Management Science

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

The Institute of Management Sciences 1966 American Meeting

To cite this article:
(1965) The Institute of Management Sciences 1966 American Meeting. Management Science 12(4):C-33-C-74.
https://doi.org/10.1287/mnsc.12.4.C33

THE INSTITUTE OF MANAGEMENT SCIENCES

1966 AMERICAN MEETING

February 16 through 19, 1966
Statler Hilton Hotel
Dallas, Texas

COMMITTEE MEMBERS

General Chairman and Program Chairman: Albert H. Rubenstein, Northwestern University.

Program: Norman R. Baker, Purdue University; Arthur A. Brown, Arthur D. Little, Inc.; Robert E. Machol, University of Illinois; Joseph A. Mehan, Atlantic Refining Company; Leonard Swanson, Northwestern University.

Arrangements: Philip K. Bates, Texas Instruments, Inc., Chairman; William M. Campbell, Atlantic Refining Company; Jay W. Colin, Texas Instruments, Inc.; Adolph F. Moravec, General Dynamics/Ft. Worth; Max H. Post, T. I. Supply Company.

Southwestern Chapter President: Jack Lande, Ling-Temco-Vought.

TIMS 1966 AMERICAN MEETING

The 1966 American Meeting of The Institute of Management Sciences will be held on February 16-19, 1966, in the Statler Hilton Hotel, Dallas, Texas.

The theme of the meeting is "The Accomplishments of Management Sciences so far in particular industries and institutional settings and the opportunities for future contributions". Each of the invited paper sessions focuses on one industry or field of application. The first speaker has been asked to survey the state of the art of application of management sciences to his field as seen by a management science practitioner. The second speaker has been

asked to point up opportunities for future applications, as seen by management. A lot of time has been provided in these "theme" sessions for participation by the audience.

In addition to the theme sessions, there are a number of contributed paper sessions, organized into groups of related papers. Several of the TIMS colleges will also conduct sessions. The extra day (Saturday) is to provide for the possible continuation of some of the college sessions.

Wherever possible, groups of related sessions (theme, contributed paper, and college sessions) have been scheduled in sequence.

REGISTRATION

The Registration Desk in the mezzanine of the Statler Hilton Hotel will be open during the following periods:

Tuesday, February 15	7:00 p.m. to 10:00 p.m.
Wednesday, February 16	8:30 a.m. to 5:30 p.m.
Thursday, February 17	8:30 a.m. to 5:30 p.m.
Friday, February 18	8:30 a.m. to 2:00 p.m.

The Registration Fees are:

Member	$17	
Non-Member	$22	($5.00 may be applied toward membership)
Student	$7	

(The registration fee includes the cost of the Luncheon on Friday, February 18. All registrants are urged to attend.)

FUNCTIONS at the Hotel include:

Wednesday, February 16	— 6:00 p.m.	Mixer	(cash bar)
Wednesday, February 16	— 7:30 p.m.	SWIMS Dinner Meeting	
Thursday, February 17	— 6:00 p.m.	Mixer	(cash bar)
Friday, February 18	—12:15 p.m.	Luncheon	(cost included in fee)

ACCOMMODATIONS

Reservations must be received by the hotel ten days prior to the meeting to assure space.

The hotel is located on Commerce Street in downtown Dallas. Parking is available to guests. Texas law prohibits the public sale of liquor by the drink. However . . . Facilities of the Stetson Club are made available to those registered at the hotel and their guests. Limousine fare from Dallas Love Field is $1.00, the trip taking 45 minutes. Cab fare from Love Field is about $2.45, and takes 15 to 20 minutes.

RECRUITING NOTICES

Firms desiring to post recruiting notices may do so on a board to be provided in the registration area. Notices must not exceed 8½" x 11" and must be approved and posted by the Arrangements Chairman.

BOOK DISPLAY

There will be a book display in the registration area. Authors or publishers desiring to display their books may arrange to do so through the Arrangements Chairman.

COPIES OF PAPERS

Please write directly to authors for copies of papers in which you are interested. Neither the General Chairman, nor other officers of TIMS have copies for distribution.

FEBRUARY CLIMATE AND DRESS IN DALLAS

Texas weather can be unpredictable. Rain is a probability, with temperatures ranging from 35° to 60°.

As to Dress: You will prefer the light to medium weight wool suits. A lightweight wrap or topcoat is essential for warmth.

For the Women: Bring dark silks and a dark cotton for the bright sunny days. Lightweight wools for day and night.

ENTERTAINMENT

The Dallas Theater Center, designed by Frank Lloyd Wright, is a training and producing center for the dramatic arts. Its resident company presents classics, original scripts, adaptations, musicals, contemporary and period pieces and theatrical reviews. A block of tickets for their Thursday performance has been reserved. They may be obtained on a first come, first served basis at $2 per seat—limit 2 per registrant.

The Dallas Symphony Orchestra will present a concert on February 19 with Charles Munch conducting.

Theater Three has "Dark of the Moon" on the schedule.

Please contact Arrangements Chairman for ticket assistance or information.

PROGRAM OF WOMEN'S EVENTS

Current activities of interest to women will be available at the registration desk. Maps and brief descriptions of the points of interest will be supplied. Besides the conducted tours, you may want to visit Neiman-Marcus—the center of fabulous fashion (fashion shows daily); North Park Shopping Center, Dallas Museum of Fashion, and State Fair Park where 8 museums are grouped for visitor convenience.

Reprinted from Management Science, Vol. 12, No. 5, January, 1966

PROGRAM PLAN

1966 TIMS American Meeting, Statler Hilton Hotel, Dallas, Texas

LOCATION	Wednesday February 16	Thursday February 17	Friday February 18	Saturday February 19
MEZZANINE	Registration Desk 8:30 am - 5:30 pm	Registration Desk 8:30 am - 5:30 pm	Registration Desk 8:30 am - 2:00 pm	
	Morning Session 9:00 am - 12:00 pm	Morning Session 9:00 am - 12:00 pm	Morning Session 9:00 am - 12:00 pm	Continuation of College Sessions
Embassy East	A.1. Advertising	C.1. Public Accounting	E.1. Chemicals	
Embassy West	A.2. Military	C.2. Gov't—Federal	E.2. Universities	
Gold Room	A.3. College on Measurements	C.3. College on Logistics	E.3. Aerospace	
Ballroom Assembly	A.4. Contributed Papers —Applications to Manufacturing Problems	C.4. Contributed Papers —Behavorial and Experimental Studies	E.4. Contributed Papers —Applications to Planning and Control of R and D	
Noon Break 12:00 - 2:00			Luncheon Banquet 12:15 Junior Ballroom. Chairman: Albert H. Rubenstein; Speaker: P. E. Haggerty, President, Texas Instruments, Inc. "Management Science in a Growth Company"	

	Afternoon Session 2:00 - 5:00	Afternoon Session 2:00 - 5:00	Afternoon Session 2:00 - 5:00	
Embassy East	B.1. Pharmaceuticals	D.1. Food	F.1. Petroleum	
Embassy West	B.2. Investment	D.2. Gov't - Local	F.2. Communications Utilities	
Gold Room	B.3. College on Organization	D.3. College on Simulation	F.3. Manned Space Flight	
Ballroom Assembly	B.4. Contributed Papers —General Applications	D.4. Contributed Papers —Applications to Non-Manufacturing Problems	F.4. College on Research and Development (COLRAD)	
Evening	Mixer 6:00 - 8:00 Embassy Room SWIMS Dinner Meeting 7:30 pm Embassy East	Mixer 6:00 - 8:00 Embassy Room		

PROGRAM FOR THE
1966 TIMS AMERICAN MEETING
February 16 - 19, 1966
STATLER HILTON, DALLAS, TEXAS

WEDNESDAY, FEBRUARY 16, 1966

Sessions A. 1, A. 2, A. 3, and A. 4 are concurrent

A. 1. ADVERTISING

Location: Embassy East

Chairman: Sebastian B. Littauer, Professor of Industrial Engineering, Columbia University, New York, New York.

a. STATE OF THE ART SPEAKER: Stanley I. Cohen. Title of Paper: "The Rise of Management Science in Advertising." Address: Benton and Bowles, Inc., 666 Fifth Avenue, New York, New York 10019.

b. MANAGEMENT SPEAKER: Benjamin Lipstein. Title of Paper: "The Prospect for Management Science in Advertising." Address: Vice President, Director of Research and Information Services, Sullivan, Stauffer, Colwell and Bayles, Inc., 575 Lexington, New York, New York.

A. 2. MILITARY

Location: Embassy West

Chairman: Colonel Raymond S. Isenson, United States Army, Staff Assistant to DD/Research and Technology, ODDR and E, Office of Secretary of Defense, Washington, D.C. 20301.

a. STATE OF THE ART SPEAKER: Major David I. Cleland. Title of Paper: "Contemporary Military Program Management." Address: Assistant Head of Systems Mgmt. Dept., USAF, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio.

b. MANAGEMENT SPEAKER: Colonel Barton S. Pulling. Title of Paper: "Project Management in Industry of the Military Research and Development Program." Address: Colonel, USAF (Retired), Program Manager, AN/APQ-108, Conductron Corporation, Ann Arbor, Michigan.

A. 3. COLLEGE ON MEASUREMENTS

Location: Gold Room

Chairman: Peter A. Firmin, Tulane University, New Orleans, Louisiana.

a. "On Statistical Cost Analysis and Operations Research", Charles H. Kriebel, Carnegie Institute of Technology.

b. "The Audit Function—A Study of Goal Formation and Attainment", Neil C. Churchill, Carnegie Institute of Technology; and Trevor Sainsbury, University of Pittsburgh.

c. "Flow of Funds Approach to Cost of Capital", Russell Taussig, Columbia University.

d. "Transfer Pricing and the Motivation and Evaluation of Bank Branch Managers", Alexander A. Robichek, Stanford University.

e. "The Concept of the Information System of the Organization", James J. Linn, Massachusetts Institute of Technology.

A. 4. CONTRIBUTED PAPERS ON THE APPLICATION OF THE MANAGEMENT SCIENCES TO MANUFACTURING PROBLEMS

Location: Ballroom Assembly

Chairman: Ferdinand K. Levy, Rice University, Houston, Texas

a. "The Use of Assembly Line Balancing Techniques for Project Resource Balancing", C. L. Moodie, Purdue University, West Lafayette, Indiana.

b. "Real-Time Transistor Classification", J. W. Colin, Robert M. McClure, and Michael O'Hagan, Texas Instruments, Incorporated, Dallas, Texas.

c. "Linear Programming Optimization of a Transistor Testing Operation", J. W. Colin and Michael O'Hagan, Texas Instruments, Incorporated, Dallas, Texas.

d. "A Historical Perspective on Numerical Control", Mark Morgan, I.B.M., Hopewell Junction, New York.

e. "On An Optimal Facility Design and Location Problem", Richard L. Francis, Northwestern University, Evanston, Illinois.

