTERIOS G. KEFALAS, University of Georgia, Athens, Georgia 30602.

Business enterprises can be conceptualized as open systems, as it is evident in the works of S. Beer, Katz and Kahn, Lawrence and Lorsh, A.K. Rice, Lee Thayer, J.D. Thompson, Carzo and Yanouzas, Johnson, Katz and Rosenzweig, and others. The main theme common in all these works is that business enterprises, as all open systems, must adapt themselves to their environments. This paper presents a conceptual framework that grants the process of acquisition of external data and the conversion of these data into information a protagonist's role. Companies that manage to adapt themselves to their environments (including manipulation of them) do so by virtue of their metabolic capability, i.e., gathering of data via an environmental monitoring system and translation of data into information. Most scholars concerning themselves with the recently popularized "environmental crisis" would agree that in order to

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effectively manage the environment we must know what it is, what it was, and what it can be. For business enterprises this appeal for knowledge about the environment is an appeal for gathering, evaluation, transmission, and utilization of data about state relationships between the enterprise and its environment. In this paper the enterprise-environment interaction system is conceptualized as an organic goal-directed (cybernetic) system. The local system (esoteric box) is the enterprise. This is the system whose behavior is to be examined. The environment is taken as more or less a "given" which is subject to manipulation by the enterprise. The linking process between the two subsystems (enterprise and environment) is the process of acquisition of information.

SA5.1 An Insight Into Industry's Need and Selection Criteria, ASHOK N. BAKHRU, Management Sciences, Scott Paper Company, Philadelphia, Pennsylvania.

This paper discusses the Management Sciences activity at Scott Paper Company and the factors that determined the success or failure of projects. In this context, a profile of a successful Management Sciences Analyst is drawn. This profile includes technical skills and human skills requirements. Also discussed are the selection criteria used in the hiring process to ensure the acquisition of this talent. Some conclusions are drawn, with caution, with respect to industry's need for management science analysts.

SA5.2 Consultants in the 70's, NORMAN I. AGIN, Mathematica, Princeton, New Jersey 08540.

The nature of the operations research-management science consultant in the 70's will change. The principal, underlying cause of the change will be the need for consulting and research firms to have staff which are "smarter than their clients." The talk will discuss the implications of this on the characteristics of demand for management scientists during the 70's.

SA5.3 An Approach for Utilizing Management Scientists in Improving the Management of State and Local Governments, EUGENE D. LUNDBERG, Management Systems, The MITRE Corporation, P. O. Box 208, Bedford, Massachusetts 01730.

State and local governments represent a major growth industry. Direct expenditures for goods and services by such governments are increasing rapidly and now approximate 13% GNP. These governments for the most part are operating with outmoded organizational structures and archaic management systems. Although management science has had a significant impact in improving the management of industrial organizations and to a lesser extent some agencies of the federal government, it has not had any equivalent impact on the management of state and local governments. One of the major impediments to improving this situation

is the inability of scientific and technical personnel to relate effectively to operating managers in these governments. An approach will be discussed which has demonstrated a way in which this gap can be closed and management scientists can more effectively contribute to improving the management of state and local governments.

SA5.4 The Definition of a "Super Star" in Management Sciences,
FLOYD GUESS, Amoco, Chicago, Illinois.

In the formative years of the management sciences profession, there was a tendency in the industrial environment to consider the management scientist a model builder - a developer of tools and techniques. The early day "super stars" were often considered individuals without standing and technical prowess. As the profession has progressed and matured, however, the emphasis has shifted. Industry used the contemporary "super star" much more than an outstanding mathematician or engineer. This paper explores the manager's viewpoint of the characteristics and qualities of the exceptional man. Why is he a success? How is he recognized? Why is he in demand? --- even in today's depressed job market.

SA5.5 Career Opportunities in the Public Sector for Environmental Managers, NORMAN L. DUNFEE, Environmental Protection Agency, Office of Air Programs, Office of Manpower Development, Post Office Box 12055, Research Triangle Park, Durham, North Carolina 27709.

We as a nation have recognized that controlling pollution is a matter of grave concern. This concern has been shown by the attention directed toward environmental quality by citizens, state legislatures, Congress and a host of other interested groups.

