PROCEEDINGS

of the Second International

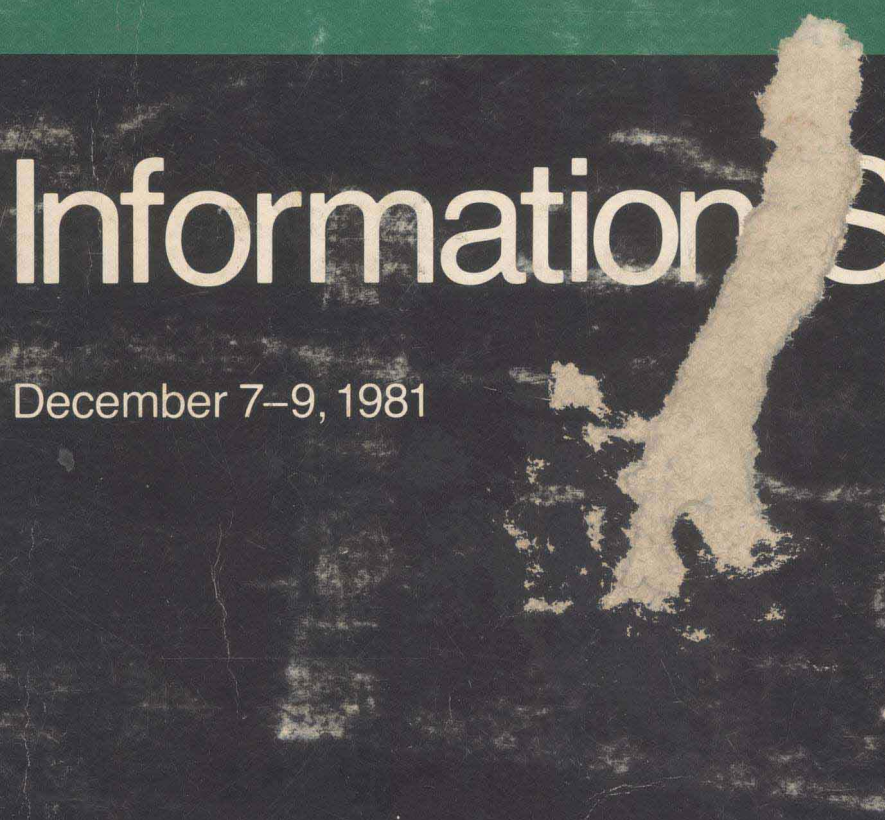
Conference

on

Information Systems

December 7–9, 1981

Cambridge, Mass.



Sponsored by

The Society for Management Information Systems (Research and Education in Information Systems)

and

The Institute of Management Sciences (College on Information Systems)

In cooperation with

Association for Computing Machinery (Special Interest Group on Business Data Processing)

and

Association for Systems Management

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Catherine A. Ross
Editor

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FOREWORD

As academics in the information systems field, we face today a robust set of challenges. To a great extent, our field is still undefined. In academia, it overlaps with several other fields and draws upon other disciplines for its core knowledge. In the world of practice, scores of state-of-the-art experiments are taking place which we are too poor in research manpower to observe adequately. The technology on which we are, in part, based and the managerial practices connected with it are changing rapidly. Our continuing attempts to identify and amplify the theories which define our field have still as yet achieved only modest success.

As researchers, we are far too few. Each of us has at least five potential research projects of interest for each one in which he or she is engaged. As teachers, huge student demand for existing and additional courses takes up significant amounts of time. Relief from this bind appears far away. Almost all of us have open faculty positions which the limited numbers of doctoral students cannot fill.

For many of us, it is difficult to interpret the usefulness and academic validity of our work to non-information systems faculty peers. We have only the bare beginning of what Peter Keen termed a "cumulative tradition" in his paper at CIS I last year.

In the past we have seldom come together as a disciplinary group. We have been diffused into many conference settings--as part of others' agendas. The development of a sense of community has been difficult at best.

With this background, the second annual Conference on Information Systems is certainly appropriate. Gary Dickson, Marty Bariff, and Eph McLean did an outstanding job last year in getting us underway. They developed a program which surfaced and discussed a broad range of issues for those of us in the information systems field. CIS I was a distinct success.

It has been a pleasure to build upon this base in developing CIS II. Since research is the bedrock of any academic disciplines, we have focused on research this year. The response to the call for papers for this conference was gratifying with well over eighty papers received by the deadline. Those selected by the program committee, under the able leadership of John Henderson, are presented here in full or part.