WEDNESDAY, FEBRUARY 16, 1966

Sessions B. 1, B. 2, B. 3, and B. 4 are concurrent

B. 1. PHARMACEUTICALS

Location: Embassy East

Chairman: Donald T. Asher, Head, Operations Analysis Section, Division of Commercial Development, Abbott Laboratories, North Chicago, Illinois 60064.

a. STATE OF THE ART SPEAKER: Robert J. Hunter. Title of Paper: "The Application of Management Science in a Pharmaceutical Company." Address: Supervisor, Management Research, Smith Kline and French Laboratories, 1500 Spring Garden Street, Philadelphia, Pennsylvania 19101.

b. MANAGEMENT SPEAKER: Charles S. Brown. Title of Paper: "The Role of Management Sciences in the Pharmaceutical Industry." Address: Executive Vice President, Abbott Laboratories, North Chicago, Illinois 60064.

B. 2. INVESTMENT

Location: Embassy West

Chairman: Harry Grossman, Security First National Bank, P. O. Box 2097—Terminal Annex, Los Angeles 54, California.

a. STATE OF THE ART SPEAKER: Gerald D. Blackwill. Title of Paper: "Management Science in the Field of Investment—State of the Art." Address: Security First National Bank, P. O. Box 2097—Terminal Annex, Los Angeles 54, California.

b. MANAGEMENT SPEAKER: Mr. Herbert Ayers. Title of Paper: "Some Guesses About Where We Are Going in the Application of Quantitative Techniques to the Investment Problem." Address: Operations Research and Management Sciences, Morgan Guaranty and Trust Co. of New York, 32 Wall Street, New York, New York 10015.

c. SPECIAL SPEAKER: H. Martin Weingartner. Title of Paper: "Optimal Timing of Bond Refunding." Address: Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

B. 3. COLLEGE ON ORGANIZATION

Location: Gold Room

Chairman: William H. Starbuck, Associate Professor of Economics and Administrative Sciences, Purdue University, Lafayette, Indiana.

a. "Group Composition, Input Load and Group Information Processing", Michael J. Driver, Purdue University.

b. "Computer Simulation of a Decision-Making Group", John M. Dutton, Purdue University.

c. "A Notion of Equilibrium and Its Possibility Under Majority Rule", Charles R. Plott, Purdue University.

B. 4. CONTRIBUTED PAPERS ON GENERAL APPLICATIONS OF THE MANAGEMENT SCIENCES

Location: Ballroom Assembly

Chairman: Donald B. Owen, Graduate Research Center of the Southwest, Dallas, Texas.

a. "Designing the Fundamental Information System—A Guide to Productive Data Processing", A. F. Moravec, General Dynamics, Fort Worth, Texas.

b. "Optimal Design of a Stochastic System with Dominating Fixed Costs", Satinder Mullick, Corning Glass Works, Corning, New York.

c. "Qùeues with Multiple Poisson Input", Carl M. Harris, Western Electric Company, Inc., Princeton, New Jersey.

d. "The Theory of the Firm: A Comparison of Marginal Analysis, Linear Programming, and Computer Simulation", Thomas H. Naylor, Duke University, Durham, North Carolina.

e. "On Some Stochastic Tactical Submarine Games", A. Charnes, Northwestern University, Evanston, Illinois; and R. G. Schroeder, U.S. Naval Postgraduate School, Monterey, California.

THURSDAY, FEBRUARY 17, 1966

Sessions C. 1, C. 2, C. 3, and C. 4 are concurrent

C. 1. PUBLIC ACCOUNTING

Location: Embassy East

Chairman: E. Leonard Arnoff, Ernst and Ernst, 1300 Union Commerce Building, Cleveland, Ohio 44114.

a. STATE OF THE ART SPEAKER: Leland A. Moody. Title of Paper: "Development of Management Science in the Public Accounting Profession". Address: Arthur Andersen & Co., 1320 West Third Street, Los Angeles, California 90017.

b. MANAGEMENT SPEAKER: Bertrand J. Belda. Title of Paper: "Challenges and Opportunities in Client Service and Accounting Technology". Address: Ernst and Ernst, 1356 Union Commerce Building, Cleveland, Ohio 44114.

C. 2. GOVERNMENT—FEDERAL

Location: Embassy West

Chairman: David Novick, The RAND Corporation, 1700 Main Street, Santa Monica, California.

a. STATE OF THE ART SPEAKER: W. E. Cushen. Title of Paper: "State-Of-The-Art In Non-Military Management Sciences in the Federal Government". Address: Tech. Analysis Group, National Bureau of Standards, Washington, D.C.

b. MANAGEMENT SPEAKER: Walter A. Hahn. Title of paper: "Environmental Science Services and the Management Sciences." Address: Director, Planning and Program Evaluation, Environmental Science Services Administration, Washington Science Center, Rockville, Maryland 20852.

C. 3. COLLEGE ON LOGISTICS

Location: Gold Room

Chairman: Stedman B. Noble, Research Analysis Corporation, McLean, Virginia.

a. "Logistics Information Systems," Charles B. Tompkins, University of California at Los Angeles.

b. "A Multi-Mode Transportation Network Model," Raymond W. Lewis, Erling F. Rosholdt and William L. Wilkinson; The George Washington University.

c. "Programming the Procurement of Airlift and Sealift Forces," G. R. Fitzpatrick, J. Bracken, M. J. O'Brien, L. G. Wentling and J. C. Whiton; Research Analysis Corporation.

d. "A Model for Predicting Patronage on New Intercity Transportation Systems," Bernard M. Levin, National Bureau of Standards.

C. 4. CONTRIBUTED PAPERS ON BEHAVIORAL AND EXPERIMENTAL STUDIES

Location: Ballroom Assembly

Chairman: C. Jackson Grayson, Tulane University, New Orleans, Louisiana.

a. "The Relationship Between Certain Characteristics of Industrial Research Proposals and Their Subsequent Disposition", Norman R. Baker, Purdue. University, West Lafayette, Indiana; and Jack Siegman and Jon Larson, Northwestern University, Evanston, Illinois.

b. "A Experimental Study of Bargaining Studies: Series One", D. F. Grodosk, D. P. Leitch, W. H. Starbuck, and R. E. Walton; Purdue University, West Lafayette, Indiana.

c. "A Study of the Information Searching Behavior of X-Ray Crystallographers" R. W. Trueswell, University of Massachusetts, Amherst, Massachusetts; and G. J. Rath and A. H. Rubenstein, Northwestern University, Evanston, Illinois.

d. "An Experimental Study of Bidding Behavior", Richard F. Barton, University of Kansas, Lawrence, Kansas.

e. "Management Use of Computerized Micro-Analytic Behavioral Simulations," Arnold E. Amstutz, Massachusetts Institute of Technology, Cambridge, Massachusetts.

THURSDAY, FEBRUARY 17, 1966

Sessions D. 1, D. 2, D. 3, and D. 4 are concurrent

D. 1. FOOD C. 4.

Location: Embassy East

Chairman: Lawrence Friedman, Operations Research Director, M and M's Candies, High Street, Hackettstown, New Jersey.

a. STATE OF THE ART SPEAKER: Paul A. Strassmann. Title of Paper: "Management Sciences in the Food Industry." Address: Director of Systems and Procedures, National Dairy Products Corporation, 260 Madison Avenue, New York, New York 10016.

b. MANAGEMENT SPEAKER: Terrance Hanold. Title of Paper: "Management Use of Management Science". Address: Executive Vice President and Chief of Financial Office, The Pillsbury Company, Minneapolis, Minnesota 55402.

D. 2. GOVERNMENT—LOCAL

Location: Embassy West

Chairman: Arthur A. Brown, Operations Research Group, A. D. Little, Inc., 130 North Franklin Street, Chicago, Illinois 60606.

a STATE OF THE ART SPEAKER: Claud Gruen. Title of Paper: "Systems Analysis Applied to the Problems of Local Urban Government". Address: c/o A. D. Little, Inc., 500 Sansome, San Francisco 11, California.

b. MANAGEMENT SPEAKER: J. L. Brownlee. Title of Paper: To be announced. Address: City Manager, City Hall, Fort Worth, Texas.

D. 3. COLLEGE ON SIMULATION

Location: Gold Room

D. 4. CONTRIBUTED PAPERS ON THE APPLICATION OF THE MANAGEMENT SCIENCES TO NON-MANUFACTURING PROBLEMS

Location: Ballroom Assembly

Chairman: Francis R. Cella, University of Oklahoma, Norman, Oklahoma.

a. "A Computer Simulation Model of Railroad Freight Transportation Systems", William P. Allman, Northwestern University and U.S. Department of Commerce, National Bureau of Standards, Washington, D.C.

b. "The Effect of Consumer Advertising on Retail Availability", George H. Haines, Jr., and Alvin J. Silk, University of California, Los Angeles.

c. "A Simulation Approach to Districting", James D. Thoerson, Texas Instruments, Incorporated, Dallas, Texas.

d. "A Probability Model for Guiding Investment and Underwriting Decisions of Casualty Insurance Manageemnts", Robert L. Street and Charles S. Beightler, University of Texas, Austin, Texas.

e. "Planning for Non-Renewable Mineral Resources: A Preliminary Model", W. A. Wallace, J. R. Dunn, and D. Bishko, Rensselaer Polytechnic Institute, Troy, New York.

f. "Scheduling of a Large Forestry-Cutting Problem on a Digital Computer By Decomposition of Linear Programming", Mike T. Tcheng, Saint Louis University, Saint Louis, Missouri.

FRIDAY, FEBRUARY 18, 1966

Sessions E. 1, E. 2, E. 3, and E. 4 are concurrent

E. 1. CHEMICALS

Location: Embassy East

Chairman: Sidney W. Hess, Atlas Chemical Industries, Wilmington, Delaware 19899.

a. STATE OF THE ART SPEAKER: Gerald T. Westbrook. Title of Paper: "Management Science—What Has It Accomplished in the Chemical Industries". Address: Dow Chemical Company, Midland, Michigan.

b. MANAGEMENT SPEAKER: Robert E. Pyle. Title of Paper: "Management Science in the Chemical Industry—Today and Tomorrow". Address: Assistant Controller, Chemicals Division, Union Carbide Corporation, 30 East 42nd Street, New York, New York 10017.

E. 2. UNIVERSITIES

Location: Embassy West

Chairman: Robert E. Machol, Head-Systems Engineering Department, University of Illinois at Chicago Circle, P. O. Box 4348, Chicago, Illinois 60680.

a. STATE OF THE ART SPEAKER: Gustave J. Rath. Title of Paper: "Management Science in University Operations". Address: Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

b. MANAGEMENT SPEAKER: Charles J. Hitch. Title of Paper: "Management Science in a Large University. Address: Comptroller, University of California, Berkeley, California.

E. 3. AEROSPACE

Location: Gold Room

Chairman: John B. Lathrop, Lockheed-California Company, Burbank, California 91503.

a. STATE OF THE ART SPEAKER: Donald G. Malcolm. Title of Paper: "Mangement Science State of the Art in the Aerospace Industry". Address: President, Management Technology, Inc., 8939 South Sepulveda Blvd., Los Angeles, California 90045.

b. MANAGEMENT SPEAKER: W. H. Statler. Title of Paper: "Management Science and Aerospace Industry Management". Address: Deputy Director of Engineering, Lockheed California Company, Burbank, California.

