

Center for Information
Systems Research

Annual Report

For the Academic Year
Ended June 30, 1978



Table of Contents

Message from the Director	3
Six New Sponsors	
New Faculty	
New Seminar Series	
Research on Top "Management Information Needs"	
Other Research Areas	
Dissemination of Research Results	
Finances, Student Support	
CISR – A Brief Description	5
Faculty and Staff – Biographies	5
Description of Research Results	
(In order of Principal Investigator)	7
Teaching Programs	9
Publications	9
The Center's Working Paper Series	
Student Working Paper Series	
Other Publications	
Theses	
Participating Sponsors	12
Modes of Interaction between CISR and Participating Sponsors	
Current Sponsors	13

Message from the Director

The Center for Information Systems Research (CISR) was established in 1974 with four major objectives. These were (1) to perform high quality work which is relevant to and useful for practicing managers in the information systems field, (2) to ensure the relevance of the research through increased contact with the managers of the information systems function in industry and non-profit organizations, (3) to provide students, at all levels, with increased opportunities for real-world involvement during the course of their studies, and (4) to expand support for the MIS area at the Sloan School. It is encouraging to be able to report progress toward attaining all of these goals.

In the four years since the founding of the Center, many changes have taken place in terms of sponsoring organizations, research areas, and the formal nature of the Center itself. We have grown from the initial four sponsors to the current level of thirteen. Useful methods of interactions with sponsors have slowly evolved and grown strikingly in number and type. Although we are far from mature as an organization, we are increasingly being singled out as an example of an academically-based organization which is communicating well with industry and working on research projects of interest to practicing managers.

The addition of two full-time research staff members to the nine faculty associated with the Center has made it possible to carry out well organized and engineered research projects. The full time staff is abetted by other professionals brought in for particular projects and has blended effectively with Undergraduate, Masters' and Doctoral students in the research process. As a result we have an interesting blend of skills in the research. Although to some extent everyone participates in each stage, the faculty dominates in the research design, the staff is responsible for the management of projects, and the students contribute significantly in the data gathering and analysis process.

Through this intense involvement of students in the research process, several mutually beneficial relationships occur. The Center has a source of plentiful, intelligent and enthusiastic human resources to carry out research. Sloan students have meaningful and challenging experiences as they perform their thesis and course research in real-world organizations dealing with real problems (and often receive significant financial support). Sponsoring organizations receive the benefits of extensive research into, and increased knowledge about, computer-based problems of importance. Finally, the Sloan School of Management benefits through the educational experiences realized by both its faculty and students.

We have employed as many as ten full-time professionals (in addition to our current core staff) at one point in time on particular research projects. The staff will ebb and flow as major grants from federal and state agencies and departments are undertaken and completed.

Each of our on-going research projects focuses on an issue which we believe is relevant to the management of the information systems function in today's world. Significantly, half of these projects have been initiated at the direct request of one or more of our sponsors. Detailed descriptions of each current research project, and biographies of the faculty and core staff involved, appear later in this report. However, I would like to highlight four major events of the past year which are noteworthy. These are (1) an increase in the number of sponsoring organizations, (2) additions to our faculty, (3) the introduction of a new type of seminar series, and (4) particularly significant progress in one sponsor-initiated research project.

In addition, I would like to comment briefly on other on-going research, the mechanisms for dissemination of results, and CISR's finances.

Six New Sponsors

The number of organizations sponsoring CISR grew by almost 100% as Citibank, IBM Americas/Far East, IBM/General Systems Division, Sun Company, General Motors Corporation, and The Chase Manhattan Bank, all became sponsors for the first time. All are currently active sponsors, engaged either in assisting CISR faculty and staff in the design of a particular research program or serving as sites for research projects.

New Faculty

It was clear more than a year ago that the areas of office automation and microprocessors were going to significantly affect the information systems field within the next few years. Our search for faculty with interests in these areas was rewarded when Michael Zisman and Hoo-Min Toong joined us in July 1977. Both are currently involved in applied research. Each has won research grants from non-CISR sources and each is receiving support from CISR funds. Hoo-Min Toong is working, together with a group of students, with one of our newest CISR sponsors in one major area of applied microprocessor research. Michael Zisman, as noted later in this report, has several research projects underway concerning the impact of office automation technology.

New Seminar Series

In addition to the annual summer research seminar, CISR, for the past two years, has sponsored traditional large-audience, multiple-lecture, single-subject conferences. In 1976, a conference was sponsored concerning "The Implementation of Information Systems". In 1977, we joined with IBM at San Jose, The Wharton School, and the ACM in sponsoring a seminar on "Decision Support Systems". These seminars all were, however, essentially lecture-based with relatively passive participation from a large and heterogeneous group of attendees. Together, with some of our sponsoring organizations, we felt the need for a more interactive, joint-learning forum.

As a result, in March of this year, we held a small, 28-person, 2½-day seminar at MIT's Endicott House aimed at discussion of the topic of the "Management of Data Processing in an Increasingly Decentralized World". Participants included a representative from each sponsoring organization and a small number of invited guests. In planning this seminar, we hoped to create an informal atmosphere which would

focus on actual practice as presented by participants and would generate frank discussion among all the participants. Approximately half the time was spent listening to "up-front" presentations—by selected participants—of approaches to this topic. The remainder of the time was spent in roundtable group discussions of these approaches and the issues they raised.

From both our observations and attendees' feedback, our goal of active, widespread participation was accomplished and the substantive outcomes will be published in the near future. By bringing together multi-talented, experienced and motivated people, we were able to generate a great deal of useful thought and deepen our understanding of practical approaches to the question of how to manage data processing in an increasingly decentralized world.

Since the benefits gained by this more active approach to the learning process appear to be great, it is planned to continue this "small, invited-participant seminar" series. Current plans call for this to be done on a twice-a-year basis. The next seminar is tentatively scheduled for the Fall of 1978 and will be on "Decision Support Systems".