The Conference and the enclosed papers are structured into three principal tracks. Looked at broadly, the tracks deal with:

Issues in the development of information systems

Social, organizational, and measurement issues

Issues dealing with the management of the information function

This range of issues is important. It is at least one way to describe our field.

It takes the efforts of many dedicated individuals to successfully pull together a conference of this magnitude. We would like to acknowledge the following people for the roles they carried out in support of the Second International Conference on Information Systems.

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And special thanks to Evelyn Bickley for registration and administrative support, V. Thomas Dock, H. Albert Napier and Martin L. Bariff for their efforts on fund raising, and Catherine Ross for her dedication, editorial experience, and just plain hard work in producing the Proceedings which follow.

We would also like to acknowledge the professional societies supporting the conference and, in particular, SMIS which has taken a central role.

Ephraim R. McLean
John F. Rockart

December, 1981
Cambridge, Massachusetts

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Research in the Art of Developing and Implementing Computer Based Information Systems

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INTRODUCTION

Significant advances have been made in characteristics of and the methodologies for the design and implementation of computer based information systems. The credit for these advances as well as the blame for the failures in these areas often have been contributed to many different sources. At a minimum there appear to be at least four different contributors to both the problems and their solution. They are as follows:

1. The vendors of computer hardware, software, systems, and services.

2. The systems department within organizations that design, build, and maintain these systems.

3. The user community which to varying degrees participates in several or all phases of the development process.

4. The academic community which both supplies new graduates to the systems and user community and is a source of research results.

The purpose of this paper is to present a perspective of the contribution of academic research to the evolution of the state of the art in both the characteristics of and the design processes for computer based information systems. In addition, the paper will shed some light on the key areas of research that some academics believe should be explored in this area and the specific areas of research that are addressed by papers in the Developing Information Systems Track (Track I) of this Conference. The paper will not address the more controversial and possibly more meaningful subject of the relative contributions of the four groups listed above to both the problems and solutions of this area and expectations for future contributions from the four groups.

PERSPECTIVES ON THE NEED FOR RESEARCH

At the planning meeting for this conference held earlier this year, an attempt was made to come to some consensus on the problems faced by organizations in the development of information systems and the potential research questions which if addressed and solved could make significant progress toward the understanding and solution of these organizational problems. A group of ten Business School professors[1] identified the following subject areas:

1. What is the role of the user organization and the end user in the systems development process?

2. What are the cognitive processes relevant to both the designer and eventually user of an information system in the design activity, and how can knowledge of this cogni-

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[1] R. Ashenhurst, I. Benbasat, G. Davis, R. Hackathorn, J. Henderson, J. Hoffer, K. Kendall, B. Konsynski, A. Merten, and H. Morgan.

tive process assist in both the building and use of the system?

3. What is the impact of organizational structure and the characteristics of the target system on the design process?

4. How can designers and builders of information systems elicit and validate information systems requirements?

5. How systematic is the development process and how much of this process can be automated?

6. What is and how can organizations build reliable, secure, auditable computer based information systems?

A simple answer to the first question concerning the role of the user organization and the end user in the development process is to say that this role is important. But the exact nature of this role is something that both user organizations and researchers have been struggling with for a long time. What are the characteristics of both the system and the user organization that affect the role? How does the user role change during each of the phases of the life cycle of development of the system? Is there such a thing as too much involvement by the user organization and the end user in the development of the system?

Over the last ten years significant research activities have been undertaken in an attempt to understand the cognitive process involved in the design and the use of information systems. The study of these processes and the assumption that knowledge of them will improve both design and use of systems appears obvious since design of an information system is a complex task and the system itself will play a significant role in the activities of individuals and organizations. Of all the areas of previous and future research in the information area, this one seems to be one of the most difficult. While many of the other areas deal with more concrete reference disciplines such as mathematics and engineering, this research area deals with the reference disciplines of the social scientists, particularly psychologists. It has been and will continue to be more difficult to demonstrate the impact of research results in this area.

