BUREAUCRACY AND SYSTEM DESIGN:

COMMUNICATION BARRIERS IN THE DEVELOPMENT AND IMPLEMENTATION OF ORGANIZATIONAL INFORMATION SYSTEMS

by

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Abstract

Problems with computer information systems are often attributed to breakdowns in communication between system designers and users. Misunderstanding between these groups often results in systems which fail to meet user requirements. While research has examined specific aspects of this problem, it has neglected the broader social and technical contexts in which communication barriers arise. This thesis corrects that deficiency by examining contextual factors which contribute to communication problems within IS design.

The study examines design problems from the perspective of individuals directly involved in that process. Because of substantial differences in training and experience, designers and users may apply distinct interpretive frames in describing system requirements. The fundamental problem in IS design consists of bridging these differences so that design information can be accurately communicated from user to developer.

This thesis reports a two-phase study of a conceptual model describing how aspects of the social and technical contexts of IS design create communication barriers. The first phase uses in-depth interviews with design professionals to explore questions regarding managerial and technical frames of reference, the social organization and technical process of system design, and resultant communication patterns and IS outcomes. A model is developed describing how these aspects of the social and technical context establish dysfunctional communication patterns between users and developers. Phase Two uses questionnaire data to refine and validate this model. The analysis uses a particular exploratory procedure to initially refine and then formally validate the model using Latent Structure Analysis.

The results support the proposed explanation of IS design problems, including

the distinction between managerial and technical frames of reference. The analysis indicates that existing social and technical arrangements for IS design create significant barriers between designers and users. Results of the quantitative analysis corroborate the proposed relationships between social and technical variables and related communication outcomes, and thus substantiate the model.

The study offers important insights into communication processes in IS design, particularly in terms of its broader social and technical contexts. Existing procedures for IS design process appear to generate as many communication problems as they bridge. Specific implications are discussed for overcoming these difficulties, as well as for further research in this area.

For Pam and Zenon
and The Cosmic Goof

Each provided, in their own way,
exactly what was needed.

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CHAPTER ONE: Communication and the Design of Organizational Information Systems: Locating the Problem

Introduction

In the thirty years since their introduction, computer technologies have occupied an increasingly important role in organizations. Since the first vacuum-tube giants took on routine accounting functions, a growing range of organizational and managerial tasks have been fallen to successive waves of automation. Inspired by visions of a fully automated "management information system" (MIS), early applications of computer technology promised access to a wealth of information required to operate the firm. In pursuing this vision through successive generations of computing machinery, new capabilities have been added to support a growing range of clerical and operational functions, as well as to directly facilitate managerial planning and decision making. Recent advances in integrating these functions within centralized information storage and retrieval systems has led current observers to refer to such applications as truly organizational, as opposed to strictly managerial, information systems. While this level of development may not yet be the norm, computer-based 'Organizational Information Systems' (OIS) are well on their way to becoming a ubiquitous feature of modern organizations.

It is ironic therefore, that the application of OIS technology has also been a source of significant and persistent difficulty for managers and systems professionals alike. Most attempts to automate management information functions have failed to deliver expected productivity gains. Instead, the implementation of these systems has frequently been accompanied by problems which defeat many of the benefits that automation is purported to offer. Several systems have even been described as outright failures (Hershman, 1968; Diebold, 1969; Dearden, 1966, 1972). Problems in the early development of information systems were so frequent that by the mid 1970's the idea of "MIS failure" had emerged as a distinct rubric for management and systems research (Ackoff, 1967; Dickson and Simmons, 1970; Minzberg, 1975).

While it is possible that technical "bugs" might account for some early difficulties, by the mid 1970's it was widely acknowledged that 'unfavorable' reactions on the part of the users of such systems were responsible for the vast majority of OIS problems. Among such reactions, research has identified a pattern typical of many failed systems. The following scenario, paraphrased from an early review by Dickson and Simmons (1970), describes the pattern: In many installations, systems are designed by external experts and implemented without attention to user training and orientation. Novice users are left to cope with systems which they often find cumbersome, inflexible, and inconsistent with established routines. In many cases, these systems provide only a marginal pay-back in terms of information access or utility, fostering perceptions that adapting to the new system is ultimately a losing proposition. In "typical" cases of MIS failure, people have responded to such conditions by simply abandoning the system and reverting to proven manual procedures. Employees may refuse to follow required procedures and insist upon using paper files instead of elaborate (and expensive) databases. Reluctant managerial users may ignore piles of un-solicited output and continue to operate without the benefit of "the most up to date information". Lower level employees, who may be unable to avoid the technology, the entire system can easily be disabled by an accurately misplaced paper clip or hair pin.

Thus, problems in gaining acceptance of automated systems, in obtaining effective utilization of system procedures and outputs, and in occasional instances of sabotage, are frequently observed among examples of MIS failure (Dickson and Simmons, 1970). The persistence of such difficulties well into the third decade of IS development (see, for example, McCosh, 1984; Rudelius, et al, 1982; Lucas 1987) clearly indicates the presence of a problem of considerable import for continued application of this technology.

However, many systems have been enthusiastically received by employees and have shown evidence of fulfilling their potential as useful tools (Lucas, 1975, 1987). These successes reinforced the idea that OIS difficulties are not inherent in the technology itself, but arise from specific implementations of the technology; a view which has spurred extensive research to identify the most effective means of developing and implementing information technologies within organizations (for example, Cerullo, 1979; Faerber and Ratliff, 1980; McCosh, 1984). This research has begun to identify a number of factors which affect the outcomes of system development and implementation, among which procedures for information system design have figured highly. It is the process of designing specific applications of information technology which is the focus of the present study.

Many critics have attributed problems in the implementation of organizational information systems to the failure of design processes to capture the actual information needs of particular users and translate these into appropriate technical specifications (eg. Rudelius, et al, 1982; McCosh, 1984). When systems are implemented which do not fulfill the actual needs of the user, it should be no surprise to observe the range of unfavorable responses described above. When employees are asked to work with systems which impose strange and cumbersome ways of accomplishing familiar tasks it is little wonder that they may revert to manual methods.

One of the most widely reported explanations for problems in OIS design is that system designers and their prospective clients often occupy very different worlds of experience. By implication, the way each interprets organizational situations and construes these in terms of information requirements will be based on very different sets of background, training and interests.

Research has suggested that managers and designers differ in a number of ways which can affect the interpretation of design issues and situations. Areas of difference which appear to have some relevance include attitudes and values (Kaiser and Srinivasan, 1982), personality (Kaiser and Bostrom, 1984), training and professional experience (McAlister and Hallam, 1980; Lapointe, 1982), cognitive styles (Doktor, 1978; Rucks and Ginter, 1982), and use of specialized professional jargon (Faerber and Ratliff, 1980; Hariton, 1986).

While such differences may represent minor obstacles individually, collectively they constitute a substantial barrier preventing designers and users from clearly understanding the nature and requirements of each others' work (Kaiser and Srinivasan, 1982). Within the design process this is thought to create misunderstandings about the information requirements to be satisfied by the system under development and, if unchecked, to the implementation of systems which fail to provide the information that managers and other personnel actually require to do their work (Bostrom and Heinen, 1977).

The existence of a "communication gap" of this kind between managers and information system designers has been an issue of concern to OIS researchers for nearly three decades. As early as 1965, Churchman and Schainblatt argued that the design process entails a fundamental problem of understanding between the technical expertise of the designer and the practical needs of the manager. Ackoff (1967) elaborated this analysis by suggesting that observed MIS deficiencies were a direct result of erroneous assumptions made by system developers about management's information requirements. Since then, the question of MIS designers' ability to understand and effectively respond to managements' information needs has been a recurring theme for both practitioners and researchers, frequently couched in terms of poor communication (McAlister and Hallam, 1980; Bostrom and Heinen, 1977; Kaiser and Bostrom, 1984; Guinan, 1986). While it is widely believed that communication problems represent a significant barrier to OIS development, research on the fundamental nature of those problems has been sparse. Practitioners seem content to publish admonitions that designers and managers develop more effective communication skills, without carefully investigating the exact nature and extent of the problem (Lapointe, 1982; Hariton, 1985). Although researchers have taken a more critical look at the problem, only a small number have tackled OIS communication issues head on. Among these, the emphasis has been to isolate specific communication behaviors which distinguish effective from ineffective designers and which may help to overcome specific problems in mutual understanding (Kaiser and Bostrom, 1984; Guinan and Scudder, 1987).

While such studies contribute to our understanding of the problem, none has attempted to provide an analysis of the underlying causes of OIS design problems construed specifically as problems in communication. Few studies, for example, critically evaluate the way in which OIS design operates as a process of communication in its own right. Among these, only a handful have considered the broader social and organizational contexts in which that process is embedded, and none have sought to understand how specific aspects of OIS communication problems may arise as a product of these larger social and organizational forces. Without the benefit of research articulating these broader dimensions of the problem, the effort to correct OIS design problems may remain confined to an examination of more superficial aspects of the problem.

The development of a conceptual model describing the role which broader contextual factors may have in creating communication barriers in this setting is thus an important step toward understanding the underlying nature of OIS design problems. To the extent that such a model can describe the fundamental nature of communication problems occurring in the design context, and can identify the conditions underlying those problems, we will be in much stronger position to seek effective solutions to those difficulties.

This thesis seeks to develop and empirically test such a model, using an "Interpretive" view of communication as a primary background against which to analyze specific features of the design process. By construing OIS design as a process of conveying and translating system requirements from the practical understanding of the manager to the technical understanding of the system developer, this perspective directs attention towards aspects of the design process which affect the extent and quality of understanding between these groups. Of particular interest in this study are specific features of the social and technical contexts of OIS design which appear to create barriers to understanding between user and designer groups. The model developed in this study thus seeks to explain the process by which these contextual factors contribute to problems of understanding which underlie many OIS failures. By providing this explanation, the model offers insight into the nature of persistent design problems, and may help to ultimately alleviate such problems.

System Design as Communication

A more detailed examination of the problem of understanding between designers and users will be useful in order to clarify the specific focus of this study. We begin by identifying two characteristics of information system design which highlight the fundamental role of communication in the design process and the importance of mutual understanding between designers and users. The first characteristic concerns the unique nature of computer-based information systems. For most managers, the application of technology to different functional areas of their organizations presents little challenge. Most managers are reasonably well versed in the development of procedures which enable employees to use technology in fulfilling organizational goals. Knowing the capabilities and limitations of the specific machinery, the development of procedures is simply a matter of defining how those features are to be utilized. For many managers however, computer technology presents something of an anomaly. Computers do not have uniquely definable functions in the same way that other kinds of machinery do. As Weizenbaum (1976) argues, computers are designed to be "universal machines" (p.60): their primary function is to simulate the operation of other kinds of technologies, as defined by given software programs. Thus, for example, word processing programs provide instructions which enable a computer to operate "as if" it were a typewriter (with several added features), and mathematical software provides instructions for the computer to simulate a very sophisticated adding machine. While the computer adds some of its own unique character to the performance of these functions (extremes of speed and storage capacity, for example) the kind of function the computer performs is essentially dependent on its programming.

It is this aspect of computer technology which initially creates the need for a detailed process of system design as an initial step in the implementation of the technology. Since the computer has no distinct functions of its own, the specific operations that it is to fulfill in a given case must be defined prior to its implementation. This frequently places the prospective user in the awkward position of having to envision a set of potential applications for a tool with which s/he may as yet have no practical experience. Without knowing the exact functions the new computer will perform, nor the particular way in which those functions will be carried out, the user must anticipate how s/he (or his/her employees) will use the computer to fulfill organizational goals. Unless the prospective user is also a skilled computer programmer, this initial projection of user needs must then be communicated to another individual to be used in creating the working system. Since managers and programmers work within fundamentally different worlds of experience, the user's original practical understanding of what the system will do must first be translated into technical terms which the programmer will recognize as specifications for configuring a particular system. These specifications are then re-translated into machine-readable code to create the programs on which the system will operate. What this means, in effect, is that the initial identification of needs put forth by the manager must undergo at least two significant transformations on its way to being incorporated into a working system.

The essential point here is that the inherent flexibility of computer technology necessitates the introduction of a complex process of translation and interpretation through which the technology can be implemented within a specific organization. For the technology to effectively fulfill organizational goals, a significant gulf must be bridged between the manager's practical understanding of system requirements and the precise technical specifications which a programmer will follow to develop the actual system. The process of system design entails a series of translations which provides such a bridge. The linking nature of the design process is illustrated below in Figure 1.1.

In its capacity as a bridge between the practical understanding of the manager and the exacting requirements of the system developer, OIS design thus functions as a process of communication between producers and prospective users of OIS technology. The design process entails a series of organized procedures which enable information to be transferred from user to developer, and at the same time to be re-cast in terms which the developer can use to construct the desired system. To the extent that this process provides an accurate movement of information between these groups, the development of information systems can be expected to be relatively successful. As we have seen however, frequent difficulties in obtaining systems which match user requirements and expectations suggest the possibility of basic flaws in existing procedures for communicating this information. Because the need for complex design procedures is inherent in OIS technology, continued development of this technology will necessitate a careful understanding of the ways in which this communication link can be made to function more effectively.

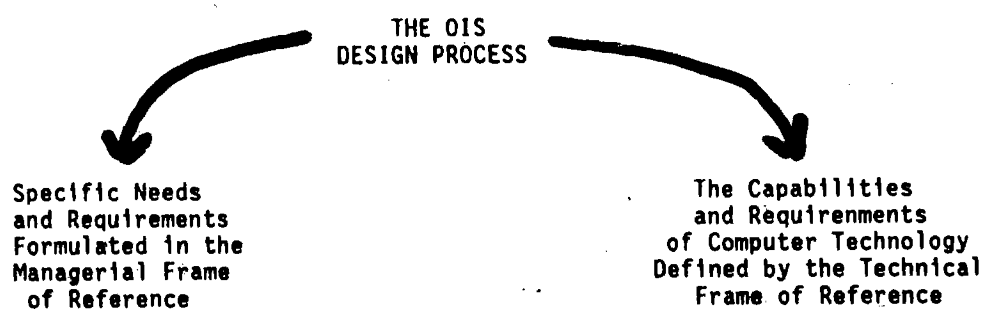


Figure 1.1: <u>The Bridging Role of OIS Design</u>

A second aspect of the OIS design process further illuminates the nature of communication processes and problems in this context. Although the process of moving information between designers and users harbors several potential difficulties, the prospect of obtaining mutual understanding between these groups is further complicated by the unique qualities of the commodity which computer systems assist the organization in managing, namely, information. Information and its use within the organization is both the subject about which managers and systems developers must ultimately communicate, as well as the means of conducting that communication. The unique properties of information within human and organizational contexts thus have an important bearing on the ability of the design process to achieve common understanding between designers and users. If information were a tangible commodity that could be transported directly from manager to programmer, the design process would be without difficulty. What we actually "transport" in communication is not "information" however, but the raw, unprocessed "data" of sensory experience, onto which we impose our own internal frameworks to select meaningful patterns. In other words, incoming data is converted to information internally, through a process which attaches value to selected aspects of experience. Information can thus be defined as data rendered meaningful through association with individual values.

The import of this distinction lies in the essential individuality of meaning. If data becomes meaningful primarily in relation to individual goals and values, what constitutes information for one individual may remain un-differentiated data for another. While we may put considerable effort into ensuring that our meanings parallel those of our partners, the fact remains that what is meaningful for one may be of little consequence for another.

If we accept this characterization of information, several important implications are evident for OIS design. To begin with, determining the information needs of individuals within the organization appears far more difficult than it first might seem. If it is unclear exactly which elements of the ongoing flow of data different employees utilize as 'information', it will be difficult to determine what the information requirements will be. Without an intimate knowledge of how each person approaches their specific tasks, the manager risks imposing a mistaken interpretation of others' information needs in attempting to describe system requirements.

If the problem of interpreting information needs poses a threat to effective design within the organization, the potential for difficulty is even greater when that task rests in the hands of an external party. When we entrust external experts to manage the design process, we introduce significant problems in the accurate interpretation of design information as it passes from manager to designer, and then among the various professionals who undertake specific design tasks. When we add to this the fact that the systems experts who undertake this task will likely be far more experienced in the world of computers than that of the specific organization, then the likelihood for errors in interpretation and understanding are multiplied. Under such conditions, the prospect that the system will accurately reflect the organization's actual requirements appears rather remote.

What this discussion reveals is the problematic nature of the communication process underlying OIS design. When we consider that individuals with very different training and experience must interact together to accomplish the design process, the potential for inaccurate or distorted interpretations of system requirements is apparent. The large number of failures reported in the literature might be considered testament to the great difficulty faced in achieving understanding between designers and users.

Both aspects of OIS design discussed in this section point toward the central importance of communication processes as a basis for effective system design. Given this discussion, we may propose that the essential character of the design process is to provide a means of conveying and translating a specification of system requirements from the practical world of the manager to the technical world of the system developer, and that the essential problem is a failure to reflect accurately the needs of managers in the completed system. Having formulated the problem in this manner, we can now begin to utline a strategy for addressing these issues.

An Interpretive Analysis of OIS Design Problems

We begin by identifying the general features of a theoretical perspective appropriate to the specification of this problem, and by providing a brief description of the research design couched within that perspective. Drawing upon the 'Interpretive' tradition of social theory, this analysis enables us to identify specific features in the broader context of OIS design which may illuminate communication problems in this setting.

The formulation of OIS design problems outlined above is consistent with an Interpretive orientation toward social theory (Burrell and Morgan, 1979:28). This framework emphasizes the subjective meanings and experiences of individual actors as a basis for explaining social action. Interpretive theories describe social processes in terms of the subjective understandings which guide individuals' engagement in social activities. Individual experience is given meaning largely in terms of interpretive categories derived from ongoing social activity. These interpretive systems or "frames of reference" provide the basis for our perception of external reality as orderly, and for our understanding of the purposefulness of our own and others' social behavior, both of which are essential to coordinated social action.

Because individual frames of reference (and perceptions of reality) are essentially unique, the question of how complex social activities are accomplished is problematic. In general, interpretive theory suggests that coordinated action is possible because significant portions of experience occur within a stable social environment. This means that as frames of reference develop, a significant body of shared knowledge is accumulated as a basis for coordinating action. This information becomes part of the tacit knowledge which members of a particular community normally possess as a basis for group membership, and provides the basis on which collective activity is undertaken in an apparently seamless and natural fashion (Berger and Luckman, 1966).

Two components of this shared knowledge are important for coordinating social action. The first concerns the specific social organization within which tasks are accomplished. Most complex activities are undertaken by assigning specific roles to individuals. Within the communities which undertake such activities, distinct sub-groups perform specialized functions in the service of overall goals. Knowledge of the various types of individuals involved in an activity, and the range of 'typical' behavior to be expected from each, allows individuals to coordinate their actions toward a collective purpose.

The second component concerns the use of specific techniques and procedures for accomplishing the task at hand. Within any group, specific ways of working typically become accepted as the norm. While these may not be the only way of accomplishing the task, nor even the most effective, they are procedures which have evolved historically and which adequately serve the needs of the group. Knowledge of accepted methods and procedures is essential if one is to be seen as contributing appropriately to the task.

Within the interpretive tradition then, individuals function largely within the existentially isolated universe of their own frames of reference, but are able to participate in complex social activities on the basis of an accumulated body of shared knowledge. The latter enables the individual to participate in the practical activities of a specific community in a manner that s/he and others will perceive as 'normal and effective'.

This perspective is useful in describing important aspects of communication within OIS design, and in suggesting a specific focus for an empirical study to illuminate problems in this area. To begin with, the discussion above suggests a unique interpretation of communication processes operating within OIS design. As we have suggested, designers and users frequently occupy distinct fields of experience, and so can be expected to operate within significantly different frames of reference. If this is the case, the 'gulf' which the design process must bridge can be understood essentially as that between these distinct frames of reference. The essential problem in system design, in other words, is one of facilitating the transmission of meanings initially constructed within a managerial frame of reference to the distinctly different technical frame. When this process is successful, sufficient common understanding is achieved between the two frames to enable descriptions of organizational and managerial needs to be effectively translated into technical specifications. This success is manifested in practical terms by the development of a system which matches the users actual requirements. By the same token, problems in completed systems may be due in part to the failure to establish shared understanding between these frames of reference.

Evidence of various individual and cognitive differences between managerial and technical groups tends to support the suggestion that distinct frames of reference are at play within the design process. When it is effective, the design process should bridge these frames and enable designers and users to coordinate their understanding of system requirements. Conversely, the failure of information systems to fulfill user requirements may be indicative of problems which prevents such understanding from occurring.

The advantage of formulating OIS design problems in this way is that it focuses attention toward the design process itself, and not toward specific communication behaviors which managers and designers use in OIS planning and development. While specific behaviors help to enact the design process, the discussion above suggests that the communication difficulties underlying OIS failure are to be found within the social and technical structure of the design process itself, and not simply in the actions of those who conduct that process.

Moreover, the interpretive orientation is also helpful in specifying particular aspects of the design process towards which more detailed investigation might usefully be directed. The analysis above suggests that the basis for coordinating the process of system design should be sought within the broader social context in which the design process is enacted. In particular, an analysis of the social organization of design professionals and the set of technical procedures used to conduct design processes should afford considerable insight into the underlying cause of problems in system design. Where evidence of OIS failure is present, it should be possible to locate within these aspects of the design context the basis for a breakdown in understanding which would contribute toward problems in bridging managerial and technical frames of reference.

The interpretive perspective thus suggests an approach to the investigation of OIS design problems rather different from those which have been employed to date. In particular, it suggests an investigation of how aspects of the social organization of the design community and the technical tools and procedures of system design may contribute to problems of understanding between distinct managerial and technical frames of reference. In light of the earlier suggestion that system design is fundamentally communicational in nature, this approach may prove particularly useful. Since it is the design process itself which creates the bridge between these separate spheres of human activity, it is within the structure of that process that we should seek an understanding of communication breakdown.

The Focus and Design of the Study

The present study seeks to illuminate the nature of communication problems within OIS design in the manner suggested by the analysis outlined above. Our purpose is to examine the broader social and technical contexts of systems design in an effort to describe how specific aspects of those contexts contribute toward the creation of barriers to communication and understanding within the design process, focusing on aspects of the social organization of the design community, and on the use of specific technical design tools. The aim of the investigation is to illuminate the process through which such problems arise, so that steps might be taken to alleviate them.

This novel approach to the problem necessitates an exploratory approach, developing an initial model which describes how major features of the design context contribute to communication breakdowns between designers and users. The model seeks to illuminate the mechanism through which specific forces in the social and technical context of systems design ultimately lead toward breakdowns in communication which underlie some OIS failures.

The population from which empirical data is drawn is the community of professionals whose work is to design and implement information technology for organizational uses. This group consists primarily of managers of information systems departments in large organizations, systems analysts and programmers, and some free-lance computer consultants. The focus on this professional community reflects the idea that the design process itself constitutes the communication link of interest. Since the professional activities of this community enact the communication 'bridge' between managerial and technical frames of reference, this population was deemed appropriate for the purposes of this study.

The study follows a three-stage procedure in developing and testing the conceptual model discussed above. The first stage involves a review of the literature to provide essential background information and illuminate current understandings about the process of system design and the nature of communication problems within that setting. The second phase of the study undertakes the initial development of a model based on data obtained in a series of focused interviews with design professionals. The data collected is used to define specific components of the OIS design context which appear to affect the quality of communication in that context.

The third phase of the investigation involves the collection and analysis of additional data to further refine and validate the model. A questionnaire is developed using the model to define specific variables; data obtained from a sample of ninety-two design professionals are then analyzed to provide an empirical assessment of the model's validity.

The results of this investigation provide several useful insights into the nature of the design process and the types of influences under which it operates. The two principle factors identified in the previous discussion proved, as expected, to have a significant impact on the nature and quality of communication processes in the design context. A number of specific conclusions are drawn from the study concerning the general nature of communication in the design context and the critical role this process plays in the effective implementation of organizational information systems. The study concludes with consideration of several major implications regarding methods for improving the quality of OIS design, as well as for further research into this complex and interesting problem.

CHAPTER TWO: Communication and System Design: A Review of the Literature

Overview

The first stage of this study entails a literature review summarizing research and commentary in three major areas: (1) problems associated with MIS Failure; (2) explanations for these problems; and (3) research on communication within the system design context. The review provides information concerning the particular nature of IS design problems, as well as an assessment of research suggesting an alternative approachs to the problem. We begin with a description of the literature reviewed.

The Literature

The literature surveyed in this chapter includes empirical studies and reviews of research from academic journals, theoretical studies of issues and trends in computing, as well as an extensive body of professional literature. Academic journals reviewed included those in management and systems science, organizational behavior, sociology and related social sciences, as well as communications. The review covers materials published since the mid-Sixties and continuing until the time of writing.

The quality of the literature is generally disappointing. Much of the material describing OIS problems originates with practitioners - primarily managers, data processing professionals, and MIS consultants - and as a result is generally not derived from systematic, theory-based research. In many cases, problems have not been defined with reference to any theoretical framework. Much of this work falls into the class of studies which Kling (1982) describes as un-critically promoting the advancement of computer technology. An indication of this is the fact that none of the studies critically examine the assumption of computer technology's basic applicability to managerial work.

The quality of research reported in the literature is particularly weak. Much of the practical literature is anecdotal or based on single case studies. Where conclusions are based on empirical data, those data are seldom collected in a systematic or controlled manner. In many studies, methodological problems raise doubts about the validity of results.

Recent work addressing communication issues in OIS design is somewhat better. Many studies demonstrate greater concern for rigorous data collection and analysis, and are likely to provide more reliable results. Unfortunately, the narrowness of some studies tends to limit the broader utility of the results. Because this work constitutes only a small portion of the present review, the need for additional high-quality research in this area is indicated. We turn now to a summary of literature in the three areas defined above.

OIS Failure: The Dimensions of the Problem

An extensive literature exists under the rubric of "OIS failure". This literature has grown steadily over the past two decades, indicating both the complexity of the problem and its importance to researchers and practitioners.

An early focus in this literature was to document individual cases of failed OIS developments (Williams, 1964; Dearden, 1966; Hershman, 1968; Diebold, 1969). Early recognition that OIS failures were more often the resullt of human rather then technical factors (Dickson and Simmons, 1970; Faerber and Ratliff, 1980), spurred a concerted effort to understand the nature of human responses to OIS and to suggest methods for improving system design and implementation.

In their 1970 review, Dickson and Simmons identify three negative responses among users:

(1) Avoidance - ignoring the system and its output; refusing or minimizing involvement with the system;

(2) Projection - blaming the system for external difficulties such as managerial or technical incompetence;

(3) Aggression - attempting to "beat the system"; outright sabotage.

While these were noted at all organizational levels, the authors note that aggressive responses were observed more among individuals with little control over system use, whereas avoidance was more evident when use of the system was discretionary (p.62-63).

Studies conducted in the 1970's and early 1980's provide further evidence that users were frequently dissatisfied with and resistant to their OIS (see for example, Swanson, 1974; Edstrom, 1977; Alter and Ginzberg, 1978; King, 1978; Cerullo, 1979; Faerber and Ratliff, 1980; McCosh, 1984). These studies consist mainly of individual case studies or comparative examinations of selected implementations. Among these, three major directions were pursued to identify the nature and source of 'unfavorable' responses to the technology: (1) investigation of responses among lower level workers, (2) investigation of managerial responses, (3) examination of related organizational issues. Major findings are summarized below.

A. Worker's Responses to OIS

Only a small number of studies examine responses among lower level workers, presumably because of the predominant emphasis on management applications of IS. The technology does affect individuals in numerous clerical and operational positions however, and some difficulties clearly arise at this level.

One group of studies suggests that information technology has produced a general "de-skilling" of lower-level positions (Booth and Plowright, 1982; Cordell, 1985). Many jobs (eg. data entry, word-processing) have become routinized as computer-related procedures and schedules have taken over. Kling (1973) argues that this contributes toward feelings of powerlessness which, coupled with threats to job security (Booth and Plowright, 1982), often creates strongly negative responses among lower level workers.

Other studies suggest that information technology creates the potential for job enrichment among operational staff, contributing toward increased job satisfaction (Federico, et al, 1980; Olson and Turner, 1985). Critical factors affecting this outcome appear to be a "user-orientation" among system development staff, and the degree to which organizational changes are effectively addressed in implementing the system (Demb, 1979). These findings add to the growing recognition that individual responses to OIS are strongly moderated by implementation procedures.

B. Management Responses

Managements' response to OIS has also been cool, though in different ways and for different reasons. Managers have considerably more discretion over OIS use (Kling and Iacono, 1984), and as a result, tend more passively to technology, for example by ignoring system output, avoiding training, or not rewarding subordinates' use of the system (Dickson and Simmons, 1970).

There is considerable agreement in the literature concerning the basis for this lackluster response. A problem reported throughout the literature concerns the quality or utility of the information provided by such systems (Ackoff, 1967; Cerullo, 1979; Miller 1981; King and Rodriguez, 1981; Cheney and Dickson, 1982; King and Epstein, 1983). Many managers feel the information they receive simply does not fulfill their requirements.

According to one study (Crescenzi and Reck, 1985), managers require information which is relevant to critical components of their business, is reliable and timely enough for strategic planning, and is understandable. Because information provided by OIS is typically a detailed summary of operational data, often presented at a level of analysis inappropriate to the problem at hand (Rucks and Ginter, 1982; Lynch, 1984). Many managers have elected to rely on traditional and often more reliable sources of information.

Several studies suggest that problems in fulfilling managers' information needs arise from information systems which embody inaccurate assumptions about the nature of managerial work (Ackoff, 1967: Davis and Grove, 1986). In a now classic article, Ackoff (1967) argues that designers frequently assume that:

> (1 the critical deficiency under which most managers operate in the lack of relevant information, (2) the manager needs the information he wants, (3) if the manager has the information he needs his decision making will improve, (4) better communication between managers improves organizational performance, (5) a manager does not need to understand how his information system works, only how to use it. (p. 147)

Ackoff suggests that systems which reflect these assumptions tend to flood the manager with too much information, fail to condense data into a concise format, and provide little assistance for interpreting what is provided.

Evidence suggests that problems of this kind are related to a discrepancy between the nature of managerial decision making and the nature of computer technology. Managerial decision making is not easily reduced to structured, programmable procedures. It often involves a balance of factual information with personal value judgements based on little more than gossip, rumor or hunches (Minzberg, 1971; Wente, 1983; Pollock, 1983; Luthans and Larsen, 1986). Even if they provide appropriate "facts and figures", computers may not be capable of providing the 'soft' information managers typically rely upon.

These problems are uniquely difficult for top executives. Studies indicate that OIS has made few inroads into top decision making, and is viewed with considerable skepticism by senior management (Spooner, 1980; Gruber, 1982; Price; 1982; Martin and Winch, 1984). One reason for this is the essentially strategic focus of executive decision making (Rucks and Ginter, 1982). Since most OIS are based on operational-level data, they offer little support for the long-range business planning which top executives do. Most executives believe that their information requirements are so complex and unstructured that executive-level systems remain quite ineffective (Martin and Winch, 1984).

The literature suggests therefore that while managers consider information technology to be a useful tool within their organizations, they frequently resist technology themselves and seldom trust the information it supplies. However, variation in these responses suggests that a number of positive impacts can be realized with IS technology (Jackson, 1970). As before, the use of a user-oriented development process and careful management of organizational change appear to be factors which most closely relate to positive outcomes among managers (Lucas, 1974; 1986).

C. Organizational Issues

While OIS difficulties are revealed primarily through individual reactions, often these are indicative of problems at the organizational level. Several authors (eg. Ginzberg, 1980; Markus and Robey, 1983) use the concept of "Organizational Validity" to describe quality of the match between information systems and their organizational settings. Markus and Robey (1983:206-211) identify four major types of organizational validity which appear to usefully describe the nature of particular OIS problems:

(1) User-System Fit - The authors identify two distinct dimensions of user-system fit: (1) the match between the system and various characteristics of the individual, including personal attitudes, values, and cognitive styles; and (2) the match between the system and the individual's organizational role or job characteristics. When systems conflict with either of these, users are likely to respond negatively.

(2) Organization Structure-System Fit - The consistency between the system and the organization's formal structure, including its task structure, management and communication channels, as well as formal control systems and decision rules. Inconsistencies between the technology and any of these are viewed as potential causes of OIS failure. Problems of this kind are illustrated in a study by Cheney and Dickson (1982) in which an information system was found to make the decision environment of managers increasingly programmed and stable, while not affecting the variety of the work being done. These were perceived as negative changes by the users involved, contributing to lower satisfaction with the system itself as well as the job.

(3) Power Distribution-System Fit - Citing research by Kling (1978), and others (Bariff and Galbraith, 1978; Bjorn-Andersen and Pedersen, 1980), the authors suggest that any implementation which upsets the balance of power within an organization will likely meet with resistance. It may be that the strong resistance of middle managers is reflective of this type of organizational invalidity.

(4) Environment-System Fit - The final type suggests the importance of matching the information system with the demands of the external environment. Since the work of Lawrence and Lorch (1967) it is recognized that particular organizational and managerial structures function more effectively under specific environmental conditions. If an organization is effectively adapted to a dynamic environment, an information system would have to be appropriately flexible to serve that organization. The inflexibility common in many OIS no doubt creates this form of invalidity in many executive-level systems.

The issue of organizational validity demonatrates that problems in the application of information technology may result from factors at a broader level of analysis. While mismatches between individual and system characteristics do occur, difficulties in OIS technology frequantly arise from an inability to meet the broader requirements these systems are expected to fulfill.

Summary

Research cited above provides insight into the nature of so-called 'OIS failures'. Unfavorable responses to OIS implementation appear to be the product of a mis-match between the perceived needs of the individual user and the outcomes provided by the technology. The conclusion appears to be that if systems impose unfamiliar methods of work, remove autonomy and variety from the job, or fail to provide required information, individuals will likely not respond favorably. These results indicate the importance of understanding and being able to represent the user's requirements within the system design process.