If we are to protect our vital natural resources, improve air and water quality, and control other sources of environmental pollution, large numbers of trained, qualified people are needed to plan and implement control programs at the federal, state and local levels of government. The control of pollution requires a wide variety of technical skills and management "know how". Engineers, biological scientists, chemists, sanitarians, and others with health-related backgrounds are needed. In addition management scientists, computer and system specialists, urban planners, economists, lawyers and social scientists and a variety of professionals are needed to balance control agency manpower teams. This discussion will be concerned with defining manpower needs of control agencies, occupational categories needed, sources of manpower, training opportunities, and salary ranges for environmental health manpower.

SA5.6 Hiring Criteria and the Evaluation Process: Priorities and Considerations, L. J. BORKOWSKI, Corporate Personnel Department, Montgomery Ward, P. O. Box 8339, Chicago, Illinois.

The theme of the selection process as it relates to the management scientist tends to become more complex and multi-faceted than with the usual high talent professional.

Because of the unique position that the management scientist holds in an organization, it becomes imperative that he is evaluated not only in terms of technical competence but also in such areas as survivability, communication, and business rapport. The level that the management scientist normally holds in an organization is one in which he has a great deal of exposure. This exposure can be both positive and negative, depending upon the individual himself.

The basic ability to become a translator of concepts to pragmatic businessmen is of utmost importance. The translation process would, therefore, include such things as his rapport with other people, his empathy to business decisions, his pragmatic approach to both the philosophy of the organization and the long-and short-range objectives.

SA6.1 A Successful System for Forecasting and Inventory Control, J.L. BISHOP, JR., Dow Corning Corporation, Midland, Michigan.

The wealth of management science literature dealing with "optimal" solutions to the inventory control "problem" would be impressive if it were not accompanied by a dearth of evidence of the (successful) application of these tools. As a hesitant step into this breach, the author describes an evolutionary approach to a system for the centralized control of inventories of finished products in several branch warehouses. Embodying forecasting and inventory ordering, this system is characterized by a man-computer partnership. Both manual overrides of the computer-generated order parameters and exception reporting allowed significant cost savings with no degradation of service. The pertinent aspects of this system (Computer Oriented Managed Inventory Control System -- COMICS) are described and illustrated.

The use of a very simple "inventory control doctrine" in the implementation of the above system allowed the operating personnel to gain confidence in the system and management science in general. Based upon this confidence, the development of a simple simulation model was possible. This model allowed the evaluation of alternative, simple algorithms. The experiments will continue to expand in the complexity of the algorithms evaluated and the breadth of the organization encompassed. In the future, this work will be published to provide a means of comparing the theoretical contributions to this aspect of the needs of a firm.

SA6.2 Chip Allocation Optimization System (CHAOS), G. F. FINKE and V. VENKATESAN, Weyerhaeuser Company, Tacoma, Washington.

The buying and selling of wood chips has become "big business" at Weyerhaeuser. The accelerated growth in demand for paper products the world over has greatly increased the utilization of wood fiber. Like any other business firm in a competitive environment, Weyerhaeuser would like to acquire and utilize wood chips in a fashion which will maximize its profits while still satisfying any pre-established requirements. This is best accomplished by establishing a chip flow network based upon the purchase price and quantity available at each chip source, the demand for chips and their value at each destination, and the cost of transporting chips between each source and destination. Out of the many possible chip flow networks, there is one which will be the most profitable to Weyerhaeuser. It is the goal of this model to assist in determining such a network.

SA6.3 Management Science and Art in Dow's Logistics, JIM D. SAVVAS, Manager, Systems, U.S. Area Operations, The Dow Chemical Company, Midland, Michigan 48640.

Fifteen years ago, logistics was almost entirely an "art" in industry, generally, and in The Dow Chemical Company, specifically. Some of this art has recently been superseded by various management science concepts and tools.

This paper sketches some of the management science concepts which have been developed and/or adopted for use in the logistics operations of Dow. Some new tools, founded on these concepts, are also singled out for discussion as potentially of interest to a TIMS audience.

As an aid for the audience to assess the applicability of the concepts used by Dow to whatever organizations are of interest to them, a brief description of the nature of Dow's logistics operations is presented.