E. 4. CONTRIBUTED PAPERS ON THE APPLICATION OF THE MANAGEMENT SCIENCES TO THE PLANNING AND CONTROL OF R AND D.

Location: Ballroom Assembly

Chairman: Richard A. Dudek, Texas Technological College, Lubbock, Texas.

a. "KAPPA: A Single Parameter Descriptor for Project Manpower Utilization Patterns", S. William Yost and Richard S. Rosenbloom, Harvard University, Cambridge, Massachusetts.

b. "Criteria for the Timing of Research Decisions", J. M. Keenan, Stanford Research Institute, Fort Ord, California; and Jerry L. Dake, U.S. Naval Postgraduate School, Monterey, California.

c. "A Study of Parallel and Sequential Research Strategies", W. J. Abernathy and Richard S. Rosenbloom, Harvard University, Cambridge, Massachusetts.

d. "Computer Forecasting—From Research to Implementation", R. R. Klimpel and G. T. Westbrook, Dow Chemical Company, Midland, Michigan.

e. "Subjective Estimates in CPM Planning for Development Projects—An Analysis", Talmadge A. Wilson, USAF Command; and William R. King, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

f. "Scientific and Engineering Manpower Projection and Cost Models", Harvey B. Safeer, Research Analysis Corporation, McLean, Virginia.

FRIDAY, FEBRUARY 18, 1966

Sessions F. 1, F. 2, F. 3, and F. 4 are concurrent

F. 1. PETROLEUM

Location: Embassy East

Chairman: Julius Aronofsky, Manager, Operations Research Department, Socony Mobil Oil Co., Inc., 150 East 42nd Street, New York, New York 10017.

a. STATE OF THE ART SPEAKER: Robert H. Grant. Title of Paper: "Management Science—State of the Art in 1965". Address: Manager of Systems Department, Celanese Corporation of America, 522 Fifth Avenue, New York, New York 10036.

b. MANAGEMENT SPEAKER: Howard W. Blauvelt. Title of Paper: "Management Use of New Techniques for Planning, Appraising Operations and Capital Investment Strategy." Address: Vice President, Coordinating and Planning, Continental Oil Company, 30 Rockefeller Plaza, New York 20, New York.

F. 2. COMMUNICATIONS UTILITIES

Location: Embassy West

Chairman: Robert W. Amory, American Telephone and Telegraph, 195 Broadway, New York, New York 10007

a. STATE OF THE ART SPEAKERS: William W. Hardgrave and Walter H. MacWilliams. Title of Paper: "Management Science in Communications: State of Art". Address: Bell Telephone Laboratories, Holmdel, New Jersey 07733.

b. MANAGEMENT SPEAKER: Richard A. Mathews. Title of Paper: "Management Science in Communications Utilities: From the Manager's Point of View". Address: New York Telephone Company, 140 West Street, Room 2600, New York, New York 10007.

F. 3. MANNED SPACE FLIGHT

Location: Gold Room

Chairman: Anatole Browde, McDonnell Aircraft Corporation, Lambert-Saint Louis Municipal Airport, Box 516, St. Louis, Missouri 63166

a. STATE OF THE ART SPEAKER: Robert N. Lindley. Title of Paper: "Gemini Engineering Program". Address: Engineering Manager, Gemini, Mc-

Donnell Aircraft Corporation, St. Louis, Missouri.

b. MANAGEMENT SPEAKER: Thomas J. Markley. Title of Paper: "Apollo Spacecraft Program Management". Address: Chief of Apollo Program Control, Manned Space Flight Center, Houston, Texas.

F. 4. COLLEGE ON RESEARCH AND DEVELOPMENT

Location: Ballroom Assembly

Chairman: Albert H. Rubenstein, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois

Reports and discussion on study committees of COLRAD:

1) Study Committee on Project Selection
2) Survey and Analysis of Project Resource Expenditure
3) The COLRAD COOP Plan
4) The Directory of Research on Research Management
5) A proposed Study Committee on International Comparisons of R and D Management, initiated at the TIMS-Vienna Meeting in September, 1965.

See list of participants, at the end of this program, for mailing addresses of authors.

ABSTRACTS

A. 1. a. "The Rise of Management in Advertising," Stanley I. Cohen, Benton & Bowles, Inc.

Over the past decade, the roles of Management Science and Operations Research in Advertising have grown, under the salient influence of computer methodology, from a modest experimental project state to a full scale systems state. The rate of growth manifests itself in (1) the size and complexity of problems being tackled, and (2) the widening sphere of techniques being brought into use. The classic areas of Advertising Research such as Marketing. Product, Consumer, Media, and Copy Research are availing themselves of the mathematical and statistical modeling techniques being designed throughout the entire research community of the world. Techniques such as mathematical programming, simulation, Baysian analysis, multivariate analysis, and Markoff analysis have become everyday production and research tools to the Advertising Industry. This paper will outline the growth and the current state of important areas of Advertising Research in relation to their involvement with Operations Research and Management Science.

A. 1. b. "The Prospect for Management Science in Advertising," Benjamin Lipstein, Sullivan, Stauffer, Colwell & Bayles, Inc.

The rate of innovation of new Management Science methods in advertising has been increasing very rapidly over the last few years. Many of these new methods have now become part of the operating procedures of the large advertising agencies. The acceptance and interest of agency management in these new tools provides a clue as to the effect which the Management Sciences will have on the business in the immediate years ahead. Some of the most recent Management Science innovations are discussed as they are likely to effect the marketing advertising process in the agency of tomorrow.

A. 2. a. "Contemporary Military Program Management", Major David I. Cleland, Air Force Institute of Technology.

Increasing centralization in the national defense establishment, dynamic acceleration in the conception and development of weaponry, and changing roles of the military establishments have motivated thoughtful Miliary Program Managers to evaluate the way in which decisions are made and executed. Increasing complexity of development decisions on military weapons which are closely related to military strategy decisions have resulted in the emergence of a unique approach to the management of human and non-human resources in the development and acquisition of weaponry.

The above conditions have affected military program management science; this paper will be devoted to examining both the qualitative and quantitative management responsibilities that must be assumed by a contemporary Military Program Manager. In the main, the paper deals with the description of the

environment, the decision process, and the method of execution of decisions. The Military Program Manager is recognized as an extraordinary individual who must possess a totality of skills including both qualitative and quantitative capabilities coupled with those firm convictions necessary to support the making and execution of decisions in an environment of risk and uncertainty.

A. 2. b. "Project Management in Industry of the Military Research and Development Program," Colonel Barton S. Pulling, Conductron Corporation.

The industrial Program Manager (PM) of a militarily funded research and development project is faced with the dilemma of managing a project where DOD ground rules are mainly established for the management of multimillion dollar production type contracts but where the actual industrial atmosphere is more akin to the academic, governmental or not-for-profit laboratory.

The technical problem to be discussed is the development and flight test of a singular, state-of-the-art focussed, coherent, synthetic aperture reconnaissance radar. A technical overview will be given in a generalized manner only to that extent necessary to familiarize the reader or audience with the unique differences between prototype development for a defined flight test program conducted by skilled engineers and production development for operational use by assigned military personnel.

The management techniques used will be elaborated upon, essentially scaling down where applicable the promulgated DOD management procedures, deiberately and positively rejecting inapplicable DOD procedures and the selection of substitute techniques from the catalog of management science.

The successes and failures of the above approach will be analyzed as objectively as is possible by the person responsible for making and implementing many of the various choices. An assessment of problems and failures will be undertaken, again being as objective as possible in assigning causes to the contractor, to the government or to the nature of the development itself.

The conclusion will emphasize the vast difference between the real world in which the small defense contractor works and the world which the defense procurement planner believes he has brought about. Specific problems will be highlighted and recommendations will be made to enable management scientists to bring those two worlds closer together.

The observations to be made and the opinions to be expressed will be those of the writer, not necessarily those of his firm.

A. 3. a. "On Statistical Cost Analysis and Operations Research", Charles H. Kriebel, Carnegie Institute of Technology.

Although the operations research or management scientist is both a theoretician and an empiricist, the literature on data analysis problems in operations research is relatively sparse. This report discusses a variety of empirical problems in obtaining statistical estimates of operating costs for a quadratic programming model and presents a case history.

A. 3. b. "The Audit Function—A Study of Goal Formation and Attainment", Neil C. Churchill, Carnegie Institute of Technology; and Trevor Sainsbury, University of Pittsburgh.

An empirical examination of the process of formulation of internal audit goals, the actions taken for their achievement, and the measures utilized in performance evaluation. Particular attention is given to the influence of the degrees of specificity with which goals and performance measurements can be established and to the resulting behavior.

A. 3. c. "Flow of Funds Approach to Cost of Capital", Russell Taussig, Columbia University.

This paper proposes an operational measure of cost of capital based on a weighting of fund flows over a normal period of years rather than a weighting based on balance sheet data at a point in time. Statistics will be included, showing the difference in decision making for a representative sample of industrial organizations. Also included will be empircal data on the alternative approaches to the inclusion of income taxes in investment decision analyses. The sensitivity of decisions to income tax changes will be analyzed for categories of investment decisions, and a methodology for the inclusion of income taxes under the flow of funds approach will be suggested.

A. 3. d. "Transfer Pricing and the Motivation and Evaluation of Bank Branch Managers", Alexander A. Robichek, Stanford University.

A number of approaches are currently used by branch banks to motivate and evaluate branch managers. Most of the methods, however, have not proven wholly satisfactory. A brief examination of the most commonly used methods and their shortcomings is provided in the first section of the paper. The paper then outlines an approach designed to induce branch managers to act in such a way as to accomplish the overall objective of the bank. The approach rests on the assumption that branch managers will act in a profit maximizing manner if they are given an appropriate objective. It proposes a system of transfer prices which will lead profit maximizing branch managers also to attain the overall firm objective. A hypothetical example illustrates the proposed system.

A. 3. e. "The Concept of the Information System of the Organization." James J. Linn, Massachusetts Institute of Technology.

The nature of the information system of the organization is relatively unexplored. Most of the statements about information systems are confined to statements about information, the output of the sytem, or a component of the organization or a segment of operations which is considered to be a part of the information system.

The information system is a collection of certain functions of an organization. Which functions to include and which to reject are a matter of opinion rather than fact. The various functions performed in an organization along

with the relevance of each to the information system of the organization are discussed. A suggested definition of the information system of the firm in terms of these functions is given.

This is a conceptual definition. Because of the joint embodiment of functions in physical elements, additional rules must be developed to produce an operational definition. This problem, and the relationship between the information system and the total organization are considered in the discussion of the proposed definition.

A. 4. a. "The Use of Assembly Line Balancing Techniques for Project Resource Balancing", C. L. Moodie, Purdue University.

This paper analyzes the similarities and differences between assembly line balancing and project resource balancing and proposes a procedure for transforming the latter problem into an assembly line balancing problem. An optimal solution procedure is proposed using integer programming, and good feasible solutions are proposed with heuristic procedures. Multiple resources for single projects are considered and generalizations are made for the multi project problem.