Popular Explanations of OIS Failure

A major concern in the literature has been to explain the range of human and organizational problems associated with OIS technology. The professional literature contains numerous analyses of OIS problems based largely on case studies and experiences with individual systems (for example King, 1978; Cerullo, 1979; Elam, 1979; Faerber and Ratliff, 1980: Miller, 1981). Many analyses focus the blame for OIS troubles toward one of the two major parties in the system design process: users tend to blame designers for their difficulties, and designers blame users. Over time, the appearance of some common ground between the combatants has enabled a broader understanding of the problem to emerge. A summary of these accounts provides what is now considered common wisdom concerning the nature of OIS failure.

A. The Technical Perspective

Within the systems-oriented literature, OIS problems are usually attributed to the resistance which users put forth against information technology (Swanson, 1974; Miller, 1981; Ginzberg 1981; Mathews, 1984; Hariton; 1985). System designers typically experience OIS problems in the form of a backlash from users. This has led commentators to suggest that problems in OIS originate within two major areas of user behavior: (1) unrealistic expectations, and (2) inappropriate attitudes toward technology.

The problem of unrealistic expectations is said to arise from a lack of understanding about the capabilities of computer systems among prospective users (Anderson, 1978; Ginzberg, 1981). Faerber and Ratliff (1980) suggest that managers often overestimate the capability of the technology, citing examples of managers expecting computers to actually make, rather than simply support managerial decisions, and others who blindly accept computer output as the unequivocal truth (p.19). Errant notions about computer capabilities have no doubt led some managers to make inappropriate demands of systems designers. The inevitabe disappointment arising from such expectations is experienced by designers as resistance and ineffective systems use on the part of users.

Inappropriate attitudes among users are cited as a second major source of OIS problems (Elizur and Guttman, 1976; Kaiser and Srinivasan, 1982; Swanson, 1982). Technical personnel often interpret the resistance they meet from users as an indication that users hold uncooperative, anti-technology attitudes (Rafaeli, 1986). Such attitudes are said to arise either from a generalized resistance to change of any type, or from a specific bias against the computer itself (Dickson and Simmons, 1970). In either case, inappropriate attitudes toward OIS are frequently cited as a source of difficulty by OIS designers.

Based on this interpretation, designers have focused their attack on OIS problems toward the development of strategies for educating and winning over troublesome clients. In several studies, user involvement in OIS design and implementation is shown to significantly improve users' satisfaction with and acceptance of systems (Swanson, 1974; Cerullo, 1979, 1980; Faerber and Ratliff, 1980; Lynch, 1984). In some cases, this satisfaction has been directly related to later use of the system (Edstrom, 1977 McCosh, 1984). These findings have formed the basis for the development of participative strategies for system design (Lucas, 1974; 1986; Mumford and Henshall, 1979) to be discussed in the Chapter to follow.

B. The Users' Perspective

In contrast to this technical perspective, users tend to attribute the difficulties they experience either to system designers themselves or to the procedures they use. Several authors describe OIS problems as a product of difficulties which users experience in their encounters with technical personnel (McAlister and Hallam, 1980; Lapointe, 1982; Kaiser and Bostrom, 1984; Lynch, 1984; Hariton, 1985). Many echo Ackoff's early (1967) charge that designers hold inaccurate assumptions about managerial work, and fail to represent managerial needs in the systems they construct (King, 1978; Olson and Turner, 1986).

The argument usually advanced is that designers do not understand the nature of managerial work and do not seem to grasp the relevance of particular kinds of information, nor the importance of presenting that information in a particular way. Instead, designers identify the requested information in terms of overly broad categories, and then cast these into a technically idealized management system. Systems designed on this basis represent a technician's view of what managers do, which seldom matches the actual needs of the manager (Kling, 1973; Senn, 1978; Marcus and Robey, 1983; Cronan and Means, 1984).

Several explanations are offered for designers' failure to understand managers' information needs. For example, designers are said to have unique personality types (Couger and Zawacki, 1978; Kintisch, 1977) and cognitive styles (Zmud, 1979; Allen 1982), as well as distinct professional training and experience (McAllister and Hallam, 1980; Lapointe; 1982). Each of these is said to act as a barrier preventing designers from understanding managers' requirements.

Martin (1984) adds to this argument the observation that existing design procedures also contribute to OIS difficulties. Figure 2.1 outlines Martin's summary of problems which users raise concerning the design process. Many of these problems result from design procedures which make it necessary to translate user requirements into rigid, and difficult-to-verify technical specifications (1984).

1. The traditional development life cycle is takes too long. There is frequently a delay of years in getting new systems or applications mounted.
2. Changes to systems once they are in place are difficult, and sometimes cannot be made at all.
3. Programs developed according to traditional methods frequently contain errors and do not perform as expected.
4. Systems delivered often do not match true user requirements.
5. It is often difficult to understand systems personnel and to adeuqately communicate precise requirements to them.
6. Users are asked to "sign-off" on formal specifications which are unclear, difficult to check, and often contain errors and omissions.
7. Systems generally cost more than anticipated, both to develop and to maintain.
8. Due to the difficulty and length of the development process, large-scale projects, or those requiring advanced functions are frequently delayed.

FIGURE 2.1: Common Complaints Regarding Traditional Design Methods (Adapted from Martin, 1984).

C. A Problem of Communication

While OIS problems can be approached from within one or the other of the perspectives outlined above, more recent work suggests that these opposing camps simply reflect different aspects of a single, more fundamental problem. The issues outlined above can be alternatively described as a problem regarding the relationship between the two groups.

For example, unrealistic expectations on the part of managers are often the result of over-zealous marketing on the part of technical advocates (Rucks and Ginter, 1982); negative user attitudes may result from unwanted changes in the work environment (Rafaeli, 1986) or other aspects of a poorly managed implementation (Cerullo, 1979; Demb, 1979); designers' failure to understand managerial information needs is paralleled by managements' ignorance of technical requirements (Mathews, 1984; Hariton, 1985); and so on. In a broader perspective, opposing views on OIS problems can be seen as complementary aspects of a single, more fundamental process affecting systems design.

From a relational perspective, unfavorable responses to OIS cannot be attributed directly to one group or the other, nor can these be seen as the ultimate cause of the problems which affect both groups. Each of these problems is relational in the sense that it describes a process occurring, not <u>within</u> either of the two groups, but <u>between</u> them. The difficulties which pit designers against users are merely symptomatic of a more fundamental problem affecting the entire relationship between the two groups.

The idea of a "communication barrier" between designers and users is frequently used in the literature as a shorthand to describe relational problems between designers and users (Kling, 1973; Faerber and Ratliff, 1980; Marcus and Robey, 1983; Cronan and Means, 1984; Guinan and Bostrom, 1986). The term provides a simple and intuitively useful explanation for many problems experienced in IS development. In this form however, the concept is so encompassing that it has become a catch-all to indicate any one of several kinds of difficulties encountered with OIS technology. References to "communication problems" in the literature encompass a variety of problems, including misunderstanding each others' information requirements (Lynch, 1984); lack of management (or systems) experience (McAllister and Hallam, 1980; Lapointe; 1982); differences in attitudes and values (Kaiser and Srinivasan, 1982), personality (Kaiser and Bostrom, 1982) and cognitive styles (Doktor, 1970; Rucks and Ginter, 1982); use of distinct technical jargon (Faerber and Ratliff, 1980; Hariton, 1986); the presence of conflict between the two groups (Dickson and Simmons, 1970); and so on. The concept has come to mean virtually any difference that might exist between the two groups, or any facet of the working process which might be a potential source of disagreement or misunderstanding.

While the notion of a communication gap between designers and users appears to capture a number of important dimensions of OIS difficulty, a lack of clarity its precise nature makes it difficult to define or evaluate empirically. The essential lesson to be gleaned from this concept is the notion that OIS difficulties originate in the relationship between designers and users. Using these terms, we avoid the problem of polarizing the issue, and can focus more productively on the process which joins the activities of these groups into a purposeful enterprise. It is this focus that the present study will pursue in greater depth.

We turn now to an examination of research focusing on system design as a problem of communication.

Research on Communication and Systems Design

While the idea of a "communication gap" between designers and users is found widely in the literature, empirical support for this concept is sparse. This is no doubt related to problems in defining the concept, as discussed above. Two research thrusts have been pursued to identify the causes of misunderstanding between designers and users. The first of these focuses on the assumption that the two groups differ in ways which prevent understanding. The second concerns the actual interactions which occur between designers and users. While the latter work is still largely exploratory, it appears to be the most active area of current research. A summary of this literature is outlined below. A.

User/Designer Differences

Most of the research concerning user/designer differences has been conducted within the tradition of "individual differences" research, focussing on psychological differences which affect individuals' responses to computers. This research has identified a range of differences which appear to affect individuals' acceptance and usage of OIS. Reviews by Allen (1982) and Wickens and Kramer (1985) indicate that individual responses to computer use are clearly affected by several aspects of individual cognition. In particular, perceptual processes, patterns of attention, and styles of decision making all appear to be significant in this respect. Allen (1982) points out that an awareness of such differences poses a significant challenge to computer engineering.

Researchers have used the idea of personal and professional differences between designers and users as a major focus for addressing problems in system development. Early research probed a variety of "personality" variables in search of an explanation for frequent mis-use of systems by users. Lucas (1975) studied a variety of attitudinal, personal and situational factors and found that effective and ineffective users differed each other largely in terms of their attitudes toward the system and their personal decision making styles. Later research (Zmud, 1979; Robey, 1979) also found differences in motivational characteristics between active users and non-users. While these studies do not address user/designer differences directly, later research (Kaiser and Bostrom, 1982; Rafaeli, 1986) indicates that individuals who actively use IS often exhibit similar attitudinal and personal traits to those held by designers. These findings support the idea that individuals who do not use IS technology differ from designers on a number of underlying personal dimensions.

Among several "personality" variables examined within the literature, user attitudes has received the greatest attention. In one study, Elizur and Guttman (1976) found significant variation in attitudes toward computer use throughout an organization depending on the amount of "administrative distance" from the centralized computing centre. The closer one was to the development, operation, or administration of the computer, the more favorable one's attitude. This finding has recently been replicated in a study by Walker (1985).

Kaiser and Srinivasan (1982) found evidence of differences between designers and users on several attitudes related to computer use, including need for user-orientation, need for knowledge of user requirements, and need for user involvement in design. Consistent with the finding discussed above, they also suggest that users who work closely with design personnel often come to share attitudes with them as the project proceeds. This finding has been interpreted differently by Kaiser and Bostrom (1986), who found that similarities among designers and users who participate in design were more a product of self-selection for involvement by the users themselves than a movement toward more favorable attitudes. They suggest that while some users tend to be more "systems oriented", the majority display attitudes and personal qualities which clearly distinguish them from designers and other technical personnel (p.56).

As in other attitude research, the exact relationship between attitudes and actual behavior can be problematic. It is generally assumed that attitudes are related to system use; however, it is not clear how attitudes toward computer use are formed, nor how closely these affect actual involvement with the computer. In addition, Robey (1978) has suggested that the relationship between user attitudes and actual system use is mediated by a variety of other variables, including user satisfaction and degree of choice in system use. Rafaeli (1986) has shown that positive attitudes toward computer use are closely related to overall job quality and job involvement, so that individuals who feel positively about their work and are highly committed to their organizations respond more favorably to information technology than those who are dissatisfied. Thus, while research points toward significant attitudinal differences between users and designers, it is difficult to draw any firm conclusions regarding how such attitudes might directly affect understanding between these groups.

While attitude research suggests differences in basic orientations toward computer technology, studies concerning differences in cognitive styles between designers and users provide clear evidence that such differences are reflected within the design process itself. Differences in attitudes and other personality factors are generally considered secondary to a more fundamental schism in the ways that designers and users actually think. It is these deeper differences which are said to cause problems in understanding on which OIS failures are thought to rest.

Several researchers (McKenny and Keen, 1974; Mintzberg, 1976) have used a version of the Meyers-Briggs Type Indicator (MBTI) to assess potential differences between designers and users. The MBTI provides an assessment of individuals' general orientations toward the world, as well as their modes of processing information. In research using this instrument, both McKenny and Keen (1974) and Mintzberg (1976) describe systems design work as being essentially "Analytical" in nature, while managerial work is more "Intuitive". Several studies use this characterization to describe differences between managerial and systems personnel (Keen, 1977; Gingras, 1977; Alavi and Henderson, 1981; Wade, 1981; Kaiser and Bostrom, 1982). The results generally support the idea of distinct information processing styles between systems personnel and managers.

Kaiser and Bostrom (1982) suggest that some negative results in this research may arise from self-selection of more analytical managerial types to take part in system projects, making managers and designers appear more similar than they actually are.

Findings of distinct cognitive styles are also supported by Doktor (1978), Benbasat and Dexter (1979), and Walker (1986). The former examined the problem-solving styles of executive level managers and management scientists (including systems personnel), finding significant differences between these groups in the way they approached and solved problems. Walker (1986) found differences in cognitive style relating to both the nature of an individual's work and their position in the organization. Benbasat and Dexter (1979) provide evidence that cognitive styles actually impact individuals' use of information system output. They found that individuals characterized as "analytical" in cognitive style tended to perform better using information in the form of a structured, aggregate report, whereas non-analytical individuals performed better using a flexible data-base inquiry system. These results strongly reflect the DP technician's penchant for standardized, structured reporting, and managements' frequent rejection of this as inflexible and unusable.

The general characterization of systems-oriented work as highly analytical, logical and sequential, while managerial work is more intuitive and relational, has led several authors to characterize the work of the systems designer as essentially "Left-brain", and the work of the manager as more "Right-brain" (McKenny and Keen, 1974; Mintzberg, 1978). While this may be only broadly suggestive of the differences between these groups, at least one study (Doktor, 1978) reports actual differences in brain wave activity in individuals doing tasks that simulate these different kinds of activity.

The major thrust of the research in this area has been to lend extensive support to the notion that designers and users differ considerably in their styles of information processing. Computer personnel evidently process information in an analytical and logical fashion, whereas managers function in a less structured, more intuitive fashion. Each performs best using tools which are appropriate to their own unique style of information processing.

These results have an important bearing on problems of MIS development and use. As Ghani and Lusk (1982) suggest, information systems function appropriately only to the extent that the amount and the type of information presented is tailored to the specific needs of the individual user. To the extent that systems are designed within a purely analytical mode, they are unlikely to serve the needs of someone operating within a more intuitive framework. Similarly, any attempt by a highly analytical individual to define the information needs of an intuitive type will be more likely to fail in fulfilling those requirements. It is on the basis of such arguments that researchers have attributed the blame for MIS difficulties to problems of understanding between designers and users of OIS, based primarily on differences between these groups' information processing styles.

B. User/Designer Interaction

A second area of research on communication and system design focuses directly on issues of user/designer interaction and seeks to identify how MIS difficulties arise out of flaws in this process. Because research of this kind has only been undertaken within the last five years, only a handful of studies are available, most of which are openly exploratory in nature. Many of these studies have been more concerned with an evaluation of potential approaches to the problem than with the provision of specific results. The findings outlined below are therefore merely suggestive of areas for further investigation.

One of the earliest studies focussing on communication between designers and users (Cronan and Means, 1984) used a survey instrument to identify differences in these groups' perceptions of their respective participation in the design process. The results suggested that the two groups differ in their assessments of (1) the effectiveness and utility of IS for organizations, (2) the importance of information requirements analysis, and (3) the importance of flexibility in system design, as well as in a number of other concerns regarding the design process. While the study did not include any actual observation of designer/user interaction, Cronan interprets these results to suggest that a major communication barrier exists between the groups and that improved communication between these group would improve design effectiveness.

In a follow-up study, Cronan (1984) attempts to place these findings within a broader framework of communication theory. He identifies three "theories" of communication - McGregor's (1960) characteristics of an effective group, the nominal group technique, and Transactional Analysis - which he considers useful in describing the problems encountered. These are then used to construct a prescriptive model for communication within the design process.

It is evident that Cronan's attempt to prescribe user/designer communication is premature. No actual evidence is collected which would support claims about communication processes between these groups. None of the three elements of his framework offer an adequate conceptual basis for analysing such behavior, and no explanation is offered for the assumed efficacy of his prescriptions. In setting out his framework, and indeed in his original research, Cronan neglects to define the precise meaning of communication itself, evidently choosing to un-critically adopt everyday usage of the term.

The failure to explicitly define communication and to examine issues of user/designer communication within an appropriate conceptual framework is characteristic of many works in this area. Many researchers acknowledge the critical importance of communication processes as an underlying basis for effective system design (Senn, 1979; Freedman and Marshall, 1984), but few advance a clear conceptual understanding of how that process is to be understood. In particular, none provide a clear indication of how the assumed breakdown in understanding between these groups is connected to actual events in the interactive process in which designers and users participate.

One study by Salaway (1984), offers a welcome break in this trend. The study undertook a content analysis of conversations between designers and users who worked together on development projects. Salaway found the verbal content of these conversations to be highly redundant, and yet to contain a number of dysfunctional elements and to be generally error prone. This very negative assessment of designer/user interaction squares with the notion that misunderstandings between these groups are relatively frequent.

The most successful attempt to date to provide a framework for studying communication and system design has been put forth by Bostrom and associates (Bostrom, 1983, 1984; Guinan and Bostrom, 1986). Bostrom provides a definition of communication closely aligned with a symbolic interactionist perspective - ie. communication is seen as a process of symbolic exchange between individuals with distinct perceptual and interpretive frames, the outcomes of which are shared meanings, mutual goal attainment, and the establishment of some degree of rapport (Bostrom and Guinan, 1986). Based on this definition, Bostrom goes on to develop a model of communicative competence specifically applicable to the system design context. Within this general model Bostrom outlines a number of specific communication patterns or behaviors which he suggests lead to effective interaction.

Two recent studies have utilized Bostrom's framework to explore the communicative behavior of designers and users. Guinan's (1986) field study of user/designer interaction indicated that designers who were considered to be particularly effective (ie. to produce successful systems) tended to exhibit more of the communication patterns outlined by Bostrom than did their less productive counterparts. Guinan and Scudder (1986) report similar results in a broader sample of subjects.

Empirical support for Bostrom's model is significant from two points of views. First, it indicates the presence of a connection between the actual interactive behavior of systems designers and the concrete outcomes of their work. This provides at least tentative support for the argument that ineffective communication between designers and users may help account for specific problems in implementing OIS. Second, these studies suggest that at least some of the barriers to understanding between designers and users may be successfully examined through closer study of the interaction processes in which they participate. The viability of a communicative approach to these problems is strengthened by these results.

The general utility of Bostrom's conceptual framework is limited because of its exclusive focus on only the verbal aspects of user/designer interaction, as well as its emphasis on a very narrowly defined model of communicative competence. Nonetheless, this work represents the best available example of how a communicative perspective might be applied in directly investigating issues of communication within the design process. In particular, aspects of the conceptual framework on which this work is based offer considerable promise as a way of approaching the central problem of understanding between designers and users.

In connection with this general framework, Guinan and Bostrom (1986) have outlined a comprehensive agenda for ongoing research. Among the areas identified as priorities they include: (1) the need to understand how communication processes operate as an underlying basis for specific strategies of system design, (2) the need to explore differences in the interpretive "frames" which managers and systems personnel use to interpret communication, and (3) the need to understand how additional external factors (ie. organizational sub-cultures) affect the success of designer/user interaction. The current study hopes to provide some initial headway in these areas.

Limitations in the Existing Literature

A number of problems are apparent within the research discussed above which suggest the need for an alternative approach to the study of communication within system design. Two major issues are outlined below as areas in particular need of clarification:

1. Limited Conception of Communication

The first problem concerns the basic concept of communication employed in the available literature. Even in the research literature, few authors question what is being referred to as "communication". Most studies simply adopt conventional usage of the concept. Common sense notions of communication are far too imprecise to be of much value however. References to "communication problems" in the literature include a range of problems including semantic difficulties related to the use of professional jargon (Faerber and Ratliff, 1980; Green, 1980: Hariton, 1986); a lack of regular contact in work routines (Lynch, 1984); the lack of common training and experience (McAlister and Hallman, 1980); differences in language patterns and conversational skills (Thompson and Carroll, 1981; Guinan and Scudder, 1987); and simply "not getting along" with one another (Dickson and Simmons, 1970; Mathews, 1984). It is difficult to know how one might begin to address problems of communication between designers and users without some agreement on the basic definition of the problem.

More significantly, popular notions of communication tend to be somewhat restrictive. The common tendency to associate communication strictly with verbal exchange, for example, tends to overlook deeper questions regarding how participants derive meaning from an exchange of messages, how those meanings are affected by external factors, and how the interaction contributes toward the accomplishment of coordinated social activity. Recent theories of communication which define communication as a symbolic process through which individuals negotiate shared meanings about mutually significant events (eg. Pearce and Cronen, 1980; Putnam, 1983; Donellon, et al, 1986) enable a far more penetrating analysis of communication processes. The introduction of a stronger theoretical framework into research on OIS communication problems could greatly assist the effort to assist in the resolution of outstanding difficulties.

2. Inattention to Social and Organizational Contexts

In lieu of deeper questioning of the nature of communication, the existing literature has tended to neglect a wide range of contextual influences under which communication normally operates. In particular, a focus on communication as verbal exchange tends to ignore a number of organizational and technical factors which form the context in which the design process is embedded. Like any social activity, the design process is influenced by the social dynamics of its institutional setting, as well as by historical processes which have shaped existing technologies and guided their application within management circles. Inattention to such factors denies us the opportunity to understand the true complexity of the problem, as it does our ability to meaningfully resolve it.

Based on discussions in Chapter One, it evident that two areas of particular interest have gone un-examined in this regard: (1) the social organization of the community of professionals who do systems design, and (2) the nature of the specific tools and procedures through which design work is conducted. These forces impose important structural considerations which undoubtedly affect the manner in which designers and users interact. Attention to these broader contextual factors will contribute significantly to our understanding of communication problems in this setting.

Summary

The literature reviewed here provides several insights into the nature of OIS difficulties and several valuable indications of an appropriate approach to these problems. The literature on OIS Failure makes it evident that several specific problems in OIS design can be attributed to communication problems between designers and users. There is considerable evidence that differences between designers and users play a significant role in preventing common understanding between these groups. In particular, differences in cognitive style appear to have an important bearing on how accurately each can understand the others requirements within the design process. Efforts to improve OIS design should focus on how to bridge this fundamental communication barrier. In particular, a need was identified for research which (1) employs a more sophisticated conceptual framework for defining the nature of communication processes within the design context, and (2) focuses on contextual factors such as the social organization of the design community and the technical procedures of design. It is toward the development of such an approach that we now turn our attention.

CHAPTER THREE: OIS Design: Historical, Social and Technical Contexts

Introduction

In reviewing the research literature concerning communication barriers in OIS design, it was noted that existing approaches to this problem have ignored the broader social and technical contexts of system design. It was argued that an alternative approach focusing on contextual factors be adopted in an attempt to more fully understand the nature of communication processes within the design process. As a point of departure for that approach, it will be useful to define in more detail the nature of the process referred as "OIS design". The purpose of this chapter will be to describe the nature of the tools and procedures which systems professionals use to design specific applications of OIS technology within particular organizational settings, and to describe important elements of the social organization of systems professionals in which those tools are put to use. This discussion will provide essential background from which to mount a more detailed empirical study of the role which these factors play in the creation of barriers to understanding within the design process.

We begin with a brief description of the historical development of OIS technology, within which significant features of the design context have arisen.

An Historical Description of OIS Technology

The term "Organizational Information System" (or OIS) is the most recent of several terms used to denote systems employed by organizations to collect, store, retrieve and manipulate the data on which major work functions are based. The most generic of such terms, "Information System" (IS), is defined by Lucas as "a set of organized procedures that, when executed, provides information to support decision making and control in the organization" (1986, p.10). Other terms refer to specific applications of information technology, or to the specific technical tools involved. Thus, "Management Information System" (MIS), denotes an application of IS technology to support management needs, while "Decision Support System" (DSS) describes a more specific application intended to facilitate managerial decision making. The most recent addition to this terminological jungle, "OIS" suggests a more global view of both the tools and the applications involved, indicating an orientation which addresses the interests of the organization as a whole, and not just of specific groups.

Few of these distinctions have much practical significance however. In practice, most information systems are designed to fulfill management purposes, many are intended to support higher-level decision making, and most are computerized (though many have important manual components). These distinctions do have import however in relation to the historical development of "IS" technology. While the overall intent of the technology has remained more or less constant, both the extent and the nature of its application have evolved rapidly in the wake of major advances in computing equipment. Technical advances have frequently meant changes in how information systems have been conceptualized and used within organizations, and it is these changes which are reflected in different IS terminology. The succession of terms used to describe information systems thus embodies much of the historical process underlying the most recent version of the technology.

A summary of the major phases through which IS technology has progressed is depicted in Figure 3.1. Successive phases in the process are represented by the acronyms commonly used to describe different forms of IS technology. Each is related to specific developments in computer technology and to attendant changes in the application of information systems, as discussed below.

The first major "era" of IS development is marked by the use of information technology in what has been called a "Data Processing" (or DP) mode, referring to the application of computers in processing and recording day-to-day clerical transactions (Panko, 1987). This was the technology of the 1960's, in which the effort was to 'automate' routine tasks within the organization. DP technologies focus upon operational tasks such as recording sales or service transactions, automated billing, maintaining accounts, compiling monthly reports, and so on. Improvements in technology through the late 1960's and early 1970's set the stage for IS to move beyond operational tasks and into management. Techniques for automatically capturing data at the operational level, improvements in data storage and retrieval, and more effective reporting systems created the possibility of applications tailored to managerial requirements (Lucas, 1973). For management scientists, these developments offered hope for the resurrection of a technology that had proven ineffective only a decade earlier: The Management Information System or "MIS" (Walsh, 1979).

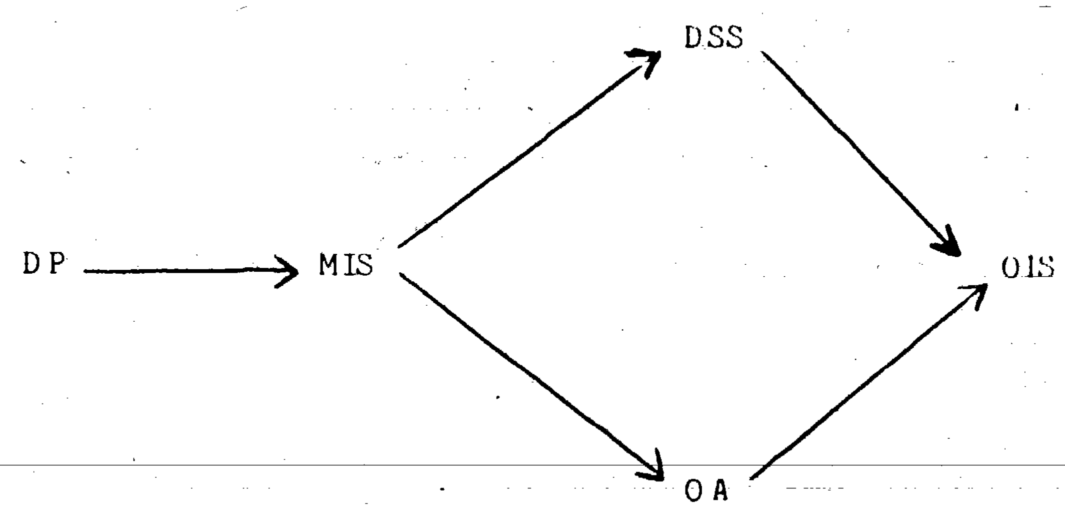


FIGURE 3.1: The Historical Development of OIS Technology

Often marketed with exaggerated claims of its performance, the new MIS was expected to offer substantial gains in organizational effectiveness. Much of this effectiveness has never been demonstrated. The traditional DP technology on which MIS was founded was capable of supporting only routine and standardized tasks; management reporting based on such capabilities was often reduced to non-selective "dumping" of entire data files, or presentation of standardized, fixed-format reports (Panko, 1987). With MIS, managers frequently found themselves either inundated by mounds of useless data or restricted to reports whose contents were frequently out of date and in a form that was of little relevance to the problem at hand. Widespread reports of "MIS Failure" discussed earlier date largely from this period.

Two major technical developments during the 1970's spurred movement beyond early MIS technology. The first was the introduction of sophisticated systems for accessing data and for presenting it in flexible, user-defined formats. Known as Data Base Management Systems or "DBMS" (Godlove, 1979), these permit users to selectively access only those data that are pertinent to the situation at hand, and to organize that data to enable meaningful analyses and decision making.

These features redefined the focus and purpose of IS technology away from traditional MIS and toward what came to be known as the Decision Support System or "DSS" (Keen and Scott-Morton, 1978). DSS technology recognized the folly of attempting to automate managerial functions, and helped to re-conceptualize the nature of IS as a management support tool. In this form, information systems offered the possibility of supporting higher level management functions such as strategic planning and decision making. During the early 1980's, DSS was recognized as the state of the art in IS technology, offering management a powerful, yet flexible tool for analysing organizational information.

The emergence of DSS was paralleled by a second development: introduction of several new technologies under the umbrella of Office Automation or "OA" (Russell, 1981). Developments which spawned Office Automation included the introduction of sophisticated microcomputers and microcomputer networks (Frisch, 1982; Saal, 1983), as well as the emergence of new software products including wordprocessing and spreadsheet packages, which made sophisticated applications readily available to every corner of the organization.

The rapid growth of the microcomputer industry encompassed several new tools for managing information within the workplace, many of which were no longer under the strict purview of management. A new generation of sophisticated computer users arose who demanded increasing access to systems as well as data. Such pressures brought about another shift in IS technology away from a centralized, management orientation toward what is now termed "distributed processing": an emphasis on the user as the central focus of the technology (Keen and Scott-Morton, 1978; Lucas, 1986; Martin, 1984).

The development of DSS and OA have shaped the evolution of MIS toward a technology which uses distributed rather than centralized computing resources, which provides flexibility in accessing and manipulating organizational information resources, and is primarily user-driven (Martin, 1984; Panko, 1987). These features allow the new technology to support a far broader range of applications, allowing the system to address the needs of users throughout the organization, including, but not limited to management. State of the art systems today provide opportunities for employees at various levels to share technical and data resources to fulfill organizational goals more effectively. In this sense they are appropriately termed organizational information systems.

The evolution of this technology clearly reflects a dynamic relationship between advances in computing equipment and the changing nature of the organizations to which it is applied. Distinct forms of IS technology have evolved as organizations have learned new ways to adapt technical innovations and, in turn, as technology has responded to changing organizational demands. While the movement toward more accessible and 'friendly' systems has helped to increase users' technical literacy however, this does not seem to have eliminated fundamental problems in system design. Even in very sophisticated systems, the basic problem of translating the user's practical needs into precise technical form remains largely unchanged, as is indicated by the persistence of design problems despite technical advances.

The Social and Technical Contexts of OIS Design

System design methodologies have evolved under the same conditions which shaped OIS technology. As indicated earlier however, existing methodologies may be at least partially to blame for ineffective applications of OIS technology in many organizations. To provide some insight into the social and technical contexts of OIS design, the present section discusses the development of existing design methodologies.

The Early Days

When computers were first introduced into organizations, individuals with the training to operate a major computer installation were extremely rare. Part of the difficulty in securing such an individual was that they usually performed a variety of what we now consider to be distinct tasks, including those of systems engineer, analyst, programmer, and operator, in addition to frequently being the principal user (Kraft, 1977). Since standardized training for computer personnel was not yet in existence, those who could perform this complex set of roles were often highly educated in such fields as mathematics and engineering, and frequently did not fit the mold of the typical "corporate man" (Weinberg, 1971). For these reasons, the computer operator of the early 1960's was often a highly valuable, highly paid, yet difficult to manage employee. Because computer technology was quite foreign to most executives and represented a substantial corporate investment, many executives found themselves having to place complete trust and responsibility in an individual whose methods they often did not understand and whose commitment to corporate goals might well have been suspect. This often created an awkward relationship between executives and the computer expert (Kraft, 1977).

<u>The Bureaucratic Transformation</u>

As DP technology changed during the 1960's, a major transformation in the social and organizational context of its application was also unfolding. Phillip Kraft and his associates (Kraft, 1977,1979; Kraft and Dubnoff, 1986) discuss the major forces and movements in this transformation, describing them as a major shift toward "bureaucratization". Kraft's analysis is helpful in understanding the context in which OIS design methodologies were originally developed.

As data processing became increasingly familiar, the need for trained personnel became pressing. Major corporations took advantage of this opportunity to influence the development of both computer technology and computer personnel. Because early computer workers had proven expensive and difficult to manage, the corporate world invested large sums in research and development efforts designed to provide new technical aids for bringing the computer more effectively within corporate control. Included here was the funding of technical schools and programs to train the upcoming generation of computer workers.

Kraft describes several developments which reflect the underlying strategy employed to transform computing work. Among these he includes:

(1) decomposition of computing work into tasks that could be carried out by less skilled personnel,

(2) development of programming languages which overcame the need to rely on knowledge of machine-readable code (a skill which reinforced management's dependence on a highly trained expert),

(3) development of structured techniques for programming and systems design which enabled development tasks to be broken down into easily manageable components,

(4) development of standardized training programs for programmers and other technical personnel,

(5) creation of commercial software houses to create "canned" programs available off-the-shelf,

(6) assignment of computing resources to organizational units over which management has greater control (ie. Finance/Accounting). (Kraft, 1977, 1979; Kraft and Dubnoff, 1986).

Kraft maintains that these had the cumulative effect of breaking the technical stranglehold that management perceived themselves to be under. With the task of operating a complex computer installation now effectively reduced to more manageable pieces, management could take control over its computing resources.