Research on "Top Management Information Needs"

CISR has developed a method for assisting the chief executive and his/her top management to define their information needs and to design information systems to support these needs. We have tested the method through thesis research in eight organizations in the past year and feel it is useful for sponsors to be aware of this research area. Initial reactions in the organizations where this method has been employed have been very positive. It is believed that the design and implementation of executive information systems, through this and other methods, will be a major frontier in the data processing environment over the next few years. We are increasing our research efforts in this area.

Other Research Areas

Research with regard to technical, managerial, and human aspects of information systems continues in several areas not mentioned above. Included among these are projects concerning privacy and security issues, database design, end-user needs analysis, DP career path planning, and the implementation of decision support systems. These are described fully later in this report.

Dissemination of Research Results

The dissemination of CISR research results is an important phase in the life cycle of a research project. To date the most successful vehicle for this dissemination has been the annual one-week CISR Summer Seminar. The purpose of this session is to provide a forum for faculty and staff members to discuss the progress to date on their research projects and to present the conclusions and implications for the data processing field which evolve from the research. June 1978 marked the third annual CISR Summer Seminar and saw the largest number of registrants to date. There were over 160 people in attendance from more than 130 different organizations, including participants from Mexico, Canada, Finland, Japan and Germany.

In addition, CISR faculty and staff have published five working papers in the past year, bringing the total of CISR working papers to thirty-seven. A list of CISR publications appears on page 9 of this report.

Finances, Student Support

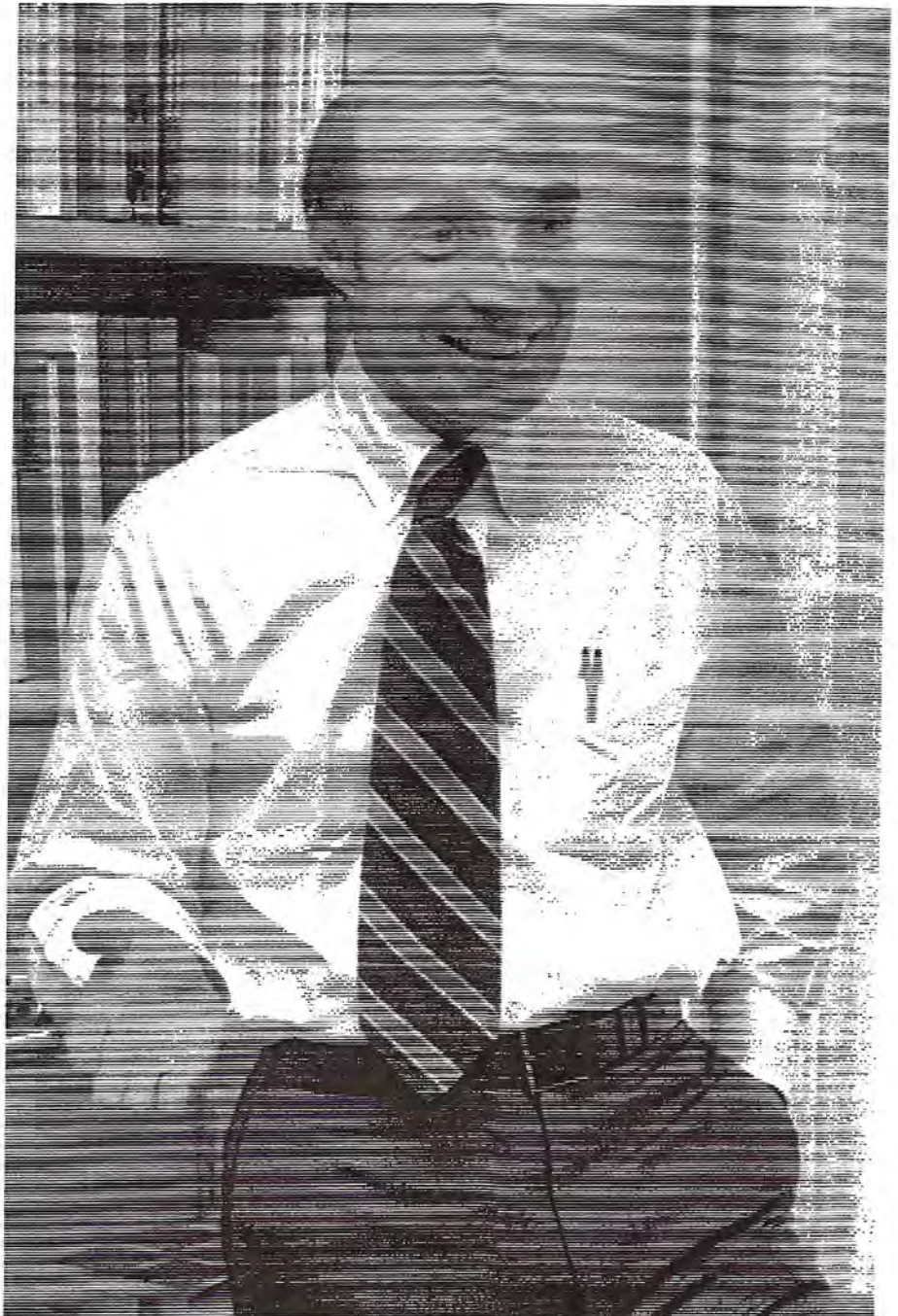
In the fiscal year ended June 1978 CISR financial support was provided through a variety of sources. Unrestricted research funds provided by the sponsoring organizations totaled more than \$200,000. In addition, research contracts from both government agencies and private organizations provided several hundred thousand dollars of additional research support.

In the past four years CISR has provided financial support for over one hundred students and has provided research topics for both theses and term projects for more than two hundred students.

The remainder of this report presents details on the research projects, faculty and staff backgrounds, and general information about the Center.



John F. Rockart
Director, CISR
Senior Lecturer of Management



CISR — A Brief Description

The Center for Information Systems Research (CISR) was established at the MIT Sloan School of Management in mid-1974. CISR's activities focus on research aimed at improving the effectiveness of information-processing tools and techniques available to managers in the private sector and policy makers in the public sector. Critical aspects of computer-based information systems are of primary interest.