For many years, academic researchers and a growing number of managers within organizations have urged that organizations develop some sort of life cycle management process. The need for this life cycle process grew out of a recognition that the building of systems was a complex organizational activity and had to be managed with such classical management techniques such as cost-benefit analyses, progress reviews, and management decision processes which lead to either the termination of a project or commitment to continue. Proliferation of life cycle management techniques in organizations and development of commerical products which provide organizations with a generalized methodology have led to a number of significant unanswered questions. What is the impact of the organizational structure on the life cycle process? For example, what is the difference between the life cycle management process of a decentralized manufacturing firm and that of a centralized utility? By organizational structure, we refer to both the structure of the systems development department and that of the organization as a whole. The second major question in this area relates to the characteristics of a life cycle management process and the characteristics of the target system itself. Most life cycle management methodologies were developed in an era when we were building centralized systems, based on file management technology, to support day-to-day organizational activities, at a time when

the major cost associated with building a system was often the hardware itself. This situation leads to the following questions:

1. What is the impact on the life cycle processes of building organizational computer based systems in a database environment? Does the existence of a data administration function or the use of the specific model of data affect this life cycle management process?

2. Is the same life cycle management process used to build centralized systems of use when we are now trying to build large distributed systems?

3. What characteristics of the life cycle process associated with the building of transaction processing systems are relevant to the building of decision support systems?

Practitioners and researchers alike have concluded that it is extremely important to accurately elicit and validate the requirements of the user. Many formal and informal techniques have been proposed to improve the efficiency and quality of this collection and validation process. Which techniques are most effective? How are these techniques effected by the skills of the systems analysts, the capabilities of the user specifying the requirements, the characteristics of the system being built, and the underlying hardware and software that is available for the eventual system?

Practitioners and educators of the last few years have been telling the user organizations that computer systems are effective tools that can be used to reduced costs, increased reliability, and permit orderly evolution in various components of the business function. While systems professionals have been eager to convince others of the value of using this technology, some practitioners and researchers claim that these same professionals have not taken advantage of this technology to assist themselves in the building of systems. The analogy of the shoemaker's children comes to mind--a shoemaker's children are the most likely to walk around with holes in the soles of their shoes. How systematic is the development or various phases of the process? How much of the process can be automated? What are the characteristics of the organizational problem and computer technology which could lead to effective use of automated tools for the development process?

Educators, vendors, and systems departments within organizations have done an excellent job within the last few years of convincing executive and user managers of the power of information systems technology. One direct result of this effective education and selling job has been the fact that organizations have often become very dependent on computer based information systems. As recently as five years ago, a failure of a major computer based information system in many organizations would have resulted in a temporary inconvenience usually associated with needing to temporarily reassign groups of employees to manually perform the operations normally performed by the computer system. Today, we see a significantly higher dependency on computer systems where either a loss or failure of the sytem would have a major impact on the organization, including in some cases failure of the organization itself. Recently there have been many concerns expressed that while organizations have become more dependent on computer based information systems, it is not always the case that the systems have become more dependable. While the hardware itself may have increased significantly in reliability and dependability, the software both provided by the vendor and developed inhouse has not necessarily grown in dependability at the same rate. What is reliable, secure, and auditable information systems? How can an organi-

zation ensure that it has such systems? What will it cost to produce such systems versus the cost of producing new sytems that do not have those characteristics? What is the role of the user, the information systems department, the computer systems vendor, and the internal and external auditors in both building these types of systems and ensuring these desirable characteristics? Who can executive management of an organization that has grown to depend on the computer systems go to receive assurance that all is well?

The above comments reflect some of the attitudes and opinions of the individuals at the planning conference. While the papers submitted addressed some of these issues and in some sense can be classified according to the six subject areas above, a review of both submitted and accepted papers reveals another perspective on research in this area. Some of these papers are directed at improving the process by which we build information systems. Other papers are directed at improving the systems (products) that result from this process. Some papers address both issues.

Examples of papers that address the product issues are as follows. The paper by Vasarhelyi uses a simulated stock market environment to study various cognitive styles and their impact on effective use of information systems. Similarly, Gremillion and Jenkins study the effect of color on information presentation. They directly address the question as to whether color enhances assimulation of information. Ein-Dor, et al., discuss evaluation of a specific information system with respect to its portability, contribution to performance, user satisfaction, and application to major problems of the organization.

Several papers are directed explicitly at the process by which we build systems. The paper by Carlis, et al., addresses the possibility of applying decision support technology to the process of database design. In the papers by Salaway and Kaiser and Srinivasan, the specific problems associated with collecting user requirements and eliciting user feedback during the development process are approached. Several of the papers address the combination of product and process. Included in these is the paper by Donovan and Kim, related to axiomatic approach to productivity; the paper by Konsynski and Kottemann, on the complexity measures in system development; and the paper by Maes, et al., on the use of decision tables.