Kraft describes this transition as a gradual one occurring throughout the early development of computer technology. It is clear however that the bureaucratization of computer personnel was well in hand by the early stages of the "MIS" era. In fact, the movement from early DP to MIS technology has been described by Borum (1980) as simply another instance of a much broader shift toward management control over computer technology and personnel.

Traditional OIS Design: The Impact of Bureaucratization

The transformation described above significantly affected the development of procedures for information system design. Among the skills of the early computer expert, the ability to analyze requirements for a proposed system and translate these into a working application were an obvious focus for managerial concern. In the transformation Kraft describes, systems design was subject to the same decomposition and de-skilling that other technical tasks had.

The bureaucratization of system design was accomplished through a series of developments which transformed design functions from a highly skilled art into a set of standardized procedures (Kraft, 1979). Specific developments which accomplished this were:

(1) decomposition of systems design into a set of discrete functions which could be assigned separately or in sequence to junior technical staff,

(2) development of structured design tools which reduced complex tasks into standardized technical procedures,

(3) imposition of a hierarchical division of labour to facilitate supervision of technical personnel,

(4) establishment of management systems to gain control and accountability for the design process as a whole.

While these developments evolved as part of the formalized technology of systems design during the early days of MIS, they remain a dominant feature of formal system development methodologies still in use today. The following examination of current procedures for system design reveals the significant impact which these early developments have had on the technical process of system design and the social organization of the community in which that process is conducted.

A. The Traditional Technology of System Design

Figure 3.1 illustrates the sequence of tasks which constitute the traditional "System Development Life Cycle" -- a standard sequence of design tasks widely used in OIS development projects (Martin, 1984). This cycle reveals the decomposition of the development process into a prescribed sequence of stages, each of which is formulated as a distinct function in itself. Within each stage, a variety of techniques have been introduced to simplify complex tasks and to provide standardized outcomes for each. A brief outline of the major steps in the cycle and the principle tools employed in each stage is presented below:

The "Requirements" stage involves identification of the major functional requirements which the system is to fulfill. This phase is critical, since it involves the very difficult task of translating managerial information requirements into a set of technical specifications from which the system will actually be developed. The effectiveness of this translation is particularly important since misunderstandings are easily carried forward into subsequent stages and may go un-checked until late in the development sequence.

To avoid such problems, a variety of technical tools for "information requirements analysis" (Taggart and Tharp, 1977) have been developed to provide standardized and systematic means of defining system requirements. These attempt to provide a means through which management and technical staff can communicate their needs to one another.

The "Specifications" stage involves translation of system requirements into technical specifications which will guide production of the system. These include a definition of the functional specifications of the software which will satisfy system requirements, as well as a description of appropriate hardware to support the data and software requirements. A variety of structured tools are frequently used here to facilitate uniform translation and interpretation of specifications (Couger and Knapp, 1974).

The third step involves development of an overall conceptual design of the system as a whole. Working from detailed specifications and using a variety of modeling techniques (Chapin, 1974; Fergus, 1974; Hartman, et al; 1974) the designer first develops working models of functional components of the system (ie. modules), and then combines these to create an overall design of the system as a working unit. The importance of detailed and accurate requirements and specifications is paramount here, since any degree of interpretive discretion on the part of the designer may have significant impacts on the developing system.

Design is followed by the actual production of the system, beginning with writing software programs and development of logical structures for data storage and retrieval. Structured programming methodologies are frequently utilized here

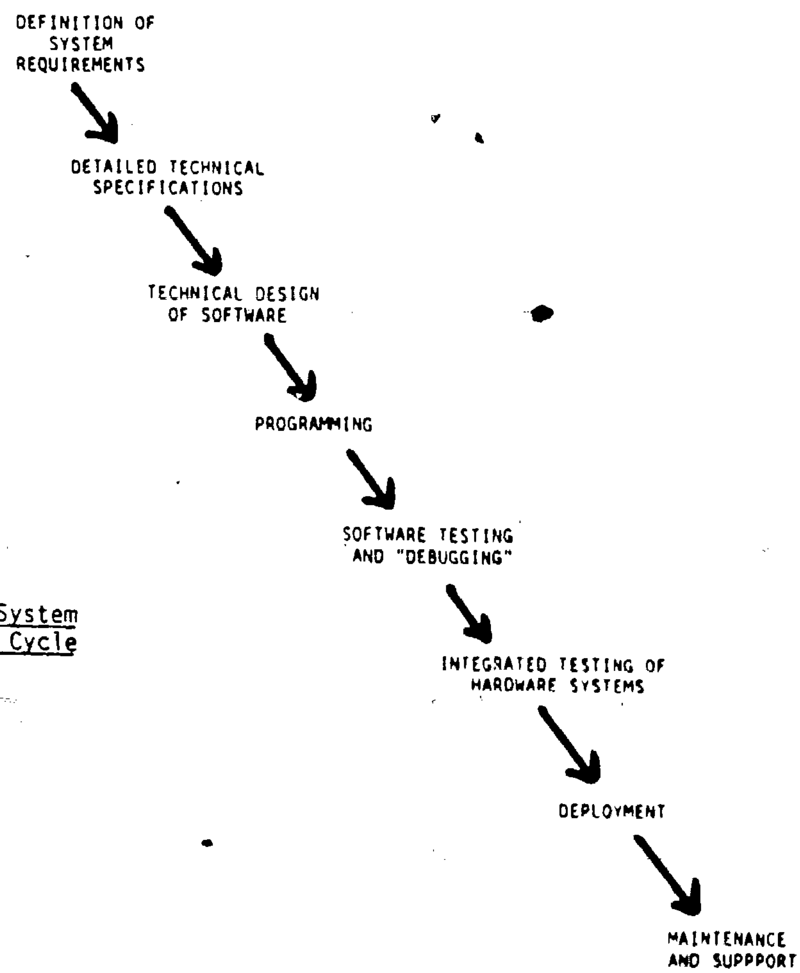


Figure 3.2:
The Traditional System Development Life Cycle

to facilitate translation of specifications into machine-readable code (Kraft, 1977), followed by extensive testing, or "debugging", first of the performance of the software itself, and later of the entire system. Both forms of testing are done in relation to pre-determined technical standards (Enger, 1976).

The final two steps involve the actual deployment of the system into the organization and its ongoing maintenance. Deployment typically involves a period of on-site debugging and trouble shooting, as well as user training (although training is not traditionally considered part of the design process). Maintenance consists of correcting minor problems in program performance and updating procedures as required from time to time. Both stages entail the use of specific technical tools and standards.

The traditional development cycle thus provides a sequence of steps which lead eventually to the implementation of an information system. Decomposition of the overall process into discrete steps, and the use of various technical tools within each step make it possible for the extremely complex task of system design to be handled by a team of technical specialists within a clearly defined set of technical guidelines.

The particular strength of these procedures lies in the degree of standardization they afford. Standardization allows each stage to be undertaken by anyone with proper technical training and supervision. This makes management no longer dependent on a single expert, and provides an effective foundation for regulating the design process. Thus, while the traditional cycle appears to be a logical approach to system design, its major function rests in the establishment of a framework for managerial control (Kling and Iacono, 1984).

B. The Social Organization of System Design

Decomposition and standardization of the design process through the traditional development cycle was accompanied historically by the development of bureaucratic mechanisms of coordination and control. As a growing compliment of specialized computer workers swelled organizational ranks, the need for adequate supervision became increasingly apparent (Greenbaum, 1976). This led to changes in the organizational units in which the design function was carried out. While not a direct aspect of the design process *per se*, these remain a predominant feature of the technology of system design.

Two aspects of the social organization of system design are important here. The first concerns the establishment of a traditional hierarchy of authority as a mechanism for supervising design workers. In decomposing the design process into distinct areas of technical responsibility, a specialized division of labour was created. Individuals assigned to relatively narrow technical tasks were made accountable to others with broader responsibility, imposing a hierarchical authority structure which paralleled the division of technical tasks.

This early development in the social organization of computing is still evident today. Virtually all organizations which do system development employ a hierarchical division of labour to manage complex design projects. These hierarchies are a major structural features of the community of professionals involved in design work. While the names attached to specific positions vary between organizations, the typical structure of this community can be described as follows:

At the highest level are MIS Managers who heads the organizational units in which the design function is housed. Their primary responsibility is for project management, including budgetary control and adherence to contracts and schedules. Below the MIS Manager is usually a "Project Leader" who is usually responsible for supervising an individual project. This person will in turn supervise one or two "Senior Systems Analysts", whose main responsibility lies in the analysis of user information needs and the overall conceptual design of the system. This individual is often the main contact with the prospective user. Under the Senior Analyst are typically a group of "Junior Analysts" whose work consists of translating requirements statements obtained from the senior analyst into technical specifications. These are usually passed on to programmers, who actually produce the programs which fulfill these specifications. In large software houses, one often finds a distinction between "Senior" and "Junior" programmers, the former being assigned to the development of new systems, and the latter being involved mainly with routine maintenance and upgrading of established systems. Somewhat removed from this typical hierarchy, may also be technicians and other staff who work primarily with hardware.

With development work increasingly being located within large DP or MIS departments, the need for additional management structures was apparent. A second development in the organization of the design process arose in response to problems in managing large-scale development projects. Complex tasks such as requirements analysis or programming often required a number of individuals working on different components at the same time. These groups were often formed into distinct organizational units to facilitate management of that function. While this facilitated supervision of individual workers, it was often unclear who was overseeing the project as a whole. With the major components of the design process widely distributed throughout the organization, the need for stricter organizational controls became increasingly apparent.

This problem frequently came to light when the ultimate users of the system under development became concerned about the rate of progress or mounting costs. Users legitimately wanted assurances that the project would be completed on time and within budget. This reinforced the need for procedures for monitoring the project through various stages and assessing progress in relation to cost and performance criteria.

In response to these demands, system development houses introduced complex systems for project management, including procedures for defining the specific sequence of stages the process should proceed through, and defining the specific results which clients could expect at each stage. Built into these plans were specific points at which clients would "sign off" on specific aspects of the work - providing security that the project was proceeding according to plan.

The ability of large development firms to meet clients' expectations of the development process made such procedures an important part of the "business" of system design. A group's ability to manage a project effectively (ie. meet time and cost constraints) became such a strong selling point that individual firms developed proprietary systems which they sold to clients as distinct development "methodologies" (see for example Appendix A). Marketed as unique approaches to system design, these are essentially formalized procedures for project management which facilitate the accomplishment of large-scale design projects.

To summarize, existing design methodologies reflect their heritage within the context of large bureaucratic organizations. The need for organizational controls which arose as computers proliferated in organizations created a particular social structure among those who conduct the design process. It is within such structures that most design work is now undertaken. As we will see, even the introduction of innovative design tools to compliment new forms of OIS technology not altered the traditional social context.

Some Recent Developments in the Design Process

While the previous discussion outlines the primary features of system design, this chapter would not be complete without reference to some recent developments. Most design technologies discussed above evolved as part of the early "MIS" era, or appeared over the decade which followed. While this would not seem to describe "current" methodology, very little fundamental change has occurred in OIS design since traditional methods were formalized.

This may be attributed to the essentially bureaucratic nature of the processes just described. Such structures are notably resistant to change, often preferring to co-opt new developments rather than adopt them. Many of the innovations that have occurred in systems design have tended to be absorbed into the traditional methodology and adjusted to suit that context.

One example of this co-optation concern an entire group of procedures for "information requirements analysis" (Taggart and Tharp, 1977). These are essentially structured interview techniques which were developed to address problems of misunderstanding between system designers and users. Within the traditional design framework, these have taken on the less useful function of formalizing and standardizing the interaction occurring between designers and users, often exacerbating the problem of understanding. For users, these techniques have become another technical tool which demands that they translate requirements which are already vague and unclear into a language which is both unfamiliar and intimidating. Although the availability of techniques for defining information needs undoubtedly aids the design process, it is doubtful that understanding in any deep sense is facilitated by current applications of these techniques.

A second innovation that has been adopted by existing design methodologies without fundamentally changing their form has been the widespread use of participative design strategies (Mumford and Henshall, 1979; King and Rodriguez, 1981). One of the early lessons from MIS research was that participation by users in the development process frequently alleviated problems in gaining user support and cooperation. By involving the user as a direct participant in developing technical specifications, and implementing the system, these techniques were found to secure user interest and support for the system, and to make the identification of requirements more accurate.

Research has shown that participative methodologies substantially increase users' understanding and acceptance of the systems they help design, and ensure more effective usage (Swanson, 1974; Edstrom, 1977). It is unclear whether such gains are obtained by giving participants a voice in major design choices, or simply by having users participate in carrying out choices already established by the design team. In the latter scenario, participation simply serves the function of educating users and securing their cooperation in a predetermined system, rather than giving them a meaningful say in the design of their systems (Edstrom, 1977; King, 1978; Kling and Iocono, 1984).

A third innovation occurred with the development of so called "Fourth Generation" or non-procedural programming languages (Martin, 1984). These essentially automate certain programming procedures, making it possible for a relative novice to develop applications quickly and efficiently. In the hands of a skilled developer, these tools make it possible to bypass traditional techniques and rapidly produce a prototype of a program which might otherwise take months to develop.

Within the context of traditional development methodologies, fourth generation languages are useful in developing working prototypes of a finished system so that users can request changes before the system goes to production. This "prototyping" technique (Boar, 1984), has been shown to greatly enhance implementation success by helping to identify and correct errors before they become entrenched within a full blown system (Sroka and Rader, 1986). Prototyping is still relatively new however, and remains largely outside traditional methodologies. It tends to be very demanding on computer resources and allows untrained users to develop applications which may be inconsistent with existing systems. For these reasons prototyping is often viewed with suspicion by traditional developers. Many believe that prototyping must be carefully controlled within a broader, more traditional development framework (Hounsell and Birch, 1985).

Fourth generation techniques have been received enthusiastically by users. The ability to bypass the traditional methods and develop applications rapidly has opened up new possibilities for "distributed" and "end-user" computing. With the availability of inexpensive microcomputers these tools have been a major force in defining the most recent conception of what an ideal information system could be. As long as responsibility for system development remains locked within traditional structures however, our ability to realize that potential may be significantly delayed.

Looking Ahead

While these developments represent a significant addition to the process of systems design, none provides a solution to the fundamental problems which plague information technology. Even with these techniques, problems in OIS design have not vanished. System design continues to present difficulties for managers and systems professionals alike (Hariton, 1985; Guinan and Bostrom, 1986). In fact, continued efforts to develop new approaches to OIS design only underline the fundamental problems in this area.

What is significant about these developments however, is that each seeks to improve the design process by providing a means of enhancing communication between designers and users. Each recognizes the fundamental problem as one of failed understanding between these groups, and introduces, by way of some technical process, a means of improving their interchange. At the same time, each presupposes a basic level of communication between these groups to function as a design tool (Guinan and Bostrom, 1986). Without effective interaction between these groups, no set of technical procedures can serve as a basis for effective design. This reinforces the crucial role which communication plays for the entire process of system design. In addressing problems of OIS design therefore, it will not be sufficient to simply impose technical procedures which mimic or replace human understanding; an understanding of how communication functions in the design process is essential if design procedures are to be improved.

Summary

This chapter provides an introduction to OIS technology and to the historical context in which it evolved. The tendency for the design process to be located in highly bureaucratic structures has shaped both the procedures of design and the organization of the professional community in which it is carried out. Most design projects of any scale follow the traditional development cycle, most make use of structured techniques for system analysis, design and programming, and most are undertaken within a hierarchical division of labour.

These characteristics of system design are part of the taken-for-granted world of the computer worker. These have also been overlooked by scholars and practitioners attempting to understand problems in OIS design. This study contends that these contextual features play an important role in creating and enlarging barriers to communication within the design process. The chapters which follow describe an empirical study which seeks to model the manner in which these factors affect the nature and quality of communication in this setting.

CHAPTER FOUR: An Empirical Study of Communication Barriers in OIS Design: Design and Methodology

Overview

The aim of this thesis has been defined as the development and evaluation of a model describing how particular features of the social and technical context of system design create communication barriers between OIS designers and users. Having reviewed the literature relevant to this area, we may now begin an examination of the central problem by describing the development of the model in question, and by undertaking an empirical study to refine and formally test that model. We begin by describing the design and methodology employed in gathering and analyzing empirical data for these tasks.

This chapter outlines the overall two-phase design of the study, followed by a description of specific methodological issues confronted in collecting appropriate data for each phase. Included here is a description of the general population from which samples for both portions of the study are drawn. The chapter closes with a brief discussion of the techniques used to analyze the data collected in the second part of the study. The results of specific portions of the study are reported separately in subsequent chapters.

The Overall Design of the Study

The decision to pursue the empirical component of his study in two distinct phases is based on a recognition that two fundamentally different kinds of research tasks are involved in initially developing and later evaluating a model of OIS communication problems. The first task requires a descriptive approach relying primarily on qualitative data. The aim here is to provide a detailed description of specific aspects of communication in OIS design and to develop an understanding of how these function within the design context. It is this rich, qualitative description of OIS design which will provide a basis for defining specific elements and relationships to be depicted in the model.

The second task requires a more quantitative approach. The aim here is to provide empirical evidence to refine the representation of elements and relationships in the model, and then to assess the validity of the model as a whole. To undertake this evaluation of the model, a large body of data is required. The second portion of the study thus uses a fundamentally different methodology to provide a final assessment of the model developed above.

The study proceeds through two distinct phases employing distinct modes of data gathering and analysis. The first phase is essentially a descriptive study which uses qualitative techniques to obtain detailed accounts of the social and technical contexts of system design and to determine their impact on design problems. Data for this portion of the study are obtained through interviews with a sample of individuals having direct involvement in the system design process. A detailed interview protocol was developed to focus these interviews toward specific aspects of the design process, as defined above. Interviews were conducted with a small sample of individuals to provide the data on which an analysis of communication problems in this context was carried out.

Data from the qualitative portion of the study were examined to identify features of the design context which might systematically affect communication in this setting. This examination was guided by an interpretive analysis of communication breakdown, as previewed in Chapter One. By focusing attention toward specific aspects of the communication process, this perspective provided the basis for selecting elements and relationships for inclusion in the model.

For example, the focus of the model was defined to be specific features of the social and technical context of system design which create communication barriers between designers and users. We defined such barriers as problems in the accomplishment of shared understanding between technical and managerial frames of reference. In examining data from the first part of the study, we therefore seek to identify how the social organization of design professionals and their use of specific design techniques may affect translation of design specifications between managerial and technical frames of reference. Based on this analysis, a model is proposed which describes how the major components of the design context affect communication within OIS design.

The second phase of the study is quantitative in nature. Based on the results from phase one, specific variables are identified to operationalize elements of the model. To collect data which support rigorous testing of these constructs, a questionnaire was developed for distribution to a large sample of systems design professionals. Initial questionnaire items were based on tentative relationships defined in the model. An initial version of the questionnaire was pre-tested on a small group of subjects, and after revision was sent to system design professionals in two major professional organizations for completion.

Data obtained with the questionnaire were analyzed following procedures described below. These procedures provide a basis for refining the model by providing support for the validity of individual elements and relationships in the model. With this support, a formal validation of the model as a whole was undertaken using the same questionnaire data.

This two-stage design offers several advantages in terms of the overall validity of the study. We begin with tentative notions about possible causes of communication breakdown in the design process which appear to be conceptually valid and consistent with the literature. The first phase provides detailed observations which support construction of an empirically grounded model which tests and elaborates these initial hypotheses. While this phase provides basic observational support for the model, its empirical base is relatively small and cannot support any claim to generalizability. The second phase extends the study to a broader sample and offers statistical verification to confirm the wider utility of the description offered. In total, the study provides a balanced approach to the problem of empirically supporting the model and ensuring the overall validity of the results.

We now turn to a more detailed description of specific methodological aspects of the two major phases.

Phase One: Initial Interviews

The first part of the study provides an description of the social and technical contexts of system design as they relate to problems in OIS design. We have argued elsewhere that aspects of the social organization of design professionals and the technical procedures they use may contribute to communication problems in the design process. In this section our aim is to obtain evidence to support such arguments and provide a concrete account of how contextual factors affect communication in this setting.

Because our initial analysis is couched within an interpretive framework, it is appropriate that we adopt an approach consistent with that orientation. It was decided that simple interview techniques would provide the best strategy for obtaining descriptions of design problems as understood by participants in the process. While it was considered desirable to have participants speak openly on these concerns, it was also felt that direction should be given to assist in collecting data directly related to the issues under investigation. It was decided that the interview strategy described by Merton (Merton, et al, 1956) as the "Focused Interview" offered an appropriate format for balancing openness and structure in the interviews.

In this format, the interviewer directs attention toward a specific issue or incident and allows the respondent to discuss their reactions to that subject. Typically, the researcher enters the interview with a specific set of hypotheses in mind which direct attention towards specific topics. Considerable room is left for subjects to define the content of their responses, while maintaining a focus toward specific issues. The analysis of this material seeks to define the interpretive schemes which subjects use to frame their responses to the question at hand.

The population from which interviews were sought was defined as all individuals operating in a professional capacity related or contributing to the process of system design. Since the study focuses on the design process itself, and since this group is primarily responsible for that process, this was deemed an appropriate sample. The sample was initially limited to individuals working within the greater Vancouver area, but was later expanded to include individuals from Toronto as additional opportunities arose. Included were individuals occupying any of the several categories of design work described in chapter three, from MIS manager to systems technician, as well as those who work as private consultants. It was also felt that other professionals not directly involved in design work but who contributed to it in significant ways should also be sought for interviews. This included educators who trained various occupational groups doing system design, as well as personnel recruiters specializing in systems- related placement. The latter were of interest because of their "inside knowledge" about the technical and personal qualities of effective systems personnel. Both groups operate on the boundary of the system design culture and were believed to have special insight into the nature and social context of design work.

Since this initial phase was descriptive and not intended to support statistical or logical inference, no concrete specifications were established for sampling this population. However, two general guidelines were followed in obtaining the sample: (1) the sample was to include a diversity of positions within IS design, and (2) the representation of groups in the sample should correspond with their level of involvement in the design process. As interviews were scheduled, effort was made to contact individuals from a spectrum of occupations, and to ensure that groups closely involved in design work were most strongly represented in the sample. Particular effort was made to ensure that senior-level systems analysts would constitute the major group in the sample, since this group is most directly responsible for system design.

This specification affected the size of the sample eventually obtained. Senior analysts are extremely busy individuals, and while many were interested in the study, it was often difficult to schedule interview time. It was often necessary to reschedule appointments, and occasionally to cancel interviews altogether. Because of this, the relative size of other groups in the sample had to be constrained, although it would have been possible to inflate the sample with others less directly involved with system design.

Prospective subjects were initially contacted through systems consulting firms listed in the Vancouver phone book. Interviews were scheduled with a single individual active in this field, and these frequently led to additional contacts. Contacts with educators and career placement officials were also initiated by telephone, and also led to contacts among additional colleagues.

The sample that was eventually obtained for the first phase included a total of twenty-two individuals: fifteen design professionals, including four MIS managers, one technical specialist, one senior level programmer, and nine senior analysts. Two of the analysts interviewed were private consultants, the remainder were members of large consulting firms. The sample also included three individuals working in systems-oriented placement and four educators in systems training.

Most interviews were conducted in Vancouver over a period of four months beginning in April of 1985. Two supplementary interviews were conducted in the Toronto area to enhance the representation of senior analysts in the sample. The interviews were all between sixty and ninety minutes in length, conducted during business hours in the offices of the individuals involved. In two cases, follow-up interviews were scheduled to pursue additional questions.

Data was initially collected by taking notes of subjects' responses. This was soon found to be awkward and was replaced by tape-recording the interviews. Permission to record interviews was obtained at the beginning of each session. In all cases, initial notes or recordings made of the interviews were reviewed as soon as possible after the interview and a more extensive set of notes made. Consistent with the focussed interview technique, data were summarized in reference to a specific set of pre-defined issues, as discussed below. Additional notes were made concerning topics raised by the subject, as well as the interviewer's general impressions.

The interviews followed a protocol designed in reference to the analysis of communication barriers initially previewed in Chapter One. Five major areas of interest were identified for which detailed empirical data was sought. These included:

(1) Managerial vs. Technical Frames of Reference - Differences between designers and users as a basis for distinct frames of reference; including differences in personality, attitudes, education, cognitive styles, etc.

(2) The Social Organization of the Design Community - Subject's understanding of the organizational structures in which design work is carried out. For example, major job classifications and major differences and relationships among these,

(3) Design Tools and Procedures - The use of specific technical tools and procedures; the impact of these on the design process and the ability to overcome specific barriers.

(4) Communication Patterns Between Designers and Users - The effectiveness of relationships (ie. communication) between management and systems personnel; the existence of conflicts concerning basic goals, interests, values, etc.

(5) Design Outcomes - Subjects' awareness and interpretation of MIS difficulties in general, and as a possible outcome of ineffective designer/user communication.

It was also recognized that particular groups might have special knowledge which could be tapped by more focused questions. A number of additional questions were added to the basic protocol for these groups. For example, individuals in the career placement field were asked questions regarding qualifications exhibited by the "best" systems designers, educators were asked about the background preparation provided for specific groups, and so on. A detailed outline of the interview protocol is provided in Appendix B.

One difficulty that was anticipated in designing the interviews was the potential for the interviewer to bias subjects' descriptions of MIS difficulties by initially defining them as "communication" problems. Although the idea of communication problems is cited frequently in the literature, it was felt that defining the issue in this way would unfairly bias responses in favor of the interpretation suggested by the model. It was decided to open the interviews with a general statement about "MIS difficulties" and not to introduce the idea of communication unless it was first offered by the subject. If the subject were raised, it would be pursued in depth to determine how the subject understood the relationship between communication and design problems.

Data collected in the interviews were analyzed after the majority of the interviews were completed. Notes from each interview were initially summarized for each of the areas defined above. In addition to documenting responses, the analysis also sought to develop a composite view of important elements in each area by synthesizing specific points which the sample as a whole identified with OIS problems. These formed the basis for an initial definition of major elements to be included in the model. In doing this, emphasis was placed on understanding the nature and the role of communication processes in creating OIS problems.

Because of the diversity of the sample, it was recognized that unanimity of perspectives might be difficult to achieve. The aim in analyzing the data was therefore to develop a unified framework representing major areas of overlap among the diverse perspectives. The resultant framework outlines the major features of OIS difficulty and their relation to problems of communication, as viewed by individuals directly involved in the design process. The results of the interview portion of the study are reported in detail in Chapter Five.

This analysis provided the basis for a tentative model of communication barriers within OIS design. The derivation of this model from the interview data is described in detail in Chapter Six. With this step completed, it was then possible to evaluate the model more rigorously. The methodology for this second phase of the study is described below.

A Survey of System Design Professionals

The model derived from interview data depicts a set of relationships among features of the design context which operate jointly to create communication barriers in OIS design. In this sense, the model offers a tentative explanation of communication problems in the design setting. The objective of phase two is to provide empirical data to initially refine this tentative model, and to formally test its validity.

Methodologically, this presents a challenge. Traditional methods are designed to examine individual relationships between isolated variables. The causal process depicted in the present model is clearly multivariate in nature, making the use of more traditional methods inappropriate. To examine the present model, it was necessary to identify methods which would not decompose complex processes into isolated relationships between dependent and independent variables. It was necessary to look beyond traditional approaches in obtaining evidence to support the model.

A fundamental question in selecting a research strategy concerns the nature of the analysis to be undertaken. In this case, we required a technique which would allow us to draw conclusions regarding the overall structure of relationships among the factors identified above. Recent multivariate statistical techniques now offer readily accessible methods which support this type of analysis (Dillon and Goldstein, 1984; James, et al, 1982). In particular, a class of techniques known as "Latent Structure Analysis" (Dillon and Goldstein, 1984:p.490) are especially suited to the problem of describing multivariate relationships among sets of interacting variables. These techniques are particularly useful for assessing the effectiveness of structural models, they are appropriate here in assessing the overall validity of the model.

While the statistical procedures for Latent Structure Analysis are complex, the format of the analysis is relatively straightforward. The technique assumes a theoretical model which outlines the principle structural components of the process being described (ie. the major constructs in the model), as well as the causal relationships which are assumed to exist among these. These components are then operationalized to provide a detailed "measurement model" (Bentler, 1985) specifying relationships between observable variables and the latent constructs they represent. Using data for each of the observed variables, statistical procedures are conducted which examine interrelationships among the various elements of the model. From this analysis, estimates of the relative strength and direction of specified causal relationships are derived and statistical tests of goodness of fit are performed to assess the validity of the model in question (Bentler, 1985).

This analysis requires a number of basic conditions to be met to provide a valid assessment of a model (James, et al, 1982:p.26). The first condition is that each of the major constructs in the model be operationalized in terms of empirically measurable variables. Theoretical constructs are often difficult to observe directly. In lieu of direct measurement, observable variables are sought as indicators of these underlying constructs. A second condition is provision of empirical support for the assumed composition of these latent constructs. Ideally, the relationships between observed and latent variables should be both conceptually and empirically supported before entering the analysis. A third condition is that the major causal relations assumed to exist among latent constructs empirically supported before undertaking the analysis. Meeting each of these conditions ensures the validity of the overall structural analysis, which then assesses the accuracy with which the model as a whole reflects the underlying structure of the data provided.

In the present study, we enter this phase of the analysis with a tentative formulation of the model based on qualitative data. Several steps are required to refine this initial version of the model so it is amenable to rigorous test. Several steps must be taken to meet the conditions outlined above. In pursuing the empirical validation offered by latent structure analysis therefore, an important focus of this study will be to refine the existing model to a point where more rigorous verification can be undertaken.

The first refinement required in pursuing this objective is the provision of concrete definitions for the major constructs and relationships suggested by the model, as well as a more detailed description of the causal process through which these affect communication between designers and users. By empirically defining these relationships, it will be possible to identify variables to represent what are now only hypothetical constructs in the model.

Following these initial refinements, it will be useful to test specific aspects of the model to fulfill the second and third conditions outlined above. Evidence will be provided to establish the empirical validity of the constructs depicted in the model, as well as to support the assumed relationships among these. With this support, it will then be possible to proceed with a rigorous test of the model's overall validity.

In summary, the specific objectives to be pursued in the second phase of the study are as follows:

(1) To undertake refinement of the model derived from Phase One which will enable major constructs to be operationalized in terms of specific, empirically observable variables,

(2) To obtain empirical data which will provide an initial validation of the major components of the model, as well as their assumed relationships,

(3) To undertake a formal evaluation of the model using latent structure analysis to ascertain its general validity.

In pursuing these objectives, data had to be obtained to fulfill the requirements for statistical inference. This was taken to mean data that were expressed in quantitative form and from an appropriately large sample. A questionnaire strategy was chosen for this task, because it provided a relatively easy method of obtaining data from a large sample. By constructing an appropriately worded questionnaire and distributing it to a large sample of individuals, it was assumed that data appropriate to the desired analytical techniques could be collected.

The purpose of the questionnaire was to gather data concerning the major elements depicted in the model. The first step in developing an appropriate questionnaire was therefore to review the results of the first phase of the study and identify the specific features for which empirical support would be sought. Because Phase One provided a detailed description of system design problems, several variables were identified for each major component of the model. These can be summarized within seven major categories:

(1) subjects' educational background and work experience

(2) the organizational context in which subjects work

(3) specific aspects of subjects' involvement in the design process

(4) the design strategies and tools typically used

(5) communication and socialization patterns within the work setting

(6) the perceived outcomes of the design process

(7) personal demographics

An initial draft of the questionnaire was developed to reflect the variables identified in these categories. The goal in developing this draft was to include as many as possible of the variables identified in the first phase, with the expectation that refinement of the questionnaire would reduce this number. A total of forty-nine items were included in the first draft, most of which required a simple check-off response. A smaller number of items used a ranking format to indicate, for example, the relative importance of specific work activities or work group preferences. Others asked for more detailed written responses.

To assess the appropriateness of the items, and to check for coding problems, a pretest of the questionnaire was undertaken. A first step was to have the instrument reviewed by colleagues familiar with questionnaire construction and with the general research area. This review provided useful feedback on the content and format of several items.

A sample of fifteen system development personnel at a major educational institution were then asked to complete the questionnaire, and to provide feedback on problems they had in completing any of the items. A total of fourteen questionnaires were returned, several of which included comments on the questionnaire itself. Responses from this sample were entered into a computer file according to a tentative coding scheme and elementary descriptive statistics were obtained to examine the initial qualities of the data. Respondents' feedback concerning the questionnaire items was reviewed to assess potential problems in item format or wording.

The results of these tests enabled significant improvements to be made in the questionnaire. Several coding anomalies were encountered which indicated the need to reconsider how the data were to be structured. This led to the revision of the coding scheme for several items, and to changing some response formats on the questionnaire itself. Summaries of the data showed unusual response distributions for some items, suggesting additional revisions. Feedback from respondents concerning the structure and format of the questionnaire provided additional information that helped to re-structure parts of the instrument.

A second draft of the questionnaire was developed based on the pretest results. The number of items was reduced from forty-nine to thirty-seven, and response formats for many of the questions were clarified. The pretest also suggested the need to include a number of attitude items concerning the nature of organizations and management, and the potential role of computers as a management tool. The importance of these issues had been overlooked in constructing the original instrument and were added at this point without further pretesting. A copy of the final version of the questionnaire is provided in Appendix C.