A. 4. b. "Real-Time Transistor Classification", J. W. Colin, Robert M. McClure, and Michael O'Hagan, Texas Instruments, Incorporated.

A real-time system employing a small (4K) computer for control of an automatic transistor testing and classifying machine is described. A comparison is made between the new and the previously used system showing the advantages and added features gained with real-time computer control. An illustration of the implementation of an optimal testing plan (predetermined by an off-line IBM 7044) is given. The man-machine dialog necessary for the start-up procedure will be described. Diagnostic features of the system will also be discussed.

A. 4. c. "Linear Programming Optimization of a Transistor Testing Operation", J. W. Colin and Michael O'Hagan, Texas Instruments, Incorporated.

A computer implemented linear programming model of an automatic transistor testing operation is developed. Using predicted test yields as developed from *sampled attribute test results* via a simulation phase, a linear programming optimization phase computes the optimal test quantities and testing orders given unit demands. The results are then back-solved to give predicted system performance.

Actual system results will be given. The system effectively functions as a closed loop control on a multi-variate stochastic process. The problem is also related to the classification of binary vectors and draws heavily on the results of combinatorial analysis.

The operating system is a four link chain job on the IBM 7044 system and is written in FORTRAN IV. The system acronym is TOMCAT derived from: Testing Optimized Mathematically for the Continuous Automatic Tester.

A. 4. d. "A Historical Perspective on Numerical Control", Mark Morgan, I.B.M.

Born at M.I.T. as a new way to operate milling machines, Numerical Control has expanded into fields beyond machine tools. As a means of communication between man and machines, it is the basis of manufacturing enterprises that are operated through data processing techniques.

What has been done in the past fifteen years—by whom, when, and how—to make possible such an evolution? Did the machine tool companies lead the way? Did the large data processing companies participate in the marketing of Numerical Control hardware? How did those companies contribute with software developments? What was the effect on the engineering profession? What was the role of the electrical manufacturing companies? What other applications has Numerical Control generated? Which applications are blossoming, which faltering?

This paper reviews the aforementioned topics, analyzing the technical, business, and management aspects of Numerical Control as it progressed through the years.

A. 4. e. "On An Optimal Facility Design and Location Problem," Richard L. Francis, Northwestern University.

The problem is one of locating and determining the shape of a facility S of known area A. The facility is to be located in some subset L of the plane in an optimal manner, that is, for any possible facility S of Area A in L, there is a real number, F (S), for example, total cost; it is desired to find a facility S* which minimizes F (S). S* will be called an optimal facility.

For a class of problems having a structure that allows F (S) to be defined in a particular manner, a sufficient condition is given for finding an optimal facility. The sufficient condition is shown to be a special case of the Neyman-Pearson lemma.

Applications of the theory to some particularly simple warehouse design problems are given.

B. 1. a. "The Application of Management Science in a Pharmaceutical Company", Robert J. Hunter, Smith Kline and French Laboratories.

This paper will give a synopsis of the case study of three projects worked on at Smith Kline and French Laboratories.

(1) Distribution Simulation—a series of simulations which facilitate the determination of the costs of various methods of distribution available to a pharmaceutical manufacturer.

(2) POSE (Program for Optimizing your Sales Efforts—a project developed for drug wholesalers).
POSE is a simulation which uses customer data (location, sales volume, sales territory, etc.) and order taking policy (number and length of outgoing and incoming phone calls, etc.) to aid the wholesaler in finding the best mix of telephone and sales order taking calls in his trading area.

(3) Production Scheduling—use of simulation and linear programming technique to optimize the use of a chemical production facility.

B. 1. b. "The Role of Management Sciences in the Pharmaceutical Industry," Charles S. Brown, Abbott Laboratories.

In an industry that is fast approaching its first century mark, accelerating change might appear to be an unexpected characteristic of the Pharmaceutical Industry. The management of these changes looms as a major challenge to those responsible for continued progress in these companies. The expanding use of a variety of Management Science techniques has played a major role in preserving the vitality of this important industrial group.

B. 2. a. "Management Science in the Field of Investment—State of the Art," Gerald D. Blackwill, Security First National Bank.

Management Science has established a position of growing importance in the field of investment. Individual investment risk analysis and multiple risk analysis are two Management Science applications currently in use.

Discriminant analysis, linear regression, and simulation techniques are being used by banks and investment firms in their analysis of risk and return on individual investments. Linear programming, quadratic programming, and simulation techniques are being used in the field of multiple investment risk analysis.

Credit scoring, securities investment, and capital investment evaluation are applications in individual investment risk analysis. Each of these techniques is used to develop a set of profit potentials and their associated probabilities. In the case of credit scoring, discriminant functions are used to derive the credit score that maximizes profits. Securities investment techniques are a combination of linear regression and simulation models. The output from these models is then used in multiple investment risk analysis models. Capital investment evaluation uses simulation models to assess the probability distribution of return or present value.

Quadratic programming, linear programming, and simulation models are used in multiple investment risk analysis. Multiple risk analysis almost invariably requires prior individual investment risk analysis. For example, a portfolio selection model requires an implied or explicit probability distribution of expected return of individual securities.

If there are no significant correlations between the characteristics of the investments, a linear programming model using capital budgeting inputs can be applied. If there are significant correlations, then either a quadratic model, a modified linear model, or a simulation model is used.

This paper will discuss these present uses of Management Science techniques.

B. 2. b. "Some Guesses About Where We Are Going in the Application of Quantitative Techniques to the Investment Problem", Mr. Herbert Ayers, Morgan Guaranty and Trust Company of New York.

The ultimate results from any line of significant research are always of interest and the application of quantitative methods to investment problems is no exception. In this paper are presented some guesses as to the future. The word "guesses" is to be emphasized. It is likely that there will be useful common stock evaluation models probably predicated on estimates of future

economic events more than upon past events. This and possibly simulation techniques may change the function of the traditional financial analyst somewhat so that he spends more time on the difficult judgemental problems. It seems likely that we will have useful portfolio selection models and more quantitative methods for evaluating the performances of a portfolio than we have today. Econometric models of industry will probably be used to analyze industrial inter-relationships. Models of bond markets are already used for pricing and bidding. It is expected that this work will be extended. The investment problem belongs to the sequential decision process family, but to apply the various available mathematical machinery presupposes the existence of explicit preference functions, one of the currently weakest areas. Progress is anticipated on the required explicit function.

B. 2. c. "Optimal Timing of Bond Refunding," H. Martin Weingartner, Massachusetts Institute of Technology.

Corporate Bonds are frequently issued with a call privilege—giving the issuer the right to redeem the bond before maturity by payment of a premium specified at time of issue. This privilege may become relevant when interest rates fall relative to the original coupon rate. However, the decision to call the old bond and issue a new one must take into account a variety of factors. Not only may interest rates fall further, but also the new bond, because of its schedule of call premiums and the issue costs, cannot be replaced economically for some interval of time. A model is formulated to arrive at an optimal decision with respect to timing of the refunding.

B. 3. a. "Group Composition, Input Load and Group Information Processing", Michael J. Driver, Purdue University.

This research is based on a model of human information processing which specifies that the amount of information sought, received and utilized in making decisions is a joint function of organizational structure, member personality and environmental demands. The model specifies that individuals develop characteristic levels of cognitive complexity which determine their information processing capacities. This complexity level varies in a systematic curvilinear fashion with both stress and information load in the environment. A third factor is the complexity of the organization structure, but this has not been analyzed as yet.

These studies have analyzed the information processing behavior of three to four man groups in two simulated settings: (a) a tactical-negotiation game, and (b) an internation simulation. In both settings, some groups were homogeneously composed from individuals with generally complex cognitive structure, while other groups were manned by cognitively simpler persons. In the tactical-negotiation game stress was held constant while information load was varied. In the internation simulation, stress was varied and information load was held constant. Results in both settings show that both types of group display curvilinear pattern of information processing as input load or stress increases but that at all values more complex groups use more data than simpler groups.

B. 3. b. "Computer Simulation of a Decision-Making Group", John M. Dutton, Purdue University.

This is a study of problem-solving by a human group. The group performs central coordination and planning for an actual man-machine system. The objective of the study is a computer simulation of the problem-solving activities of this group as a means to further knowledge of cognitive activity, organizational interaction and artificial intelligence.

The man-machine system controlled by the group is a medium-sized manufacturing facility which is operated as a job-shop. The primary function of the control group is to schedule production through the plant. The environmental demands placed upon the control group are severe. Production capacity is limited and delivery requirements stringent. Moreover, the group operates with a strong budget constraint.

The job-shop scheduling problem which is solved by the group is one of immense proportions. Nevertheless, the group consistently outperforms the heuristic and formal methods which have been devised to handle problems of smaller magnitude. Apparently, the problem-solving activities and structure of the group have emerged over time from the environmental setting and the task. And it is the purpose of this study to analyze the essential properties of this emergent system.

B. 3. c. "The Notion and Possibility of Equilibrium Under Majority Rule," Charles R. Plott, Purdue University.

The paper sets forth a notion of equilibrium within a decision making body which is attempting to decide on the magnitudes of several variables and which is operating under majority rule. Each member of the decision making body is assumed to have a well behaved utility function defined on the set of variables and casts his vote for those changes in the variables which would increase his utility. A particular set of all possible magnitudes of the variables is said to be an equilibrium point if and only if no possible change or combinations of changes in the variables can receive a majority vote.

The relationship that must exist between the utility functions for a point to be an equilibrium point are deduced. These conditions are derived both for cases when there is no constraint placed on the variables and when there exists a resource constraint. And, the possibility of the existence of an equilibrium is evaluated.

B. 4. a. "Designing the Fundamental Information System—A Guide to Productive Data Processing," A. F. Moravec, General Dynamics.

Current literature abounds with various ideas and suggestions concerning the many types of data processing systems available to the user. It includes various configurations of hardware (equipment) and various kinds of software (programs and documentation) with which one can accomplish any kind of data processing one can ingenuously develop. To say the least, not only is the sum total of data processing a picture of complexity today, but in addition, there is a major loss of sight concerning the basic needs of the user and his requirements, both present and future. On the other hand, the user must

understand the basic concepts and trends now taking place in electronic data processing so that he can incorporate these into his future planning.

The purpose of this paper is to provide a basic understanding of the future trend in electronic data processing operations and in the construction of information systems. The discussion will include: pressure for new kinds of EDP Systems, revised concept of business systems, engineering, revised concept of mechanization, total systems approach vs. single information flow, the concept of the fundamental information system, and the basic steps in designing a new kind of information system.

B. 4. b. "Optimal Design of a Stochastic System with Dominating Fixed Costs," Satinder Mullick, Corning Glass Works, Corning, New York.

Executives in a wide variety of formal organizations have been required on countless occasions to make decisions involving what accountants often refer to as "fixed costs," large incremental charges which occur when investments are made or when departments or divisions are closed in the face of declining demand. In many cases, manufacturing, for example, large elements of cost vary in proportion to organization activity but there are other organizations in which so-called "fixed costs" are quite dominant. Academic institutions are of this kind and so also are various branches of government, and eleemosynary organizations such as hospitals, where ward staffs tend to remain stable over wide ranges of patient census.