The Center is taking a multi-faceted approach to the task of improving the effectiveness of information processing in organizations today. A set of private and non-profit sector sponsors provide assistance in defining and investigating significant research areas. The sponsoring organizations represent several different commercial viewpoints and consist both of major users of information systems and computer vendors. In the public sector, CISR is developing and testing state-of-the-art management information systems to assist public policy makers. Basic research on fundamental issues (e.g., centralization and decentralization of computing, database research) affecting both sectors is being performed. Finally, CISR is dedicated to disseminating significant research findings to the information systems user community through teaching, seminars, working papers, and publications.

Research at CISR is pragmatic, problem-based, and application-driven. Research efforts are performed primarily in application areas of immediate interest to managers and policy makers and are performed in areas in which results are expected to have a fruitful payoff within one to five years.

The Center was established at the Sloan School of Management, in part, due to the recognition by the School of the increasing complexity of the managerial function today and the need for vastly improved information-processing tools and techniques to carry out this job. Secondly, there was an evident need to institute more effective relationships between academics and private and public sector managers in a joint effort to improve computer-based information systems.

As the biographies in this report note, CISR's faculty brings a wide range of specialized training to information systems problems. This disciplinary training ranges from the technical fields of computer science and electrical engineering to the people-focused disciplines of law, psychology, and organizational behavior.

These disciplinary strengths are balanced by a strong recognition and awareness of the needs of users in applications areas. It is this unusual balance that is felt to be essential in keeping the research focus on issues of effectiveness. A team approach to research allows a multi-disciplinary approach to relevant problems.

A major strength of the Center is its ability to draw on other parts of the M.I.T. complex. Faculty skills in the areas of economics, public policy, and statistics have been drawn upon in joint research projects which CISR has undertaken. During the past two years, CISR has enjoyed an especially strong relationship with the MIT Energy Laboratory.



Faculty and Staff Biographies

Robert M. Alloway

Assistant Professor of Management Science, Alfred P. Sloan School of Management, MIT, is specializing in contingency approaches to creating computer-based information systems, with emphasis on the special management problems created by the need to design "temporary management systems" for the development and implementation process. Before coming to MIT, Dr. Alloway did his doctoral work at the Harvard Business School in Management of Technology, was an Instructor of Sociology at Boston College, and spent five years as a project manager for major corporations.

Christine V. Bullen

Assistant Director, CISR, and Research Associate, Alfred P. Sloan School of Management, MIT, has conducted research in both the private and public sectors. She is also involved in research identifying management information needs and designing computer-based systems to support these needs. Ms. Bullen's industry experience includes the corporate planning staff of Inforex, Inc., the professional staff of Arthur D. Little, Inc., and Executive Assistant to the President of the Brand Rating Research Corporation.



Peter P. Chen

Assistant Professor of Management Science, Alfred P. Sloan School of Management, MIT, specializes in database management systems and in computer system performance evaluation. His research focus is on providing management tools for database and information system design. His industrial experience includes principal programmer, Digital Equipment Corporation, principal engineer, Honeywell Information Systems, and Student Associate, IBM. His recent professional activities include: Program Chairman, First International Conference on Very Large Data Bases, Boston, MA, 1975, and Program Co-Chairman, International Symposium on Computer System Performance Modeling, Measurement, and Evaluation, Boston, MA, 1976. In addition to his affiliation with CISR, Dr. Chen is also a member of MIT's Operations Research Center. Before coming to MIT, he was a Teaching Fellow at Harvard University.



John J. Donovan

Associate Professor of Management Science, Alfred P. Sloan School of Management, MIT, is specializing within the areas of new technologies relevant to decision support systems and public sector policy analysis. Before joining the faculty of the Sloan School, he served as an Associate Professor of Electrical Engineering and staff member of the MIT Laboratory for Computer Science (formerly Project MAC) where he received MIT's Schultz award for excellence in teaching. He is also a Clinical Associate Professor of Pediatrics at Tufts Medical School where he received an award in 1974 for outstanding contributions to medicine. His industrial experience includes co-founder and former chairman of the board, MITROL, Inc., co-founder and former president of INTERCOMP, board member, Financial Publishing, Inc., and consultant to several major firms.

He is author of the book *Systems Programming*, and co-author of *Operating Systems* (with Professor Madnick).

Stephen E. Humphrey

Research Staff, CISR, is a 1978 graduate of the Alfred P. Sloan School of Management, MIT. While a Masters' student, he researched the critical success factor method as a means for the determination of executive information needs. Prior to attending the Sloan School, he instituted a pioneer program of unit management for The Cambridge Hospital in Cambridge, Massachusetts and also acted as a financial consultant for a local non-profit foundation. He is currently involved in the design of a management information system for a large Boston teaching hospital and he is engaged in research with several CISR corporate sponsors.

Stuart E. Madnick

Associate Professor of Management Science, Alfred P. Sloan School of Management, MIT, and affiliate member of the MIT Laboratory for Computer Science (formerly Project MAC), is in charge of MIT's major management information technology courses and is the principal investigator of several major research projects associated with the design, implementation, and effectiveness of information systems. He has been active in industry, especially in the design and implementation of advanced information systems in medicine, manufacturing, and information retrieval. His experience includes technical director and board member, MITROL, Inc., various positions in IBM, Honeywell Information Systems, and Lockheed and consultant to several major firms. His recent professional activities include: Associate Editor, *ACM Transactions on Database Systems*; founding member, IEEE Technical Committee on Database Engineering; and Conference Chairman, 1977 International Conference on Very Large Data Bases. He is the author of several books and articles in the field of computer science and management information systems.