With a revised questionnaire in place, an appropriate sample was now sought. The general population selected for the questionnaire study was the same as that used in the initial interview stage, namely, all individuals operating in a professional capacity directly related or contributing to the process of information system design. Additional groups used in the first part of the study but who were peripheral to design work per se (eg. educators, career placement individuals) were not included. The population was also geographically delimited to members of that group operating within the metropolitan Toronto area. This limitation was adopted primarily to facilitate distribution of questionnaires, but was not thought to impose too great a limitation, since this group represents the major portion of the systems development work undertaken within central Canada. In selecting a specific sample to whom questionnaires would be sent it was recognized that a trade-off would ultimately have to be made between obtaining a truly representative random sample and finding a convenient method for distributing and collecting questionnaires. Because limited funds were available to support questionnaire distribution, it was felt that convenience would have to out-weigh the finer details of sampling methodology.

In considering how individuals in the population could be contacted, it was decided that professional organizations in the system design field would provide a useful vehicle for accessing a large sample of appropriate individuals. The directors of three professional organizations were contacted to obtain information about the composition of their membership, and to explore possibilities for distributing a questionnaire among them. One of these was composed largely of individuals in lower echelon positions that involved computer work, but were not active in systems design. That organization was not given further consideration in sample selection. The other two, The Association of Systems Management and The Canadian Information Processing Association, both had a membership in the Toronto area made up primarily of MIS managers, systems analysts, programmers, and other technical personnel who were regularly engaged in system development work.

The composition of these groups was considered appropriate for the present study. Each represented a group of individuals from a variety of job classifications directly connected with system design, and thus afforded access to a useful cross-section of the defined population. It was recognized that restricting the sample to members of these organizations would introduce a potential bias and probably compromise the randomness of the sample. It was also understood that no assurance could be provided that the representation of specific sub-groups within the sample would parallel that in the larger population. Despite these limitations, it was felt that the use of two separate organizations, both of which had a broad range of membership, would increase the likelihood that the sample would be fairly balanced. Within these limitations, it was decided to seek the assistance of the two organizations in distributing the questionnaire.

Both organizations agreed to distribute copies of the questionnaire to their Toronto membership. The Association for Systems Management had approximately three hundred members in the Toronto region, while the Canadian Information Processing Society represented nearly two hundred. Because membership lists for both organizations were confidential, there was no way to determine how many of these were dual memberships. Five hundred copies of the questionnaire were forwarded for distribution in May of 1986. Each questionnaire included a letter of introduction from the researcher explaining the research and assuring anonymity of respondents and confidentiality of results. Subjects were informed that a copy of the results of the study would be available to any participant who requested them, and a contact address was provided. A copy of that letter is included in Appendix C. A stamped, pre-addressed envelope was also provide with each questionnaire to facilitate return of completed instruments.

Completed questionnaires were assigned identifying code numbers as they were received. These numbers were used to identify individual cases as responses were coded and entered into computer files. The coding scheme developed within the pretest was used in entering all data. Items on the questionnaire which called for written responses were not coded in this process. Many of these items were included to obtain detailed, qualitative responses to specific issues, and were not intended for use in evaluating the model. The original questionnaires were retained and kept in locked storage, to be destroyed after completion of the study.

A total of ninety-four questionnaires were returned by September of 1986. Of these, one was only partially completed, and a second had been completed by an individual whose job responsibilities were not consistent with the population under consideration. Both of these were rejected as unusable. A total of ninety-two responses were retained for the final sample, representing a response rate of 18.4 percent. This relatively low figure may have been caused by duplicate memberships in the two organizations, the timing of the survey near the beginning of summer holidays, and the unexpected occurrence of a postal strike. A sample of ninety-two responses was deemed sufficient for the intended analysis.

Data Analysis

The analysis of the questionnaire data was intended to establish the overall validity of the model derived in Phase One using Latent Structure Analysis. In pursuing this analysis several stages of data analysis had to be undertaken before a final evaluation could be made.

Each step in this analysis is dependent on the outcome of previous steps. In this sense, the analysis is essentially exploratory in nature. Each stage examines a particular aspect of the data to provide a growing body of evidence supporting the validity of the model. For that reason, a detailed description of the methods used to analyze the data will be postponed until Chapter Seven. For the present, it is possible to outline in general terms the three major phases through which the analysis moves, and to indicate the strategies pursued in each.

(1) Examining the Major Components of the Model - one of the two major conditions which must be met to permit latent structure analysis is the provision of empirical support for the major constructs in the model. The first phase of the analysis provides this support. From the interview data, specific empirical dimensions were identified to provide a concrete definition for the major constructs. To use these variables in further analysis, it is essential to demonstrate that specific sets of variables provide an empirically valid and stable representation of those broader constructs.

For example, the interview study identified specific variables as indicators of the social organization of the design community. One of the aims of the second phase of data analysis was to indicate that these variables could be reliably combined to provide a composite indicator of a broader construct of "bureaucratized design". Similar verification had to be provided for other major concepts in the model, including the notion of managerial and technical "frames of reference", "patterns of communication", and so on.

A variety of multivariate statistical methods were used in this phase depending on the specific variables in question and the type of result desired. For example, Cluster Analysis was initially used to define distinct groups within the sample which reflected the impact of the hierarchical organization of the design process. Statistical tests were undertaken to establish the validity of this grouping and to examine in more detail the nature of the differences between the groups that were identified.

Other constructs in the model were evaluated in relation to this initial grouping. The model predicts, for example, that distinct types of involvement in the design process should be related to basic "frames of reference", to the use of specific design tools, to communication patterns in the workplace, and to various opinions relevant to the design context. Discriminant Analysis was used to determine if combinations of variables representing each of these constructs were useful in distinguishing between the groups identified earlier. Statistical support for several of these was taken to indicate the validity of the broader constructs represented. The results thus provide empirical support for the validity of the major theoretical constructs on which the model is based.

(2) <u>An Assessment of Major Relationships</u> - The second condition to be fulfilled before undertaking a formal analysis of the model is the provision of initial support for the proposed relationships between major components. Since each of the constructs is represented by several variables, the problem in this portion of the study is to provide an analysis of relationships between multivariate groups of descriptors. While the final stage of the analysis assesses the causal significance of these relationships, the present task was provide evidence supporting the existence of these relationships, and to assist in examining their strength and nature.

The technique used for this purpose was Canonical Correlation analysis, a technique suited to examining relationships between multivariate sets of variables. The approach was essentially exploratory, with all possible relationships between components being examined. The outcomes of this analysis support several significant relationships predicted in the model, and provide initial evidence regarding the strength and directionality of these relations. A detailed summary of these results, described in Chapter Eight, provides the basis for additional refinement of the model prior to its final evaluation.

(3) A Final Structural Evaluation of the Model - Having satisfied the basic conditions for the application of structural modeling techniques, a refined version of the model was subjected to assessment using Latent Structure Analysis. The purpose of this analysis was to derive an assessment of the overall validity of the model. The technique provides quantitative estimates of the major parameters of relationships depicted in the model, based on a specification of relationships between sets of variables representing those constructs. The procedure also provides a detailed examination of the strength and directionality of relationships predicted in the model, as well as statistical tests of the overall goodness of fit between the specified model and the inherent mathematical structure of the data. The latter tests provide the desired assessment of the model's overall validity.

Summary

The steps outlined above provide a series of analytical explorations to accumulate a body of evidence to assess the validity of the model. At each step, additional insight is gained into specific aspects of the design process, and opportunities to revise the model are made available. While the overall procedure is conducted with a specific end in sight, it is essentially exploratory and seeks to develop further insight into the structure of the design process, as revealed in the data. The study thus attempts to make use of more formal quantitative techniques within an essentially exploratory framework, methodologically combining both exploratory and confirmatory elements to provide a rigorous examination of the model in question.

We are now able to examining the empirical results of the study, beginning with a summary of the interview results from Phase One.

CHAPTER FIVE: The Interview Results

Introduction

This chapter summarizes the results of the interview phase of the study. The data examined here provides an empirical base from which a model of communication barriers in OIS design is to be derived. The results are presented in a framework of five major categories, reflecting the assumptions and hypotheses outlined in chapter one. Specifically, the results are reported in terms of:

(1) Managerial and Technical Frames of Reference,

(2) The Social Organization of The Design Community,

(3) The use of Specific Design Tools and Procedures,

(4) Resultant Communication Patterns

(5) Design Outcomes

Each section discusses the types of data that were sought and the relevance of that information in relation to the OIS communication problems, as well as details concerning the data actually obtained. The development of a conceptual model of communication barriers based on these data is outlined in Chapter Six.

The Interview Results

Managerial vs. Technical Frames of Reference

A central element in our initial definition of OIS communication problems is the notion that distinct managerial and technical frames of reference present barriers to understanding between designers and users. In exploring this concept, it is important to establish (1) whether such differences were recognized among sub-groups within the design community (eg. do managers differ from analysts, technicians from programmers, and so on), (2) the perceived nature of those differences, and (3) their importance with respect to communication barriers within the design community. The aim in obtaining this data was to establish whether significant differences were recognized within the design community which could be construed as a distinction in frames of reference. This judgement would be based on evidence of a consistent set of attributes distinguishing between identifiable groups.

A number of specific differences are identified in the literature. The present aim is to further establish and explore their validity. In particular, information was sought to determine the extent to which such differences were acknowledged among design professionals, and to define the specific groups between which these differences were seen to be significant. These data were considered important to establish the validity of the 'frame of reference' concept, and to obtain additional information concerning problems of understanding in the design process.

The results are discussed within two broad categories: (1) personality differences and (2) differences in cognitive style among design professionals. Additional data were also obtained to suggest a connection between individual differences and aspects of the broader organizational context. These are discussed below in terms of: (3) differences in professional training, and (4) differences in the nature of technical and managerial work.

1. Personality Differences

All subjects acknowledged differences between technically and managerially oriented individuals as a basis for IS design problems. However, many found it difficult to pinpoint the exact nature or locus of such difference. About one third of the sample used the idea of "personality differences" to describe variances in personal and social orientation between groups. Among these, two thirds suggested that technically oriented personnel tend to be introverted, while managerially oriented individuals are more extroverted. Technical people were described as "quiet", "self-absorbed", and "independent", while managers were seen to be more "open" and "outgoing", and to "like to talk to people". The frequency of such interpretations indicates that personality differences are widely acknowledged within the present sample.

Differences in "social skills" evidenced by managerial and technical personnel were also identified. Managers were seen to be highly social in orientation and to exhibit preferences for working with others. They were described as socially competent in both one-on-one and group situations. It was suggested that managers are highly flexible in their behavior, frequently shifting postures and attitudes to match the social context. Several subjects identified this "contingent" nature of managers' behavior as an indication of superior communication skills.

Technical personnel were generally seen as non-social, preferring to work alone if given the choice. Most subjects saw technical people as possessing less refined social skills, particularly in group situations. One individual described them as "socially clumsy", tending to be static and inflexible in their orientation. While this view was the norm, one individual suggested that such differences were not fundamental, but were simply the product of age differences between systems people and managers. Because most managers are older, their increased social experience and "savvy" gives them the appearance of being more socially confident and adept. Younger technical people only appear less socially adept as a product of inexperience. Regardless of how the differences are interpreted however, the data suggest differences in how technical and managerial groups function socially.

While personality differences were usually discussed in very broad terms, some interviews revealed a more detailed perspective. One placement consultant suggested that technical people consistently score lower on tests of achievement motivation than do managers. Rejecting the conclusion that technical people are less motivated, the individual suggested that these groups simply differ regarding the locus of evaluation for achievement. It was suggested that managers normally judge success in terms of external, social indicators like status, power, salary, and so on, whereas technical people are driven more by the pursuit of technical excellence, as defined by a limited peer group. The suggestion is that technical people are not less motivated, but that they exhibit a different type of motivation based on a unique set of values.

The differences described above were commonly related to problems of understanding between designers and users. Such differences are widely recognized, and frequently interpreted a source of problems in understanding between distinct groups in the design community. In particular, they were seen to be an important cause of problems in system development. One individual suggested however that such differences were not necessarily personal, but may be a product of differences in the work and the working context of different groups. It may not be accurate to suggest that personality differences themselves constitute the distinction between managerial and technical frames of reference.

2. Cognitive Differences

While individual differences tentatively support a distinction between technical and managerial frames of reference, evidence of cognitive differences is necessary to link that distinction to problems of understanding between the two groups. The interview findings provide insight into the process through which differences in cognitive style affect problems of understanding within the design context.

Differences in "thinking" between managerial and technical personnel were mentioned in over eighty percent of the interviews. Initially, these were described in rather general terms. As one individual put it, "analysts just don't think like businessmen". With additional probing, more detailed descriptions of differences became apparent. In general, these can be summarized in terms of a distinction between "Logical" and "Heuristic" styles of problem solving.

Subjects indicated that technical individuals use a predominantly logical orientation, reflected in a highly analytical and quantitative approach to problem solving. These people were thought to address problems by breaking them down into smaller units and by seeking discrete "facts" to address components separately. They tend to tend to rely on sharp distinctions, using "black and white" definitions to define discrete logical categories. In this respect many subjects saw technical thinking as somewhat rigid and inflexible.

Decision making within the technical style was said to be highly structured. Decision situations are viewed in narrow terms, with only a limited range of information being accepted as appropriately factual. Technical decision making was said to be slow and difficult, because logical relationships were carefully examined in pursuit of a single "correct" solution. At least one interview characterized this as typically "Left-Brain" thinking.

In contrast, managerial problem solving was frequently seen as more "Right-brained" or "Heuristic". Subjects thought that managers use a broader and more open-ended approach to problem solving, for example by considering human and organizational criteria in defining and analyzing problems. Rather than using black and white categories, managers were thought to use a more flexible style of analysis, seeking complex patterns within a multifaceted body of information. Decisions were made by striking a heuristic balance between multiple, often competing values. Because of this, managers were seen to be faster, more flexible, and generally more effective in their decision making.

Subjects frequently associated these differences with problems in IS design. As one analyst suggested,

> Technical people can't think in terms of what managers need ... they don't have the business perspective that would allow them to conceptualize how things relate to one another. They may know a little about accounting or marketing, but they don't know how to put the whole thing together.

The suggestion here is that technical people think differently from the way managers do, so their ability to understand managerial information needs is hampered. The unique style of technical personnel makes them approach the design task from a unique perspective with its own set of norms and values.

Subjects frequently referred to differences in cognitive style in terms of the orientation toward technical excellence which dominates the designers' perspective. For example,

> a lot of technical people are attracted to system design because of the intellectual stimulation that comes from writing programs and understanding file access structures and memory maps, and so on ... which are all totally irrelevant to solving business problems.

Designers were seen to be intrigued by the technical aspects of a project, and to have little understanding or interest in the organizational application. What managers interpret in business terms, designers frequently interpret in technical terms. The gap between these interpretations all too often becomes evident in systems which don't fulfill expected requirements.

3. Differences in Training

While the results thus far support the concept of distinct frames of reference, they do little to extend that concept beyond what is available in the literature. The Interpretive framework suggests however that frames of reference operate not only at an individual level, but should be reflected in the broader social context of OIS design. Two additional interview results offer insight into the broader aspects of this problem. The first of these concerns differences in the training of designers and users.

Differences in the content of technical and managerial training were identified by the sample as obvious areas of distinction between users and developers of OIS. For example, managerial students receive less exposure to computing equipment than technical students, and are not trained in specific programming languages, design tools, and so on. Technical students do not get exposure to business analysis techniques nor to the softer "people" skills which management students often do. These differences present something of a "knowledge gap" between designers and users which most members of the sample acknowledged.

Less obvious are the distinct responses to workplace technology which these training differences create. Several interviews suggested that despite advances in computer education, the level of literacy among managers remains relatively low. One analyst suggested that "managers still don't know how to use technology to solve problems". This was attributed to the fact that managers do not receive technical training which allows them to use computers as a problem solving tool.

One instructor of both managerial and technical groups suggested that management students often have difficulty learning programming because "they don't have a facility for conceptualizing business problems in terms of 'programmable' steps". Another discussed difficulties motivating technical students to be interested in problem solving unless it could be done on a computer. Training thus appears to steer students toward very different relationships with technology.

While differences in the content of training can be are not surprising, the interviews suggest a deeper contrast concerning the basic structure and focus of education in each area. Technical training was said to be more specialized, with an explicit focus on specific tools and techniques. More time is spent practising quantitative and analytical skills than in understanding the larger contexts in which those skills will be applied. Students learn computer skills using specific languages and techniques to complete pre-defined programming assignments, paralleling an actual software development setting. Emphasis is given to structured techniques which reinforce a mechanistic problem solving mode.

Technical students are taught to address problems from the perspective of the technology itself, and to evaluate solutions in terms of how faithfully specific techniques and principles have been applied. The techniques themselves supply the basis for defining the problem as well as the criteria against which solutions are judged. This contributes to a "one best solution" mentality in which technical excellence provides the predominant criteria for success.

In pedagogical terms, emphasis is given to the acquisition of basic skills rather than to a broader understanding of principles and their application to specific settings. The assumption appears to be that the tools themselves, if correctly applied, embody a solution regardless of the details of the case.

Management training was seen as much broader in both scope and purpose. Managerial students are exposed to a broad range of subjects and study a variety of different perspectives on business and organizational practice. The aim is to prepare students for the greater variety managers are assumed to face in business life. Thus while technical students are groomed to undertake very focused and detailed work, management students learn to approach problems from a multi-dimensional perspective, and to apply broader analytical frameworks.

Two educators identified the use of case studies to illustrate the unique focus of management education. Case studies present students with complex problems for which there are often a variety of potential interpretations and solutions. Students apply a broad background of information to provide an analysis of the problem. The aim is to give managerial students experience in dealing with the complex, and sometimes ill-defined situations which managers typically face.

In addressing such problems, students learn that there is no single "correct" solution, only solutions which optimize and balance diverse aspects more effectively than others. This reinforces a flexible, heuristic approach to problem solving. Management pedagogy emphasizes the development of students' ability to make balanced judgements about complex situations, within a specific value framework.

An additional observation about educational differences illustrates the impact such differences have on problems in OIS design. According to one interview, technical students are taught to analyze situations in terms of broad principles which operate uniformly across different contexts. Management students, on the other hand, are taught that individual situations differ in important ways and that these differences have to be accounted for in devising solutions to specific problems.

For example, managers recognize that a given problem can vary from industry to industry, from organization to organization, or even from department to department. Contextual factors are always an important consideration in management decision making. From a technical perspective, these factors are seen as minor issues which have little impact on the operation of broader principles. A technical analysis of an organization might well suggest, therefore, that the same accounting system would fulfill the needs of two separate branches, whereas a managerial analysis might reveal important differences between branches which make their needs different. A system developed on the basis of a purely technical analysis could easily find limbo in at least one of these settings.

By focusing on distinct bodies of knowledge, by emphasizing different kinds of problem solving, and by imparting different values, the two forms of education strongly affect the cognitive and professional orientations of students. Those who succeed in either area undergo a socialization which reflects the qualities embodied in the training itself. The training in each area reinforces unique managerial and technical cognitive styles, and encourages the formation of distinct frames of reference.

4. Differences in the Nature of Work

Many of the differences in personality, cognitive style, and educational background discussed above were interpreted by the sample to be part of a single, more fundamental distinction between technical and managerial groups. Specifically, each of these differences was thought to reflect the unique occupational demands to which each group responds.

Subjects indicated that technical work is defined largely by the demands of computer technology. Success in this area, requires specific mental attitudes and attributes in addition to specialized technical training. One must have an affinity for highly structured and detailed work, and an ability to maintain a narrow focus of attention. Individuals who successfully complete technical training will have these abilities honed to a high level through participation in training which augments these basic attributes with a host of technical tools and procedures. In the work context itself, technical jobs often require further specialization and further narrowing of one's focus.

Pursuit of a technical career thus reinforces specific characteristics which enable individuals to work effectively within a technological framework. The requirements of technical work define the basic personal, cognitive and educational qualities which form the elements of a technical frame of reference.

Similarly, the qualities which distinguish managers and managerial education were thought to reflect the demands of managerial work. Managerial work was said to be characterized by its emphasis on "people" and "business" issues and by the demands of the organizational context in which these occur. This work is highly varied and unpredictable, involving activities which demand a broad range of social, business, and organizational skills. One must deal with information in a variety of different forms, and from several different sources. Decisions are often made under time constraints and with incomplete information. Decisions are appraised on business, organizational and political grounds, and often require a delicate balancing of the three.

These demands define the appropriate personal, cognitive and educational qualities of an effective manager. Highly developed social skills, a strong external focus, flexibility in interpersonal relations and problem solving, and decision making based on careful balancing of perspectives, are all qualities demanded by managerial work. Individuals who possess such qualities and whose education has enhanced those skills will tend to function well in this context. As before, the occupational context defines the basic nature of the managerial frame of reference.

Summary

The data presented above describes a range of differences believed to affect problems of understanding within the design process. An obvious feature of these differences is their coherence around occupational distinctions. The distinction between managerial and technical work provides the fundamental basis on which the entire range of differences hinges. The idea that design professionals recognize fundamental differences between managerial and technical personnel is thus clearly supported by these data.

While design professionals construe this difference as one between distinct groups (ie. managers and technical personnel), careful examination of the differences suggests that the distinction is more accurately one of cognitive and social orientation, and not one of membership in a specific group. Rather than suggesting a distinction between specific groups (ie. designers and users), the data supports the interpretation that the difference is between the frames of reference which these groups use to orient their behavior within the design context. The important variable here, in other words, is not group membership, but cognitive and social orientation.

A focus on the frame of reference per se as the salient difference has several implications for the present study. In describing problems in OIS design it is more useful to refer to barriers between interpretive frames than between specific groups. It is likely, for example, that managers and technical people differ in how closely they conform to the 'typical' orientation ascribed to their respective occupational groups. As a result, problems in understanding between specific individuals may be explained more effectively in terms of frames of reference than by group membership. This perspective also leads us to suspect that differences in orientation among sub-groups of design professionals may indicate the potential for misunderstanding within the design community itself.

The interview data thus support several tentative conclusions. The concept of distinct frames of reference operating in the design context appears to be tentatively supported. The data provide concrete descriptions of differences related to that distinction, and demonstrate their internal coherence based on occupational focus. The data also indicate that design professionals construe these differences as a source of communication problems in the design context. Specifically, the data suggest that differences in the interpretation of design information may result from differences in interpretive frames among individuals working in the design context. Thirdly, the data indicate that the most significant differences affecting communication in the design context are not necessarily tied to specific groups (ie. designers and users) but are more related to the interpretive frames which individuals utilize to orient themselves within their occupational context. It is thus possible for communication barriers to arise at any point where information must pass between individuals whose occupational orientations differ. These data thus identify the possibility of communication breakdown not only between designers and users, but also between different sectors of the design community itself.

The Social Organization of System Design

Given a basic distinction between technical and managerial frames of reference, we can now examine some of the contextual factors which affect their operation within the design process. The occupational basis for this distinction suggests an important relationship between the work one undertakes and the orientation one uses in approaching specific cognitive and social tasks. It was suggested above that the requirements of specific roles within the design community itself might also constitute a basis for differences in orientation which could affect the nature and quality of understanding. The present section examines this suggestion by describing important features of the social organization of system design.

Major features of this organization were explored in Chapter Three, which described the general structure of occupational roles within the design community. Data collected within the interviews sought to confirm this pattern of organization and to examine the impact this structure may have in relation to communication barriers. In particular, the interviews sought to explore the suggestion that the organization of design roles and tasks may affect the interpretation of design information as it passes through various hands in the development of OIS.

Issues relating to the organization of design work were implicated as a source of difficulty in over three fourths (77%) of the interviews. A common theme among these was that the traditional division of labour contributes to a distinction of interests and opportunities among systems professionals which was said to reinforce group differences and to contribute to communication problems between them. In this respect, the interview data supports the argument that the social organization of the design process contributes to communication problems in OIS design. Specific results supporting this claim are outlined below.

One aspect of the social organization of system design frequently cited in the interviews was the specialization which organizations impose on design work. The segmentation of design work into specialized job categories was said to be the most potent factor affecting communication in this setting. In describing this specialization, most of the interviews referred to the traditional division of labour outlined in Chapter Three. In addition to describing the relative status of various hierarchical levels, the interviews also revealed the actual involvement of various design professionals in carrying out specific portions of a design project.

MIS managers, for example, are primarily involved in the administration of the organizational units in which design projects are conducted; their involvement in design per se is normally limited to overseeing initial feasibility studies. Responsibility for actually conducting feasibility studies and for defining the overall scope and purpose of projects falls in the hands of the senior analyst. Junior analysts look after what is called "external design", where a description of the system's output is defined and translated into specifications. These descriptions are used by senior programmers to define the structure of systems and programs which will provide that output, referred to as the "internal design" of the system. Junior programmers, in turn, follow these specifications to produce components of the system, and finally technical and engineering personnel install and test the system.

Several areas of difficulty were mentioned in relation to this structure. Because successive stages are handled by different individuals, portions of the project must pass from one person to another as the project matures. Several interviews indicated that movement of information between individuals was frequently a cause of misunderstanding and mis-communication of specifications. This was partly explained in terms of what communication experts call 'serial transmission effects'; however, several interviews also suggested that because each position has its own specialized training and its own distinct interests and priorities, the potential for misinterpretation grows exponentially with the number of steps involved.

Segmentation of design work was also related to a decreasing awareness about the overall nature and purpose of the system. As specifications are passed from analysts to programmers, the system as a whole is usually broken into smaller and smaller modules. By the time specific components go to production, individual programmers frequently have no idea of the broader system into which their module is to fit, nor of the specific business application the component is to fulfill. The potential for misinterpreting specifications is enormous under these conditions.

Hierarchical structures were seen to contribute to problems of communication and understanding through other means. Responsibility for the actual production of information systems is consistently given to individuals (ie. programmers) whose principle orientation is technical and not managerial. The range of levels between "design" and "production" was described as a gradient reflecting an increasingly concentrated technical emphasis. While MIS managers tend to be "organization men" and to maintain an essentially managerial orientation, successively lower levels demonstrate more of a technical focus and orientation.

Several interviews suggested that a major watershed occurs between analysts and programmers. While analysts retain some degree of interest and understanding of managerial problems and perspectives, programmers have very little sense of the organizational applications to which their products were put. Programmers and technical staff were seen to be exclusively "systems-oriented", while analysts exhibited an active interest in users' applications. The existence of this programmer/analyst split was seen as a major barrier affecting the quality of systems design.

Although analysts appear to be marginally aware of managerial perspectives, several interviews expressed concern regarding even their abilities to understand managerial information needs. Because organizations consistently promote employees who are most effective at their current job, demonstrated technical excellence as a programmer is often the principle basis for promotion to analyst. In the traditional system development hierarchy, the normal career path is to begin as a junior programmer working on maintenance and upgrading assignments. Those who are particularly good at this are eventually assigned tasks for new system development. Programmers who exhibit technical excellence (ie. who demonstrate speed and consistency in writing error-free code) are frequently promoted to junior analyst positions, and so on. Because advancement is based largely on technical excellence, the people who get to be top analysts are frequently "the cream of the engineers", as one interview put it. Even with increasing interest in managerial concerns at the analyst level therefore, the fundamental orientation continues to be technical and not managerial.

The situation is worse for those who do not advance up the bureaucratic ladder. Programmers in lower level positions have few opportunities to develop external interests and skills. Housed within departments that are isolated and steeped in technical sub-culture, lower level personnel get little exposure to broader organizational perspectives. "If you're hired as a computer programmer", one person suggested, "you'll be allowed to get additional training only in technical courses". The technical specialization demanded by the bureaucratic context tends to insulate technical groups from exposure to broader experiences and points of view, and reinforces distinctions in perspective and orientation.

Summary

This part of the study provides evidence that the organization of individuals working in OIS design has a major impact on the nature and quality of communication in the design process. The use of a specialized division of labour not only introduces a number of distinct levels through which design information must pass, it also segregates individuals into sub-groups with distinct occupational orientations. These structures create problems in moving information through a sequence of individuals and at the same time reinforce distinctions in managerial and technical orientation. These structures thus contribute to the formation and reinforcement of distinct frames of reference and so contribute to problems of understanding within the design process.

Design Tools and Procedures

A second contextual factor identified in outlining an Interpretive approach to OIS problems concerns the technical tools and procedures employed in the design process. It has been suggested that these techniques can affect the quality of communication within the design context by establishing patterns of interaction among design professionals which ultimately contribute to problems of understanding between them.

Data was sought in the interviews to support these arguments. In particular, subjects were asked to identify specific design techniques in common use, to discuss problems associated with these, as well as to comment on the use of more recent design innovations. The aim here was to obtain a description of the impact which specific design tools have on relationships between designer and user, and to determine if these conform to the analysis outlined above.

Data from the interviews generally supported this analysis. Just over four fifths (80%) of the sample identified the use of specific design tools as a contributing factor in IS design problems. Most of these comments were critical of traditional design tools, suggesting that these can contribute to system failures. The effect of these tools on communication between designers and users was less evident in the data, although the results are not inconsistent with such an interpretation. Mixed results concerning the effectiveness of non- traditional design tools suggest cautious optimism among design professionals regarding the effectiveness of these techniques.

The interviews provided considerable insight into the nature of the technical process of system design. The following summary describes the basic features of that process, as background to an examination of related outcomes. As outlined in Chapter Three, structured design tools were originally developed to allow complex design tasks to be broken down into specific procedures to be carried out by technical personnel. An important basis for this was the standardization of design procedures and the development of specific guidelines for individual components of the process. These were often reflected in the use of standardized forms which concretely define various steps and provide structured guidelines for carrying these out. For this reason, traditional design techniques are often referred to as being "forms driven".

Techniques for information requirements analysis are typically forms-driven. These are undertaken using standardized interview formats which ask users to identify specific functions they wish the system to support. The analyst obtains specification of the user's needs by recording on standardized forms descriptions of the report formats and other output the user feels would be appropriate. These "external" specifications are then submitted for translation into a detailed "internal" design.

The translation between external and internal specifications is accomplished using structured design tools, which organize requirements into modules and provide technical specifications for each of these. Standardized forms provide descriptions of appropriate information flows, data structures, and so on, which are then passed to other technical staff for production. The eventual production of the system uses structured programming techniques to further translate internal specifications into machine-readable code. Standardized forms enable isolated components of the system to be completed by a staff of programmers, each working on part of the overall system. Such methods clearly facilitate bureaucratic management of the design process.

The interview data identifies several difficulties within the traditional design process. Reliance on a forms-driven methodology was generally seen to be problematic. Standardized procedures tend to re-define user requirements within rigid technical specifications. Most methods ask users to "sign off" on these specifications as a protection against potential error; however, most users find it difficult to fully understand these specifications because of their highly technical form.

A more damning criticism is that structured techniques can become an end in themselves rather than a tool to fulfill broader requirements. For an novice designer, forms-driven tools provide a 'cook-book' defining the range and scope of the development process; the forms themselves structure the complete process. When this is done however, the design technology takes on a life of its own with no apparent relationship to the original user. When the forms are complete, the design is complete, whether it fulfills the users requirements or not. Without attention to the larger purpose for which the system was originally proposed, structured techniques can lead the development process astray.

This is related to the fact that structured techniques are designed for individuals with technical and not managerial expertise. Without understanding the managerial applications for which the system is being developed, use of these techniques reduces the analysis of <u>business</u> problems to a purely technical exercise. Employed within a purely technical orientation, these tools enhance the likelihood of such an outcome.

Several examples of this were given regarding information requirements analysis. Standard forms for identifying user needs are frequently applied without real understanding of the underlying business problems the user is facing. Typically, these ask the user to define what s/he "wants" from the system. The problem with this is that managers often cannot articulate their information needs, particularly if they are not familiar with the technology. Faced with this question managers often describe what they're currently using, including existing flaws and inconsistencies. A system built on this information simply automates existing inefficiencies.

Asking what the user wants assumes that they have accurately diagnosed their problems and can articulate this in terms of information requirements. Without an analysis of the managerial problems being addressed, no technical tools will effectively capture the users real requirements. This problem is only accentuated if the individual doing the analysis has no managerial training or experience.

According to several interviews, techniques for information requirements analysis provide only a superficial view of managerial tasks, and do not provide an analysis of underlying needs. Without proper attention to larger managerial issues, these tools often address the wrong level of analysis, and capture the wrong data for system design. In the right hands these techniques help to examine the underlying structure of information usage, and to devise systems which address fundamental needs. Used inappropriately, the tool becomes an end in itself, with predictably unsatisfactory results. The difference lies in the ability to locate use of these tools within an analysis of the user's business context.

Structured design and programming were similarly criticized. These too can be followed blindly, without attention to managerial concerns. This frequently occurs when design work is placed in the hands of individuals who do not understand managerial work. Structured design allows the system to be developed by technical personnel who, may never have had contact with the users of the system. Without connection to the user, the designer or programmer must base the design on an "idealized" user - an imaginary person following textbook procedures for the work that they do. When such idealizations are done by individuals with a strictly technical orientation, the results are likely to be disastrous.

Structured techniques were recognized as an effective way of breaking complex tasks down into more manageable units. They were also seen to create duplication of effort and problems in consistency of work done by different individuals. Even with strict standards, differences in approach between designers can have significant impacts on system performance. Structured techniques are especially well suited for tasks which are highly routine to begin with. As technology moves toward increasingly complex managerial tasks however, such techniques are increasingly ineffective. Traditional methodologies were seen to be outmoded in the light of more recent movements in technology as a whole, and in the technology of design in particular.

One such development received considerable attention in the interviews. The advent of so-called "fourth generation" programming languages and "prototyping" tools, was seen as a significant shift in system development. The advantage of these tools is the ease and speed with which applications can be developed. Using these tools, a developer can obtain rough specifications for a system one day and return the next day with a tentative model for the user to examine. Because changes can be made quickly, the system can be tailored to suit the user's requirements in far less time than it would take a single version to be produced using traditional methods.