Libraries also are organizations of this kind, where the variable expenses associated with acquisitions (excluding expenditures paid for books), cataloging, binding, and library use are quite small per unit of library activity, and are indeed, trivial relative to the much larger expenditures paid in the form of staff salaries. In such cases executive decisions as to when staff shall be augmented or curtailed become critical to provision of adequate service on the one hand and economical operation on the other. In general, such decisions tend to lag the need for action—perhaps this is why these stable costs are characterized as "fixed"—so that service becomes inadequate in time of rising demand and costs inordinately high when demand is declining.

Various mathematical models and decision rules using discontinuous total cost functions are developed to guide in the optimal design of the library service centers with an objective to achieve efficient operating characteristics. This approach offers larger possibilities for more general application to other situations in which fixed costs are dominant, situations which are mathematically intractable because of discontinuities.

B. 4. c. "Queues with Multiple Poisson Input," Carl M. Harris, Western Electric Company, Inc.

Closed expressions for steady state probabilities are derived and several measures of effectiveness are examined for a single channel, first come, first served queueing system in which the arrival discipline is a multiple Poisson process and the service times are exponential. In particular, we relax the standard Poisson assumption. We allow two types of arrivals, singlets and doublets (2 simultaneous arrivals, i.e., a batch of two), each governed by a separate, independent Poisson distribution.

Several specific areas of applications are discussed.

B. 4. d. "The Theory of the Firm: A Comparison of Marginal Analysis, Linear Programming, and Computer Simulation", Thomas H. Naylor, Duke University.

Within the past fifteen years the body of knowledge which is known in the literature as "the theory of the firm" has undergone what amounts to a major transformation process. With the advent of the electronic computer and the discipline of operations research, the traditional concept of the theory of the firm (e.g., J. R. Hicks' model of the firm) has been subjected to a number of rather formidable alterations. As a result of the transformation it is now possible to identify at least three different approaches to the theory of the firm. These alternative models of the firm may be classified as (1) marginal analysis models, (2) mathematical programming models, and (3) computer simulation models.

Although each of the analytical approaches to the theory of the firm has been described repeatedly in the literature, there has been no real attempt to compare these alternative theories of the firm. There appears to be a definite need for a detailed comparison of marginal analysis, mathematical programming, and computer simulation in the light of the applicability to theory of the firm. This paper represents an attempt to at least partially fill this gap.

B. 4. e. "On Some Stochastic Tactical Antisubmarine Games," A. Charnes, Northwestern University, and R. G. Schroeder, U. S. Naval Postgraduate School.

We develop some mathematical models of tactical problems which arise in Antisubmarine Warfare. Specifically, we consider a game of pursuit between a hunter-killer force, P1, and a submarine, P2. The game consists of a sequence of moves and it terminates when P2 is caught or evades P1. When the players move, they observe the current tactical configuration (state) and they choose a tactical plan of action (decision). This joint choice of decisions determines an immediate "payoff" and the game transists to a new state in a Markovian fashion. Our mathematical formulation of the above problem is a stochastic game as defined by Shapley in 1953. He demonstrated the existence of a value and optimal strategies (a solution). We propose an iterative technique to approximate the solution to within desired accuracy. Each iteration of our technique is obtained by solving a set of linear programs.

To provide a more realistic model we propose several variations of the basic game. One variation is a constrained stochastic game. Here an implicit restriction on the expected duration of the game is rendered by means of constraints on the strategies. We also examine the implications of perfect information and in this case the mathematical model is reduced to an ordinary Markovian decision model. Finally, we restrict the number of moves to be finite and show our linear programming techniques may be used to find the solution.

C. 1. a. "Development of Management Science in the Public Accounting Profession," Leland A. Moody, Arthur Andersen & Co.

Public accounting firms were among the earliest to employ management scientists. For the most part, the function of the management scientists in these firms has been to provide specialized professional services to clients. Over the years, however, their work has resulted in some management science techniques becoming common place methods used by other members of the firms' professional staffs. In addition, their presence has had some influence on the auditing function itself.

Management scientists working in public accounting have faced certain restrictions unique to the profession. On the other hand, the special characteristics of the profession have provided them with exceptional opportunities to make successful implementations of analytical results.

Some very recent developments strongly suggest that the importance of management scientists to public accounting and the number needed will increase rapidly in the future.

This paper reviews some of the work which has been done by management science groups in public accounting firms. It also describes the effect these groups have had on other functions within the firms. The problems and successes which have been experienced are compared with similar ones in business and industry; reasons are given for those that are peculiar to the public accounting profession. Historical trends, together with very recent developments, are interpreted into the near term prospects for management science in public accounting.

C. 1. b. "Challenges and Opportunities in Client Service and Accounting Technology," Bertrand J. Belda, Ernst and Ernst.

The public accounting profession has been one of the leading groups to recognize and embrace the management sciences. The merger of operations researchers and other management sciences skills into the practice of the C.P.A. firms has given new and deeper dimensions to their client services. The developments and accomplishments to date are impressive, but there are many additional opportunities for management sciences to make an even greater contribution. These potentials lie, not only in the field of more effective management services to business, but also in the area of accounting technology, itself.

The speaker will emphasize an important challenge to the management sciences as a major factor in developing decision-oriented managemnt information in the area of the identification and evaluation of normally *unrecorded* events that have significant impacts upon business success. Thus, the problem of detecting and measuring missed potentials resulting in lost sales, lost profits and other opportunities are often as important to the welfare of the business as are the analyses of historic patterns and the development of future programs.

This presentation will also suggest that management sciences can contribute significantly to the development of more meaningful financial reports. Through the analytical and evaluative capability of operations research, the speaker believes that it is both practicable and useful to develop interpretative data on a sound economic value basis, rather than to cling to the traditional historic cost basis now generally used by accountants. In this manner, the

measurement and quantification of income and financial position could be made on an economic value basis in current dollars, and thereby provide more useful interpretation of business progress (or lack of it).

C. 2. a. "State-Of-The-Art In Non-Military Management Sciences in the Federal Government," W. E. Cushen, National Bureau of Standards.

A survey of ongoing inhouse and contract work in the Operations Research/Management Sciences that is related to the programs of the civilian agencies of government will be presented. In general, these efforts are significantly smaller than their defense counterparts and much smaller than their required level.

Particularly significant in the context of the civilian agency programs, are the following problem areas:

(a) How to Determine Measures of Effectiveness of Public Service Programs. (The social utility function fails to reflect the important phenomenon of rebuttal and debate in an open society.)

(b) How to Determine the "Ought" as Distinguished From the Rationale in "Optimum". (What should the agency goals be; how should the service mission be interpreted into the Management Science context?).

(c) The Question of "Least Changes". (Which small number of conditions would result in the evolution of an optimal solution in which the freedom of human choice creates the improvement?)

(d) The Complimentary of "The Rationale" and "The Forceful". (Questions of perspective, inter-agency collaboration, the system of checks and balances, the multiple echelons of decision makers, Legislative-Executive Branch inter-play, etc.)

C. 2. b. "Environmental Science Services and The Management Sciences," W. A. Hahn, Director, Planning and Program Evaluation; and R. M. White, Administrator of the Environmental Science Services Administration of the Department of Commerce.

Rejuvenation and reorganization of the environmental science and service activities in the Department of Commerce have drawn heavily on management sciences capabilities and personnel. In a number of areas, during a two-year period, significant identifiable contributions were made by OR/MS personnel acting in concert with line managers. OR/MS involvement was either inappropriate or inadequate in other instances. Implementation now in progress offers a wide spectrum of challenge to management scientists to make substantive contributions toward achieving statutory and organizational objectives. An example covers the initiation in a civilian agency of the much discussed planning-programming-budgeting activity. This paper takes the management viewpoint. It covers the views of three levels of management—that of the leader of the organizational planning team, the administrator of the agency, and the assistant secretary of the cabinet department. A key theme is the interactions between these managers and the management sciences and substantive specialist professionals. Descriptions of specific problem areas emphasize solutions and only incidentally describe method. The scope is limited to a portion of a single civilian department of the Federal government. No claims are made for wider applicability, but there are implications for other areas and questions for the profession to explore.

C. 3. b. "A Multi-Mode Transportation Network Model", Raymond W. Lewis, Erling F. Rosholdt and William L. Wilkinson; The George Washington University.

This paper describes a comprehensive transportation network model which exploits the special capabilities of large scale, high speed computing equipment in the evaluation of large complex transportation schemes. The model was developed to approach the fundamental requirement to compare quantitatively the performance of difference transportation force levels against the cost of procuring, maintaining, and operating these force levels. Specifically, in the execution of contingency plans difference force levels of airlift and sealift were to be evaluated in measurable terms of total lift over time which could then be weighed against the cost requirements for each combination.

C. 3. c. "Programming the Procurement of Airlift and Sealift Forces", G. R. Fitzpatrick, J. Bracken, M. J. O'Brien, L. G. Wentling and J. C. Whiton; Research Analysis Corporation.

A linear programming model is described that analyzes the strategic deployment mix of airlift forces, sealift forces and prepositioning to accomplish composite requirements of a complex of possible contingencies. It solves for the least-cost mix of means of deployment which possess the capability to meet any one of a spectrum of contingencies, or to meet simultaneous contingencies. The model was developed by RAC and used in an analysis of deployment systems conducted by RAC in support of the Assistant Secretary of Defense (Comptroller). The results of the analysis have been directly incorporated in the preparation of the 1965 memorandum from the Secretary of Defense to the President, "Recommended FY 1967-71 Airlift and Sealift Forces," which forms the basis for preparing the Fiscal Year 1967 budget with respect to airlift and sealift forces among other purposes. The paper will discuss assumptions, describe the structure of the model, costs, and other inputs, consider how the model is used, and discuss various extensions.

C. 4. a. "The Relationship Between Certain Characteristics of Industrial Research Proposals and Their Subsequent Disposition," Norman R. Baker, Purdue University; and Jack Siegman and Jon Larson, Northwestern University.

The ideas produced by three idea generation groups operating within a large industrial R and D laboratory were studied over a period of two years. The purpose of this paper is to: 1) relate the final disposition of each of these ideas to subjective evaluations of "goodness" as generated for each idea during each group's time span; and, 2) to study the role of urgency, predictability, and time horizon in the disposition of these ideas. The findings were: 1) A significant and positive relationship was found between subjective evaluations and actual idea dispositions. The higher the subjective evaluation rating of an idea, the greater the likelihood of the idea being accepted as a new project or incorporated into an existing project as contrasted with those ideas which were evaluated lower. 2) It was also found that the urgency of the need which

the idea might satisfy was significantly related to the chances of the idea becoming a project. 3) Finally, a positive correlation was found between subjective evaluation and urgency, predictability, and shortness of time horizon.

C. 4. b. "An Experimental Study of Bargaining Studies: Series One", D. F. Grodosk, D. P. Leitch, W. H. Starbuck, and R. E. Walton; Purdue University.

This report concerns the first series of experiments on bilateral bargaining strategies.