Jeffrey A. Meldman

Assistant Professor of Management Science, Alfred P. Sloan School of Management, MIT, specializes in legal and social problems of computer-based information systems, and in the use of computer systems in the legal community. His research and teaching focus on privacy and security, proprietary protection of software, and computer-aided legal analysis. He is a member of the Massachusetts Security and Privacy Council, and has served as a privacy consultant to the Federal Judicial Center and the U.S. Congress Office of Technology Assessment. As an attorney, he has practiced in the areas of patents, privacy, and criminal justice. He is currently on the part-time faculties of Boston College Law School and of the Franklin Pierce Law Center, and has been an Instructor in the Department of Electrical Engineering and Computer Science at MIT.

John F. Rockart

Director, CISR and Senior Lecturer of Management, Alfred P. Sloan School of Management, MIT, has taught and conducted research within the areas of management planning and control systems and the use of computer-based information systems. He presently supervises a research project concerning the centralization versus the decentralization of computers and is

involved in several other projects. Dr. Rockart spent four years with IBM. He designed and installed computer systems as an MIT Fellow in Africa before joining the Sloan School in 1966. He serves on the board of directors of two companies. A significant part of his recent research has been in providing computer-based support in the health care delivery systems area. He consults and teaches in the computer area for several major companies. He is co-author of the book *Computers and the Learning Process* (with Dean Michael S. Scott Morton).

Michael S. Scott Morton

Professor of Management Science and Associate Dean, Alfred P. Sloan School of Management, MIT, is a specialist on the problems of developing computer systems to support managerial decisions. He is also active in the field of coordinating corporate planning and control systems with management information systems. He has wide research and consulting experience with U.S. and foreign corporations on the design and implementation of integrated planning and control information systems. Before coming to MIT, Dr. Scott Morton was an IBM Fellow, Harvard University where he received his doctorate. His industrial experience includes membership on the boards of directors of several corporations as well as maintaining active consulting relationships with major corporations. He is formerly a director of data processing for the City of Pittsburgh, and an engineer with Rolls-Royce Ltd. He is author of the book *Management Decisions Systems* and co-author of *Computers and The Learning Process* (with Dr. John F. Rockart) and *Decision Support Systems: An Organizational Perspective* (with Professor Peter G.W. Keen).

Hoo-min D. Toong

Assistant Professor of Management Science and Computer Science, Alfred P. Sloan School of Management, MIT, is specializing in processor architectures and their relationship to the software/hardware issues of distributed multiprocessor systems. He is a member of the Laboratory for Computer Science and is in charge of the Digital Systems Laboratory. He has developed minicomputer, microcomputer, and digital system design courses, and has received a departmental teaching award. Dr. Toong has been active in both government and private industry, participating in the design and implementation of advanced hardware and software systems. He has consulted on a wide variety of problems for several major organizations.

Michael D. Zisman

Assistant Professor of Management Science, Alfred P. Sloan School of Management, MIT, specializes in the area of office automation. Other research areas in which Dr. Zisman has worked and published include decision support systems and database management. Before coming to MIT he spent two years as a lecturer at The Wharton School, University of Pennsylvania, where he completed his doctorate. Previous to that position, Dr. Zisman spent five years in the University of Pennsylvania's MIS Department in various management positions, serving the last two years there as a director of that department. He has consulted on a wide variety of information systems management problems for U.S. corporations and universities and is co-founder and treasurer of International Data Base Systems, Inc.



Description of Research Areas in Order of Principal Investigator

Robert M. Alloway

Management of DP Career Paths

DP personnel have traditionally experienced traps and ceilings in their career paths due to the specialized, technical nature of their jobs. The type of systems being created in shifting from transaction processing systems toward decision support systems requires DP personnel to broaden their skill mix. In addition, the technological base of DP is rapidly changing, placing a premium on staying current to overcome the threat of obsolescence. These three trends produce conflicting demands on DP personnel and management. We have undertaken exploratory research in this critical area of career paths in DP. Included in the work are aspects of motivation, career satisfaction, productivity, turnover, and quality from the dual perspectives of the individual and DP department. Initial findings focus on career anchors, job characteristics, legitimization of multiple career paths, the opportunities for advancement presented by DP management, individuals' career expectations, skill mixes, evaluation/reward procedures, management of expectations, and DP planning and control systems.

The Complete Life Cycle of DP Projects

The life cycle model of DP projects used by most managers is obsolete. It focuses solely on the last third of the complete process; it ignores several critical points where managerial intervention can enhance success; and it actually contributes to the failure of more sophisticated, managerially-oriented systems. A complete life cycle model provides some very interesting insights into the causes of project failures, the source and limitations of user requests for new systems, project approval criteria, DP performance and evaluation standards, DP management policies and procedures, and the dynamics of the DP department itself. CISR research is focusing on the application of the model in a variety of industries.

Peter P. Chen

A New Approach to Database Design

There are very few tools available for designing databases, especially for selecting a "good" logical data structure for a given application. A diagrammatic technique called the entity-relationship (E-R) diagram has been developed to be used in systems analysis. The database designer first draws an E-R diagram and then translates it to a data-structure diagram (in the case of an IMS database or a network database) or a set of tables (in the case of a relational database).

The E-R diagram can also be used as a descriptive tool for the information model of an enterprise (i.e., an overall picture of the data and their relationships). The resultant information model can be used as a basis for communications between system designers and managers and as a blueprint for the integration of different information systems in the enterprise. Current research involves the testing of the E-R technique in several companies.

John J. Donovan

Decision Support Systems

This research is primarily concerned with the tools and techniques necessary for the improved development, use, and evaluation of decision support systems in both the public and private sector. Research has been and will continue to be applications-driven. There is a dual focus in our work. One objective is the development of the necessary new tools and technologies to allow more efficient and effective implementation of decision support systems. A parallel, but inseparable, goal is the development of application systems which provide significant managerial decision support but which also give us a "proving ground" for the tools and technologies developed.

The *technology research* has been concerned with the development of both the tools and new approaches to the implementation of decision support systems. A major portion of the basic technology research being performed is presently supported by the Naval Electronic Systems Command and Rome Air Development. This research has resulted in advancements in databases, security, hierarchical programming technologies and the development of a generalized management information system (GMIS).