Fourth generation tools place designers and users in a different relationship than they have in traditional design. Rather than one having to formulate his information needs in abstract terms and relay these to someone who does not share the same understanding of the work involved, designers and users can now sit down together with a common reference point and identify in how the system should perform. The developer can use this concrete example, rather than abstract information depicted on standard forms, to create a system which the user already understands and approves. By giving users and developers a focus for communicating information requirements the potential for understanding is greatly enhanced.

Fourth generation tools also enable systems to be easily altered when needs change. Traditional methodologies often produce systems which are difficult to change. Two kinds of changes are frequently encountered however which make the need for flexibility critical. Because organizations are inherently dynamic, the needs of individuals frequently change as new products and developed, new markets arise, and so on. Because traditional methods may take several months or even years to complete a final product, such changes can make a system obsolete shortly after implementation.

A second type of change occurs as a result of the learning which inevitably arises when individuals work with a system. It is often difficult for managers to anticipate how a system might be used until they have some direct experience with it. Once a system is in use, requests for new functions and capabilities often increase geometrically. Designers refer to this as the "Gee, it would be nice if.." syndrome. As one individual suggested "no matter how much time and money you spend in the design process, you just can not conceive of what is the best solution until you're halfway there". The flexibility and speed of fourth generation tools enables the developer to cope with both types of change.

While fourth generation tools were widely supported, they were not considered a panacea for design problems. For example, the flexibility of these tools is won at great cost to computing resources. Programs which run on "4GL" systems are often regarded as wasteful by computer experts. Moreover, these programs seldom go through the same degree of error checking and testing which traditional products do, and concerns have been raised about their consistency and stability. In the context of large-scale systems, 4GL systems have also raised concern about the integrity and security of corporate data bases.

Another concern expressed was the danger that prototypes themselves simply become formalized as the final system. The problem here is the same as with information analysis techniques: unless the prototype is considered within the broader context of the system as a whole, it may simply recreate existing inefficiencies and do little to provide a coherent solution to broader problems. The need for 4GL tools to be situated within a broader analysis of managerial needs was expressed by several developers.

While forth generation tools clearly represent an advance in system design, their use is still limited. They were seen to be especially useful for smaller system development, and for providing an effective basis for defining user information needs. In the latter capacity, they appear to facilitate understanding between designer and user. Unless they are applied within an understanding of the organization as a whole, however, these can easily fall prey to the problems traditional methods do. The key to effective use of design tools appears to be the ability to locate users' needs within a broader understanding of organizational and managerial requirements.

Summary

Data obtained in this portion of the study suggest the importance of the technical context in affecting the quality of OIS design. Traditional design tools were originally developed to facilitate communication of design information within a bureaucratized design process. It is evident, however, that many of these tools have had the opposite effect. These tools are often the source of significant mis-communication, either because they necessitate the re-translation of design specifications through a series of technical forms, or because they are employed by individuals whose ability to understand business problems is limited. When these tools supersede human judgement, their application is more often a source of communication problems than a solution.

A notable exception in the availability of fourth-generation design tools which operate by facilitating communication between designer and user. The appearance of these tools reinforces the suggestion that older methods often create as many communication barriers as they were intended to overcome.

Resultant Communication Patterns and Processes

The previous section provides evidence that the use of specific design tools influences patterns of interaction between designers and users. By establishing specific constraints or opportunities for interaction, different methods appear to impact the type of communication and understanding that is able to develop.

The present section outlines evidence which helps to illuminate this relationship.

Data were sought to support the idea that traditional structured techniques introduce specific communication patterns within the design community which isolate sub-groups from interaction with each other, which reinforce basic managerial and technical distinctions among these groups, and which make understanding difficult to achieve. Each of these outcomes is believed to affect the overall quality of the design process and its products.

The impact of communication on system design was spontaneously recognized in over 88% of the interviews. In fact, most described the design process in terms which suggest the inseparability of communication and design. For example, five system developers described system design as a process of "translation". The analyst's job, as one suggested, is to "take English language statements about users' needs and turn these into computer language statements". The ability to accomplish this translation was seen as a fundamental skill distinguishing effective analysts from poor ones.

Linguistic metaphors were frequently used to describe the design process. The basic problem in system design was said to be that managers and developers "speak different languages". In this respect, systems analysis was described as being similar to that of an "interpreter": assessing the information provided by one group and expressing that information in terms another group can understand. Similarly, problems in OIS design were described in terms of the failure of this translation. In describing the underlying cause of OIS difficulties, one analyst suggested that "nine times out of ten its a communication problem between the end user and the system developer". Others suggested that problems in translating managerial needs into technical language was the major flaw in most failed systems. Two dimensions of this problem were identified: (1) users' inability to identify and articulate their needs, and (2) designers' inability to interpret and translate these into appropriate specifications.

While both parties are equally implicated, discussions of OIS problems frequently attributed IS failure to a lack of communication skill among designers. We have already examined evidence suggesting that designers may not possess the social skills to interact effectively with managers because of their heavily technical background. The current interviews support this. One person suggested that a number of OIS problems arise from the inability of designers to "look the user in the eye and talk his business".

There was a strong indication however that the problem may not simply reside in designers' personal communication skills. Several interviews suggested that the problem might be one of inadequate information and training. Many designers do not appear to have a knowledge of managerial work, nor the training to know what questions to ask. As one analyst said, "even if the analyst's communication skills are not a problem, the basic problem of translating between two different languages is still there".

One perspective on this problem which coincides with arguments outlined above concerns the impact of traditional design methodologies on communication between designers and users. The structure in which traditional design is conducted was said to reinforce barriers between occupational groups. Barriers are particularly evident between managers and the lower-level personnel who actually produce information systems. Traditional technical work was described by one individual as a "back-room job", housed in isolated departments and having little formal contact with other groups. Because of technical specialization, lower personnel have few opportunities to develop the contacts, or obtain the information which would enable them to understand the applications to which their systems were being put. Existing methods force these people to interact more with the computer than with users, reinforcing mechanical working and thinking habits.

Structural boundaries between programmers and managers in traditional design work accentuate the role of the analyst as "translator". The more these groups are separated by specialization, the more difficult the problem of bridging the gulf between them. The problem is accentuated by the use of design tools which constrain analysts to use standardized formats for conveying information. These necessitate additional translation between the user and the producer of the system, adding another link in the chain of communication and increasing the potential for miscommunication. Because of this, several interviews suggested that communication between designers and programmers is often as problematic as that between designers and users.

Relationships between communication problems and traditional design methods have concerned systems professionals for some time. Efforts to overcome problems in this relationship have had some impact. More than one analyst suggested that the growing familiarity with computer technology by the general public is helping to bridge the gap between designers and users. This is accentuated by the availability of microcomputers in a growing number of organizations. Changes in design methodology also appear to be helping. The use of user-based steering committees to guide system development and other means of obtaining user involvement have helped to improve understanding between technical and managerial groups. Fourth generation design tools, as discussed earlier, are also having some impact on communication between these groups.

Most interviews suggested that these developments are still slow in affecting major changes however. The predominant difficulty in IS design continues to be the failure of communication processes between designers and users. At least part of this problem appears related to the formal structure and methodology of traditional design.

Summary

These results reveal the importance of communication processes within OIS design, and point to significant problems in communication within that task. The data indicate a systematic relationship between the social organization and the technical tools of system design, and the communication patterns which designers engage in. Specifically, the traditional design hierarchy reinforces the isolation of specific groups so that communication between them is minimized. Use of structured design techniques was also implicated in creating barriers to the communication of design information. These appear to contribute to barriers of understanding between designers and users.

Design Outcomes

The last area of concern in the interviews was the ultimate outcome of the OIS design processes. Many predicted outcomes were discussed in previous chapters, since these are what the present study has set out to examine. We have suggested that information systems have a high rate of "failure" because the quality of communication within the design process prevents developers from effectively understanding the needs of prospective users. This was said to be manifested in systems which were rejected because they did not meet the expectations and requirements of users. This argument suggests a relationship between communication processes within system design and the effectiveness of the systems which result from that process. The present section provides evidence which examines this relationship.

The interviews suggest that OIS failures are closely related to communication processes in the manner described. A consistent set of outcomes was defined by the sample as consequences of ineffective communication between designers and users. In addition, suggestions were put forth regarding the mechanisms by which these outcomes are produced. A summary of these results will complete our examination of the interview data.

Since the interviews were initially grounded on the premise that OIS problems manifest themselves in the failure of completed systems to meet user requirements, it is unfair to suggest that the interviews offered support for such a conclusion. What the results do provide is a detailed description of how this is actually experienced by professionals in the field, and how these results arise.

One of the most common outcomes was the lack of flexibility exhibited in ineffective systems. Several kinds of flexibility were identified: (1) Systems should accommodate users with a variety of skill levels; those which assume the same skill level among all users are frustrating for those who are either above or below the assumed level. Flexibility is also required to accommodate changes in user sophistication as experience grows. (2) Systems should respond to developments in the organization as it matures as a business, or as it responds to changing conditions. Failed systems are often too rigidly structured to enable such changes to be made with ease. (3) Systems are often set up to support routine operations, and may not be flexible enough to deal with exceptional circumstances. Managers who believe their role to be concerned with "exception management" find little support from such systems.

A second outcome, also associated with inflexibility, is the imposition of procedures which are awkward and unfamiliar to the user, and require considerable training to be useful. Systems often entail complex procedures for data entry, upgrading, and information access. Users often feel at a loss with systems that are complex and baffling. Managers experience this in trying to gain access to information; if data are presented in an unfamiliar way, it is unlikely to satisfy immediate needs.

Problems with centralization of computing and information resources were identified as a third outcome. Issues of data security and integrity are of real import, particularly in designing large systems. In addressing these concerns, the need for control over resources often overshadows the access needs of the user. Questions of control over resources often become a frustrating political issue within organizations, to which individual users may turn their backs.

The principle complaint however, concerns the actual ability of systems to meet the functional requirements of the business. In many cases, systems simply do not provide the informational support which users expect. This frequently occurs when the design methodology merely recreates the old system rather than introducing new capabilities which help to solve business problems. Users are frequently led to expect answers to important problems. If the design only replicates existing procedures, many of these expectations will be dashed and interest in the system will wane. This is often true with higher level management functions, which are difficult to support at the best of times. Inability to address a manager's information needs is often reflected in the failure of the system to support complex decision making tasks, strategic planning needs, and so on. Unless systems are specifically designed to address these broader issues, support for the system is not likely to be sustained.

The mechanism which underlies these problems is evidently a complex one. The entire summary of results in this chapter details various facets of the process which evidently brings such problems to light. In characterizing the nature of these problems however, several members of the sample referred again to the fundamental problem of understanding between designers and users. The range of barriers outlined here all tend to manifest themselves in a basic failure of understanding between these groups. Differences in personal and professional orientation, reinforcement of these through education, the social structure of design personnel, and the use of specific design strategies all contribute to difficulties in fully understanding the two 'groups' needs. This failure of understanding is reflected in the systems which are the products of ineffective design.

The basis for this failure occurs in the process of translating from "user language" into "computer language". As the design passes through several hands, subtle changes are made which progressively shift the emerging system toward a technical perspective. In obtaining initial specifications, it is never possible to fully describe the users needs. Where several users are involved, minor differences leave room for "interpretation" by technical experts. In writing formal specifications, the analyst uses his technical orientation to fill in gaps and reconcile inconsistencies in the original description. This is accomplished by making inferences, based on a technical perspective of what "should" be included in the system. As the design passes from stage to stage, gaps and inconsistencies are "evened out" through the application of appropriate technical principles.

Throughout this process, technical values gradually overtake the original organizational values embodied in the system description. As the design emerges, the system becomes increasingly structured by technical interests and less by the business interests which initiated the project. A technical interpretation of design specifications is increasingly reinforced as structured tools are used to produce the system. Even with the best of intentions, the broader structure of the design process can take over and alter the focus of the system away from the user's orientation and toward that of the technician who produces it.

The context and structure of the design process thus significantly shape the outcomes of that process. In particular, structural forces affecting communication between users and designers can make understanding between these groups difficult, and can ultimately affect the success of the design project.

Summary

The interview results presented in this chapter provides a description of major components and relationships hypothesized in the argument advanced earlier in this thesis. These results suggest that the major thrust of the argument advanced thus far accord well with the experience of a small, but varied sample of systems development professionals. This offers some initial validation of the proposed explanation of OIS design problems. In addition, the results provide a rich empirical base from which we may now begin to outline in more concrete terms a conceptual model describing major forces operating in the design context to affect the nature and quality of communication. While many of the components for such a model have been identified in the present chapter, it will be helpful to explicitly focus this wide-ranging analysis with the aid of a model which summarizes the critical features of the process implicitly described above. It is toward the articulation of that model that we now turn.

CHAPTER SIX: The Social and Technical Context of System Design: An Interpretive Model

Toward a Conceptual Model of User/Designer Communication

The interview results support several of the arguments advanced earlier regarding communication barriers within OIS design. In particular, the idea of distinct managerial and technical frames of reference, the social organization of the design community, and the use of specific design tools are all supported as factors contributing to communication problems between users and developers. The data also provide a plausible explanation of how these factors create problems in the design process. Implicitly in these results therefore is a description of a causal process potentially responsible for the emergence of communication barriers in OIS design. The purpose of the present chapter will be to explicitly extract that description from the results presented earlier.

This chapter describes the hypothesized causal process in the form of a conceptual model outlining (1) aspects of the social and technical contexts of OIS design which directly affect the creation of communication barriers, (2) the outcomes of those factors in terms of communication patterns and OIS design outcomes, and (3) a set of causal relationships which describe how communication barriers arise.

We begin with a discussion of the general framework in which the model is couched. We then proceed with the derivation of the model by identifying factors affecting communication in OIS design, by describing the causal relationships through which their impact is felt, and by demonstrating that specific communication and OIS outcomes logically result from these. The chapter concludes with an illustration of how the model can be employed to explain problems of communication in OIS design.

Theoretical Orientation and Assumptions of the Model

Any attempt to describe the underlying features of a social process must make certain assumptions about the nature of social reality, about the kinds of phenomena worth attending to, and about the means of apprehending these. Consistent sets of such assumptions form the basis for major theoretical "paradigms", recognizable as accepted research traditions within specific areas of study (Burrell and Morgan, 1979). Having defined the focus of this analysis to be fundamentally a problem of understanding among designers and users, it is appropriate that the study be located within an orientation that acknowledges the role of individuals' subjective states as a basis for social behavior. The analysis must offer grounds for describing differences between participants in terms of these internal states, as well as for associating such differences with specific aspects of the design process. In addition, the analysis must describe how such differences may be reflected in actual design outcomes which explain the origin of OIS problems. In short, the appropriate orientation for this model is one which provides a clear connection between the subjective experience of understanding and the concrete actions of individuals within a social process such as system design.

The assumptions of the "Interpretive" paradigm (Silverman, 1971; Burrell and Morgan, 1979; Putnam, 1983) fit these requirements. The Interpretive perspective is an extension of Symbolic Interactionist and Phenomenological approaches to social behavior (Burrell and Morgan, 1979), and offers an alternative to traditional frameworks which focus on overt behavior. Interpretive theories rest on the premise that the social world is best understood in terms of the subjective meanings and experiences of the individuals whose actions constitute that world. Unlike the behaviorist's focus on objective "behavior", interpretive scholars focus on human "action" - the meaning-endowed activity which individuals direct toward specific ends and purposes. Subjective experience is structured in terms of the purposeful actions we undertake within the social world, and made meaningful in relation to the purposes and intentions we pursue (Schutz, 1967).

Within this framework, individual experience is made intelligible on the basis of a personal set of categories and meanings accumulated in ongoing social experience. Because individual experience is fundamentally social, these interpretive schemes are always formed in a specific social context. In this way, the individual shares similar interpretive categories with others in the same social group. The ongoing creation of a shared interpretive scheme allows experience to be structured around a limited number of "typical" social practices, lending a sense of order to an otherwise chaotic existence (Berger and Luckman, 1966).

Based on this conception of social action, interpretive scholars assume that social events are best understood through an examination of the interpretive schemes which underlie purposeful social activities (Burrell and Morgan, 1979; Putnam, 1983). Analysis frequently seeks to uncover the latent interpretive schemes which give order and purpose to observed action. Interactions are examined as sequences of behavior which initially establish a shared interpretive scheme, and then enact that scheme in the form of coordinated, purposeful action (Pearce and Cronen, 1980).

In applying this framework within the present study it is assumed that communication between designers and users can be usefully interpreted in terms of the description outlined above, and that such an interpretation can usefully apprehend important aspects of understanding between these two groups. Increasing use of an Interpretive perspective by communication scholars (Pearce and Cronen, 1980; Putnam and Pacanowski, 1983), and by students of organizational science (Silverman, 1971; Burrell and Morgan, 1979), suggest that such assumptions may be warranted. In addition, the perspective outlined above offers a unique opportunity to approach the problem of understanding between designers and users in a way which explicitly links concrete actions of systems design with the subjective understandings which are claimed to be the source of OIS difficulty. We now turn to the task of detailing these connections.

An Interpretive Concept of Communication Breakdown

In Chapter Two it was argued that existing research frequently reflects a limited conception of communication, and one which is of little value for addressing questions of subjective understanding. Interpretive approaches view communication as a process of shared meaning construction (Pierce and Cronen 1980; 1979; Putnam, 1983) and are more suited to an exploration of current issues.

Within an interpretive framework, no assumption is made that individual experience is a direct reflection of external reality. Instead, our experience of an objective social reality is seen as the outcome of a social process in which we actively construct a shared basis for interpreting experience (Berger and Luckman, 1966). Individual events are made meaningful by reference to a matrix of social knowledge which serves as a reference for interpreting ongoing experience. Based on cumulative individual experience, these interpretive schemes, or frames of reference, embody the background knowledge and interpretive knowledge common to the social groups in which we participate. In this way, experiences shared within a particular group are embodied within individual frames of reference and form a basis for "culturally" shared interpretations.

Communication is the underlying basis of this process. Because individual frames of reference are unique, the establishment of a shared interpretive scheme is essential for coordinated action. Communication can thus be defined as the process through which we establish and use shared interpretive schemes to coordinate human activity (Schutz, 1967). Participants initially negotiate a shared basis for interpretation, and then employ that scheme to construct meaningful sequences of behavior, the outcome of which is a sense of shared meaning and understanding. Communication is thus more than a simple transfer of information; it is a complex exchange of symbolic behavior through which both parties construct mutually intelligible action (Berger and Luckman, 1966).

This process is fraught with potential barriers. Problems in understanding arise because of a failure to establish shared interpretive frameworks. Because each person interprets events within their own frame of reference, understanding can only be accomplished in areas where these overlap. Problems arise when divergent frames prevent agreement on the basic purpose and meaning of interaction or the appropriateness of specific behavior. Such disagreement may cause the participants to derive different understandings of what has transpired, and may only become apparent when subsequent action reveals the discrepancy.

Within an interpretive perspective therefore, the nature of "communication breakdown" is not that one person fails to accurately decode another's messages, but that the two, in conjunction, employ interpretive schemes which produce incompatible action. Many of the difficulties encountered within systems design reflect this kind of mis-interpretation. Even when developers and users carefully work through a set of structured design requirements, systems often do not embody the kinds of information requirements that users intended. The problem of understanding is not so much a matter of correctly hearing the others' words, it is more a matter of being able to correctly understand the intention behind the words - a kind of understanding which is prevented when fundamental frames of reference differ.

Deriving the Model

Having outlined an interpretive definition of communication breakdown, our task now is to provide a concrete description of specific elements of the design context which contribute to such problems in OIS design. Our initial aim is to describe specific factors which prevent participants from achieving mutual understanding. In addition, we must also describe causal relationships among these elements which describe how problems in understanding are generated.

Since the model is intended to describe processes affecting communication within the design context in general and not in any particular case, it is appropriate to formulate the elements of this model in relatively broad terms. The interview results provide considerable detail in describing elements of the design context; our present aim is to locate within that discussion a more general pattern which describes the process underlying a variety of OIS problems. By formulating the model in this way we are not describing the design context per se, but rather the system of causal relationships through which specific features of that context contribute to problems in communication and understanding.

Since the problems of interest have been defined in terms of barriers to understanding, the process we are interested in describing can be construed as the emergence of such barriers over time as a product of various contextual forces. So far we have seen how these barriers initially arise with individual differences, are gradually reinforced by educational processes, and then reach full force within bureaucratically structured organizations. In this sense, it is useful to portray the model as a temporal sequence of phases through which barriers initially appear and are brought to maturity through the influence of forces within the design context. Within this framework, the model's task is to describe where in the sequence of events specific contextual forces are felt, and to illustrate the specific set of relationships proposed as an explanation for the emergence of the barriers involved.

We begin the derivation of this model by outlining the major temporal phases through which communication barriers might be seen to emerge. We then re-trace these steps, describing major contextual variables which affect this sequence, and outlining specific causal relationships suggested in the interview data. We conclude with an overview of the model as a whole and a description of its application.

The Basis for Misunderstanding: Technical vs. Managerial Frames of Reference

The nature of OIS communication barriers has been described as a failure to bridge managerial and technical frames of reference. We describes OIS design as a social process specifically intended to bridge these fundamentally different ways of understanding system requirements. The breakdown of that process was described as the basis on which misunderstandings between system developers and prospective users occur. Within the broader Interpretive framework, the gulf which separates these interpretive frames is, by definition, the source of misunderstanding between these groups. When we propose to construct a model illustrating the emergence of misunderstanding within the design context therefore, this is equivalent to proposing that we document the emergence and the outcome of distinct technical and managerial frames.

Following this argument, we can identify specific phases in the emergence of communication barriers by describing the emergence and maturation of managerial and technical frames of reference within the design context. By mapping the major movements in this development, we can provide a framework within which the impact of other contextual forces can be located and described. The sequence of developments in this process will thus provide identifiable landmarks through which to examine the contribution which various forces make to the emergence of communication barriers.

As the interview results indicate, an initial basis for the emergence of managerial and technical frames of reference is evident long before individuals actively participate in the design process. A number of individual differences in personality, attitudes, values and so on lie in the background to the initial formation of separate technical and managerial interests and perceptions. Important here are fundamental differences in cognitive style which form the focal point for differentiating between individuals who will be drawn toward either a technical or managerial career. Evidence presented earlier suggests that an entire cluster of personal and cognitive differences are evident as a precursor to, and probably an influential factor in, the initial selection of a managerial or technical career path. For purposes of the present model therefore, we can consider this cluster of differences to be the starting point for the emergence of distinct managerial and technical frames of reference.

While personality and cognitive differences may influence career choices, the impact of educational processes marks a new phase in the emergence of distinct frames of reference. The interview results indicate that several aspects of the formal training given to both managerial and technical students strongly impacts the ways in which they define and approach problems, on the kinds of information they will seek in addressing problem situations, and on the values from which they will judge potential solutions. Differences in training also extend to the social realm, where different social skills, experiences, and expectations are instilled. The distinct educational backgrounds which managerial and technical students experience strongly influences both their cognitive and social orientations.

Educational forces thus mark the initial formation of a true distinction between managerial and technical frames of reference. What began as a loose constellation of individual differences has now coalesced into a uniform set of differences which are recognized and accepted as a basic feature of the social world these groups share. The influence of the educational context thus creates a new order of socialization which crystallizes initial differences into a orderly and socially recognized distinction.

The next phase in the emergence of communication barriers occurs when individuals enter their professional careers within an organized design setting. The organizational context represents the most powerful set of influences affecting the development of communication barriers. As the interview results show, a number of factors contribute toward communication problems in this context. Some of these are a by-product of the nature of large, complex organizations. An emphasis on functional specialization within a particular area, the tendency for design personnel to be functionally if not physically separated from other areas of the organization, and the tendency for both management and technical personnel to maintain social ties within their own groups, all tend to reinforce and strengthen the initial frames of reference which the two groups bring with them into the organization. Within this context, initial differences become institutionalized as part of the organization's culture, adding a new dimension to the interpretive barrier growing between the two groups.

While the general organizational context tends to formalize and entrench the original frames of reference, specific factors concerning the structure and organization of the design process itself contribute further to the emergence of barriers. The interview data provides concrete evidence that both the social organization of the design community itself, and the use of specific design procedures both contribute to further difficulties in communication. Specifically, the tendency for design tasks to be broken down into distinct specialties and arranged in hierarchical systems, and for individuals to use standardized design tools to convey important elements of design information, both contribute toward emerging communication problems. These impose even further separations between individuals with distinct frames of reference, making it increasingly difficult for these groups to develop shared experience or understanding.

These forces have their impact primarily through the establishment of specific patterns of interaction and communication among design personnel, and between system developers and users. These patterns limit the range of professional and social contact which technical personnel may be involved in, and restrict opportunities to gain understanding about the nature of managerial work. This separation further draws these groups apart and introduces additional problems in allowing common understanding to develop between these groups. In particular, these groups come to have difficulty agreeing on the nature and meaning of specific system requirements. The outcome of these misunderstandings is finally realized in the development of systems which fail to address the needs of the user, and which impose technically elegant, but often ineffective means of accomplishing managerial tasks.

What the data suggest therefore is a sequence of five major phases which trace the initial emergence of managerial and technical frames of reference through their institutionalization within formal organizations to the eventual establishment of barriers to understanding reflected in specific system outcomes. These five stages are illustrated in Figure 6.1 below. This hypothetical sequence represents one way of conceptualizing the emergence of communication barriers that is consistent with the observations presented in the previous chapter. This framework is advantageous in that it describes a specific structure in which we can now begin to represent the impact which specific contextual factors have on the establishment of communication barriers. In this way it is helpful in describing causal relationships between specific contextual forces and the

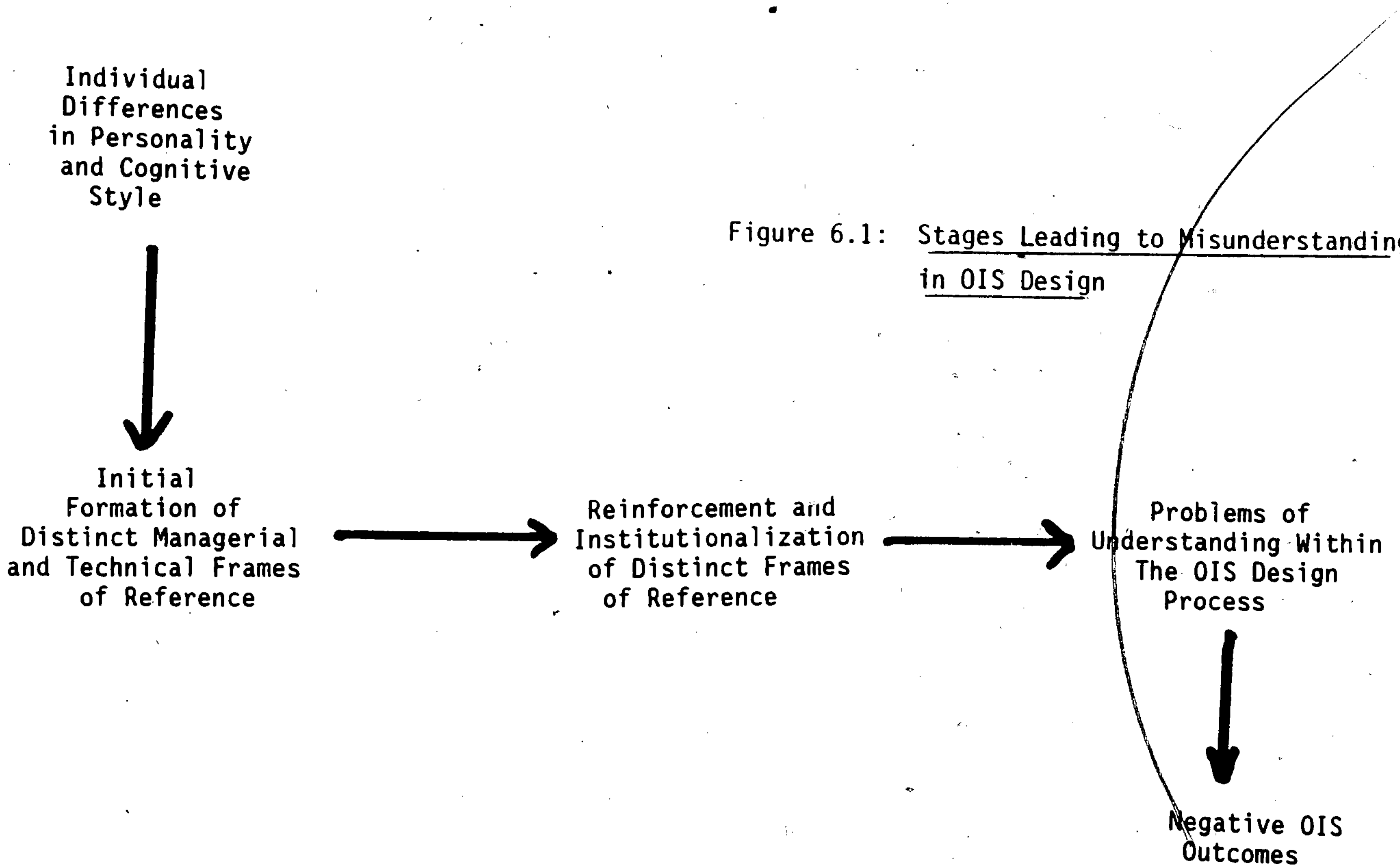


Figure 6.1: Stages Leading to Misunderstanding in OIS Design

emergence of problems in understanding which underlie OIS difficulties.

While the impact of several contextual factors has already been suggested by the present discussion, it will be useful to provide a detailed review of specific factors in order to identify how each of these enters into the process identified above. On the basis of that discussion we will then be in a position to complete the model so that it represents the entire system of influences identified in the interview data. We turn now to a discussion of these factors.

Contextual Factors

The majority of factors which impact the design process can be discussed under three major headings. Several factors operating at an individual level as a precursor to the emergence of distinct frames of reference have already been discussed. These are treated here as background factors which describe the origin and early development of managerial and technical perspectives. Other factors operate primarily at the level of the work organization. Among these, the bureaucratic nature of complex organizations in itself contributes several important dimensions. More particularly, the social organization of the design community and the specific technical tools and procedures of system design have been specified throughout the thesis as factors of special interest. The discussion below provides a summary of the major factors operating in each of these areas, and offers a tentative description of relationships between them.

A. Background Factors - Individual-level differences between designers and users have already been discussed. It will now be possible to provide a better understanding of their significance within the design context. Basic personality factors are significant at a very early stage in the formation of distinct managerial and technical frames of reference, acting as general orientations out of which further distinctions eventually emerge. Studies have suggested, that innate characteristics and early developmental experiences probably contribute equally to the emergence of basic personality orientations from which further distinctions in cognitive style, values, attitudes toward work, and personal and professional aspirations appear to develop (Marcus and Robey, 1983). These factors are significant in the present context primarily as factors influencing the selection of a career path oriented either toward managerial or more technical work.

Having made a specific career choice, individuals typically undergo some form of professional training. The educational process embodies several forces which reinforce and institutionalize the germinal distinctions already in place. These forces are evident in the formal structure of the training itself, as well as in the informal social structure of the institution. As we have seen, technically and managerially oriented students are often formally separated within these institutions, or attend completely different institutions. Each receives specialized training from instructors who are experts in a narrow specialty, and who become exemplars of "correct" thinking and behavior.

Technically oriented students follow a focused curriculum emphasizing meticulous step-by step work habits and the search for "technically correct" solutions. Managerial students follow a much broader course of studies, instilling an awareness of the complex, multi-valued nature of business situations and providing tools for decision making which call for delicately balanced judgements.

The interview data also suggest that many of these formal distinctions are reinforced by informal social processes in which management students and "techies" tend to remain socially isolated from each other, and where the effort to retain a distinct group identity is often openly encouraged. These social processes represent the early formation and institutionalization of distinct frames of reference within managerial and technical groups of students. Initial tendencies toward specific cognitive and social orientations are thus reinforced and ritualized within this context to create the first indications of a closed and specialized interpretive framework.

As indicated earlier, these factors contribute toward the movement from the initial stage in the model toward the formation of a specific distinction between managerial and technical interests. The educational setting appears to be largely instrumental here, evidently by providing a basis for focusing specific differences into coherent systems of both cognitive and social preferences. It is through this influence that specific technical and managerial orientations first come into being and become part of the social milieu within which aspiring managers and system designers form basic understandings of the nature of their chosen careers. Even at this early stage, we have the basis for fundamental disagreement between these groups.

B. Organizational Factors

1. Formal and Informal Organizational Factors - Organizational factors have a significant effect on the continued development of distinct frames of reference, and by implication on the emergence of further barriers to communication within the design setting. These factors include those operating within the common context of work for both OIS designers and users (ie. the general structure of bureaucratic organizations), as well as specific aspects of the organization of the design community itself.

Complex organizations include a number of factors which tend to reinforce and strengthen the isolation between technical and managerial groups. As in the educational context, many of these factors are part of the formal constitution of complex organizations. For example, managerial and technical groups are often separated as a formal feature of organizational structure. OIS designers are normally housed within a specific Data Processing (DP) unit that may be both physically and functionally isolated from the operating core of the organization. This separation has two important impacts: (1) DP units frequently operate under their own set of objectives and may be unaware or dis-interested in the objectives of other departments which they serve, and (2) as distinct organizational units, DP departments must compete with others for scarce resources, often creating an adversarial climate between these units. Both outcomes tend to create a background of mistrust and misunderstanding which becomes part of the context in which the design process is located.

Within these formal structures a number of other factors have been identified as barriers to designer/user communication. These can be referred to as informal or "emergent" in the sense that they are part of the ongoing social process which arises within the organizational setting. One of these concerns the continued separation of technical and managerial personnel in informal social interaction both on and off the job. Both groups tend to associate with their peers and not with members of other groups. In addition, relationships between designers and users are often less than amiable, possibly as a result of political differences between DP and other departments. Examples of one-upmanship on the part of both groups, and the use of technical jargon to create dependency relations have been noted in the literature (Johnson and Kaplan, 1979).