Most existing experimental work has focused on the bargaining agreement, the kind of bargain struck. In the work reported here, the bargaining agreement is a secondary interest. The primary interest is the kinds of bargaining strategies used, e.g., the extent to which threats are employed.

The first series of three experiments is directed toward commitment timing. Alternative commitment strategies are, in their extreme forms: (1) bargainer A states his final position at the outset of the negotiations, or (2) bargainer A makes only tentative position statements until after bargainer B has stated his final position. The independent variables treated are (1) the amounts of information given the bargainers about the range within which negotiations are feasible and (2) the availability of a "take-it-or-leave-it" message.

C. 4. c. "A Study of the Information Searching Behavior of X-Ray Crystallographers," R. W. Trueswell, University of Massachusetts; and G. J. Rath and A. H. Rubenstein, Northwestern University.

A set of information services is presented to several scientists while they are being studied with respect to their information searching behavior. Information event cards completed by the scientists in real time data collections and a telephone tape recording data technique are used in addition to questionnaire schedules for collecting data about the information searching behavior of the scientist. The reaction by the scientists to the set of information services is described.

C. 4. d. "An Experimental Study of Bidding Behavior", Richard F. Barton, University of Kansas.

This experiment was structured to require both conflict behavior and cooperative behavior by the subjects. The context of the experimental environment was that of the retail automobile repair industry. Each subject managed one firm and each was admonished to maximize his profit over two weeks of simulated daily bidding and operations. The firms were constrained by shop capacity, by a given level of fixed overhead, by the random sequence of job opportunities, and by the bidding behavior of two competitors.

In 5 runs of the experiment, covering 32 simulated 3-firm industries, subjects were in general unable to cooperate sufficiently to earn what had been given to them as the historical normal profits for the industry. On the other hand, their conflict behavior did not lead to ruin. When opportunities for collusion were injected, joint payoffs failed to increase significantly. In a sixth run, with highly sophisticated subjects, effective tacit collusion was finally observed.

C. 4. e. "Management Use of Computerized Micro-Analytic Behavioral Simulations," Arnold E. Amstutz, Massachusetts Institute of Technology.

The paper reviews the development, testing, and implementation of a large scale computerized micro-analytic simulation of market behavior. Problems associated with model conception and specification, function verification, and system and sub-system testing and validation are discussed with reference to an operating system. Sample simulation runs based on regional test markets are evaluated and representative management uses of the system are discussed.

D. 1. a. "Management Sciences in the Food Industry," Paul A. Strassmann, National Dairy Product Corporation.

Narrowing profit margins and increased reliance on methods of mass production and mass distribution have made it particularly attractive for firms in the food industry to employ operations known to have contributed to the management sciences in the food industry.

D. 1. b. "Management Use of Management Science," Terrance Hanold, The Pillsbury Company.

Abstract not available.

D. 2. a. "Systems Analysis Applied to the Problems of Local Urban Government," Claud Gruen, A. D. Little, Inc.

What techniques of systems analysis and management information systems are currently being used and developed for local government. An appraisal of the future of these techniques in relation to the possible benefits of current and future developments and an indication of the most likely forms such developments will take.

D. 2. b. J. L. Brownlee, City Manager, Ft. Worth, Texas.

Title and abstract not available.

D. 4. a. "A Computer Simuation Model of Railroad Freight Transportation Systems", William P. Allman, U. S. Department of Commerce, National Bureau of Standards.

A railroad freight transportation system may be viewed as a collection of freight origin and destination points, trackage connecting these points, switching yards where trackage intersects, plus supporting facilities and resources. The objective of the railroad enterprise is considered as being to satisfy and accommodate time-dependent demands imposed upon it for movement of freight cars between points in the system. For purposes of investigating total

system operations at a synoptic level, the railroad may be effectively represented by a network of major yards and trackage links thru which trains haul freight cars. Car movements are governed by basic preplanned policies pertaining to train routes, capacities, and schedules, and the assignment of cars to trains. We view the following as the three basic policy questions of railroad freight operations:

a) Where should trains of what capacity run when, i.e., how many trains should be run over the various links of the network, at what times should such trains be run, and what should the capacities of such trains be?

b) How should freight cars be sorted (classified) into group categories at switching yards?

c) What group categories of freight cars should a train haul between various points along its route?

The paper describes a computer model which has been developed to permit simulation of the three basic railroad operating policies at a synoptic, total-system level. Major inputs are time-dependent demands imposed upon the railroad system, train routing and scheduling policies, train taking and setting off policies, and freight car sorting (classification) policies. Major outputs are individual yard and total system performance variables which describe freight car transit times, yard activity volumes, waiting delays, etc. Availability of resources, such as motive power units and personnel with which to accomplish operations, is not considered. In the model, trains travel over their routes as time advances, appropriately taking and setting off freight cars at yards. Cars wait at yards to be taken by trains, and also undergo time-consuming yard servicing and switching operations which may cause them to be delayed. Progress notices may be printed as significant events actually occur thru time. The model recognizes train connections whereby cars setoff from one train at a yard have a "guaranteed" connection to another train which departs from the yard. Also, a classification hump may exist at any yard, and the model will accordingly consider the hump's bottleneck effect, and resulting delays to freight cars. Numerous variables in the model may be either deterministic or probabilistic.

The model is programmed in the General Purpose System Simulator III simulation language for the IBM 7090-94 computer, and is designed to accommodate a 20-yard network, with the number of trains and freight cars which may be represented limited by computer storage. Advantages and disadvantages of GPSS III for aggregation flow-type models will be discussed, as will experiences in applying real world data to the model.

D. 4. b. "The Effect of Consumer Advertising on Retail Availability", George H. Haines, Jr., and Alvin J. Silk, University of California, Los Angeles.

Advertising practitioners frequently assert that advertising in consumer media has an effect upon the retail availability of the product advertised. In making shelf-space allocations, retailers presumably take into account the amount of manufacturer-sponsored advertising that persists for products as

well as other factors affecting demand. This notion, in turn, leads to the belief that an increase in advertising leads to increased availability of the product to consumers in retail stores and the combination of these two factors leads to an increase in sales to consumers. However, previous studies and theoretical discussions of the effect of advertising upon retail sales have usually ignored this commonsense notion.

The purpose of this paper is to present and attempt to test a model which depicts the effects of advertising expenditures on retail availability and thereby explore the question whether the effects of advertising upon distribution can be ignored in attempting to assess the return from advertising.

D. 4. c. "A Simulation Approach to Districting", James D. Thoreson, Texas Instruments, Incorporated.

The political districting process can be thought of as locating geographical boundaries that enclose electoral populations. Equal population, as specified by the Supreme Court, suggest the use of quantitative procedures in districting that would draw district boundaries on an impartial basis. Such analytical procedures could unquestionably aid in achieving equitable appointment on a population basis. The purpose of this paper was to create rational districting schemes through the development of analytical techniques. The intent was to provide an efficient means of generating many impartial districting arrangements that satisfy both the equal population requirement and a number of traditional districting criteria including contiguity, compactness, preservation of political boundaries, and singular representation.

The approach taken was to simulate national districting logic with an abstract model. The model was then programmed for use on the IBM 7044 digital computer, the speed of which permits rapid generation of a multitude of alternative arrangements. Additionally the computer permits rapid calcula tion and tabulation of population measurements concerning each simulated districting arrangement. Based on these quantitative measurements, the more equitable plans could then be selected as the better districting arrangements.

Numerous arrangements were generated using data appropriate to the State of Iowa. The results were used in submitting Senate districting plans to the Joint Reapportionment Committee of the 61st Iowa General Assembly.

This paper demonstrates that computer simulation can be used effectively in creating districting solutions based on population equality. Moreover, the computational speed of the digital computer permits rapid calculation and determination of the superior arrangements. It also shows that additional criteria can be programmed into the model to accommodate current districting requirements.

D. 4. d. "A Probability Model for Guiding Investment and Underwriting Decisions of Casualty Insurance Managements", Robert L. Street and Charles S. Beightler, University of Texas.

This paper deals with the development and application of a probability model for use by management of a casualty insurance company in making certain decisions. The areas of securities investments and underwriting policies

of the company are the management problems dealt with in this paper. The model constructed has as its objective the maximization of the probability of realizing a stated operating profit during a specified period. A predictor model for determining future losses is the heart of the method described. This predictor model uses probability distributions of claims frequencies based upon known characteristics of individual risks. Other factors taken into account by the general model are expected values of earned premiums, operating expenses and returns on available investment choices. A single line of insurance, workmen's compensation, is used to develop the model described.

D. 4. e. "Planning for Non-Renewable Mineral Resources: A Preliminary Model," W. A. Wallace, J. R. Dunn, and D. Bishko; Rensselaer Polytechnic Institute.

The recent use of simulation as a decision-making tool, and the notably urgent problem of the misuse and depletion of non-renewable mineral resources have led the authors to investigate the use of simulation to analyze the economic feasibility of a formalized planning function for non-renewable mineral resources. The preliminary study is being conducted using sand and gravel as the non-renewable mineral resource.

The computerized mathematical model developed for investigating this problem considers five major areas of cost:

1. the material value and associated labor and overhead costs at the mineral deposit,
2. transportation costs from the mineral deposit to the mixing plant (or construction site),
3. total labor and overhead costs (including loading and unloading) at the mixing plant,
4. transportation costs from the mixing plant to the construction site, and
5. total labor and overhead costs associated with handling the material at the construction site.

These costs are accumulated for an entire development, city, etc. for a period from 10 to 50 years, and are compared with and without a formalized planning function for the mineral resource. The model, which is programmed in FORTRAN IV for analysis on an IBM 360 Mod 50 computer, includes such factors as population growth and its accompanying construction requirements, depletion of and zoning out of existing deposits, and the costs of establishing new deposit sites.

D. 4. f. "Scheduling of a Large Forestry-Cutting Problem on a Digital Computer By Decomposition of Linear Programming", Mike T. Tcheng, Saint Louis University.

A decomposition of a linear programming model is developed for the scheduling of a very large forestry-cutting problem. Computational algorithm and a computer program package designed for this model are also developed. The computational and programming experience and the results from the

actual solving of an industrial real-life problem are discussed.

The problem involves the scheduling of more than a thousand woodlands for cutting over a cycle of 24 years. The result of this study is an appreciable gain in total wood volume, production, total yield of 1.28 million cords (volume unit: 4′ x 4′ x 8′) to 1.47 million cords or an average increase of dollar output of over $40,000 annually. The objective of the study, to maximize the total lumber yield, was obtained. This study is the first decomposition of a linear programming model with a computer solution successfully applied to large scale forestry management problems. It provides another example of the feasibility of applying Analytical and Quantitative methods to the problems in the forestry industry.

E. 1. a. "Management Science—What Has It Accomplished in the Chemical Industries," Gerald T. Westbrook, Dow Chemical Company.

The state of the art of management science in the chemical industries is explored from several viewpoints. Included in these are an analysis by techniques, by management function, by product class and by major company. An attempt will be made to identify those features of the chemical industry that are unique and create specific opportunities or problems for the management scientist.