The *applied research* has been concerned with the development of applications and the evaluation of the basic tools developed. Example applications include forecasting systems, early warning systems, managerial control systems, and systems which assist energy policy actions. The systems developed are currently in use. This allows ongoing evaluation of the tools and technologies over a long period of time.

Stuart E. Madnick

Applications of Composite Information Systems

We have come to realize that computer models and databases are key to the development of decision support systems. But how do we combine independently developed models and databases to tackle complex interdisciplinary problems, such as energy policy analysis or global project planning? The concept of composite information systems (CIS), based upon explicit separation of models and databases and use of effective linking strategies, has been found to offer comparative advantages in the development of both ad-hoc and institutional decision support systems.

This on-going research activity has been funded, in part, by IBM and the Air Force Rome Air Development Center. The major objectives are: (1) to formalize the concept of composite information systems, (2) to identify and categorize previous CIS-type systems, (3) to investigate the applicability of the CIS approach in a spectrum of application environments ranging from energy policy analysis to project control in an Air Force Special Program Office (SPO), and (4) to propose and investigate new mechanisms for automatically integrating the diverse components of a CIS.

INFOPLEX: New Computer Architectures to Support Composite Information Systems

The principal objectives of the INFOPLEX research project are to study new computer architectures, often called database computers,

which will be capable of supporting the continually increasing demands for even higher performance and reliability in data base systems. It has become clear that advances in computer hardware alone will not be capable of meeting these demands, thus novel organizational approaches, based upon concepts such as hierarchical decomposition and parallelism, must be used. The INFOPLEX computer architecture design is an ambitious effort aimed at meeting the performance and reliability requirements of the future and is being supported, in part, by a sizable multi-year grant from the National Science Foundation.

Systematic Design Methodology (SDM)

The basic objective of this effort is to develop a systematic approach to the design of complex systems. Although the primary focus is on the architectural design of large-scale computer applications (i.e., overall system structure) the methodology is generally applicable to any complex system. Work on this project is being supported by various sources, including NSF and the Naval Electronics Systems Command. Our preliminary results are being studied by corporations in a variety of environments, such as large-scale computer-controlled electronic switching systems and ship design.

The methodology basically consists of four steps: (1) acquisition of formal functional requirements, (2) designer assessment of interdependencies between requirements to form a graph structure, (3) decomposition of the graph into sub-graphs which have maximal internal "strength" and minimum "coupling" between sub-groups, and (4) interpretation of the sub-graphs as design subproblems.

One of the most significant results of this work has been the formal definition of a quantitative measure of system structure "goodness" — a concept usually definable only in qualitative terms. Results attained in these areas and experiences in applying this methodology have been reported in a series of seven reports.

Jeffrey A. Meldman

Privacy Legislation and Its Implications for Information Systems

Recent and pending legislation protecting the privacy rights of individuals raises serious new problems for the design and use of computer-based information systems. The Privacy Act of 1974 places significant restrictions on the collection, maintenance, and dissemination of data by federal agencies. It also establishes clear rights of access for data subjects, and creates new duties for data managers. Several states have enacted similar legislation, and similar regulation of private industry is pending. Efforts at CISR are focused on analyzing the impact of such legislation and devising methods for assisting organizations in dealing with these impacts.

The Protection of Proprietary Rights in Software

The owner of a valuable systems or application program can use various legal methods for protecting the program from unauthorized copying or appropriation. CISR research is investigating these methods and their application.

Petri Net Modeling of Management Information Systems

A continuing challenge to managers who would understand the behavior of complex man-machine information systems can be found in the lack of powerful formal techniques for modeling the interactions of the human and mechanical system components. The existing approaches range from metaphorical descriptions to mathematical "systems theory" models. Even combined, these approaches are unable to provide an adequate means of displaying the logical relationships among the participants in the system. A recently developed, graphical formalism called "Petri Nets" may provide a significant improvement in meeting proposed criteria for effectively explaining management information system logic. Research is being carried out at CISR in the application of Petri Net modeling system to a variety of situations, including legal procedures.

John F. Rockart

Centralization versus Decentralization of Computing: The "Distributed Processing" Problem

The centralization/decentralization problem is not only of major importance to management, it is also one of substantial complexity. First, it involves both cost considerations ("efficiency") and consideration of the effects and results of the chosen system ("effectiveness"). In addition, the solution to the problem seems highly dependent on characteristics, philosophies and objectives of the organization. Unfortunately, there is very little help in the current literature for managers seeking to develop a deep management-oriented understanding of the problem. A research program at CISR has developed a framework for centralization/decentralization decision making. The framework is currently being tested through interviews with a sample of 50 companies covering a variety of industries. In addition, the analysis is beginning to show important organizational and application-related factors in the use of distributed processing. This research is being carried out in conjunction with Christine V. Bullen.

Top Executive Information Needs

Too many presidents and other top executives are burdened with an excessive number of reports. They receive a huge amount of data, but little information. A method, developed at CISR, based on an analysis of "critical success factors", is being currently studied through case study application and analysis. Results to date suggest that top executives can clearly define their information needs using this method. This approach has implications for the planning and scheduling of systems to be built by the information systems department in that it ensures that executive information needs are given priority. The approach also provides an alternative to traditional systems analysis procedures for understanding the information and data base needs of the organization. This research is being carried out in conjunction with Stephen E. Humphrey.

The End Users: What Are Their Needs?

There has been a distinct trend, in many large organizations, for end users of processed information to resort to alternatives outside the internal DP shop. The reasons for this are varied. They range from the lack of responsive-

ness of the central information systems staff in satisfying end user demands (often because of ineffective communication) to the cost/benefit advantages of functionally specific hardware developed with new technologies (e.g., mini and microcomputers). Whatever the reasons in any particular case, the general trend highlights a need to more fully understand the ultimate consumer of DP services—the end user.

Research aimed at characterizing end users and assessing their attitudes and needs has been underway at CISR for several months. We have developed a conceptual model of the critical factors and their interactions, gathered considerable empirical data in ten companies, and have some interesting initial findings. The goal of this project is managerially actionable recommendations for changes in policies and procedures related to the development of DP systems and fulfillment of user information needs. This project is being carried out in conjunction with Robert M. Alloway and Christine V. Bullen.