Many of these factors contribute directly to the formation of distinct frames of reference within managerial and technical groups. The lack of ongoing contact between these groups limits the formation of any basis of mutual understanding and makes it difficult for further interaction to take place. Other factors reinforce distinctions already in place, for example, through continued enforcement of We-They attitudes and perceptions. The general context of complex organizations therefore reinforces the initial frames of reference which technical and managerial personnel bring into the organization. Within bureaucratic structures these differences become formalized as an accepted part of normal working routines. In this way, basic differences become entrenched within the formal system of the organization, as well as part of the informal culture into which individuals are socialized. These influences tend to crystallize managerial and technical frames into rigid frameworks which are extremely potent in defining the reality of those who hold them. Within the organizational context, basic frames of reference thus contribute to the growing separation and isolation of these two groups, clearly affecting the quality of communication between them.

2. The Social Organization of The Design Community - A second dimension of the formal organizational context concerns the manner in which system design work is structured. The traditional organization of systems professionals discussed earlier compartmentalizes design work into isolated components. The hierarchical arrangement of job functions has two important consequences in reinforcing differences in frames of reference: First, the work necessary to conduct the design process is fragmented and divided among a variety of different individuals. This reduces the likelihood that individuals who actually produce system components effectively understand the broader nature of the system, and significantly increases the potential for mis-communication as specific assignments are "handed off" from one individual to another. Second, the limited understanding of managerial work that may exist among technical personnel tends to be concentrated toward the top of the hierarchy so that the individuals who actually produce the system components also tend to be those who know least about management. Formal procedures for system development pose significant barriers to

effective design by imposing a technical hierarchy between the producers of the system and its ultimate users.

These formal arrangements frequently contribute to OIS problems by preventing designers and users from gaining practical experience with each others' requirements. Several differences between managerial and systems related work were identified in the interview material. The two groups seldom gain any understanding of each others' work within their training, and often have little opportunity to do so within organizational settings. This makes it difficult for both to understand and respond to the others' requirements. The formal separation of these groups within most organizations and the formal constitution of most DP departments severely limit interaction between the two groups and make it difficult for designers to gain an understanding of managerial needs.

The organization of the design community itself thus creates additional barriers to communication within the design process by setting up specific structures for interaction among designers which drive a wedge between those at the top and those at the bottom. This creates differences between designers and producers of systems which continue to reinforce managerial/technical distinctions and make it difficult to move information and effectively and establish understanding even within segments of the design community itself. Such differences form important barriers to understanding which directly affect OIS outcomes.

C. <u>The Technical Context of Design</u> - Several of the factors identified within the organizational context point toward another set of influences affecting communication within the design process. The manner of organizing and carrying out design work described above is not an isolated occurrence, but part of the broader structure of OIS design processes typical of large, bureaucratic organizations. Another aspect of this structure is the use of specific design tools and procedures which are an integral part of this structure of system design.

The interview data clearly suggest that widespread use of structured tools such as information requirements analysis and structured programming and design embody several barriers to effective communication between designers and users. Although the original intention of these techniques was to facilitate exchange of information between designers and users, this appears to have occurred only at the cost of a more general loss of understanding. Structured techniques tend to focus attention toward the technical details of system specifications so that the broader objectives and needs of the system are often forgotten. Moreover, these techniques also tend to lull both the user and the designer into complacency about the difficulty and the importance of achieving mutual understanding; the assumption seems to be that the techniques themselves can do the communicating.

One of the ways in which the use of specific design tools most strongly affects the problem of understanding between developers and users is through the establishment of specific patterns of communication within the design context. In working through various technical procedures, specific kinds of interaction are prescribed by the tools themselves, while others appear to be eliminated. For example, direct contact between the lower-level programers who actually produce specific system modules and the people who will eventually use them is virtually cut off and replaced by a series of formal procedures which translate user needs into programmable specifications. Among those who do have direct user contact, the use of traditional structured techniques tends to restrict communication about system requirements within the bounds of the specific analytical technique in use. By contrast, those who use more flexible design tools such as prototyping will tend to follow less structured and circumscribed patterns in formulating system requirements.

In other words, the use of specific design tools appears to impact the problem of understanding by creating specific patterns of communication and interaction within the design process. This structuring of communication patterns is also influenced by the hierarchical organization of design professionals, which is closely bound up with use of structured design tools. Both of these influences impose specific constraints and patterns onto communication processes within the design process (ie. among the design community itself as well as between designers and users) which affect the ability of these groups to understand one another effectively. In particular, the use of traditional structured techniques appear in the interview data to create patterns of communication which further distance individuals with distinct managerial and technical points of view, and so contribute further to existing barriers to understanding. In combination, the hierarchical organization of design professionals and their use of structured design tools appear to further exacerbate fundamental differences in interpretive frames which are maintained within the organizational setting. These constitute a second set of influences within the organizational context which function to further deepen problems of understanding.

Communication and OIS Outcomes

The description of factors affecting the emergence of communication barriers has thus far outlined contextual factors both within and outside the organization which are responsible for problems in understanding in OIS design. While this describes the major elements operating in this process, and outlines the major relationships through which these influences are felt, there remains one final relationship to be established. In the sequence of stages outlined earlier, the final outcome of the gradual emergence of communication barriers is the creation of specific OIS outcomes as a direct product of the barriers outlined above.

The interview results provide several indications that OIS difficulties are a direct result of communication barriers in the design context. Specific problems such as the inflexibility of systems produced, awkwardness and unfamiliarity of procedures imposed by these systems, and the frequent inability of systems to meet the expected business needs of the user, all appear to be the logical outcome of barriers to understanding in the design context, as described below.

To the extent that individuals within OIS design (especially the producers and consumers of OIS) are prevented from fully understanding one another's needs within the design context, it will be difficult for them to assist one another in defining the precise requirements the system is to fulfill. Various gaps and inconsistencies that arise from incomplete understanding will tend to be resolved within the specific frame of reference of the individual involved. This creates the basis for considerable mis-construal of system specifications and for important functional characteristics to be mis-translated as they proceed through several phases of the design process. Initial difficulties in understanding are thus translated directly into concrete specifications for system production. Barriers to understanding thus contribute almost inevitably to the development of systems which address the wrong set of needs, which blindly automate ineffective organizational procedures without a careful examination of their actual value, or which do not provide easy and meaningful access to information.

The data clearly support this final link in the model, establishing the relationship between communication barriers in OIS design and the specific outcomes of that process. This link represents the final stage in the process through which fundamental barriers to communication and understanding within OIS design initially arise and eventually bring about specific problems in the use of OIS technology.

A Tentative Model

The discussion above identifies specific factors which contribute to the emergence of communication barriers within the OIS design context, and indicates that this set of factors constitute the elements of a coherent and integrated process affecting the quality of communication in OIS design. By placing these elements within a framework of temporal stages, the proceeding discussion provides a basis for describing systemic interrelationships which operate within the design setting. These contribute to the establishment of communication barriers which are ultimately reflected in specific difficulties in OIS implementation. This discussion outlines, in other words, a specific model of the process underlying communication problems in OIS design.

We can visually represent the major features of this model by indicating on the previous diagram the specific locus and direction of influence which each of the contextual factors has with respect to the emergence of communication barriers. This is illust ₋ted in Figure 6.2. The elements identified in this model and the patterns of influence depicted among them constitutes a description

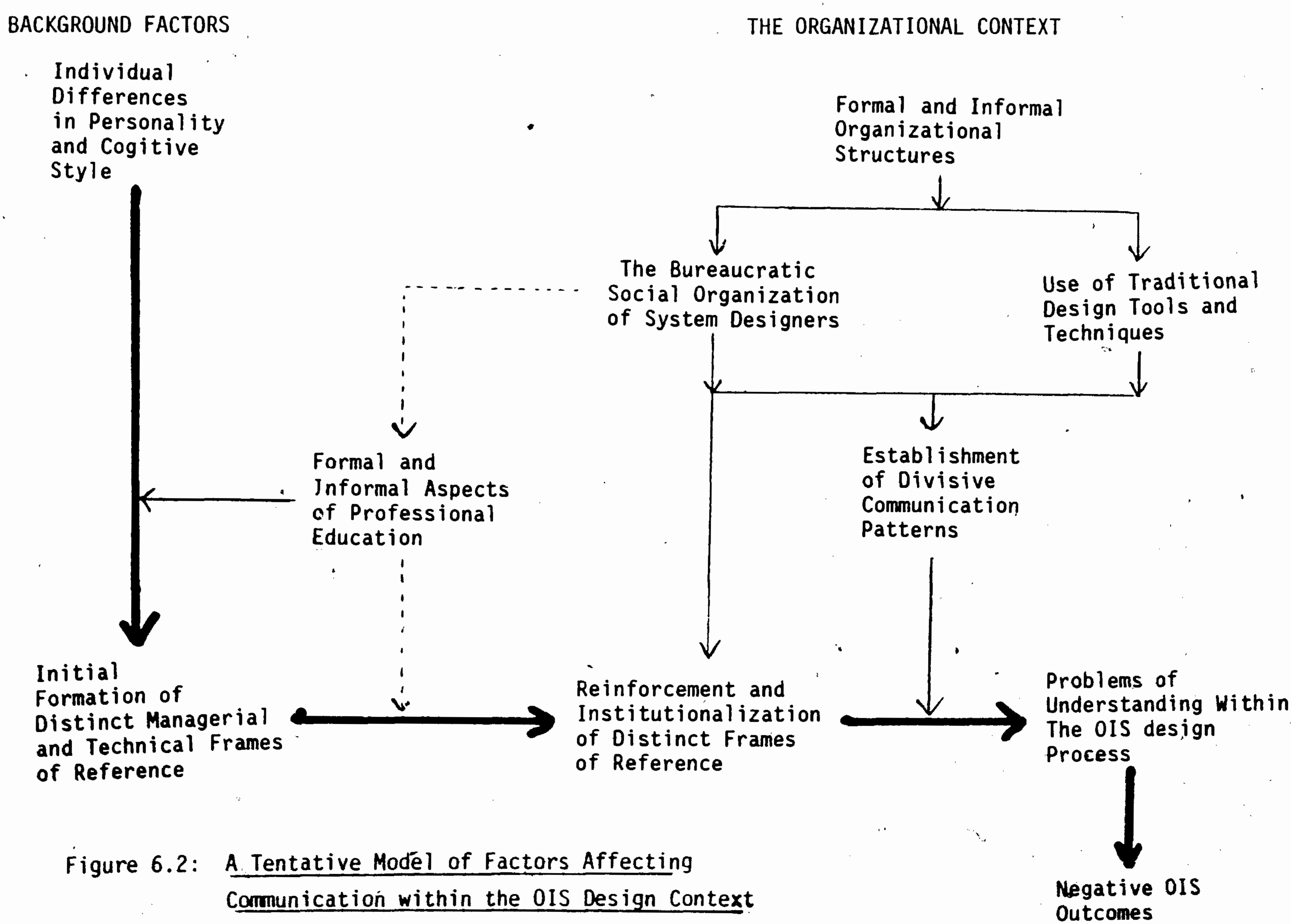


Figure 6.2: A Tentative Model of Factors Affecting Communication within the OIS Design Context

of the major features of the OIS design context which affect the nature and quality of communication in that setting. It also indicates the specific impact which each element has on the emergence of barriers to communication and understanding. In this respect, the model constitutes an explanatory framework for describing how specific problems in OIS implementation arise as a product of the action of specific forces within the design context.

Using this model, we can describe general conditions operating within the design context which affect ongoing communication processes and determine the likelihood of success in the design effort. For example, to the extent that management and systems personnel enter the organization from traditional educational settings, their initial frames of reference can be expected to differ markedly. If the organization operates according to a traditional bureaucratic model, we can expect that these groups will be housed in separate departments, where they develop distinct organizational perspectives as a product of both formal and informal aspects of the organizational setting. These act to institutionalize distinct interpretive frameworks and to drive managerial and technical individuals into more distant camps.

In the design context itself, the organization of the design process in terms of both social organization and technical procedures, will have additional impact. If these factors are traditional in form, they will tend to create within the design group itself variations in technical or managerial focus which make it difficult for lower-level personnel to understand managerial requirements. Using traditional design and production tools will also contribute toward design problems by imposing certain formal procedures for transferring and translating important pieces of design information, and by limiting the degree of contact between system developers and users. Both of these factors add to the emergence of communication barriers by establishing specific patterns of communication within the design context which make the possibility of effective understanding between technical and managerial frames increasingly difficult.

As a product of these forces, the initial differences between managerial and technical personnel become a formalized dimension of the organizational setting, and now emerge as a specific barriers to understanding within the design context. These barriers are ultimately reflected in system outcomes which fail to meet the needs of the user and thus create specific problems in user acceptance and utilization. Thus, under conditions of extreme bureaucratization, we can expect that the full range of forces will work to maximize problems in communication, while a more flexible and open system of organization may give rise to considerably fewer barriers, and potentially fewer implementation problems.

The model offers, in short, a means of analyzing the specific conditions at play within a specific design setting and can provide a potential explanation for communication problems that arise within that context. In this respect, it is offered as a candidate for explaining the origin and specific nature of communication barriers in OIS design. Before such explanations can be accepted as valid however, the model itself will have to be empirically tested to establish its value as a description of significant aspects of OIS problems. It is toward the provision of such a test that we now turn.

CHAPTER SEVEN: Questionnaire Development and Preliminary Data Exploration

Overview

Having derived a conceptual model of OIS communication barriers from the interview data, we now undertake an empirical evaluation of that model. The present chapter outlines the development of questionnaire instrument to obtain data from a sample of system design professionals, undertakes a preliminary examination of the data collected. This chapter also presents an outline of the procedures used to analyze this data.

This discussion forms a bridge between the initial interviews and the formal assessment of the model. We begin by abstracting from the interview results specific variables which will be used to measure specific components of the model. These results will ensure that the operationalization of variables in the questionnaire is consistent with the basic formulation major constructs in the model. With this basic assurance of validity, we will then proceed with a formal evaluation of the model.

Questionnaire Development

A. Identification of Variables

The first step in developing the questionnaire was to identify specific variables for major components in the model. This section describes the selection of variables from the interview data to provide a first draft of the questionnaire.

Because the model represents interactions among several contextual factors, it was recognized that an attempt to address the entire range of elements and relationships might prove overly complex. It was decided that a selective evaluation focusing on the central elements would offer sufficient verification without presenting major analytical problems. Since the five constructs used to focus the collection of interview data form the major elements of the model, these were adopted as a basis for constructing the questionnaire. Questionnaire construction was thus based on to following elements in the model:

(1) managerial vs. technical frames of reference

(2) The social organization of the design community

(3) the use of specific design tools and techniques

(4) resultant communication patterns

(5) OIS outcomes

It was recognized that each of these elements were complex, multivariate constructs. Each is multi-faceted and operates within a complex system of relationships within the design process. It was decided that all of these were best formulated as composites of several more specific dimensions. For each component therefore, a unique set of measurable dimensions were sought, using the interview data to identify specific indicators.

This approach has advantages as well as disadvantages. The use of multiple measurements allows several distinct dimensions of a construct to be acknowledged and explicitly included in the analysis. This prevents the real complexity of the phenomenon from being reduced to a single, univariate measure. Moreover, multiple measures of different facets help support the validity and stability of the construct as a whole. A disadvantage is that it may be difficult to define in advance the most effective set of dimensions to focus on. Where choices must be made regarding which dimensions to measure, practical considerations like ease or reliability of measurement may affect the ultimate interpretation of results.

For the present study, the advantages were seen to outweigh potential measurement problems. Because the study is exploratory, it was felt that fine-tuning the measurement methodology was usefully postponed until after an initial assessment of the model. While concern for measurement problems was maintained, the study proceeded with the identification of specific variables for each construct.

The initial definition of variables was accomplished through an examination of interview data in relation to the model. Major aspects of each construct were used to define areas in which specific variables were sought. Data in each of these areas was then reviewed to identify specific observations which might serve as indicators for those dimensions. In other words the model helped provided a broad outline of each construct and suggested general guidelines for appropriate observations, while the interview data helped identify specific observations to satisfy these.

A critical factor affecting choice of variables was the decision to employ a questionnaire methodology. The questionnaire format was chosen because it offers an ability to obtain data from a large sample of subjects where time and financial resources are limited. However, the use of this format constrains the types of data that can be obtained. Variables which could not be measured using self-report responses on paper-and-pencil test were thus not included in the study.

It was also recognized that reliance on self-report data might present additional limitations regarding validity and reliability of the data. Because they often portray subjects' perceptions rather than actual behavior, self-report measures cannot always be taken at face value (Kidder, 1981:147). In the present study it was decided to select variables that would allow behaviorally-oriented description whenever possible.

Another limitation arose from the use of mail to distribute the instrument.

Because length and complexity of a questionnaire can affect response rate, it was decided that the length would have to be limited. This made it impossible to incorporate standardized scales and tests containing large numbers of items. For example, it was decided not to use the Meyers-Briggs Type Indicator (MBTI) used in previous research, since the scale contains 126 items, and doubt has been expressed about the reliability and validity of sub-scales used in related research (Kaiser and Bostrom, 1982). These limitations made it necessary to limit the range of variables selected for each construct.

Within this set of limitations, specific variables were identified for each of the five constructs. These are outlined below with an explanation of their relationship to the broader construct.

(1) Technical and Managerial Frames of Reference - Five major dimensions of this construct were identified for inclusion in the questionnaire as described in Table 7.1 below.

The individual's current position was thought to provide an indicator of their occupational frame of reference, since that construct is defined largely in occupational terms. Three variables were identified as descriptors of this dimension: the area of responsibility the individual has within the design process, the number of years of experience in that position,

Major Dimensions		Variables
Current Position	-	Area of responsibility in IS design
	-	Years of experience in position
	-	Technical vs. Managerial orientation of work
Previous Work Experience	-	Area of responsibility
	-	Technical or Managerial orientation
Training	-	Type of education
	-	Level of education
Group Affiliations	-	Career aspirations
	-	Preference for group contact
Computer Programming	-	Amount of Programming Experience
Age	-	

TABLE 7.1: Initial Dimensions and Variables for the "Frame of Reference" Construct

and the relative emphasis on technical or managerial work encompassed by the position.

Since frames of reference evolve over time, previous work experience was also considered an important element of this construct. The individual's level of responsibility, as well as the technical or managerial emphasis of the work were identified as specific components of this dimension.

Professional training was identified as a third element of frame of reference. Aspects of training included here are the specific type and level training undertaken. It was assumed that the longer one spent in training, the more likely one would be to become enculturated into a specific frame of reference.

Another dimension of this construct concerns personal affiliation with a specific occupational group. It was assumed that preferences for a particular group would reflect feelings of solidarity with that group, and could be used as an indicator of similarity in frame of reference. Two specific variables were identified: preferences for involvement with specific groups on the job, and preferences for promotion to positions in different groups.

Two additional variables were also included, since the interview data suggested a relationship to occupational orientation. Since involvement in computer programming evidently influences orientations toward design work, it was useful to include amount of programming experience as a variable. The impact of age was also suggested in the interviews, and was included as a possible measure for this construct.

(2) <u>The Social Organization of The Design Community</u> - In reviewing interview data, two distinct types of information appeared useful in describing this construct. The first concerns the hierarchical structuring of design work, reflected in the patterns of professional activity which designers display as a

result of their role in the design process. The second concerns the nature of organizations themselves, suggesting that organizations might differ in degrees of bureaucratic structuring depending on the type and size of the organization, the kind of technology in use, and so on. It was decided to partition the broader construct along these lines, and to define distinct variables for each separate component.

The data suggested that bureaucratic structuring would be most evident in the degree to which design tasks were broken up and assigned to specific individuals. It was decided an effective indicator of this would be a description of subjects' actual work routines and to determine how specialized these were. To obtain consistency in these descriptions, a list of twelve design activities was developed to represent design tasks ranging from strategic management of information resources to testing and debugging programs. The specific tasks for which data were sought are outlined in Table 7.2. It was assumed that by indicating the amount of time spent in each activity the degree of specialization in the design process could be assessed.

For the second component, the interviews indicated various aspects of the organizational context could provide an indicator for bureaucratic structuring. The nature of the organizational unit within which the respondent functioned was thought to be a useful descriptor, particularly to the extent that the individual was situated within an MIS department within a large organization, in a smaller firm, or perhaps as an private consultant. An indication of the size of the organization involved as well as the type of organizational affiliation were identified as useful measures.

Interviews also suggested the importance of the technical context as a major dimension of this construct. Two indicators of technical context were identified: the kind of hardware in use, and the type of applications for which the

Major Dimensions	Variables
I. The Organizational Context	
Organizational Context	- Type of organization
	- Size of Organization
Technical Context	- Type of Hardware
	- Type of Applications
Clients	- Internal/external clients
	- Sector in which clients work
II. The Structure of Design Work	
Time spent in specific design tasks:	- strategic planning
	- project budgeting
	- analysing information needs
	- coordination meetings
	- writing specifications
	- programming
	- installing hardware
	- testing and debugging
	- upgrading existing systems
	- training users and staff
	- evaluating systems

Table 7.2: Initial Dimensions and Variables for the "Bureaucratic Organization of Systems Design" Construct

technology was employed. Large mainframe systems were assumed to be more highly bureaucratized than smaller mini-computers or networked micros. Similarly, certain applications (eg. basic transactions) tend to be more bureaucratically structured and rely on structured methodologies, while others (eg. user-based decision support) require more flexible and open systems. The latter were assumed to be an indicator of a less bureaucratized design process.

A final dimension concerns the type of clients served by the design process. Interviews indicated that designers who work with clients within a single organization become specialized and static, while those working with external clients often have broader experience and more flexible approaches. It was assumed the internal/external distinction would help assess the degree of bureaucratic structure as well. All three dimensions were included as indicators of the organizational context, as illustrated in Table 7.2.

(3) Design Tools - Four major dimensions were associated with the use of specific design tools. The principle focus of this construct can be described in terms of concrete behavioral indicators describing aspects of the design

technology in use. Several other indicators were also identified, as outlined in Table 7.3 below.

The Interviews suggested differences among designers in terms of their general approach to the design task, as well as the particular tools and techniques they use. These constitute the first two major dimensions outlined in Table 7.3. General design strategy can be described in terms of broad principles and approaches which guide the design process and focus attention toward specific aspects of the organizational setting. Within these characterizations, the nature of a individual's design strategy can be further described in terms of specific procedures and tools. Ten major design tools were identified which respondents would be asked to check off to provide a concrete description of this component.

The interviews also suggested two types of design tools associated with communication issues. The use of structured design and programming were indicated as major components of the design tool construct. In addition to simply indicating whether such tools were used or not, two additional variables were adopted as indicators of a structured focus: emphasis on systems as opposed to application programming, and the identification of specific programming languages. The latter offer some indication of the type and level of design work being done. The second type of design tool is the use of non-traditional

Major Dimensions	Variables
General Design Strategy	- Major design principles adhered to - Specific approaches advocated
Specific Design Procedures	- Several behavioral indicators of design tool use (eg. use of steering committees, system conversion, software customizing, doccumentation, etc.)
Use of Structured Methods	- Structured design - Structured programming - System vs. application programming - Programming languages
Alternative Design Tools	- Use of "fourth generation" tools (Amount) - Use of "fourth generation" tools (Type) - Use of application prototyping

Table 7.3: Initial Dimensions and Variables for the "Design Tools" Construct

procedures, particularly the use of fourth generation design tools and prototyping. Indicators of the use of such tools was chosen as another dimension of this construct.

(4) Communication Patterns - This construct was not fully illuminated by the interviews. Frequent references were made to communication problems, but these were not discussed in terms of identifiable patterns and behaviors. However, three potential indicators of communication patterns were suggested. Since these were not well defined by the interviews, it was decided that they should be represented as much as possible by behavioral indicators. The areas and their specific indicators are outlined in Figure 7.4 below.

The three dimensions all concern the social contacts which designers make in the context of their work. The first concerns the amount of time the designer spends with each of several major groups in the organizational context, assumedly as a result of the design tools and strategies used. The second dimension concerns the actual communication activities carried out with those groups. The focus here is to identify the type of interactions engaged in, whether they involve working with groups, with individuals, or working alone. The final

Major Dimensions	Variables
Social Contacts in Design Work	- Time spent with specific groups (eg. top management, end users, programmers, analysts, technical specialists, alone)
Communication Activities	- Time spent in specific communication tasks in the design process (eg. meeting with user committees, obtaining requirements from individual users, working alone on specifications, consulting with techniclal staff, etc.)
Socialization Outside Work	- Social time spent with specific groups (eg. top management, end users, programmers, analysts, technical specialists, alone)

Table 7.4: Initial Dimensions and Variables for the "Communication Patterns" Construct

dimension concerns communication links which exist outside of the work context per se, particularly in terms of preferences for socialization outside of work.

(5) Design Outcomes - Two general areas were identified as eventual outcomes of the design process. Specific indicators were suggested for each of these, as outlined in Table 7.5 below.

The first area concerns the effectiveness of the systems which result from the design process. The limitation of relying on self-report data was evident here, since most designers would tend to assess their work positively, and there was no way to validate claims that were made. For this reason it was considered useful assess these systems not only directly, but also in ways which might not be interpreted as evaluating the systems themselves. In addition to a variable seeking direct assessment of the respondents' system(s), two other avenues were also adopted. The first assessing of the effectiveness of information systems in general, assuming that responses would tend to reflect the designers' own experiences, and the second to assessment the extent to which user's understood and were able to make good use of their systems. This assumed that any difficulties evident in the system would be attributed by the designer to the users, and not to the system.

The second dimension concerns relationships between designers and users arising from involvement in the design process. Specific indicators included the extent to which users understood the nature of the design process, users ability to define their information needs, the degree to which definition of needs is a problem in the design process, and the extent to which disagreements occur between designer and users. These were all assumed to indicate the general health of the relationship between these groups.

Major Dimensions	Variables
System Outcomes	- Designers' assessment of own systems - General effectiveness of IS technology - Clients' understanding and use of systems
Communication Outcomes	- Clients' understanding of design work - Clients' computer literacy - Clients' ability to define information needs - Extent to which defining needs is a problem for designer - Frequency of disagreement between designer and user.

Table 7.5: Initial Dimensions and Variables for the "Design Outcomes" Construct

Questionnaire Development and Pretest

Having specified variables for the principle elements of the model, it was possible to begin questionnaire development. The present section describes the development of an initial draft of the questionnaire, the results of the pretest of the initial draft, and revisions made to complete a final version.

Because of the large number of variables incorporated, one criteria considered in drafting the questionnaire was the ease with which subjects could complete the instrument. It was felt that ease of completion would significantly enhance the response rate. Attention was paid to the structure of response formats in drafting specific items.

For many variables (eg. area of responsibility in current and former positions, Type and Level of education, Type of Organization, Type of computer hardware and Type of applications, Industrial sector, Type of clients, Programming languages, and others), specific sets of response categories were available which could simply be checked off. Variables requiring quantitative responses (eg. Size of organization, Age, Years of experience, etc.) were given predefined response ranges so that answers could also be checked off. The ranges were arbitrary, and selected primarily for convenience.

Some variables required the respondent's assessment regarding the extent to which they experienced certain conditions (eg. how well users can define information needs, how often problems arise from mis-defined needs, how often disagreements arise, how much programming experience they have, and so on). These were given a four-category response scale, with categories defined according to the context of the question (eg. none/very little/moderate/ extensive, or never/occasionally/quite often/always).

Several variables (Managerial/Technical focus of current and previous work, emphasis on Systems vs. Application programming, Time spent in specific design tasks, Time spent with specific groups, Preferences for different occupational groups, time spent in specific communication activities) required an estimate of the relative importance or frequency of various categories was considered appropriate. For these, subjects were asked to provide rankings indicating relative importance, or percentages indicating amount of time spent in a specific activity.

Although the sample was to consist of highly trained professionals, an items were phrased in simple terms. Technical jargon, buzz words and specific product names (eg. names of programs or techniques) were avoided whenever possible. The wording of items was kept neutral and balanced in terms of technical or managerial bias.

When a tentative set of items and response formats had been developed, initial feedback was sought from colleagues with research experience in this field. Their comments were useful in identifying potential difficulties in the wording of questions and responses for several items, and in suggesting an appropriate ordering of the items. A first draft of the questionnaire incorporated these revisions to improve the readability and format of the items.

The initial draft included a total of forty-nine items, including several write-in questions.

Before pre-testing the questionnaire, a tentative coding scheme was prepared to facilitate tabulation of responses directly into a computer file. Many items required categorical responses, limiting the metric qualities of the data to the nominal, or occasionally ordinal level. Other items could be coded as ordinal or interval data. In developing this coding scheme some concern was raised about problems of combining data of different types, and attendant limitations on the analysis which might be permissible. It was decided to examine some of these issues as part of the pretest of the questionnaire.

The next step was to pre-test the questionnaire within a sample similar to that being used in the larger study. A system development group at a major educational institution was enlisted to complete the questionnaire and provide comments on the format of specific items. The pretest sample represented a range of professions within the system development field and was deemed to represent an appropriate parallel of the larger population to be sampled later.

Fourteen questionnaires were returned from the pretest sample. All were fully completed, and several included additional comments on item format and structure. Four major steps were undertaken in using the pretest data to refine and clarify the questionnaire instrument. The first was to review comments provided by the sample regarding item and response clarity. Several comments were helpful in improving the wording of questions. The results also indicated problems with the questionnaire layout. The order of items was found to be awkward and suggestions were made for placing items together in more coherent sections.

A second step was to identify problems with the response formats and coding scheme. Comments from the sample indicated too many different kinds of response types (ie. rankings, percentages, check-off categories, etc.), and a lack of clarity in several four-category scale items. In coding the pretest data for entry into the computer, it was also noted that rankings and scales both tended to eliminate important qualities of the data. Specifically, both types of coding provided only ordinal level data for variables which could easily be represented with data having interval qualities. It was decided to replace these responses with percentage responses used elsewhere in the questionnaire. The reduced the number of distinct response types and improved the metric qualities of the data for several variables. Similar results were obtained by replacing four-category responses with a continuum scale. These changes are reflected in the final version of the instrument in Appendix D.

Using the SPSS-X statistical program, frequency distributions were calculated for each variable as a way of further examining the coding scheme. The results did not indicate any difficulties in these respects. On two items, it was apparent that multiple answers had been provided where a single response had been expected. This led to a revision of the items involved to improve their clarity.

A fourth concern was whether use of categorical responses in several areas would limit the kind of analysis that would be appropriate. While revisions for various items had improved the metric qualities of some data, several items could only be measured at a nominal or ordinal level. This is a frequent problem in questionnaire-based research and is usually overcome by the construction of multi-item scales combining categorical variables to form a single composite variable with improved metric qualities. The final step in the pretest assessed the potential for developing composite variables from items on the current instrument.

It was acknowledged that the size of the pretest sample would preclude rigorous scale construction. However, a scale was constructed for one of the constructs in order to assess the possibility of using such scales with an expanded data set. Variables representing the "Frame of Reference" construct were selected since these were largely categorical in nature. The variables were re-coded to reflect an orientation toward the two frames of reference, based on a hypothetical 10-point scale with managerial and technical orientations at opposite poles. Scores were combined to form a scale by averaging responses for each item. The result was a single indicator describing the overall orientation of each individual as a rating on a ten- point scale.

Frequency distributions and reliability statistics were calculated to asses the utility of the scale as a combination of categorical variables. The frequency distribution, although based on a small sample, suggested that a wide range of values had been attained and that the distribution of values was consistent with what was known about the sample. This suggested that a reasonable degree of variance could be expected, and that composite variables might prove useful in further analysis. The reliability coefficient for this scale was relatively low (alpha=.5511) but supported the idea that categorical variables might be combined to provide indicators with improved metric qualities. It is difficult to assess the effectiveness of this reliability given the sample size on which it was based. However, it was felt that the revised form of the questionnaire would provide data of adequate quality to support the use of composite measures.

Based on these results, several changes were made to improve the questionnaire items, the overall structure of the instrument, and the quality of the data which the instrument was capable of providing. A final draft including these improvements was formulated and arrangements made for its distribution, as discussed in Chapter Five. Additional steps taken in collecting and preparing data for further analysis are described in the next section, in preparation for the analysis of data in the chapter to follow.

A Preliminary Look at the Data

Five hundred copies of the questionnaire were reproduced and distributed according to the sampling methodology described in Chapter Four. The first responses were received within two weeks of the initial mailing, and returns were brisk for the following two weeks. This was interrupted by a postal strike during June of 1986 which lasted nearly three weeks. Because of this, and the onset of summer holidays, it was decided to postpone analysis of the data until the following September. Over the summer, additional responses slowly mounted to a total of ninety four completed questionnaires. The response rate of 18.8% was disappointing, but was not considered unreasonable given the postal strike and the timing of the survey over the Summer.

As questionnaires were received they were assigned identification numbers for coding. Several respondents had included names and addresses and had requested the results be forwarded to them when available. This information was removed and stored separately from the questionnaires to ensure the anonymity of the responses themselves.

The revised coding scheme was strictly adhered to in translating responses from the actual questionnaires into computer files. Coding was done by a paid student assistant, under instructions to discuss all questions with the researcher. In the course of data entry, two of the questionnaires were found to be incomplete. Closer study of these indicated that both had been received by someone not directly involved in systems design. It was decided to drop these from the sample, leaving a total of 92 usable cases (18.6%) in the sample to be analyzed.

Prior to undertaking the analysis this data, standard procedures for inspecting and screening the data were undertaken. This included (1) inspection of data records to identify potential coding problems, (2) examination of frequency distributions for data entry errors and outliers, (3) examination of frequency distributions to ensure appropriate variance on all variables to be used in further analysis, (4) identification of the characteristics of the sample obtained. The results of these steps helped to correct several coding errors and to ensure that the data were appropriately structured for further analysis. The inspection also revealed that sufficient variance had been obtained for most variables to be retained for the analysis. Two items (type of clients and the amount of time spent in systems as opposed to application programming) proved to have insufficient variance to be useful, and were dropped from the study.