E. 1. b. "Management Science in the Chemical Industry—Today and Tomorrow," Robert E. Pyle, Union Carbide Corporation.

Management Science as a discipline has made a significant contribution toward increasing operating management's effectiveness throughout the Chemical Industry during the past few years.

Although progress has been slow, many of the problems facing Management Science practitioners throughout the industry are gradually being overcome. In contrast to the problem-strewn path to date, the future for Management Science in the Chemical Industry looks quite encouraging.

This paper presents a manager's view of the current status of Management Science within the Chemical Industry, and the opportunity and challenge that lies ahead for these techniques in an industry that is technologically quite advanced.

E. 2. a. "Management Science in University Operations," Gustave J. Rath, Northwestern University.

A review of the literature and study by questionnaire indicate that Universities have not been using Management Science and in many cases have just begun to recognize its existence. The information sciences have been best represented with a wide variety of computer activities especially in the area of master scheduling and class sectioning. The use of formal Operations Research techniques seems to be still a research question, even though some applications are being made at lower levels. Systems analysis and synthesis techniques only applied on research and development contracts. Human factors techniques and other man-machine design viewpoints have not been generally used. The paper will present a survey of the literature, followed by a discussion of current applications.

E. 2. b. "Management Science in a Large University," Charles J. Hitch, University of California.

Abstract not available.

E. 3. a. "Management Science State of the Art in the Aerospace Industry," Donald G. Malcolm, Management Technology, Inc.

The development and use of management science techniques in the aerospace industry are reviewed as are their successes and failures. Those management problems for which promising management science assistance is in prospect are outlined together with their data, technique and communication obstacles. The audit concept for defining management information, communication and organization problems and for developing an improvement program based on better controls will be discussed. Challenging research areas for the management scientist in the aerospace industry are suggested.

E. 3. b. "Management Science and Aerospace Industry Management," W. H. Statler, Lockheed California Corporation.

The areas of successful application of operations research and management science in the aerospace industry, from the manager's point of view, will be reviewed. Relationships between management science and management judgment in the real tough problem of the aerospace industry, growing out of its explosive growth and inherent real uncertainties, will be explored. The discussion will try to include some useful suggestions for increasing the value of management science and management scientists to the aerospace manager.

E. 4. a. "KAPPA: A Single Parameter Descriptor for Project Manpower Utilization Patterns", S. William Yost and Richard S. Rosenbloom, Harvard University.

The typical research and development project is characterized by changing rates of manpower utilization. These rates change within a project and the timing of the changes varies between projects. To facilitate research into the phenomena that cause these changes we have developed a technique which describes differences between these patterns in terms of a single parameter. This parameter, called Kappa, is calculated by iteratively rescaling normalized cumulative effort-time project data to obtain a least-squares fit to a defined master curve. Empirical evidence indicates that the resultant fit is better than that obtained by either asymtotic or polynomal regression techniques involving three to five parameters. The paper concludes with a discussion of possible applications of this technique in research on project manpower utilization.

E. 4. b. "Criteria for the Timing of Research Decisions", J. M. Keenan, Stanford Research Institute, and Jerry L. Dake, U.S. Naval Postgraduate School.

Experimental designs in systems research will usually contain many heterogenous elements, each of which are subject to varying degrees of uncertainty. Procedures of sequential analysis and decision theory usually hold constant significant parameters such as the time interval between tests, the specified test procedures or sample size. In the design of a complex systems experiment the analyst may have the choice of introducing one or more intermediate tests of specific elements or modules of the total package and manipulating these parameters.

If the success of the total experiment is absolutely contingent on certain of the elements, these components typically are pretested. In some types of experiments, e.g. educational research, the conditional value of components may be scaled. Pretesting of the elements will alter the expected value of the total experiment by modifying estimates of conditional value and/or subjective probabilities of success.

The value of information derived from selective sequential testing of components will vary with time and the analyst has the option of selecting both quality of test and time of test. If the maximum expected value criterion is utilized, there will be critical values of time and cost where the marginal expense of testing will equal the marginal change in expected value for the total experiment.

The elements of a model incorporating these factors are examined in the context of a particular research project. A set of decision rules are developed for the determination of indifference points for sequential testing with time/cost parameters.

E. 4. c. "A Study of Parallel and Sequential Research Strategies", W. J. Abernathy and Richard S. Rosenbloom, Harvard University.

The identification of one or more apparently feasible approaches to accomplishing a specified technical objective is common in research and development activities. In such situations the decision maker must choose either to make a commitment to the "best" known alternative and pursue the others sequentially if the first choice proves unsuccessful or make simultaneous commitments to more than one approach to the problem (a parallel strategy).

This paper describes a model for optimal choice between parallel and sequential strategies. The model describes strategies in terms of the relationships between loss functions, time and cost distributions, and estimates of technical uncertainty. Two indices plus a third variable summarize the characteristics of the model and uniquely determine the preferred strategy. These three measures, and their relationships, describe some interesting characteristics of the preferred strategy that are not intuitively obvious. The basic model, an application of the model to a hypothetical problem, and the characteristic results that may be obtained from such an application, are presented in the paper.

E. 4. e. "Subjective Estimates in CPM Planning for Development Projects—An Analysis", Talmadge A. Wilson, USAF Command; and William R. King, Air Force Institute of Technology.

An historical analysis of activity time estimates made by a number of contractors on a large-scale systems development project is conducted using two basic hypotheses.

(1) Pre-activity time estimating accuracy improves as the beginning date of the activity approaches.

(2) Time estimates made during the progress of an activity improve in relative accuracy as the completion date of the activity approaches.

These hypotheses are tested and a model for adjusting time estimates on the basis of the estimator's past history is developed and tested. This model

should prove useful to the managers of large development projects who are concerned with the possibility of consistent bias and high variability in subjective activity time estimates.

E. 4. f. "Scientific and Engineering Manpower Projection and Cost Model," Harvey B. Safeer, Research Analysis Corporation.

This paper describes research into the feasibility of constructing a model showing the interactions among the factors relevant to Federal financing of academic research, facilities for science and graduate education in the sciences. It contains a first approximation to a workable model for projecting production of scientific and engineering manpower and the associated costs to the Federal government for direct student support, research grants and facilities expenditures. The model is designed for use in assessing the implication of alternative Federal expenditure policies (i.e., direct vs. indirect student support). When implemented, it should provide the policy planners with a quantitative tool which would not generate policy, but would enable them to realize the impact of policy decisions. Quality considerations, although highly relevant, have not been considered.

The paper is in five sections:

(1) Introduction—a general description of this type of model and its applicability as a tool in policy making and the budgetary process.

(2) The Structure of the Model—a description and analysis of a manpower flow model in which the components of Federal expenditures are directly tied to the manpower production system. This section also includes a technical appendix.

(3) Availability and Reliability of Existing Data—this section includes a detailed analysis of some of the data which are available and which can be used to implement the model. Also included are examples of the different ways in which the model can make use of existing data, not originally designed or collected for such use. All of the data in this section are from either published reports or unpublished tabulations. The only data specifically tabulated from raw data are the Federal funds for education information.

(4) Existing and Potential Sources of Data for Future Use—in this section possible data sources and the items available in each source have been listed. Some of the data have already been published, but further use can be made of the raw data to provide inputs for the model.

(5) Conclusion—describes next steps in implementing the model, and an estimate of resources required.

Because of the time limitation imposed upon the study, it was necessary to trade off completeness of coverage in any one area for completeness in the coverage of the total system.

F. 1. a. "Management Science—State of the Art in 1965", Robert H. Grant, Celanese Corporation of America.

Practitioners of management science have been courting the petroleum industry for more than a decade—a period sufficiently long to warrant the issuance of a major progress report on the course of the romance and prospects

for a permanent union. To this end, a survey of management science applications in various companies will be presented and an estimate of results to date will be given.

Areas of application to be reviewed include information systems (logistical, financial, etc.), planning and control networks, strategic program evaluation, and the supporting role of electronic data processing. In assessing results, value judgments will be rendered from the professional's viewpoint. Attention will be focused on the goals of programs, and contrasts between objectives and accomplishments will be explored. Future trends will be forecast.

F. 1. b. "Management Use of New Techniques for Planning, Appraising Operations and Capital Investment Strategy," Howard W. Blauvelt, Vice President—Continental Oil Company.

A broad spectrum of topics will be discussed in order to indicate where management science methods have a bearing on the activities of a petroleum company.

Comments will be made on technical applications in areas such as refinery simulation, logistics, capital investment appraisal, oil field exploration and the development of corporate models.

The concepts of management information systems and controls will be discussed considering problems related to the division of an integrated petroleum company into valid profit centers. The value of management information systems and controls is dependent on the correctness of the incoming data. Comments will be made on cost accounting concepts and the blending of both internal and industry data.

The role of planning—such as Continental's system for developing operating diversification and financial plans—will be discussed. In any planning function the underlying studies of political, economic, social and other environmental factors must play an important role.

Comments will be made on the use of consultants—internal and external.

F. 2. a. "Management Science in Communications: State of Art," William W. Hardgrave and Walter H. MacWilliams, Bell Telephone Laboratories.

Management science applications in communications utilities typically involve minimizing cost subject to maintaining high-qualty service, and reflects a large total volume of business and the recurring presence of both constructions and operations decisions. This paper groups the principal management science applications into basic functional categories, which are then compared according to the techniques used, difficulty of formulation and solution, degree of success to date, scope, and management/technology orientation.

Several examples are given which show the techniques used, unique features, and applicability beyond communications utilities. Two of the examples are: a) centering problems—given a function that is carried out in centers, determine how many centers to have, where to locate them, when to install new ones, and what area each should serve; b) coin collection—given the locations of coin telephones in an area and the recent past collection amounts and times, to determine collection interval and scheduling rules that minimize the collection cost, subject to maintaining a stipulated low prob-

ability of a customer's being unable to make a call because of a full box.

The successful applications and techniques are discussed and contrasted with some which at the time were unsuccessful. Potential future applications are also indicated.

F. 2. b. "Management Science in Communications Utilities: From the Manager's Point of View," Richard A. Mathews, New York Telephone Company.

This discussion will present the manager's view of the present and future role of M.S. in the communications industry. Four broad areas will be examined in light of experience, expectation and plans for the future. First—What does management expect from M.S.? Kinds of problems, form of solution and recommendation for implementation will be discussed. Second—What are our major problem areas now where we are seeking help from M.S.? Third—What has been our experience with M.S. up to now, both success and failure? Fourth —What are organizational problems in connection with M.S.?

F. 3. a. "Gemini Engineering Program", Robert N. Lindley, McDonnell Aircraft Corporation.

The Gemini program is an example of a major creative effort, practically every aspect of which has required exploitation of the technical state-of-the-art to the fullest possible extent. This creative effort has been carried out on a vast scale; for example, at its peak Gemini employed four thousand engineering personnel in industry. The complexity of the task is further emphasized by the relatively small size and weight of the spacecraft, with the concentration of engineering effort being approximately an order of magnitude greater than has been experienced on high performance military airplanes.