Michael S. Scott Morton

The Impact of Decision Support Systems on Organizations

As organizations begin to gain experience with the use of DSS for particular decisions, it becomes possible to document their experience, both the successes and the failures. The research is focused on obtaining data from on-going usage to permit useful, practical generalizations that will allow others to benefit from their applications.

Hoo-Min Toong

Microprocessors and Industrial Automation

This work is being performed in conjunction with a CISR Participating Sponsor. We are working to understand the potential of microprocessors for guiding diverse automated machine tools and, especially, to understand the types of software systems which are required.

Present computer control structures for the heavy machinery industry are not fast enough or capable enough to accommodate the computation and real time demands of the next generation of machine tools controls. This work has involved the analysis of machine tool control mechanisms and the study of hierarchical decomposition techniques to allow new computer architectural approaches to meet these requirements. An analysis of current industrial techniques has revealed several inherent weaknesses in short term and long term machine tool control and a set of clear processing needs. A new architecture is being prepared, based upon hierarchical decomposition of critical system functions.

The major objectives of this research work are:

- (1) to analyze and identify current and future control structure needs for a segment of the company's machine tool operations;
- (2) to develop and demonstrate the relevance of new multiprocessor microprocessor computer architectures to the solution of these needs;
- (3) to develop the methodology for the application and transportability of these control structures across several phases of the company's activities, including automated assembly, machine vision, paint spraying, and machine tool control.



Hoo-min D. Toong (Continued)

Microprocessors and Distributed Processing

This research project involves the development of new tools and methodologies for the easy configuration of new microprocessor computer technology in distributed networks. We expect these would be used in applications such as retailing, office automation, building maintenance and energy management, and others. These tools are viewed as crucial to the development of underlying building blocks that allow the configuration of a wide variety of networks for these industrial applications.

In particular, the project involves the development of performance measures and validation procedures for new architectures within the communications and processing environment.

Michael D. Zisman

Technology Assessment for Office Automation

The objective of this project is to perform a substantive technology assessment in the office automation domain. We will develop a three dimensional matrix to analyze the impacts of office systems technology. The first dimension is a taxonomy of office types or functions, and a major part of the project will be to develop this taxonomy. The second dimension is applicable office automation technologies, and part of the project will be devoted to developing this schedule of technologies. The third dimension is a set of legal/regulatory issues which will impact the development of office systems. By analyzing the impacts of each technology on each office type in various legal/regulatory frameworks, and then scaling appropriately, aggregate impacts can be determined.

Office Automation Technology

The objective of this work is to develop advanced technology for office automation. Work is currently underway which is directed at the development of a specification language for office procedures. This is a non-procedural language which contains primitives for describing basic office functions. Such a language can then be translated into an internal representation useful for actually automating portions of these procedures. By capturing a description of office procedures at a high level, we can develop office automation systems which integrate from a mechanical task level to an automated process level.

In a related part of this project we hope to develop a prototype for an automated office by integrating advanced hardware and software concepts and applying them to the office domain.

Algebraic Modeling Language

The purpose of this project is to design and implement a non-procedural language so that users of math programming systems can communicate problem specifications at a relatively high level instead of resorting to using "matrix generators" which are required of today's systems. With a language such as the one we propose to develop, a user could code a model as an objective equation and a set of constraint expressions. The language translator will be capable of binding the model to a user specified data collection and generating the required input to an optimizer program. Since the user will be communicating in terms of his own problem domain, substantial simplification of the process can be obtained.

Teaching Programs

Members of the Center's faculty and staff teach all the regular graduate and undergraduate courses at the Sloan School in the Management Information Systems area. In addition, they either direct or serve as faculty members of many special seminars, most often taught during the summer months at MIT. The special seminars are typically of short duration, one day to two weeks, and treat areas of information systems research and closely related management practice which are often of interest to corporate and public sector research sponsors and practitioners.

Among the recent special seminars are the following:

- Advanced Software Concepts – Operating Systems
- Computer Based Information Systems Technology – Database Systems, Telecommunications, and Performance Evaluation
- Mini-Micro Computer Systems: A Close Look at Minicomputers/Microcomputers and Their Applications to Real World Problems

- Advanced Software Engineering
- Management Game (Senior Executives Program and Accelerated Masters' Program)
- Strategic Planning Systems
- Management Control Systems
- Project Design for EDP Applications
- Office Automation: What the Future Holds
- Advanced Microprocessor Systems
- MIS's Series (Sloan Fellows Program)

Regular Sloan School graduate and undergraduate courses taught by the Center's faculty and staff in the Management Information Systems area include:

- Benchmark Computer Programming
- Principles of Management Information Systems
- Management Information Technology I
- Management Information Technology II
- Management Information Systems
- Decision Support Systems
- Advanced Computer Systems
- Systems Simulation
- Information Systems and Law

Publications

1. The Center's Working Paper Series

The CISR Working Paper Series is an important vehicle for dissemination of research results generated by faculty and staff of the Center. This series consists of reports which are in effect unrefereed early releases of insights and progress reports on projects and program areas under investigation. Listed below are the titles, authors, and release dates for these reports:

No.	Title	Author(s)	Date
1	Center for Information Systems Research: Statement of Purpose, Structure and Research Goals		
2	Application and Analysis of the Virtual Machine Approach to Information System Security and Reliability	Madnick Donovan	5/74
3	Virtual Information in DataBase Systems	Folinus Madnick Schutzman	7/74
4	A Detailed Look at Implementation Research	Ginzberg	11/74
5	A Hierarchical Approach to Information Systems	Donovan Jacoby	1/75
6	Design of a General Hierarchical Storage System	Madnick	3/75
7	INFOPLEX – Hierarchical Decomposition of a Large Information Management System Using a Microprocessor Complex	Madnick	3/75
8	Data Security and Data Processing	Madnick	3/75
9	An Application of a Generalized Management Information System to Energy Policy and Decision Making: The User's View	Donovan Gutentag Madnick Smith	9/75
10	Use of Virtual Machines in Information Systems (Superseded by No. 21)	Donovan	
11	Computer Aided Decision Making in Organizations	Alter	5/76
12	Centralized versus Decentralized Computer Systems: A New Approach to Organizational Impacts	Demb	11/75
13	Implementation as a Process of Change: A Framework and Empirical Study	Ginzberg	7/75
14	Organization of the Systems Functions in Engineering and Construction	Lazear Rockart	4/76
15	Computers and the Learning Process	Rockart	8/75