Management science concepts, and some tools, are then described as used in the following aspects of managing Dow's logistics operations: setting objectives, developing courses of action, allocating resources, taking action, feedback, learning.

SA6.4 Antifreeze Open Order Reporting, DONALD G. YOPP, Business Information Services, The Dow Chemical Company, Midland, Michigan 48640.

In a seasonal business, balancing the supply with the demand is difficult. It is further complicated when there are a large number of items supplied, many supply points, and a lag time of several weeks before adjustments can be realized.

At any point in time, orders exist which are to be shipped in the future. The accuracy of this as a tool for predicting future demand varies with the amount of time from the present to a point in the future and with the date relative to the season for a seasonal product. If one can predict accurately the demand far enough in the future, one can

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adjust the supply accordingly.

This is being attempted using the Dow antifreeze business as the first case. The data used are a file of orders for all of the different stockkeeping units comprising antifreeze.

SA6.5 Mathematical Programming Optimization of a Petrochemical Complex, JAMES G. LAROQUE, Polymer Corporation, Sarnia, Ontario, Canada.

This paper discusses the development of a nonlinear optimization routine based on iterating through a standard linear programming algorithm. Application of the method will be discussed.

SA7.1 Black Capitalists: Keys to Inner City Business Development, ALAN R. ANDREASEN, Associate Professor of Marketing, State University of New York at Buffalo.

While financing has been thought to be the most critical element holding back black business development, it is becoming increasingly clear that black managerial talent -- or, more precisely, the lack of it -- holds the key to improvement in this important area. Yet efforts to find, train and motivate black owners and managers have been hampered by a lack of adequate data on the characteristics, motivations and problems of existing black businessmen. The present paper presents key findings from an exhaustive comparative study of black and white businessmen operating in the inner city of Buffalo, New York, in the winter of 1968-69. These data offer a disheartening picture of existing black business, yet provide important clues both for predicting future inner city business dynamics and for increasing black shares of "the action."

SA7.2 Dual-Price Labels: Usage Patterns and Potential Benefits for Shoppers in Inner-City and Suburban Supermarkets, MONROE PETER FRIEDMAN, Eastern Michigan University, Ypsilanti, Michigan 48197.

Two studies were conducted relating to dual-price labels. These labels, which are used for packaged supermarket products, present the price-per-measure for individual packages as well as the price of the package itself. The first study was concerned with consumer reaction to an experimental dual-pricing program introduced in an inner-city and a suburban supermarket, each of which was located in the Washington, D.C., area. The results revealed that 25% of the inner-city-store sample of 793 and 38% of the suburban-store sample of 878 reported having used the labels. Almost all of these respondent-users claimed that the labels were helpful and it would appear that a similarly large number had continued to use them several months beyond the time they were introduced in the stores.

The second study, which was conducted in two other inner-city and suburban supermarkets in the Washington area, was concerned with how

effectively shoppers are able to compare prices without the aid of dual-price labels. Six sets of price-comparison problems were developed to conform to a two-dimensional model of difficulty in consumer price comparisons. One dimension of the model dealt with packaging practices, and the other considered pricing practices. The problems were administered to about 500 shoppers in each store and a record made of the accuracy of their responses.

The results offered strong support for the validity of the model in that both packaging and pricing factors were found to have significant effects upon response correctness. The findings suggest that shopper usage of dual-price labels would result in substantial reductions in response errors for many price-comparison problems.

Policy implications of the two studies are drawn for past as well as present legislative efforts to assist the consumer.

SA7.3 An Investigation of Discriminatory Practices in Chain Supermarkets in Rochester, New York, DAVID HONIG.

Twenty-one low, middle, and high-income area supermarkets in six chains serving Rochester, New York, were surveyed for price discrimination within chains, price-raising on welfare day, non-integral and non-unit pricing, unmarked items for sale, and food quality and sanitation violations. Four supermarkets in three chains were found to charge significantly higher prices on certain days than high-income stores in the same chain. All four were located in the black community. The chains which were involved in price-discrimination charged, on the average, 3% more for the same goods than their suburban counterparts do, which represents a loss to the poor of almost half a million dollars annually. No store, however, was found charging greater prices on welfare-check day than on other days.