The final preliminary step was to provide a description of the sample from which the data was collected. Because the sample is self-selected, it is essential to identify the actual characteristics of the sample, and to assess potential problems of interpretation which might arise in relation to that sample.

Nine variables were examined which provide a useful description of the sample. Most of these describe the design work which participants engage in, or the organizational context in which that work is done. These are useful in identifying any limitations which have to be imposed on the interpretation of further results. One variable described something of the demographic character of the sample. We begin with that variable.

The median age of the sample was 38 years, with ages ranging between 22 and 76. The oldest individual was an extreme case, with the next nearest age being 58. The distribution of ages was normal, with a slight bias toward the younger side of the spectrum. This distribution was seen to present no difficulty for further analysis.

Type of job within the design field was important in describing the sample. While it was intended to provide a balanced and representative sample of positions, the actual composition of the sample appeared to be biased somewhat toward the managerial end of the job spectrum. Nearly half (48.9%) of the sample described their job function as "MIS project management". "System design and consulting" was next with 22.8%, followed by "systems analysts and programmers" at 18.5%. Systems engineers and technical specialists were the smallest group at 2.2%. The bias toward higher level positions was perhaps natural, given that responsibility for system design is not generally given to junior level personnel. It was recognized however that the representation of lower level technical personnel might impact certain comparisons in the analysis. It was deemed important to proceed with some caution in this regard.

Levels of experience in the sample varied considerably. The mean was approximately 11 years, with a range from 1.5 to 46 years. The latter score was, again, an outlier, with the next nearest case being 29 years. The distribution was negatively skewed however, with more cases located at the lower end of the scale. This variable presented no special interpretive problems for further analysis.

The organizational context of work was unevenly represented in the sample. The majority of cases (70.7%) indicated they worked in an MIS department within a larger organization. 10.9% were associated with other departments of large organizations, 8.7 were private consultants, 4.3 from accounting firms, 3.3% were from management consulting firms, and 2.2 were with computer vendors. The majority (45.7%) were employed by firms with over one thousand employees. Only 10.9% worked in firms with less than 50 individuals. The bias in the sample is clearly toward large firms with major MIS installations.

This was seen to be a problem however. It is not unreasonable that a significant portion of the sample would represent this contingent. The fact that the remainder of the sample is evenly distributed over the remainder of the spectrum will still allow meaningful comparisons between organizations of different types. It was acknowledged, at the same time, that the bias of the sample might emphasize the bureaucratized forms of systems development which are common in these environments.

The bias toward larger systems is also reflected in the types of computer hardware evident in the sample. Nearly half of the sample (46.7%) indicated that they deal primarily with mainframe computing equipment. 16.3% use primarily mini computers, and only 7.6% use primarily micro computers and micro computer networks. The low representation of the latter is unfortunate in that this may indicate that some of the newer forms of system development which use micro-based systems may be poorly represented in the sample. This limitation may be alleviated somewhat by the observation that nearly one third of the sample (29.3%) indicated that they have experience with a variety of different types of systems. While a note of caution must be suggested then, it was believed that any imbalances in the sample would not significantly impact the interpretation of findings.

The majority of participants in the study deal with internal rather than external clients. This is an indication of the predominance of large, bureaucratized MIS installations within most organizations. It was believed that the bias in the sample toward such types of technology was not unrealistic vis a vis the actual population.

A final variable examined here concerns the industrial sector from which participants were drawn. While there was a slight predominance of representation from the manufacturing sector (23.9%), there appeared to be an equitable representation of several major sectors in the sample. No concerns were raised that particular sectors were overly dominant or under-represented.

In short, the sample is well balanced in a number of respects. There is a fair representation of the major job classifications in which design work is done, and a good balance of ages and levels of experience. A bias was noted in favor of larger organizations with separate MIS departments and mainframe computers. Because of under representation of some less bureaucratic forms of system design that might be related to this bias, it was cautioned that the analysis might emphasize the nature of more traditional forms of design over others. While this will remain an important consideration in interpreting the results, it was not seen as a serious flaw, since it was believed that larger, bureaucratized systems tend to be the norm in the larger population. Based on these considerations, we can now proceed to the formal analysis of the data. We conclude the present chapter with an outline of the procedures used in the data analysis.

The Method of Data Analysis: A Preview

The questionnaire provided a large and complex data set. While this data might support several different types of analysis, only those techniques used to fulfill the requirements for latent structure analysis are reported here. It is acknowledged that several potentially interesting aspects of the data remain un-analyzed for the moment. In Chapter Four, it was suggested that three major steps were required to ensure the quality of the data entering the final structural analysis. These include:

(1) Provision of operational definitions for each of the constructs in the model,

(2) Provision of empirical support for the composition of the major constructs, and

(3) Provision of empirical support for assumed relationships between major

constructs (cf. James, et al, 1982:26).

These requirements provide the framework under which the present analysis was conducted.

Three major phases of analysis were pursued in fulfilling these requirements, and in completing the final assessment of the model by latent structural analysis. These phases are outlined briefly below. Detailed descriptions of the particular statistical techniques used in each phase, and the results obtained, are provided in the chapter which follows.

I. PHASE ONE: Validation of Major Constructs

The first phase addresses requirements (1) and (2) above. Initial steps toward satisfying the first requirement were already taken in specifying specific sets of variables for each construct. That discussion provided an initial empirical basis for identifying the major components of the model. For present purposes, it was necessary to further specify how particular composite measures were to be derived for each construct from the existing variable sets. The constitution of these composite measures would provide the concrete operational definitions to satisfy Requirement (1).

Requirement (2) demands that the analysis demonstrate empirical support for the definitions specified above. James and associates describe techniques for providing such support in cases where the model is defined in precise mathematical terms (James, et al, 1982, p.54). In the present analysis however, we must initially define these relationships in addition to testing their validity.

A technique appropriate to this purpose is Discriminant Analysis (Dillon and Goldstein, 1984:394). This technique is used to identify differences between pre-defined groups and to test their significance against a given data set. This is done by constructing combinations of descriptor variables which maximize differences between the groups. Where significant differences exist between groups combinations of variables which characterize those differences will be statistically significant. In this sense, Discriminant analysis is can be used to define combinations of variables which describe underlying differences between groups.

Applied in this way, Discriminant analysis provides a useful method for defining and statistically testing composite measures for each construct. The technique also provides descriptive information concerning the importance of specific variables in defining group differences, which is helpful in validating the measures derived. Discriminant analysis thus offered a basis for satisfying both of the requirements outlined above.

To implement this analysis it was necessary to first identify sub-groups within the sample. Such groups had to be clearly related to the OIS design context, and to differ concerning major elements of the model. A basis for specifying groups was sought within the interview data. A recurring finding was that IS design problems arise from the bureaucratic division of design work into specialized tasks. Among the variables describing the organization of design work were descriptors of specific activities undertaken in the design process. It was decided that groups based on these variables would provide an appropriate basis for further analysis.

A Cluster Analysis (Dillon and Goldstein, 1984: 157) was performed using the behavioral indicators described above. When a tentative breakdown of groups had been defined, Discriminant analysis was performed to identify the nature of these groups, and to confirm the appropriateness of these differences for further analysis. Using this grouping, it was then possible to undertake an examination of each of the major constructs using Discriminant analysis. The purpose of this procedure was to construct composite measures for each construct, and to test the in each case to determine the exact nature of the differences within the sample and to help interpret the validity of the measures derived. These initial tests were followed by an analysis of variance to further establish the validity of each construct.

The procedure described above is outlined more concisely in Figure 7.1 below. These steps allow each of the constructs to be examined through an analysis which (1) provides composite measures to operationalize the construct, (2) statistically tests the validity of the functions derived, and (3) provides conceptual validation for the construct in question. The outcomes of this analysis are described in the section entitled "Phase One: Validation of Major Constructs" in Chapter Eight.

Figure 7.1: Outline of Data Analysis Stages and Methods:
PHASE ONE: Validation of Major Constructs

Step 1: Define and validate sub-groups in the sample based involvement in specific design activities.
Techniques:
A. Exploratory Cluster Analysis to establish tentative grouping of cases based on patterns of involvement in design process.
B. Discriminant Analysis of groups to (a) examine the nature of grouping, and (b) test significance of group distinctions.
C. Refined Cluster Analysis using discriminant scores to verify cluster grouping.
D. Analysis of Variance to determine significance of group differences on discriminant function.

Step Two: Define and Analyze of other constructs in relation to groups defined above.
Techniques:
A. Discriminant Analysis to construct composite functions for each construct and to examine group differences on these.
B. Analysis of Variance to describe and test the significance of group differences on each construct.

II. Phase Two: Assessment of Relationships Between the Constructs

The second phase analysis satisfies the third prerequisite for latent structural analysis. This phase represents a relatively straight-forward process of establishing empirical support for the major relationships predicted in the model.

Since each element is represented by a set of specific variables, it was decided that the basic requirement for this phase of the analysis was to demonstrate the presence of statistically significant relationships between these sets. By providing evidence to support the statistical and conceptual validity of these relationships, it was assumed that the final prerequisite for latent structural analysis would be fulfilled.

The technique adopted for this task was Canonical Correlation analysis. Canonical correlations describe relationships between multivariate sets of indicators for more general constructs. Procedures for this analysis calculate linear combinations of variables within each set such that the product-moment correlation between the two is as large as possible. The results of this analysis provide an indication of the strength and statistical significance of the overall relationship, as well as detailed information about the specific contribution of individual variables to that relationship. These results were considered useful in providing statistical as well as conceptual evidence to support the validity of the relationships depicted in the model.

Also included in the output of the Canonical analysis are statistics describing the variance accounted for by each Canonical function. Since functions are derived for both sets of variables, the analysis provides an assessment of variance accounted for in both directions (ie. what percentage of variance in the "criterion" variables is accounted for by the "predictor" variables, and vise versa). While it is not appropriate to attribute causality to correlational statistics, information about the relative potency of each variable set in explaining the other was interpreted as an indication of the directionality of each relationship. Tentative interpretations of causal direction were later used as a basis for specifying the directionality of major relationships between constructs.

In keeping with the exploratory stance of this analysis, it was decided that the analysis would be applied to all possible relationships between constructs in the model. The aim was to determine whether any relationships existed which were not specifically identified in the model, as well as to assess the validity of those that were predicted. The results of this survey of relationships was useful in refining the model, as well as in supporting the relationships already depicted.

These procedures are summarized in Figure 7.2. The results from this phase are reported in Chapter Eight under "Phase Two: Assessment of Relationships Between Constructs."

FIGURE 7.2: Outline of Data Analysis Stages and Techniques:
PHASE TWO: Assessment of Relationships Between Constructs

Purpose: Provide evidence to support the existence of relationships between constructs in the model.

Technique:

A. Canonical Correlation Analysis to determine strength and nature of relationships between sets of variables connected with each construct.

III. PHASE THREE: Formal Validation of the Model

With the major prerequisites for latent structural analysis satisfied, the third phase undertakes a final assessment of the model. Latent structure analysis provides a statistical assessment of a specified model by examining structural relationships among the set of constructs specified in the model. The procedure provides estimates of the strength and directionality of the relationships in that model, and subjects these to statistical tests of "goodness of fit" to provide an overall assessment of how well the model describes the underlying structure of the available data. Where a reasonable fit is demonstrated, the procedure confirms the model's validity. The steps taken in this procedure are outlined in Figure 7.3 below.

FIGURE 7.3: Outline of Data Analysis Stages and Techniques:
PHASE THREE: Formal Validation of the Model

Purpose: Examine structural relationships between constructs and provide statistical support for causal pathways depicted in the model.

Technique:

A. Latent Structural Analysis to assess overall validity of model using composite measures for each major construct.

The present analysis was conducted using the "EQS" structural equations program (Bentler, 1985). The first step was to specify a particular "measurement model" (James, et al, 1982) describing the manifest variables associated with each major construct. The measurement model for the current analysis was based on the composite measures developed in phase one to represent each of the major constructs. The specific arrangement of composite measures described in the results of that phase were used as formal operational definitions for each of the major constructs. Equations describing these relationships formed one component of the EQS input.

A second portion of the input was the specification of structural relationships to be tested. Based on the results of the analysis of relationships between variable sets for each construct, a particular set of relationships were identified for a formal test of the model. These relationships were assumed to be indicative of potential causal relations between the major constructs, the validity of which would be evaluated by the structural equations program. In specifying these relationships, the EQS program required that assumed causal relationships among the constructs be explicitly defined in terms of linear equations.

Confirmatory applications of the EQS program normally include predictions of the magnitude of the parameters defining these relationships. EQS then derives estimates of these parameters based on the available data, and tests the statistical fit of those estimates. Using the program in an exploratory mode, it was decided to allow EQS to estimate the parameters without any specification of initial values. This allowed the program to generate parameter estimates which described the best possible approximation of the specified model given the available data. Statistical tests for goodness-of-fit thus provide an assessment of the model in terms of how well it describes the underlying structure of the data.

The results of this final stage are described in Chapter Eight.

Summary

This chapter undertakes intermediary steps between the first and second phases of the study. Based on the interview results from the previous chapter, specific sets of variables were identified to assist in collecting data on each of the five major constructs in the model. The development and pretesting of a questionnaire instrument to obtain that data was described, and preliminary stages of data analysis were outlined. This prepares the ground for the major analysis which will follow outlined procedures to provide an empirical evaluation of the model. We now turn to the results of that analysis.

CHAPTER EIGHT: Data Analysis

Overview

The previous chapter prepares the way for an assessment of the model using latent structure analysis. The analysis follows a series of exploratory steps in which individual elements are examined in isolation as a preliminary step toward a complete structural analysis. This analysis introduces several refinements concerning the definition of specific constructs and relationships. The final analysis then provides a formal assessment of the model.

The results are reported under three headings: (1) validation of major constructs, (2) assessment of relationships between constructs, and (3) the validation of the model as a whole. The first two sections satisfy the preliminary requirements for latent structural analysis, while the last section reports the outcome of the final assessment. The chapter ends with a summary of the major conclusions from the analysis. The broader conclusions and implications of the study as a whole are discussed in Chapter Nine.

Phase One: Validation of Major Constructs

Step One: Definition of Sub-Groups

I. Initial Cluster Analysis

The first step was to identify sub-groups within the sample. It was decided that variables describing time spent in specific design activities provided a basis for sub-dividing the sample, since these activities reflect the social and technical context of system design. The initial analysis thus sought to determine if systematic patterns of activity could distinguish groups within the sample.

Cluster Analysis (Dillion and Goldstein, 1984) was used to assign individual cases to groups based on similarity of responses to design activity variables. This procedure calculates "distance" estimates between each pair of individuals to indicate similarity and then forms clusters whose scores are closest. This results in assignment of cases to groups whose responses adhere to similar patterns.

The variables used for this procedure were a sub-set of the indicators originally defining the "Bureaucratization of Systems Design" construct. The remaining variables, which describe subjects' organizational context, were set aside for later analysis. The CLUSTER sub-program in SPSS-X was invoked, using standardized scores for the design activity variables. The analysis employed the "hierarchical, agglomerative" clustering process (Dillion and Goldstein, 1984:p.168), and the Cosine of the combined vector of variables as the distance measure (SPSS-X Users Manual:779). The cluster linkage method was the "average linkage between groups" option (Ibid:778).

Output from this procedure has three components: (1) An "Agglomeration Schedule", describing the combination of clusters at each stage in the analysis, (2) A "Classification Table" displaying the assignment of individual cases to a specific cluster for each iteration, and (3) A graphic representation, known as a "Dendrogram", of the clusters derived. The are presented in Appendix E.

While statistical tests are not available to determine the "correct" clustering, an appropriate solution can be interpreted through visual inspection in relation to known characteristics of the sample. In the present case it was assumed that clustering would reflect job categories typically found in design work. This assumption was used to narrow the range of potential solutions to those with a reasonable number of groups - three to eight were considered appropriate for exploratory purposes.

Inspection of the Agglomeration Schedule indicated that distance coefficients dropped abruptly after the six-group solution. The accompanying Classification Table also indicated a stabilization of the clustering process at the six-group solution. Both indicators suggested a six-group solution as appropriate, and were supported by the "dendrogram" display.

II. Discriminant Analysis to Test and Describe Group Differences

Using this solution, a second step was undertaken to examine the nature and significance of these clusters. A discriminant analysis was undertaken to describe the specific combinations of criterion variables which distinguished between the groups, and to identify the composition of each cluster in terms of those variables.

The "DISCRIMINANT" procedure in SPSS-X (Users Manual,p.698) was used for this analysis, using the same criterion variables as above. The "MAHAL" method of computing discriminant functions was selected because it because it explicitly accounts for collinearity among the variables.

A summary of results is presented in Table 8.1. The analysis produced five Discriminant functions, each representing a composite of activity variables distinguishing between the groups defined above. Several indicators are useful in assessing the discriminating value of these functions. The eigenvalues indicate that there is more variability between the groups than within them. Squared canonical correlations indicate the proportion of the total variance explained by group differences on each function (Ibid:104). The results suggest significant

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	4.66402	36.70	.9074399	.0028736	468.18	60	.0001
2	4.08855	32.18	.8963707	.0162760	329.45	44	.0001
3	1.71244	13.48	.7945616	.0828211	199.29	30	.0001
4	1.33895	10.54	.7566093	.2246472	119.46	18	.0001
5	0.90317	7.11	.6888843	.5254385	51.48	8	.0001

Table 8.1 Canonical Discriminant Functions for Design Activity Variables

between group differences on these measures.

Evidence of group differences is also indicated by tests of significance based on the Wilks' Lambda statistic. The Discriminant procedure calculates Lambda for each function and uses a chi-square transformation of this value to test the significance of each function. The results indicate that all five functions are significant beyond the .0001 level, indicating that each function describes significant differences between the groups.

The next step was to identify more concretely the nature of these differences. This was done by examining correlations between the criterion variables and each discriminant function. Table 8.2 illustrates discriminant loadings for each variable on each function. These loadings were subjected to varimax rotation to distinguish patterns in the data.

The results illustrate that each function is associated with a unique set of activity variables, making it possible to describe the specific differences identified between the groups. The three activities associated with Function 1 are writing software specifications, testing and debugging systems, and programming. Since these are all technical aspects of systems production, Function 1 was interpreted as denoting "Technical Production".

	FUNCTION NUMBER				
VARIABLE	1	2	3	4	5
Writing Specifications	.68399*	-.02391	-.16425	-.00126	-.12659
Testing/Debugging	.36951*	-.12019	-.01540	.07678	.02009
Programming	.25849*	-.06134	-.00841	-.10811	.01304
Project Coordination	-.08264	.32884*	.01486	.00041	-.05633
Administering Budgets	-.11630	.31267*	-.00403	.05697	-.09223
Monitoring Progression	-.03207	.29594*	-.01810	-.02856	-.10222
Staff Supervision	-.00785	.24610*	-.01855	-.06758	-.00176
Analyzing Info. Needs	-.18322	-.32426	.74753*	-.10266	-.23302
Planning Implementation	-.02194	.11107	.13107*	.00710	-.12090
Installing Hardware	-.05166	-.11725	-.05733	.95975*	.07843
Trouble-Shooting/Support	-.07700	-.12273	-.08448	.11415	.70172*
User Training	.00908	-.13723	-.02499	-.03030	.54251*

TABLE 8.2 Correlations Between Variables and Discriminant Functions: Design Activity Variables

Function 2 is associated with four activities: meeting clients to coordinate projects, administering project budgets, monitoring project progression, and training and supervising project staff. Since these refer to administrative aspects of design, Function 2 was labeled "Project Administration". Function 3 was associated with analysing information needs and planning systems implementation. Since these tasks concern the conceptual design of systems, Function 3 was identified as "Systems Design and Analysis". The fourth function was associated with only one variable, and was labeled "Installing Hardware". The final function represented trouble shooting and software support, and training users. Since these require extensive client contact, Function 5 was labeled "User Support".

What this analysis suggests is that the six groups differ along five underlying dimensions. The five functions identified above are related to specific aspects of design work, suggesting that significant differences exist among individuals in the sample based on variations in their patterns of professional activity. This finding reinforces the notion of that the professional activities of system designers are strongly affected by the bureaucratic structuring of design work. The present analysis thus provides empirical support for the validity of this construct and indicates that bureaucratization of design work is a significant aspect of the design context. The five discriminant functions provide a set of composite measures for this construct which are both statistically and conceptually valid. The results thus provide an operational definition for this construct, and provide empirical validation for its use in the present model.

III. Refined Cluster Analysis to Define Final Sub-Groups

The analysis above describes group differences related to the bureaucratization of design work. Because the clustering used for that analysis was only tentative however, it was decided that a more refined definition of sub-groups could be obtained by re-clustering the sample using the five composite measures defined above to assign inividuals to groups.

Five discriminant scores were obtained for each individual based on the composite measures defined above. These scores were used in a second cluster analysis to refine the sub-division of the sample. Identical methods and distance measures were used in the second analysis, and the same procedures were used to interpret the results. The Results of this analysis are presented in Appendix F.

As before, a six-group solution provided the most effective clustering. Distance coefficients in the agglomeration table change significantly after the six-group solution. The classification table indicates stabilization of group assignments at this stage, and the Dendrogram illustrates six distinct groups. Based on these results, group memberships defined by this analysis were retained for use in further analyses.

IV. <u>Analysis of Variance to Test Group Differences</u>

A final step in this analysis was to describe the specific nature of the groups identified above. To provide information about group composition, an analysis of variance was performed to (1) test the statistical significance of group differences, (2) examine the specific nature of these differences, and (3) identify the composition of each group.

A simple one-way analysis of variance was provided by the "BREAKDOWN" procedure in SPSS-X (Users Manual, p.373). This provided descriptive statistics for each dimension compared across the six groups, as well as an analysis assessing the strength of between-group differences. Tests of significance were performed, and the ETA and ETA SQUARED coefficients calculated to assess the variance explained by group differences. These results are tabulated below.

Group	Sum	Mean	Std.Dev.	Sum of Squ.
1	-39.8556	-1.37433	.53033	7.87516
2	69.6663	2.58023	1.28391	42.85988
3	-22.6100	-2.51223	1.56879	19.68885
4	1.8297	.18297	.81882	6.03433
5	1.1046	.15781	1.01710	6.20700
6	- 9.5177	- .95177	.465310	1.94862
Total (within groups)	.6173	.00671	.991908	84.61387

ANALYSIS OF VARIANCE

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	300.8962	5	60.1792	61.165	.0001
Within Groups	84.6139	86	.9839		
Total	385.5101	91			

ETA = .8835 ETA SQUARED = .7805

Table 8.3 Descriptive Statistics and ANOVA for FUNCTION 1

Group	Sum	Mean	Std.Dev.	Sum of Squ.
1	64.8292	2.23549	.88952	22.15518
2	-20.4450	- .75722	.68088	12.05380
3	-29.8476	-3.31641	1.82885	26.75781
4	- 2.1014	- .21015	.93179	7.81422
5	- 2.5353	- .36218	.54391	1.77506
6	- 9.4882	- .94882	1.03452	9.63218
Total (within groups)	.4114	.00447	.965619	80.18826

ANALYSIS OF VARIANCE

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	269.7548	5	53.9510	57.861	.0001
Within Groups	80.1883	86	.9324		
Total	349.9431	91			

ETA = .8780 ETA SQUARED = .7709

Table 8.4 Descriptive Statistics and ANOVA for FUNCTION 2

Group	Sum	Mean	Std.Dev.	Sum of Squ.
1	3.1255	.10777	.78798	17.35938
2	3.1839	.11792	.69425	12.53187
3	-31.4154	-3.49060	3.17379	80.58362
4	- 2.0752	- .20752	.97222	8.50696
5	.9611	.13731	.66657	2.66592
6	25.6631	2.56631	1.05376	9.99374
Total (within groups)	- .5569	- .00605	1.23734	131.66806

ANALYSIS OF VARIANCE

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	176.7903	5	35.3581	23.094	.0001
Within Groups	131.6681	86	1.5310		
Total	308.4584	91			

ETA = .7571 ETA SQUARED = .5731

Table 8.5 Descriptive Statistics and ANOVA for FUNCTION 3

Group	Sum	Mean	Std.Dev.	Sum of Squ.
1	- 3.8696	- .13343	.43034	5.18541
2	-11.0604	- .40964	.30193	2.51363
3	- 9.4136	-1.04595	.47675	1.81833
4	- 4.1229	- .41229	.53868	2.61160
5	28.7125	4.10179	3.50304	73.62780
6	- .9417	- .09417	1.04904	9.90437
Total (within groups)	- .6959	- .00756	1.05467	95.66116

ANALYSIS OF VARIANCE

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	134.4497	5	26.8899	24.174	.0001
Within Groups	95.6612	86	1.1123		
Total	230.1109	91			

ETA = .7644 ETA SQUARED = .5843

Table 8.6 Descriptive Statistics and ANOVA for FUNCTION 4

Group	Sum	Mean	Std.Dev.	Sum of Squ.
1	-14.4418	- .49799	.55714	8.69144
2	4.7903	.17741	.97568	24.75078
3	-18.6625	-2.07361	.97830	7.65659
4	28.0451	2.80451	2.18443	42.94567
5	4.0979	.58541	.91273	4.99848
6	- 1.7529	- .17529	.45637	1.87448
Total (within groups)	- 2.0759	.02256	1.02819	90.91747

ANALYSIS OF VARIANCE

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	128.0531	5	25.6106	24.225	.0001
Within Groups	90.9175	86	1.0572		
Total	218.9706	91			

ETA = .7647 ETA SQUARED = .5848

Table 8.7 Descriptive Statistics and ANOVA for FUNCTION 5

These results verify that differences between the sub-groups are significant beyond the .0001 level for all five dimensions. The ANOVA statistics indicate that the two functions concerning technical production and project administration (Functions 1 and 2, respectively) represent the strongest differentiation between groups. The ETA Squared coefficients for these functions (.7805 and .7709) indicate that approximately 78 percent of the variance for each function is accountable by group differences.

As well as indicating the significance of the group differences, the results also provide a detailed description of their nature. By compiling a composite of each groups' ranking on the five dimensions, the composition of each group can be assessed.

	Group Means				
Group	Func. 1	Func. 2	Func. 3	Func. 4	Func. 5
1	- .1374	2.2354	.1077	- .1334	- .4979
2	2.5802	- .7572	.1179	- .4096	.1774
3	-2.5122	-3.3164	-3.4906	-1.0459	-2.0736
4	.1829	- .2101	- .2075	- .4122	2.8045
5	.1578	- .3621	.1373	4.1017	.5854
6	- .9517	- .9488	2.5663	- .0941	- .1752
Total Population	.0067	.0044	- .0060	- .0075	.0225

Table 8.8 Group Means for the Five Discriminant Functions

Table 8.8 summarizes group means for each of the functions. While group differences do not appear to be large, the reader is reminded that these values are based on standardized scores. Scores should be interpreted in terms of standard deviations, with positive scores indicating a group mean above the average for the total population. A score of 1.0 indicates a group mean one standard deviation above average for the sample.

The following group descriptions were derived from these results:

Group 1: This group scored highest on the project administration function. This group spends less time in tasks associated with user support, installation of hardware, and technical production; and were only moderately involved in system design and analysis. This group is thus made up primarily of individuals whose major focus is with the administrative aspect of systems design, and was identified as "MIS Management".

Group 2: Group two consists of members whose major activity is technical production. The group had low scores on functions relating to system design and user support, and scored well below average for installing hardware and project administration. This is consistent with the duties of lower-level Programmer/Analysts.

Group 3: The third group presented an anomaly. This group scored lower than all others on all functions. Assuming that these individuals are indeed appropriate members of the design community, this finding suggests a category of individuals whose involvement in design represents only a small portion of their professional work, or who are involved in some capacity not tapped by the variables measured. It was decided to label this group "Adjunct" participants in the design process, and to retain this group, with caution, for further analysis.

Group 4: Group four consisted of individuals occupied with user support, and to a lesser extent technical production. This group scored low on project administration, design and analysis, and installation of hardware. This configuration appeared to indicate a group with technical expertise, but with responsibility for supporting user applications. The group was identified as being involved with "Software Support".

Group 5: The fifth group scored high on installation of hardware, slightly above average on user support, technical production and systems analysis, and low on administrative activities. This portrays a well rounded group whose focus is with technical aspects of design. This group was characterized as providing "Hardware Support".

Group 6: The final group had high scores on design and analysis, and were below average on all other dimensions. Uninvolved in technical production and support, this group represented involvement in the design process with analytical aspects of design and planning, consistent with that of the "Senior Analyst".

The composition of the sample in terms of these groups is summarized in Table 8.9 below. These results indicate that the principle differences among individuals in the sample are those related to the bureaucratic organization of design work. This finding confirms the validity of this construct, and illustrates its importance as a structural feature of the design context.

Group Number	Number of Members	Professional Category
1	29	MIS Management
2	27	Programmer/Analyst
3	9	Adjunct Professional
4	10	Software Support
5	7	Hardware Support
6	10	Senior Analyst

Table 8.9 Composition of the Sample by Cluster Groups

Summary of Results So Far

The analysis thus far fulfills two major purposes toward evaluating the model. First, a specific set of groups has been identified reflecting distinct patterns of activity within the design context. These groups represent an important source of variance in the sample clearly related to structural aspects of the design context. These groups thus provide a useful basis for examination of other constructs.

Second, the analysis validates of the construct relating to the "Social Organization of the Design Community", particularly relating to the bureaucratic segmentation of that community. In future, we will focus on that facet of the design community, using the term "Bureaucratization of System Design" to reflect this aspect of social organization. The analyses above provide five composite measures which offer a specific operational definition for that construct. In these ways the analysis fulfills the first two requirements for latent structure analysis as they relate to this construct.

Step Two: Definition and Validation of Constructs

The next step in the analysis was to seek empirical definition and validation for the remaining constructs in the model. This step consists of a series of discriminant analyses seeking to (1) define composites of variables which provide reliable measures for each construct, (2) test the utility of these composites in defining differences between the groups identified above, and (3) describe the nature of these differences.

Variables used to examine the major constructs were specified earlier in Tables 7.1 to 7.5. As the reader will recall, items for "Social Organization of the Design Community", were partitioned into sub-sets, one of which was used above to describe the bureaucratic nature of that community. The remaining sub-set describes the organizational contexts in which these groups operate. To preserve this distinction, the latter will be treated as a distinct construct for the remainder of the study. With this addition, the variables described above formed the basis for the present analyses.

Items identified for each construct were entered as criterion variables into a Discriminant analysis using the sub-groups defined above. The results of each analysis are presented below in tables describing the Discriminant functions derived and related descriptive and test statistics. Relationships between the functions obtained and the initial variables are also tabulated to assist in interpreting the dimensions on which groups differed. These results include an analysis of variance for each function, to test the significance of group differences, and describe their nature. The results are reported separately for each major construct.

I. <u>The "Frame of Reference" Construct</u>

Variables representing this construct were coded with a view toward specifying subjects' basic interpretive schemes as being oriented toward either managerial or technical concerns. For variables with categorical response formats (eg. current and previous area of responsibility, type and level of education, group affiliations, and so on) a coding scheme was developed which assigned values ranging from one to ten based on their relative managerial or technical emphasis. Responses indicating a technical orientation were assigned scores below five while those indicating managerial oientation were assigned scores above five. Individual responses were coded in accordance with this standard scheme.

These variables were entered as criterion variables into a Discriminant analysis as described above. The results of this analysis are detailed in Table 8.10 below. Part 1 of the table indicates that only one discriminant function was identified. This function was significant at the .0001 level and accounted for 82.5 percent of the variance among the criterion variables. The eigenvalue (.83974) and Canonical correlation (.6756) for this function indicate that a substantial proportion of the variance within the sample is attributable to group differences defined by this composite.

PART I. Summary of Discriminant Functions

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	.83974	82.50	.6756073	.4599141	58.09	15	.0001
2	.15424	15.15	.3655517	.8461229	10.77	8	.2146
3	.02393	2.35	.1528799	.9766277	1.52	3	.6764

PART II. Correlations Between Frame of Reference Variables and Discriminant Functions

VARIABLE*	FUNCTION NUMBER 1	2	3
Job Responsibility	.99636*	.08512	-.00348
Tech/Mgmt Focus	.64646*	.30813	.05872
Group Affiliation	.20024	.97768*	-.06362
Tech/Mgmt Association	.07899	.34922*	.08191
Type of Education	.03214	.07893	.99636*

*Variables for Previous work experience and Focus of Design work were excluded from the analysis by the DISCRIMINANT procedure.

PART III. Descriptive Statistics and ANOVA for Discriminant Function 1

Group	Sum	Mean	Std.Dev.	Sum of Sqs.
MIS Management	22.6167	.98333	.48527	5.18083
Programmer/Analyst	-18.1585	-.75660	.91649	19.31905
Adjunct	.3448	.04310	1.60507	18.03381
Software Support	-4.4017	-.48908	1.34496	14.47150
Hardware Support	-1.4784	-.29569	1.50740	9.08904
Senior Analyst	1.7665	.19627	.83887	5.62970
Total (within groups)	.6893	.00883	.99808	71.72396

A N A L Y S I S O F V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	38.9242	5	7.7848	7.8148	.0001
Within Groups	71.7240	72	.9962		
Total	110.6482	77			

ETA = .5931 ETA SQUARED = .3518

Table 8.10 Summary of Discriminant Analysis of Frame of Reference Variables*

The composition of this function is described in Part II of the Table. Note that variables describing previous work experience and focus of design work were excluded from the analysis because they failed to reach minimum statistical tolerances. This can be interpreted to suggest that no significant group differences were apparent on these variables. Among the remaining variables, those reflecting current job responsibility, type of design work, and group affiliation preferences were particularly important in defining this function, while type of education and time spent with different groups were relatively less important.