COMMENTS ON RESEARCH METHODOLOGY

Several papers have appeared within the last few years which have characterized and classified the various approaches that have been taken to perform research in the information systems area. This paper will not attempt to repeat or summarize those results, but instead will raise some questions and concerns with respect to research methodologies that are in general use and that were used in some of the papers in this Conference proceedings.

Researchers in the information systems area are aware of both the importance of doing empirical research and the difficulty of doing empirical research. A review of many of the research studies in this area and of the papers in this conference lead to some concern related to the environments in which we have to do empirical research. The vast majority of empirical studies are done in one of the following ways:

1. Field research in which only one organization or one department within an organization is used as the basis of the study.

2. Field research in which the administrative activities of the university itself is used.

3. Research in which the subjects are either MBA day students, MBA evening students, or undergraduate students.

The preponderance of empirical research based on what some might argue to be a somewhat skewed sample population should cause concern for both practitioners and researchers. There appear to be at least three reasons why we are currently restricting our empirical studies to the above listed areas. First, the cost, time, and inconvenience of doing research in other environments makes anything else difficult to do given the constraints on research in terms of academic budgets and time. Second, organizations are often unwilling or unable for researchers to be actively involved in either controling or measuring their systems development activities or systems operation. Third, it may be just as difficult to make generalizations from studies done in more expanded and/or "real life" environments as it is to make generalizations from the environments in which the research is currently being performed.

Certain research questions seem to be best addressed through the use of experimental techniques. Since we are interested in organizational issues associated with the use of information and computer based information systems, the need for field research seems obvious. Both academic researchers and operating organizations can do something toward attaining this goal. Researchers should be more creative in identifying their research environment and be more willing to overcome or endure the hassles associated with field research in more realistic field environments. Operating organizations, on the other hand, should be willing to contribute time, money, and access to their organization for the benefit of this expanded research.

CONCLUSION

In most subareas of what we would identify as computer science or information systems, practice has often preceded research. This is particularly true with respect to the development of computer based information systems. We are now beginning to structure the research area and to identify the most promising research problems. Hopefully, this Conference will extend the state-of-the-art of research in this area and contribute to the dialogue among researchers and between practitioners and researchers.

A Measurement Approach to Cognitive Complexity and Perception of Information: Implications for Information Systems Design

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ABSTRACT

Business decision makers were asked to evaluate and use various information reports, as might be supplied by an information system, in several decision making scenarios. Multi-dimensional scaling was utilized to detect underlying perceptual dimensions of the information (differentiation ability), and to assess the importance or salience placed on each of these various dimensions (discriminant ability). Preference mapping was utilized to assess the underlying decision rules used by the decision makers in using the various information items in decision making tasks. As expected, individual differences were found with respect to differentiation, discrimination, and integration abilities. However, further analysis demonstrated that relatively homogeneous groupings of decision makers could be formed which utilized information in decision making in a similar manner. The implications of the study indicate that information systems designers need to consider the cognitive characteristics of decision makers, and that information reports may be tailored to relatively cognitively homogeneous groups of design makers who perceive information in the same manner.

INTRODUCTION

Information systems specialists are not only interested in their traditional role of supplying information and in making decisions regarding the manner in which it is supplied, but more recently have become interested in the decision making process. Information specialists can no longer say that their job is merely to generate data and to report the facts, because the facts they report and the way they report them determine the actions that the recipients of the reports will take. Consequently, information systems specialists should consider the recipient action required and/or desired before effective system outputs can be designed.

OVERVIEW OF HUMAN INFORMATION PROCESSING AND DECISION MAKING

Evaluation of the ways in which decision makers process information is a necessary step toward realization of the goal of improved information systems. This evaluation may include analysis of message or information attributes, the social environment of the decision making process, and the individual decision maker's personal characteristics and attitudes. For example, individual characteristics to be considered may include perceived source credibility of the message, risk attitude, problem familiarity, personality characteristics, values, attitudes, intelligence, modes of perception, modes of encoding of

information, strategies in the remembering of information, modes of thinking, and modes of problem solving. The general objective of the current research study is to evaluate some of the cognitive factors that affect the information processing of business decision makers. Specifically, this study focuses on the decision maker's modes of perception of information. An underlying postulate is that what is perceived as information by one decision maker may not be perceived as information by other decision makers. Further, as information is differentially perceived, it may also be differentially preferred (used) in the design making process. This postulate has implications for the modes of presentation of information to decision makers by the information systems.