In the performance of the engineering task, experience showed that the use of computerized management techniques did not have the flexibility necessary, and the major effort emphasized more traditional lines. The successful conduct of the program in this manner may be ascribed at least in part to the concentration of effort on to a relatively small product and to the extremely high caliber of the technical team assigned to the program.

F. 3. b. "Apollo Spacecraft Program Management," Thomas J. Markley, Manned Space Flight Center.

In this paper, the pragmatic aspects of the Management Organization, Communications, and Tools that are used in conducting the Manned Lunar Program within this decade will be discussed.

It will also cover how the organization manages the technical specifications; interfaces with Launch Vehicle, Launch Pad, and overall spacecraft; what tools are used in controlling schedules, costs, technical changes; and how problems are identified quickly in order that the Lunar In-Line Program is not degradated.

The paper will explain how PERT, Cost Reporting, Configuration Management, Contracting, Incentive Contracting, and Control Rooms are merged with the organization to bring about proper balance.

It will also discuss what management systems have not worked, the reasons why they have not worked, and what management systems are still needed.

The paper will neither discuss theories of management, nor will it recommend gadgets or tricks for Program Manageemnt of large R&D Programs, but it will be an open discussion on the existing Manned Lunar Program Management, its problems, and the application of organization, communication and tools to the solution of the problem source.

PARTICIPANTS

W. J. Abernathy, Harvard University, Cambridge, Massachusetts.

William P. Allman, U. S. Department of Commerce, National Bureau of Standards, Washington, D.C.

Robert W. Amory, American Telephone and Telegraph, 195 Broadway, New York, New York 10007.

Leonard Arnoff, Ernst and Ernst, 1356 Union Commerce Building, Cleveland, Ohio 44114.

Julius Aronofsky, Socony Mobil Oil Co., Inc., 150 East 42nd Street, New York, New York 10017.

Donald T. Asher, Abbott Laboratories, Operations Analysis Section, Division of Commercial Development, North Chicago, Illinois 60064.

Herbert Ayers, Operations Research and Management Sciences, Morgan Guaranty and Trust Co. of New York, 32 Wall Street, New York, New York 10015.

Norman R. Baker, Department of Industrial Engineering, Purdue University, West Lafayette, Indiana.

Richard F. Barton, University of Kansas, Lawrence, Kansas.

Charles S. Beightler, University of Texas, Austin, Texas.

Bertrand Belda, Ernst and Ernst, 1300 Union Commerce Building, Cleveland, Ohio 44114.

D. Bishko, Rensselaer Polytechnic Institute, Troy, New York.

Gerald D. Blackwill, Security First National Bank, P. O. Box 2097, Terminal Annex, Los Angeles 54, California.

Howard W. Blauvelt, Vice President-Coordinating and Planning, Continental Oil Company, 30 Rockefeller Plaza, New York 20, New York.

J. Bracken, Research Analysis Corporation, McLean, Virginia.

Anatole Browde, McDonnell Aircraft Corporation, Lambert-Saint Louis Municipal Airport, St. Louis, Missouri 63166.

Arthur A. Brown, A. D. Little, Inc., 130 North Franklin Street, Chicago, Illinois 60606.

Charles S. Brown, Executive Vice President, Abbott Laboratories, North Chicago, Illinois 60064.

J. L. Brownlee, City Manager, City Hall, Fort Worth, Texas.

Francis R. Cella, University of Oklahoma, Norman, Oklahoma.

A. Charnes, Department of Engineering Sciences, Northwestern University, Evanston, Illinois.

Neil C. Churchill, Carnegie Institute of Technology, Pittsburgh, Pennsylvania.

David I. Cleland, Major, Assistant Head of Systems Mgmt. Dept., USAF, Air Force Institute of Technology, Air University, Wright-Patterson AFB, Ohio.

Stanley I. Cohen, Benton and Bowles, Inc., 666 Fifth Avenue, New York, New York 10019.

J. W. Colin, Texas Instruments Incorporated, Dallas, Texas 75222.

W. E. Cushen, Tech. Analysis Group, National Bureau of Standards, Washington, D.C.

Jerry L. Dake, U. S. Naval Postgraduate School, Monterey, California.

Michael J. Driver, Purdue University, Lafayette, Indiana.

Richard A. Dudek, Texas Technology College, Lubbock, Texas.

J. R. Dunn, Rensselaer Polytechnic Institute, Troy, New York.

John M. Dutton, Purdue University, Lafayette, Indiana.

Peter A. Firmin, Tulane University, New Orleans, Louisiana.

G. R. Fitzpatrick, Research Analysis Corporation, McLean, Virgiina.

Richard L. Francis, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

Lawrence Friedman, M and M's Candies, Operations Research Director, High Street, Hackettstown, New Jersey.

Robert H. Grant, Manager of Systems Department, Celanese Corporation of America, 522 Fifth Avenue, New York, New York 10036.

C. Jackson Grayson, Tulane University, New Orleans, Louisiana.

D. F. Grodosk, Purdue University, West Lafayette, Indiana.

Harry Grossman, Security First National Bank, P. O. Box 2097-Terminal Annex, Los Angeles 54, California.

Claud Gruen, A. D. Little, Inc., 500 Sansome, San Francisco 11, California.

Walter A. Hahn, Director of Planning and Program Evaluation, Environmental Science Services Administration, Washington Science Center, Rockville, Maryland 20852.

George H. Haines, Jr., University of California, Los Angeles, California.

Terrance Hanold, Executive Vice President and Chief of Financial Office, The Pillsbury Company, Minneapolis, Minnesota 55402.

William W. Hardgrave, Bell Telephone Laboratories, Holmdel, New Jersey 07733.

Carl M. Harris, Western Electric Company, Inc., Princeton, New Jersey.

Sidney W. Hess, Atlas Chemical Industries, Wilmington, Delaware 19899.

Charles J. Hitch, Comptroller, University of California, Berkeley, California.

Robert J. Hunter, Supervisor, Management Research, Smith, Kline and French Laboratories, 1500 Spring Garden Street, Philadelphia, Pennsylvania 19101.

Raymond S. Isenson, Colonel, United States Army, Staff Assistant to DD/Research and Technology, ODDR and E, Office of Secretary of Defense, Washington, D.C. 20301.

J. M. Keenan, Stanford Research Institute, Fort Ord, California.

William R. King, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

R. R. Klimpel, Dow Chemical Company, Midland, Michigan.

Charles H. Kriebel, Carnegie Institute of Technology, Pittsburgh, Pennsylvania.

John B. Lathrop, Lockheed-California Company, Burbank, California 91503.

D. P. Leitch, Purdue University, West Lafayette, Indiana.

Bernard M. Levin, National Bureau of Standards, Washington, D.C.

Ferdinand K. Levy, Rice University, Houston Texas.

Raymond W. Lewis, The George Washington University, Washington, D.C.

Robert S. Lindley, Engineering Manager, Gemini, McDonnell Aircraft Corporation, St. Louis, Missouri.

James J. Linn, Massachusetts Institute of Technology, Alfred P. Sloan School of Management, 50 Memorial Drive, Cambridge, Massachusetts 02139.

Benjamin Lipstein, Vice President, Director of Research and Information Services, Sullivan, Stauffer, Colwell and Bayles, Inc., 575 Lexington, New York, New York.

Sebastian B. Littauer, Columbia University, Department of Industrial Engineering, New York, New York.

Robert E. Machol, Systems Engineering Department, University of Illinois at Chicago Circle, P.O. Box 4348, Chicago, Illinois 60680.

Walter H. MacWilliams, Bell Telephone Laboratories, Holmdel, New Jersey 07733.

Donald G. Malcolm, President, Management Technology, Inc., 8939 South Sepulveda Blvd., Los Angeles, California 90045.

Thomas J. Markley, Chief of Apollo Program Control, Manned Space Flight Center, Houston, Texas.

Richard A. Mathews, New York Telephone Company, 140 West Street, Room 2600, New York, New York 10007.

Robert M. McClure, Texas Instruments Incorporated, Dallas, Texas.

C. L. Moodie, Purdue University, West Lafayette, Indiana.

Leland Moody, Arthur Andersen & Co., 1320 West Third Street, Los Angeles, California 90017.

A. F. Moravec, General Dynamics, Fort Worth, Texas.

Mark Morgan, I.B.M., Hopewell Junction, New York.

Satinder Mullick, Corning Glass Works, Corning, New York.

Thomas H. Naylor, Duke University, Durham, North Carolina.

Stedman B. Noble, Research Analysis Corporation, McLean, Virginia.

David Novick, The RAND Corporation, 1700 Main Street, Santa Monica, California.

M. J. O'Brien, Research Analysis Corporation, McLean, Virginia.

Michael O'Hagan, Texas Instruments Incorporated, Dallas, Texas.

Donald B. Owen, Graduate Research Center of the Southwest, Dallas, Texas.

Charles R. Plott, Purdue University, Lafayette, Indiana.

Barton S. Pulling, Colonel, USAF (Retired), Program Manager, AN/APQ-108, Conductron Corporation, Ann Arbor, Michigan.

Robert E. Pyle, Assistant Controller, Chemicals Division, Union Carbide Corporation, 30 East 42nd Street, New York, New York 10017.

G. J. Rath, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

Alexander A. Robichek, Stanford University, Stanford, California.

Richard S. Rosenbloom, Harvard University, Cambridge, Massachusetts.

Erling F. Rosholdt, The George Washington University, Washington, D.C.,

Albert H. Rubenstein, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

Trevor Sainsbury, University of Pittsburgh, Pittsburgh, Pennsylvania.

R. G. Schroeder, U. S. Naval Postgraduate School, Monterey, California.

Jack Siegman, Department of Industrial Engineering and Management Sciences, Northwestern University, Evanston, Illinois.

Alvin J. Silk, University of California, Los Angeles, California.

William H. Starbuck, Associate Professor of Economics and Administrative Sciences, Purdue University, Lafayette, Indiana.

W. H. Statler, Deputy Director of Engineering, Lockheed California Company, Burbank, California 91503.

Paul A. Strassmann, Director of Systems and Procedures, National Dairy Products Corporation, 260 Madison Avenue, New York, New York 10016.

Robert L. Street, University of Texas, Austin, Texas.

Russell Taussig, Columbia University, New York, New York.

James D. Thoerson, Texas Instruments Incorporated, Dallas, Texas.

Charles B. Tompkins, University of California at Los Angeles, Los Angeles, California.

R. W. Trueswell, University of Massachusetts, Amherst, Massachusetts.

W. A. Wallace, Rensselaer Polytechnic Institute, Troy, New York.

R. E. Walton, Purdue University, West Lafayette, Indiana.

H. Martin Weingartner, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139.

L. G. Wentling, Research Analysis Corporation, McLean, Virginia.

Gerald T. Westbrook, Dow Chemical, Midland, Michigan.

R. M. White, U. S. Dept. of Commerce, Environmental Science Services Administration, Washington, D.C. 20235.

J. C. Whiton, Research Analysis Corporation, McLean, Virginia.

William L. Wilkinson, The George Washington University, Washington, D.C.

Talmadge A. Wilson, USAF Command.

S. William Yost, Harvard University, Cambridge, Massachusetts.