Two chains consistently price items in non-integral amounts; no chain until recently employed unit pricing; and two chains appear to leave disproportionate numbers of items for sale unmarked in their inner-city outlets. Health hazards were found in eleven stores and were serious enough in one to suggest its immediate closing for renovation. A January study of overdating found that most chain stores in Rochester probably are selling overdated, possibly spoiled, food.

The hypotheses that unequal pricing is due to either human error or to factors related to managerial incompetence were statistically rejected. Proposals were made for action on price and quality equity, addressed to both the chains and government.

SA9.1 An Algorithm for Stochastic Games with Discounted Payoff, S. SUBBA RAO, R. CHANDRASEKARAN, and K.P.K. NAIR, Case Western Reserve University, Cleveland, Ohio 44106.

The concept of two person zero sum stochastic games was first developed by Shapley assuming a positive stop probability in each of the finite number of states or positions of the game. Removing the stop probability assumption, Gillette studied the resulting nonterminating

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stochastic game and established the existence of stationary optimal strategy and unique value for both discounted and undiscounted cases. Hoffman and Karp provided a convergent algorithm for the undiscounted case. As yet, in literature there is no algorithm for the solution of stochastic games with discounted payoff. In this paper, a convergent algorithm for the discounted case is presented, and computational experience is discussed. This algorithm has applications in the military and business contexts.

SA9.2 A Mixed Integer Programming Algorithm: Experimental Results, A. RIESCO, JR., Industrial Engineering Department, University of Puerto Rico, Mayaguez, Puerto Rico 00708; and M.E. THOMAS, Industrial and Systems Engineering Department, University of Florida, Gainesville, Florida 32601.

This paper presents computational results obtained with a mixed integer programming algorithm developed earlier. The algorithm solves separable convex mixed integer programming problems with linear constraints. The optimal objective function value is bound at each iteration, by solving a sequence of nonlinear continuous optimization problems and a sequence of discrete optimization problems. The computer program prepared to test this algorithm makes use of Fiacco and McCormick's penalty function approach SUMT (Sequential Unconstrained Minimization Technique) for solving the continuous subproblem. The discrete subproblems are solved using Geoffrion's implicit enumeration technique. The experimental testing of the algorithm has been thus far limited to small problems with integer variables of the 0-1 type.

SA9.3 A Nongradient Cutting Plane Algorithm for Nonlinear Mathematical Programming Problems, STANFROMOVITZ, CHAIHO KIM, and ROBERT HAUSMAN, Graduate School of Business, University of Santa Clara, Santa Clara, California 95053.

A very powerful nongradient search algorithm for unconstrained optimization problems called simplex search has been recently developed by Spendley, Nelder, and others. Also, Kelly, Griffith, and others have developed a number of cutting plane algorithms for constrained optimization problems. These algorithms are especially effective when some of the constraints are linear or almost linear.

In this paper we adapt the simplex search algorithm to handle linear or nonlinear constraints by means of a cutting plane procedure. This new algorithm will have the robustness of a nongradient search procedure and yet take advantage of well-behaved constraints to solve general constrained optimization problems.

SA9.4 Government Expenditure Planning for Optimal Economic Growth, JATINDER N.D. GUPTA and THOMAS J. MEADERS, Department

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of Industrial and Systems Engineering, The University of Alabama in Huntsville, P.O. Box 1247, Huntsville, Alabama 35807.

There seems to be a divergence in the classical and Keynesian theories for the amount of governmental expenditure to maintain a steady growth rate of an economy. Both the classical and Keynesian theories attempt to show the directions of economic controls to be exercised by the government to maintain a steady growth of the economy. However, none of these theories indicate the exact quantity of governmental expenditure needed for the optimal growth of the economy. The first part of this paper considers the problem of finding the consumption function, marginal propensity to consume and the effect of time lags in income. Based on the statistical analysis of the available data of the United States, the consumption function is obtained and compared with the one in the existing literature. The second part of the paper describes a multi-stage formulation of the problem of finding the governmental expenditure for optimal growth under inflationary pressures. The problem is then solved by using discrete maximum principle and dynamic programming.