In the next section of this paper, an overview of human information processing and decision making is presented which develops a foundation for the subsequent sections of the paper. These sections contain the research questions, research methods, results, and summary and directions for future research, respectively.

OVERVIEW OF HUMAN INFORMATION PROCESSING AND DECISION MAKING

A number of research approaches have been utilized for evaluating various information characteristics, behavioral, and other factors by information systems researchers. These approaches are broadly categorized as Information Economics approaches (I/E) and Human Information Processing Approaches (HIP).

The premise behind the I/E approach has been that if information systems specialists, as suppliers and users of information for decision making, are to effectively integrate information models and information systems, a determination must be made of the relative utility of various information sets among users and the ways to economically represent them in the information systems model.

Information economics is primarily an ex ante normative formulation. Thus, information system alternatives, the decision rule, and utility function must each be specified prior to selecting an information system. A major limitation of most I/E formulations is the absence of explicit considerations of human information processing, behavioral variables, and behavioral relationships. A closer examination of research in this area reveals that an implicit Bayesian information processing rule is assumed. Few studies, however, have investigated the specification error that may exist if other processing rules and behavioral variables are more representative in extant information choice situations. This leads to a lack of confidence in the predictive validity of payoff differences which are forecasted from typical I/E studies (Mock & Vasarhelyi, 1978).[1]

While the I/E model concentrates on the major elements of information and decision processes, the HIP models emphasize human information processing elements. In HIP studies, researchers are typically concerned with a judgment model and the characteristics of a given decision maker. The ability dimensions encompassed in the model essentially refer to the content of cognition or the question of what kind of information is being processed by what operation and in what form (Messick, 1973). Human information processing under uncertainty may be characterized as a probability-revision process affected by the receipt of information. This probability-revision process has been typically

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[1] Mock and Vasarhelyi (1978) provide a framework for integrating or synthesizing the information economics and human information processing models. This is further discussed by Hilton (1980, 1981).

studied through use of the Brunswick lens model approach, which attempts to model the "content" or ability dimensions encompassed in the model.

Cognitive Styles/Cognitive Complexity Approaches to HIP

Supplemental HIP approaches (to the lens approach) include the evaluation of cognitive styles and cognitive complexity. These approaches are considered to be determinants that affect the probability-revision process.

In cognitive styles, the focus is on the impact of the decision makers' characteristics on components of the decision rule in information processing. In this research, an attempt is made to categorize decision makers according to their cognitive differences or, more specifically, according to their style of information processing. These styles are typically determined through the administration of psychological instruments (tests) designed to measure various personality constructs. For the most part, cognitive styles are information processing habits that develop in congenial ways around underlying personality trends. Cognitive styles research has been given a good deal of attention in the information systems literature and a synthesis is found in Zmud (1979). Cognitive complexity research has focused on problem-solving approaches used by decision makers and the number of different dimensions or constructs utilized by subjects in judging similarities and differences among people, or objects (Messick, 1973).

Because stylistic consistencies frequently interact with the ability dimensions (content of cognition factors modeled by the lens and I/E approaches) to influence the achievement level of performance, the cognitive styles/cognitive complexity research approaches are based on evaluating the style of cognition or the question of "how" (i.e., the manner in which behavior occurs). For this reason, it is important to assess the style of response to cognitive demands as well as the content of the response. The concept of the ability dimensions (content of cognition) of the decision makers, represented by the lens and I/E approaches, implies measurement of decision makers' capacities in terms of maximal performance, whereas the concept of style implies the measurement of preferred modes of operation in terms of typical performance.

Controlling Mechanisms of Personality Related to Cognitive Complexity

Stylistic aspects of cognition reflect personality dimensions that cut across affective, personal-social, and cognitive domains and thereby serve to interweave the cognitive systems with other subsystems of personality organization. The personality dimensions of primary interest in this reference are "controlling mechanisms," which are the structural dimensions of personality that determine the characteristic regulation and control of impulse, thought, and behavioral expression. These controlling mechanisms include such variables as cognitive styles, coping styles, attentional propensities, and defenses. Some of the controlling mechanisms represent dimensions of individual differences in the structural characteristics of the cognitive system itself. These dimensions primarily reflect differences in the complexity of the system.

Several measures of individual differences in cognitive complexity have been evaluated. These measures include the number of different dimensions or constructs utilized by subjects in judging similarities and differences among people, the degree of graduation or articulation within each of these dimensions, the diversity of content exhibited in the concepts generated, the number of different groups used in sorting