No.	Title	Author(s)	Date
16	GMIS: An Experimental System for Data Management and Analysis	Donovan Jacoby	9/75
17	Organizing the Information Function for Effectiveness as Well as Efficiency	Scott Morton	10/75
18	NEEMIS: Text of Governor's Presentation	Donovan Keating	12/75
19	Facilities Orientation Report— Volume I A Survey of Navy Tactical Computer Applications and Executives	Punj Madnick DeTreville	10/75
20	NEEMIS OVERVIEW: New England Management Information Systems	Donovan	2/76
21	Use of Virtual Machines in Information Systems (Supersedes No. 10)	Donovan	3/76
22	Centralization versus Decentralization of Information Systems: An Annotated Bibliography	Rockart Leventer	4/76
23	Centralization versus Decentralization of Information Systems: A Critical Survey of Current Literature	Rockart Leventer	4/76
24	Virtual Machines: A Concept that has Comparative Advantages in Security, Integrity, and in Decision Support Systems	Donovan Madnick	4/76
25	Database System Approach to Management Decision Support	Donovan	7/76
26	A Note on Performance of VM/370 in the Integration of Models and Databases (Supersedes No. 21)	Donovan	6/76
27	Institutional and Ad-Hoc Decision Support Systems and their Effective Use	Donovan Madnick	11/76
28	Virtual Machine Communication for the Implementation of Decision Support Systems	Donovan Jacoby	12/76
29	Trends in Computers and Computing: The Information Utility	Madnick	3/77
30	The Entity-Relationship Model— Toward a Unified View of Data	Chen	3/77
31	The Entity-Relationship Model— A Basis for the Enterprise View of Data	Chen	3/77
32	A Systematic Approach to the Design of Complex Systems: Application to DBMS Design and Evaluation	Andreu Madnick	3/77
33	Some Perspectives on Computerized Management Decision Making Systems	Scott Morton	3/78
34	Office Automation: Revolution or Evolution?	Zisman	4/78
35	Composite Information Systems— A New Concept in Information Systems	Lam Madnick	5/78
36	Centralization versus Decentralization of Information Systems: A Critical Survey and an Annotated Bibliography	Akoka	5/78
37	A New Approach to Defining the Chief Executive's Information Needs	Rockart	5/78

2. Student Working Paper Series

From time to time, the faculty and staff of the Center feel that certain papers generated by a student (or a group of students), whether written independently or co-authored with a CISR member, are noteworthy; the Student Working Paper Series was created to disseminate these unrefereed yet insightful reports. Listed below are the titles, authors, and release dates for these reports:

No.	Title	Author(s)	Date
S1	Center for Information Systems Research— Student Working Paper Series		
S2	A Possible Design and Estimate Cost Analysis of a Computer Based Information System for Gun Control	D. Carr P. Chen J. Donovan J. Meldman R. Pankiewicz M. Zisman	4/78

3. Other Publications of CISR Faculty and Staff

Listed below are a number of other publications and papers produced by the Center's faculty and staff during the prior academic year.

Chen, P.P., "The Entity-Relationship Model: A Basis for the Enterprise View of Data," *Proceedings of 1977 National Computer Conference*, June 1977, Dallas, Texas.

Chen, P.P., "Entity Relationship Approach to Logical Database Design," Monograph, Q. E. D. Systems, Inc., 1978.

Donovan, J.J., "Factors Affecting Residential Heating Consumption," *The New England Journal of Business and Economics*, Vol. 4, No. 1, Fall 1977.

Donovan, J.J., and H. Jacoby, "Virtual Machine Communication for the Implementation of Decision Support Systems," *IEEE Transaction of Software Engineering*, Vol. 3, No. 5, September 1977.

Donovan, J.J., "Fast Answers to Tough Energy Questions," *Scientific American*, Vol. 238, No. 2, February 1978.

Donovan, J.J., and S.E. Madnick, *Software Projects: Pedagogical Aids for Software Education and Research*, McGraw-Hill, 1977.

Madnick, S.E., "Database Machine Architecture in the Context of Information Technology Evolution," (with D. Hsiao), *Proceedings of the Third International Conference on Very Large Databases*, October 1977.

Meldman, J.A., "A Petri-Net Representation of Civil Procedure," *IDEA*, Vol. 19, No. 2, 1978.

Meldman, J.A., J.D. Nyhart and D.T. Gilbert, "Draft Proceedings of a Conference on the Use of Scientific and Technical Evidence in Formal Judicial Proceedings," Sloan School of Management, Intermediate Report, 1977.

Meldman, J.A., "A New Technique for Modeling the Behavior of Man-Machine Information Systems," *Sloan Management Review*, Vol. 18, No. 3, 1977.

Rockart, J.F., and P. Lorange, "Computer-Based Models in Strategic Planning," chapter in *Strategic Planning Systems*, by P. Lorange and R. Vancil, Prentice-Hall, 1977.

Zisman, M.D., "Representation, Specification and Automation of Office Procedures," Ph.D. Dissertation, The Wharton School Working Paper #77-09-04, 1977.

Zisman, M.D., "Use of Production Systems to Model Asynchronous, Concurrent Processes," in *Pattern Directed Preference Systems*, edited by Waterman, D. and F. Hayes-Roth, New York Academic Press, 1978.

Zisman, M.D., "Office Automation: Revolution or Evolution," *Sloan Management Review*, June 1978.