SA9.5 A Competitive Bidding Procedure for the Small Firm, JOHN F. KOTTAS and BASHEER M. KHUMAWALA, School of Business Administration, University of North Carolina, Chapel Hill, North Carolina 27514.

This paper describes a competitive bidding procedure for determining the bid for a contract where the lowest bidder wins. The procedure effectively uses both objective and subjective information about competitors in arriving at the low bid distribution. The firm's own competitive situation is then used in deciding the final bid for the contract. The procedure is illustrated for a small pipeline laying contractor.

SA9.6 On the Formulation of Mathematical Programs Involving Uncertainty, DAVID P. BARON, Northwestern University, Evanston, Illinois.

Mathematical programs are usually formulated in a deterministic manner even though the values of certain coefficients and the form of the objective function and constraints may be uncertain. A common practice is to use a point estimate of the uncertain value so that a deterministic program is obtained. In general, such a practice is inappropriate and may lead to poor solutions. Of the methods of formulating mathematical programs involving uncertainty, most may be grouped into the categories of distribution methods, chance constrained programs, and programs with recourse. Madansky has considered alternative formulations of such programs. This paper attempts to consider these formulations within a common statistical decision theory framework and to indicate certain relationships between the approaches. Programs involving more than two stages or periods will not be considered nor will computational methods be detailed.

LATE ABSTRACTS

- TA3.5 Simulation Models for Evaluating Blood Utilization with Extended Life Span, CHANDER MALKANI and C. CARL PEGELS, School of Management, State University of New York at Buffalo, Buffalo, New York 14214.

The current twenty-one day life of human blood does not provide ample opportunity for blood to be transfused. This is one of the causes of the shortage and outdate problem. This study investigates how an extended life span would affect blood utilization and determines the advantages of such a change. Two simulation models are developed to compare blood utilization with life span extended from twenty-one to twenty-eight days. Model A, written in BASIC, investigates the effects of extending the life by simulating it for four months. Model B, written in FORTRAN, is designed for use on any one type of blood group. It uses pre-determined age distributions for the daily shipment and transfusion. The age level transfusion distribution is evaluated daily on basis of on-hand inventory. The output consists of inventory status for each age level, units transfused, units shipped, shortages and wastages on a daily basis. The results reveal a considerable improvement in utilization with the extended life span.

- TA3.6 An Information-Systems Approach to Hospital Administration Problems, RONALD J. JORDAN, School of Business Administration, University of Connecticut, Bridgeport, Connecticut 06606.

In the past several years the use of information systems has developed as a vital tool to aid the businessman in the solution of management problems. However, despite the use of these techniques in the industrial sector, the field of health administration has only begun to realize the inherent advantages of these techniques. This paper analyzes the application of systems work -- namely, through systems analysis, system planning, and systems implementation -- to hospital administration. In the process, we point out some of the potential pitfalls as well as potential advantages of this procedure.

- FA1.5 Training of Disadvantaged and Their Supervisions: Some New Concepts, WAYNE E. GRIMM, Director, Chrysler Institute, Chrysler Corporation, Detroit, Michigan.

In training disadvantaged people to become successful employees, and in training hourly personnel to become effective supervisors of these new industrial employees, certain rather significant forces are beginning to emerge: (1) There are far fewer people who are incapable of learning (once motivated) than we might previously have suspected. (2) The anti-establishment attitudes shared by many of these people

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dictate teaching techniques and learning situations which are entirely different from the traditional classroom, lecture and discussion methods historically in use. Once the circle is closed and a combination of properly oriented new employees and properly trained supervisors is put together, the combination does produce some startling results.

FA3.4 Physician Participation in Hospital Management and Relationship to Employee Productivity, ROCKWELL SCHULZ, Department of Preventive Medicine, University of Wisconsin, Madison, Wisconsin 53706.

Physician participation in hospital management is promoted widely as being necessary for effective control over rising hospital costs. This presentation reviews results of a survey of the extent of physician participation in hospital management and the relationship of participation and hospital employee productivity. Preliminary findings in a two-state area indicate that while physicians are participating in the management of more hospitals there is no direct relationship between participation and employee productivity.

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