4. Theses

Several graduate students are supported by research projects and programs at the Center each year. Many of these students go on to write Masters or Doctoral theses under the guidance of CISR faculty and staff. A representative sample of this year's theses is listed below:

Akoka, Jacob, "Design Issues in Distributed Information Systems," May 1978.

Andoh, John Jr., "A Computer-Aided Procedure for the Design of Logical Data Bases," May 1978.

Alexander, Steven, "Management Applications for Multiprocessors," May 1978.

Andreu, Rafael, "A Systematic Approach to the Design and Structuring of Computer Software Systems," February 1978.

Arab-Ismaili, Mohammad, "GPES: A General Purpose Process Engineering System," May 1978.

Choing, Donald, "Translation of Entity Relationship Diagrams into Hierarchical Structures," June 1978.

Dadashzadeh, M., "Evaluating Database Management Systems: A Framework and Application to the Veteran's Administration Hospital," February 1978.

Drelles, Robert, "Representations for Computer Assisted Legal Analysis," February 1978.

Emmer, Steven, "The Use of a Corporate Financial Model for Strategic Control," June 1978.

Giordano, Feliciano, "A Comparative Analysis of Project Management in the Public and Private Sectors," June 1978.

Grabscheid, Paul and Paul Schaller, "An Educational Aid Allocation Decision Support System," June 1978.

Gutwein, J. and E. Montoya, "Critical Success Factors for Government R&D Centers," June 1978.

Hill, Claire, "An Examination of Surgical Scheduling Policies," June 1978.

Hoffman, William, "Critical Success Factors for Airline Management," May 1978.

Holden, Timothy, "An Investigation of Cluster Analysis Techniques as a Means of Structuring Specifications in the Design of Complex Systems," June 1978.

Hudock, Kathleen, "Program Budgeting: A Critical Link to Effective Planning and Budget Control at MIT," May 1978.

Humphrey, Stephen, "The Use of Critical Success Factors in Systems Analysis—A Determination of the Information Needs of a Metropolitan Hospital," May 1978.

Jones, Nathan, "Data Base Design," June 1978.

Kaku, Takeo, "A Simulation Model for Performance Analysis of Data Base Systems," June 1978.

Lindsey, Nancy, "A Decision Support System for Investment Analysis of Wind Energy Conversion Systems for Utilities," in progress.

Mann, Douglas and Seymour Small, "Decision Support System: Application to a Marketing-Manufacturing Interface," May 1978.

Martinez, Jose, "Scientific Evidence and the Administrative Process: A Case Study," June 1978.

Michelman, Eric, "Security Management in Communications Systems: Everything You've Always Wanted to Know about Public-Key Cryptosystems," June 1977.

Novicki, Kay, "An Analysis of Computer Utilization in Secondary Schools," May 1978.

Palka, Daniel, "Studies of Computer Assisted Legal Research with Emphasis on the Lexis System," June 1978.

Piazza, Louis, "Product Assessment of BASIC/VM," May 1978.

Roderick, Jane and Linda Tufts, "Critical Success Factors in a Decentralized Company," May 1978.

Rubenstein, Burt, "Organizational Strategy for Software Development Organizations," in progress.

Seo, Karen, "A Study of Linguistic Issues in the Utilization of Information Systems," February 1978.

Shulsinger, Don, "The Interactive Graphic Database Design Tool," May 1978.

Smith, Anthony, "Investigation of Large-Scale Distributed Database," June 1977.

Sorrell, John, "Insurance Industry Centralization vs. Decentralization Management Issues," May 1978.

Tan, Chiaw Meng, "Towards the Automation of Database Design," June 1978.

Zack, Barry, "Selecting a Minicomputer: A Framework and Application to the Sloan School of Management," September 1977.



Participating Sponsors

A crucial source of support for the Center's research comes in the form of unrestricted funds from CISR Participating Sponsors. A CISR Participating Sponsor is an organization which is a substantial user of computer-based information systems, and which is in agreement with the objectives, goals, philosophy and overall research program of the Center. A small number of such organizations are requested to contribute to the unrestricted support of CISR in any given year. It is strongly urged that this support be allocated from the MIS departmental operating budget. This ensures that strong linkages are maintained with the information systems professionals in the sponsoring organizations.

Specifically, CISR Participating Sponsors work with us in generating new knowledge concerning their own information systems through five basic CISR research oriented services. In addition, they learn about the results of other research projects and have an opportunity for exchange of ideas through five dissemination vehicles. Both sets of services are noted below:

Modes of Interaction Between CISR and Participating Sponsors

Research

- (1) Serve as a site for an on-going faculty/staff research project.
- (2) Develop and suggest pilot research in a *new* field expected to be of generalized research interest.
- (3) Have a student team work on-site for a term or thesis project in an area of mutual interest to faculty and sponsor.
- (4) Send a sponsor employee to MIT to take part in a research effort as a CISR Fellow.
- (5) Exchange written material for mutual commenting.

Dissemination

- (1) Attend the annual "Research Results" summer seminar (two free slots are allocated to each sponsor).
- (2) Attend other CISR single-subject seminars—several of these are run each year (e.g., Seminar on the Management of Increasingly Decentralized Data Processing, 1978).
- (3) Receive CISR working papers presenting research results, faculty viewpoints, and selected student projects.
- (4) Discuss relevant areas of interest with faculty/staff researchers through visits by sponsor personnel to MIT or by CISR staff to the sponsor.
- (5) Schedule CISR faculty/staff to deliver a talk on the sponsor's premises on relevant topics.



Sponsors of the Center

Sponsors of the Center as of June 30, 1978 are:

ALCOA

Arthur Andersen & Co.

Citibank, N.A.

General Motors Corporation

Honeywell Inc.

IBM World Trade, Americas/Far East

IBM Corporation, General Systems Division

Martin Marietta

Massachusetts Institute of Technology

M/A-Com, Inc.

(formerly Microwave Associates)

RCA

Sun Company

The Chase Manhattan Bank

Photo credit: Sid Huff