Part III of Table 8.10 provides an analysis of variance to further test and describe group differences identified by the Discriminant function identified above. These results provide additional statistical and conceptual support for the validity of the Frame of Reference construct. Recalling that criterion variables for this analysis were coded to reflect the degree of technical (low) or managerial (high) orientation, the results describe group differences which are consistent with expectations. For example, mean scores indicate that Group 1 (MIS management) scored quite high (.98333), Groups 6 (senior analysts) and 3 (the adjunct group) scored just above the population average (.19627 and .04310, respectively), while Groups 5, 4 and 2 (all technically oriented groups) scored below average for the total population. This coincides with the expectation of different professional orientations within the design context.

The ANOVA results support this conclusion, indicating that these group differences are significant at the .0001 level. It should be noted that the ETA SQUARED coefficient indicates that, while significant, group differences on this function only account for approximately 35% of the total variance. This suggests that additional sources of variance affect the sample.

In total, the results support the validity of the Frame of Reference construct, at least inasmuch as the variables included here capture significant aspects of that construct. The discriminant function identified provides a composite measure for this construct which delineates significant group differences. These results are interpreted as providing appropriate empirical support for the construct in question.

II. The "Organizational Context" Construct

This section describes the results of an analysis to establish the validity of the sub-set of variables remaining after variables for "Social Organization of System Design" were partitioned in Step One. The remaining variables describe aspects of the "Organizational Context".

These variables were coded to reflect differences among organizations in terms of the flexibility each presented as an environment for design work. Coding was based on the assumption that large, bureaucratic organizations represent an relatively rigid and inflexible environment as compared with smaller, more informal firms, and used a ten-point scale to characterize organizational features as either flexibile (high) or inflexibile (low).

The variables were entered into a Discriminant analysis, using the same procedures as above. The results of this analysis are summarized in Table 8.11. One composite function was identified which indicated differences between sub-groups significant at the .02 level. The relatively low eigenvalue (.2211) and Canonical correlation (.4255) for this function indicate that, while significant, the function accounts for only a small proportion of the between-groups variance.

The composition of this function is described in Part II of the table. The results indicate that the differentiation between groups is based on only two of the original six variables: the type of computing hardware used and the size of

PART I. Summary of Discriminant Functions

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	.22114	82.49	.4255522	.7821970	20.88	60	.0219
2	.04693	17.51	.2117220	.9551738	3.89	44	.4199

PART II. Correlations Between Organizational Context Variables and Discriminant Functions

VARIABLE	FUNCTION NUMBER 1	2
Type of Hardware	.99976*	.02212
Size of Organization	.32289*	-.11280
Industrial Sector	.00017	1.00000*
Type of Organization	-.26683	.34137*

PART III. Descriptive Statistics and ANOVA for Discriminant Function 1

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	.6000	.02069	1.00594	28.33416
Programmer/Analyst	- 2.2924	-.08490	.80251	16.74489
Adjunct	4.6365	.51517	1.08747	9.46086
Software Support	- .1696	-.01696	1.21847	13.36208
Hardware Support	-7.5588	-1.07983	1.40053	11.76901
Senior Analyst	6.0439	.60439	.83929	6.33969
Total (within groups)	.6893	.01369	1.00006	86.01072

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	14.3966	5	2.8793	2.8790	.0186
Within Groups	86.0107	86	1.0001		
Total	100.4073	91			

ETA = .3787   ETA SQUARED = .1434

Table 8.11 Summary of Discriminant Analysis of Organizational Context Variables

the organization. Two variables (Type of clients and Type of applications) were eliminated from the analysis because they failed to fulfill computational tolerances. The remaining variables (Type of Organization and Industrial Sector) contributed insignificantly to the composite function. It appears that the distinction between sub-groups is primarily a product of differences in the technical environment, with the size of the organization constituting a secondary influence.

Part III of Table 8.11 describes the analysis of variance evaluating group differences on the significant function. The results indicate that group means differ only slightly on this function. Recalling that variables were coded to reflect flexibility (high) or rigidity (low) in the organizational environment, these differences do conform with expectations. Technical groups including programmers and hardware support personnel scored relatively low on this dimension, suggesting a relatively inflexible environment consistent with the use of large mainframe systems. Groups scoring higher on this function, including administrators and systems analysts, appear to work within a more flexible setting (eg. organizations using micro-technology or a mixture of technologies).

These differences are supported by the ANOVA results which indicate that differences on this function are significant at the .018 level. The differences do not appear to be particularly strong. The ETA SQUARED coefficient indicates that only 14.3% percent of the total variance is accounted for by these differences. As defined here therefore, the organizational context appears to constitute a only minor point of difference within the sample.

These results indicate a minimal level of support for the "Organizational Context" construct. Reflecting differences organizational size and type of computing hardware, this construct can be considered statistically valid, but only of minor importance.

III. The "Design Tools" Construct

Variables for this construct were coded to reflect the assumed association of traditional design techniques (notably, structured design and programming) with increasing routinization and standardization of the design process, and non-traditional methods (eg. use of fourth-generation software, prototyping, and so on) with a more flexible and user-oriented process. The coding used a ten-point scale to indicate traditional techniques at the higher range and innovative techniques in the low range.

A Discriminant analysis was conducted using variables specified for this construct and following the established procedure. The results are presented in Table 8.12. Part I of the table indicates that three significant functions were obtained. The first accounted for 41.7% of the variance within the variable set and indicated a differentiation between groups significant at the .002 level. Function two accounted for 28.1% of the variance and was significant at .015. The third was just significant at .041, and represented an additional 20.1% of the variance. The three functions accounted for a cumulative total of 89.96% of the variance in the criterion set.

Eigenvalues and Canonical correlations for the three functions indicate that each represents a moderate differentiation between groups. Function 1 is the strongest, representing group differences which account for approximately 42% of the variance. Functions 2 and 3 provide a weaker differentiation of groups, representing 36% and 31% of the variance, respectively.

The composition of the three significant functions is depicted in Part II of Table 8.12. Function 1 provides the clearest distinction between groups in the sample, primarily representing differences in the levels of analysis designers use to focus their design efforts. These levels range from narrowly defined aspects of the problem at hand to a broad analysis of the organization's business practices. Function 2 reflects the use of fourth generation software, prototyping, and to a lesser extent, the amount of programming experience. In combination, these variables indicate a differentiation based on the extent to which non-traditional methodologies are used. Function 3 is comprised of variables concerning use of structured programming and structured design, and an emphasis toward maintenance programming. These relationships indicate that structured techniques tend to be associated with more routine aspects of the development cycle.

PART I. Summary of Discriminant Functions

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	.22489	41.71	.4284851	.6066913	41.97	20	.0028
2	.15150	28.10	.3627210	.7431295	24.93	12	.0151
3	.10863	20.15	.3130305	.8557126	13.08	6	.0416
4	.05411	10.04	.2265589	.9486711	4.42	2	.1094

PART II. Correlations Between Tools Variables and Discriminant Functions

VARIABLE	FUNCTION NUMBER 1	2	3	4
Design Focus	.99970*	.00406	-.01188	.02085
4GL Experience	-.04806	.96374*	.23849	.10964
Prototyping	.07324	.72914*	.19279	.21087
Programming Experience	-.05684	.26621*	.24282	.22525
Structured Programming	.01244	-.27238	-.93165*	-.24018
Syst vs. Appl Programming	.10222	.23632	.57257*	.56598
Structured Design	.01305	-.11141	-.38428*	-.14521
Maint vs. New Programming	.01091	.22493	.35363	.90787*

Table 8.12 Summary of Discriminant Analysis of Design Tools Variables

PART III. Descriptive Statistics and ANOVA for Discriminant Functions 1 to 3

Function 1:

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	5.6717	.20256	.98772	26.34102
Programmer/Analyst	.3086	.01143	.95431	23.67873
Adjunct	3.1723	.35248	1.12641	10.15149
Software Support	-1.5824	-.15824	1.22056	13.40792
Hardware Support	-9.3527	-1.33610	.74603	3.33939
Senior Analyst	1.1512	.11512	.95282	8.17095
Total (within groups)	-.6311	-.00693	1.00052	85.08853

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	15.1455	5	3.0291	3.0259	.0146
Within Groups	85.0885	85	1.0010		
Total	100.2340	90			

ETA = .3887   ETA SQUARED = .1511

Function 2:

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	-1.7566	-.06273	1.01497	27.81449
Programmer/Analyst	5.1577	.19102	1.06681	29.59032
Adjunct	-3.3163	-.36847	.98701	7.79357
Software Support	5.2229	.52229	.90923	7.44043
Hardware Support	-5.7430	-.82042	.61326	2.25659
Senior Analyst	1.0204	.10204	1.06079	10.12763
Total (within groups)	0.5851	.00643	1.00013	85.02305

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	9.8574	5	1.9715	1.9710	.0912
Within Groups	85.0231	85	1.0003		
Total	94.8805	91			

ETA = .3223   ETA SQUARED = .1039

Function 3:

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	-11.7333	-.41904	.95049	24.39293
Programmer/Analyst	9.0287	.33439	.87754	20.02234
Adjunct	.6417	.07130	1.27532	13.01166
Software Support	-3.0653	-.30653	1.11566	11.20432
Hardware Support	.3911	.05587	1.00743	6.08955
Senior Analyst	3.1914	.31914	1.16523	12.21998
Total (within groups)	-1.5454	-.01698	1.01135	86.94080

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	9.9356	5	1.9871	1.9428	.0956
Within Groups	86.9408	85	1.0228		
Total	96.8764	90			

ETA = .3202   ETA SQUARED = .1026

Table 8.12 Summary of Discriminant Analysis of Design Tools Variables

Part III of Table 8.12 describes the analysis of variance for the three Discriminant functions. A comparison of group means on Function 1 indicates that administrative personnel (Group 1) and senior analysts (Group 6), along with the "adjunct" group (Group 3), tend to use a broader level of analysis in approaching the design task than do the others. The group connected with technical and hardware concerns (Group 4) averages noticeably lower on this function, indicating a major difference in design focus for this group. The ANOVA results for this function show these differences to be significant at the .014 level, but that only a small amount of the variance in the sample (15.1%) is attributable to these differences. This function thus appears to represent a significant, but weak difference between groups.

Means for Function 2 and 3 are even less effective in distinguishing the groups. The results indicate that group differences on both functions failed to reach significance at the .05 level. Examination of group means for both functions does indicate a differentiation that is consistent with the model however. Use of innovative design tools (Function 2) appears more prevalent among analysts and support personnel than among administrative or technical groups. Programmers, hardware specialists, and senior analysts seem to be more active users of traditional structured techniques. While weak, these differences offer minimal support for relationships suggested by the model.

The major dimensions of difference for the "Design Tools" construct concern the focus of the design methodology and the use of traditional or innovative design techniques. Group differences on these dimensions are consistent with predictions from the model, but provide only a weak basis for distinguishing between groups. These results indicate partial support for the construct, acknowledging that certain aspects of the construct were notstatistically significant.

IV. The "Communication Patterns" Construct

Variables included as indicators for the "Communication Patterns" Construct included estimates of time spent by design personnel in specific communication activities, time spent with specific groups, and patterns of social contact on and off the job. Responses on these variables were coded using the same ten-point scale used elsewhere in this analysis, to indicate preferences for managerial (high) or technical (low) associations.

A Discriminant analysis was performed using these items. The results of that analysis are summarized in Table 8.13. Part 1 of the table reveals that two composite functions described significant differences between sub-groups. These functions represent, respectively, 48.2% and 35.6% of the variance in the variable set, with a cumulative total of 83.8%. Eigenvalues and Canonical correlations for these functions indicate that both provide a significant basis for discriminating between groups. Between-group differences defined by Function 1 were proportionally larger than within-group differences (Eigenvalue=.436), and accounted for 55.1% of the total variance. Differences on Function 2 were slightly smaller (Eigenvalue=.322; 49.3% of total variance). Function 1 defined group differences significant at the .0001 level, while Function 2 was significant at .004.

The composition of these functions is described in Part II of Table 8.13. Function 1 is composed of variables describing a communication pattern consistent with the stereotype of the isolated technical specialist, with high loadings for working alone, smaller loadings indicating association with technical groups, but with low scores for meeting clients in groups and working with top management. Function 2 represents an very different pattern, with strong loadings on variables indicating active working interactions with other design staff and clients. Both functions portray differences in interaction patterns among the

PART I. Summary of Discriminant Functions

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	.43615	48.24	.5510841	.4579061	65.22	25	.0001
2	.32212	35.63	.4936007	.6576216	34.99	16	.0040
3	.10432	11.54	.3073535	.8694577	11.68	9	.2319
4	.04125	4.56	.1990485	.9601604	3.39	4	.4941
5	.00023	0.03	.0151100	.9997717	0.19	1	.8902

PART II. Correlations Between Communication Variables and Discriminant Functions

VARIABLE	FUNCTION NUMBER 1	2
Working on tasks alone	.98272*	.00002
Time Spent Alone	.45594*	-.28286
Time Spent with Programers	-.00892	.99173*
Time Spent meeting with staff	-.10969	.22131*
Time Spent with individual clients	-.02850	-.05453
Time Spent with client groups	-.20804	.16264
Tech vs. Mgr Socialization	-.15850	-.01797
Time Spent with top Management	-.13539	-.16196

PART III. Descriptive Statistics and ANOVA for Discriminant Functions 1 and 2

Function 1:

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	-14.9088	-.53245	.95563	24.65745
Programmer/Analyst	19.0977	.70732	.91362	21.70260
Adjunct	- .8296	-.10370	1.59143	17.72870
Software Support	-4.7760	-.47760	.94502	8.03772
Hardware Support	1.0152	.14502	.45227	1.22738
Senior Analyst	.4015	.04015	1.08761	10.64608
Total (within groups)	-2.7760	-3.08424	1.00000	84.00000

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	23.9770	5	4.7954	4.7954	.0007
Within Groups	84.0000	84	1.0000		
Total	107.9770	89			

ETA = .4712 ETA SQUARED = .2221

Function 2:

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	13.8227	.49366	1.34836	49.08819
Programmer/Analyst	.2692	.00997	.67884	11.98147
Adjunct	-9.9047	-1.23809	.44894	1.41088
Software Support	- .7392	- .07392	1.02191	9.39880
Hardware Support	1.2364	.17664	.72159	3.12416
Senior Analyst	-4.6844	- .46844	.99980	8.99648
Total (within groups)	-2.2200	-2.46772	1.00000	84.00000

A N A L Y S I S   O F   V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	21.5571	5	4.3114	4.3114	.0015
Within Groups	84.0000	84	1.0000		
Total	105.5571	91			

ETA = .4519 ETA SQUARED = .2042

Table 8.13 Summary of Discriminant Analysis of Communication Patterns Variables groups which are consistent with the model.

The group differences identified by the two functions are described in Part III of Table 8.13. Group means for Function 1 indicate that technically oriented groups (ie. programmers and hardware specialists) tended to score higher on this dimension. Administrative and software support personnel scored relatively low on this dimension, indicating that they seldom work alone. This is borne out by a comparison of group means for Function 2, where administrative staff score well above the others, indicating an active involvement with others. The remaining groups all scored relatively low on this dimension, suggesting a general tendency among technically groups to operate in a more isolated environment. Notable here is the finding that Senior Analysts do not appear to be any more active in communication than their technical peers, and in fact may even be more isolated.

Analysis of variance for the composite functions indicate that group differences are statistically significant at the .0007 level for Function 1, and at the .0015 level for Function 2. In addition, the ETA SQUARED coefficients indicate that these differences account for a reasonable amount of the total variance, with Function 1 responsible for 22% and Function 2 reflecting 20%.

These results support the "Communication Patterns" construct. Two significant composites were identified which describe important differences among the sub-groups in the sample. These differences are both statistically significant and conceptually meaningful, thus confirming the validity of the construct.

V. The "Design Outcomes" Construct

Variables representing this construct were originally defined under two general categories: (1) outcomes relating to the relationship between designers and users (ie. communication outcomes), and (2) outcomes related to systems performance (ie. systems outcomes). To retaining consistency with previous coding the original variable set was re-coded using a ten-point scale to reflect positive outcomes on the high end of the scale and negative outcomes on the low end. These variables were entered in a Discriminant analysis identical those above. The results are outlined in Table 8.14.

Part 1 of the table indicates that no composite functions were identified which were significant at the .05 level. However, one function which accounted for 82.6% of the variance did achieve significance at the .08 level. While this is not highly significant, the eigenvalue and Canonical correlation for this function suggested that group differences of some import were represented by this function. The eigenvalue of .1777 indicated that between-group differences were proportionally larger than the within-group variance. The Canonical correlation of .388 indicates that group differences defined by this function account for a 38% of the total variance. Based on these results, it was decided to tentatively retain this composite for further examination.

The composition of the function is examined in Part II of Table 8.14. The function primarily reflects the occurrence of disagreement between designers and users and difficulties in defining users' information needs, with designers assessment of users' computer literacy contributing only a minor component. Group differences defined by this function are thus related to the extent to which agreement and understanding is achieved between designer and user concerning information requirements. This difference is consistent with the model and constitutes a valid dimension of the outcomes construct. The lack of systematic relationship with other variables indicates that some difficulty exists either in the specification and measurement of variables for this construct, or in the model itself.

PART I. Summary of Discriminant Functions

FUNCTION	EIGEN-VALUE	PERCENT OF VARIANCE	CANONICAL CORRELATION	WILKS LAMBDA	CHI-SQUARED	D.F.	SIG.
1	.17727	82.69	.3880448	.8190313	16.37	10	.0895
2	.03710	17.31	.1891486	.9642228	2.987	4	.5599

PART II. Correlations Between Design Outcome Variables and Discriminant Functions

VARIABLE	FUNCTION NUMBER 1	2
Frequency of Disagreement	.99895*	.04586
Difficulty in assessing needs	.31751	.94825*
Clients' knowledge of design	.07593	.28115*
Clients definition of needs	.00549	.27303*
MIS Effectiveness	.00549	.27303*
Clients knowledge of systems	.05360	.23376*
Clients computer literacy	.18873	.21573*

PART III. Descriptive Statistics and ANOVA for Discriminant Function 1

Group	Sum	Mean	Std.Dev.	Sum of Squ.
MIS Management	4.4877	.15475	.92993	24.21388
Programmer/Analyst	2.5260	.09355	1.09421	31.12987
Adjunct	-3.0669	-.47238	.97702	5.72749
Software Support	-8.3015	-.83015	.87504	6.89127
Hardware Support	2.7206	.38866	.83966	4.23023
Senior Analyst	1.4511	.14511	1.03076	9.56227
Total (within groups)	-.4225	-.00469	.98654	81.75504

A N A L Y S I S O F V A R I A N C E

Source	Sum of Squares	D.F.	Mean Square	F Ratio	Sig.
Between Groups	10.6504	5	2.1301	2.1886	.0630
Within Groups	81.7550	84	.9733		
Total	92.4054	89			

ETA = .3395 ETA SQUARED = .1153

Table 8.14 Summary of Discriminant Analysis of Design Outcomes Variables

The ANOVA results for this function (Part III) several interesting differences. The highest scoring group on this function were the hardware specialists. Administrative personnel and Senior analysts were next highest, followed by programmers. All of these groups report a somewhat positive evaluation design outcomes. The adjunct and the software support groups tended to assess outcomes negatively. Interestingly, members of the software support group would also be most likely to have direct contact with users, since it is their job to solve systems problems. The relatively positive results for the other groups may thus reflect some degree of insulation from the actual outcomes of the design process.

These differences were significant only at the .06 level, indicating only weak support for the distinctions indicated. This is confirmed by thé ETA SQUARED coefficient, which indicates that only 11.5% of the variance can be attributed to group differences.

These results indicate only marginal support for the "design outcomes" construct. The validity that might be ascribed to the construct appears to reside in only one or two items from the original variable set. The differences indicated by those variables are consistent with the model however, and do offer tentative conceptual support for the construct. Problems in supporting this construct may be related to problems in measuring the construct. The use of self-report assessments of outcomes may have been ineffective in obtaining a valid representation of important aspects. Because some indications of support have been identified, the construct will be tentatively retained for further analysis, acknowledging the need for caution in interpreting further results.

Summary of Phase One

The analyses conducted in this phase establish empirical support for the majority of constructs outlined in Chapter Four. For most cases evidence has been provided to satisfy the first two of the three prerequisites for Latent Structure Analysis.

In evaluating each element of the model refinements have been made to the original definitions of major constructs. Statistical examination of the variable sets for each component has facilitated the elimination of certain indicators which did not pass statistical tollerances. Discriminant analyses of each variable set have enabled specific composite measures to be defined for each construct. The composite functions derived in these analyses will constitute specific measurement relationships for each construct, satisfying the first prerequisite.

The identification of significant group differences for various composite functions provides evidence supporting both the conceptual and statistical validity of the constructs in question. The statistical performance of each composite is assessed within the original Discriminant analysis, as well as by an additional analysis of variance for each function. The results assess the validity of each construct by testing the consistency of the results against predictions from the model. The analyses thus also satisfy the second prerequisite by establishing the statistical and theoretical validity of the principle constructs.

These results indicate substantial validation for many of the constructs, and at least marginal support for others. In the latter cases, weak support may be associated with measurement problems related to the original variables. Support was weakest for constructs whose original variable set included several items which did not correlate with significant functions. It was decided to retain these constructs for further analysis, acknowledging potential limitations on the interpretation of results.

PHASE TWO: Assessment of Relationships Between Constructs

Phase Two concerns provision of empirical support for the relationships depicted in the model to satisfy the third requirement for Latent Structure Analysis. The technique used to validate these relationships is Canonical correlation analysis. This procedure provides an assessment of the strength and statistical significance of relationships between multivariate sets of indicators for complex constructs, as well as an examination of the contribution of specific indicators to that relationship. These results provide evidence necessary to assess both the statistical and conceptual validity of the relationships in question.

The analysis was conducted using the MANOVA procedure in SPSS-X to test all possible relationships among the six constructs described in the analyses above. This was done to ensure that no valid relationships were overlooked. Since Canonical analysis assesses relationships between sets of variables, it was considered necessary to specify a minimum of two variables to represent each construct. Where the previous analysis identified two or more functions for a construct, these were used directly in the analysis. Where only one function was identified, the variables composing that function were used instead to facilitate the multivariate analysis. Although it was considered desirable to have at least two composite measures for each construct, the alternative allowed constructs with only one significant function to be included in the present analysis. Where the model suggested a specific causal direction in these relationships, the construct considered the "cause" was used to define the "Predictor" variable set, while the "effect" construct was delineated the "Dependent" set.

The results are described below in Tables 8.17 to 8.24, which summarize the analyses in which significant relationships were obtained. For each, the following information is provided: (1) Eigenvalues and Canonical Correlations for the Canonical roots derived, (2) Multivariate Tests of Significance for the analysis, (3) A Dimension Reduction analysis indicating the significance of individual Canonical roots, (4) Correlations of Predictor and Dependent Variables with significant Canonical roots. Assessments of the validity of each construct are discussed separately below.

I. The Relationship Between Frame of Reference and The Bureaucratization of Systems Design

The relationship between these constructs was analysed using the following variables: (1) Bureaucratization of Systems Design was represented by the five composite functions defined earlier; (2) Frame of Reference was represented by the five indicators which strongly correlated with the single composite function for this construct (see Table 8.9). Since frame of reference was considered a contributing factor in relation to the bureaucratic segmentation of design, these variables were defined as the predictor set, with Bureaucratization constituting the dependent set.

The results of the analysis are presented in Table 8.15. Part I of the table describes eigenvalues, canonical correlations, and squared correlations for each of five roots derived in the analysis. Eigenvalues and variance statistics both indicate that the first function accounts for the majority of the variance (approximately 20%) in the predictor variables. Canonical correlations for the five roots indicate that the first root describes a relatively strong relationship between the two constructs (correlation of .7090), while the others represent only weak or negligible relationships (all less than .35). Squared correlations for these results indicate that only the first root accounts for any appreciable proportion of variance (50.2% compared with 10.8% for the next largest function).

Tests of significance in Part II of the table indicate that the correlation between the two sets of variables is significant beyond the .001 level. This can be interpreted to mean that the predictor set of variables (ie. Frame of Reference) has a statistically significant impact on the dependent variable set (ie. Bureaucratization) (Norusis, 1985:p.224). Part III provides a "Dimension Reduction Analysis" which assesses the number of Canonical roots which have a

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	1.01099	19.9595	.70904	.50273
2	.12142	9.6029	.32905	.10827
3	.07536	5.9602	.26472	.07008
4	.05659	4.4756	.32143	.05356
5	.00002	0.0016	.00461	.00002

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.73466	2.41136	25	.000
Hotellings	1.26438	3.25704	25	.000
Wilks	.39026	2.84434	25	.000

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 5	.39026	2.84434	25	.000
2 to 5	.78481	1.05931	16	.396
3 to 5	.88010	.99168	9	.449
4 to 5	.94642	.69310	4	.430
5 to 5	.99998	.00149	1	.969

PART IV. Correlations Between Predictor and Dependent Variables

	Variable*	Canonical Root 1
Predictor Variables	Type of Education	.34938
	Previous Work Experience	.32112
	Job Responsibility	.94145
	Group Affiliation	.66646
	Tech vs Mgr Focus of Work	.86568
Dependent Variables	Technical Production	-.79965
	Project Administration	.43002
	System Design and Analysis	-.01551
	Installing Hardware	-.25833
	User Support	-.58456

Table 8.15 Canonical Correlation Analysis of Relationship Between Frame of Reference and Bureaucratization of System Design

significant impact on this relationship. The results show that only the first function represents a significant relation between the constructs in question.

Part IV of the table is useful in examining the contribution of specific variables in defining the relationship between the constructs. Among frame of reference variables, those relating to current job responsibility, technical or managerial focus of professional work, and group affiliations, figure most significantly, while those relating to education and previous work experience are only moderately important. Among the variables for Bureaucratization, composites reflecting involvement in technical production, user support, and project administration have the largest impact. This suggests that the relationship primarily concerns differences in professional activity related to subjects' orientations toward technical or managerial positions. Such differences are consistent with the model, and clearly in line with the expected nature of this relationship.

The results thus provide support the validity of a relationship between the Frame of Reference and Bureaucratization constructs. The relationship is both statistically significant and consistent with predictions from the model. The results thus confirm the validity of the relationship in question.

II. <u>The Relationship Between Frame of Reference and Communication Patterns</u>

Variables used for the frame of reference construct in the previous section were retained for the present analysis. The Communication Patterns construct was represented by the variables which comprised the two significant functions defined in the earlier Discriminant analysis (see Table 8.13). Frame of reference was considered a contributing factor to differences in communication patterns and was therefore defined as the predictor set. The results are described in Table 8.16.

Five Canonical functions were derived, among which the first three account for the majority of the variance. However, the dimension reduction analysis in Part II indicates that only the first two of these functions are statistically significant. Related eigenvalues and variance statistics indicate that a moderate total of 78.1% of the variance is accounted for by these functions. Canonical correlations for the two roots (.6757 and .5134) also indicate a moderate association between the two constructs. Tests of significance indicate that variables representing frame of reference have a significant impact on communication patterns. This relationship was significant beyond the .001 level.

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.84053	54.85535	.67578	.45668
2	.35808	23.36921	.51348	.26367
3	.25912	16.91057	.45364	.20579
4	.05863	3.82667	.23535	.05539
5	.01591	1.03820	.12514	.01566

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.99718	2.42002	35	.000
Hotellings	1.53227	2.73182	35	.000
Wilks	.29544	2.60966	35	.000

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 5	.29544	2.60966	35	.000
2 to 5	.54376	1.81250	24	.014
3 to 5	.73847	1.41307	15	.145
4 to 5	.92982	.62061	8	.759
5 to 5	.98434	.36058	3	.782

PART IV. Correlations Between Predictor and Dependent Variables

	Variable*	Canonical Root 1	Canonical Root 1
Predictor Variables	Type of Education	.40986	-.31114
	Previous Work Experience	.23812	.22256
	Job Responsibility	.67120	.42054
	Group Affiliation	.91753	-.09376
	Tech. vs Mgr. Focus	.62890	-.18444
Dependent Variables	Meeting clients individually	.41778	.03016
	Meeting clients in groups	.33106	.05440
	Working Alone	-.53797	.03402
	Time spent with management	.66956	.49195
	Time spent with programmers	-.05921	.30412
	Time spent alone	-.42886	.12467
	Tech. vs. Mgr. Socialization	.71971	-.32917

Table 8.16 Canonical Correlation Analysis of Relationship Between Frame of Reference and Communication Patterns

Part IV illustrates the relative importance of specific variables in this relationship. Among the frame of reference set, variables representing group affiliations, current job responsibility, technical vs. managerial focus, and type of education contributed most to differences in communication patterns. The specific differences afected appear to be related primarily to socialization with different groups on the job, involvement with top management, working alone, and meeting with clients. In other words, the results suggest a relationship between one's orientation and involvement in technical or managerial activities and one's pattern of communication activities with clients and other staff members.

Such a relationship was predicted by the model, indicating that the nature of the relationship verified by this analysis is in line with theoretical expectations.

The results thus support and validate a relationship between the constructs of "frame of reference" and "communication patterns". On both statistical and theoretical grounds, it appears that a relatively strong relationship exists between these constructs which conforms with the expectations outlined in the model.

III. The Relationship Between Organizational Context and Bureaucratization of System Design

The five composite functions obtained in the earlier Discriminant analysis were used in the present analysis to represent the Bureaucratization of System Design. Since only one Discriminant function was obtained to represent "organizational context", the variables which comprised that composite, as indicated in Table 8.11, were adopted as indicators of that construct. The model predicts that aspects of organizational context should affect the degree of bureaucratization; thus, variables associated with the former construct were defined as predictor variables for this analysis, and those for the latter were designated as dependent.

The results of the analysis are illustrated in Table 8.17. These indicate that only one canonical function was obtained, accounting for all of the variance in the predictor set. The eigenvalue of .1402 for this root, and the canonical correlation of .3506, both suggest that the relationship defined by this root accounts for only a small portion of the total variance between the two sets. The squared correlation suggests that the amount of variance explained may be as low as 12%. Tests of statistical significance do indicate that the predictor variables do have a significant impact on the dependent set however, suggesting that while the relationship is weak, contextual factors do appear affect the

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.14020	100.0000	.35066	.12296

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.12296	2.41150	5	.043
Hotellings	.14020	2.41150	5	.043
Wilks	.87704	2.41150	5	.043

PART III. Correlations Between Predictor and Dependent Variables

	Variable*	Canonical Root 1
Predictor Variables	Size of Organization	.21315
	Type of Organization	-.04393
	Type of Hardware	.85783
	Industrial Sector	.53294
Dependent Variables	Technical Production	-.31530
	Project Administration	-.05935
	System analysis and design	-.05906
	Installing hardware	-.89539
	User Support	-.43670

Table 8.17 Canonical Correlation Analysis of Relationship Between Organizational Context and Bureaucratization of System Design

degree to which design work is bureaucratized.

The specific nature of this relationship is illuminated in Part IV of the table. Among the predictor variables the type of computer hardware, the industrial sector, and the size of the organization represent the greatest contribution to the relationship. These appear to impact the dependent set primarily through activities related to installing hardware, providing user support, and technical production and programming. The negative relationship between these variables suggests that individuals who scored low on the predictor set (indicating an organizational context tending toward flexibility) tended to score high on the dependent set (indicating involvement in activities related to the specific variable). The results thus suggest that individuals most active in producing and installing systems, and in providing support for users, also tend to work in relatively inflexible, restricted organizational settings. This relationship is anticipated by the model, and is consistent with the effects predicted between the two constructs.

The results of this analysis indicate a rather weak, but statistically significant relationship between features of the organizational context and the bureaucratization of the design process. The relationship conforms to theoretical expectations and is thus conceptually as well as statistically valid. These results constitute empirical validation for the relationship between these constructs.

IV. The Relationship Between Bureaucratization of System Design and Communication Patterns

Variable sets for both constructs were the same as previously defined. Bureaucratization was defined as the predictor set, while communication patterns were defined as dependent, in accordance with the original model.

The results are described in Table 8.18. Of the five Canonical roots derived, the results suggest that the initial three all define significant components of relationship between the two constructs, and a fourth just failed to reach significance at .05. The three significant roots account for a total of 84.9% of the variance within the predictor set. Canonical correlations for each root (.5850, .5051, and .4457, respectively) indicate a relationship of only moderate strength. Squared correlations for the three roots indicate that a total of 79.5% of the variance between the two variable sets is explained by the three roots however, and multivariate tests of significance indicate that the relationship is significant beyond the .001 level. These results support the conclusion that bureaucratic specialization of design work has a significant impact on the patterns of communication in which designers participate.

Correlations between specific variables and the three significant functions in Part IV of the table provide insight into the nature of the relationship

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.52039	39.81860	.58504	.34227
2	.34259	26.21405	.50514	.25517
3	.24798	18.97470	.44576	.19870
4	.18155	13.89147	.39198	.15365
5	.01439	1.10118	.11911	.01419

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.96399	2.79791	35	.000
Hotellings	1.30689	2.85276	35	.000
Wilks	.32752	2.86990	35	.000

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 5	.32752	2.86990	35	.000
2 to 5	.49796	2.55166	24	.000
3 to 5	.66855	2.31611	15	.004
4 to 5	.83434	1.91936	8	.060
5 to 5	.98581	.39336	3	.758

PART IV. Correlations Between Predictor and Dependent Variables

	Variable	Canonical Root 1	Canonical Root 2	Canonical Root 3
Predictor Variables	Meeting clients (ind.)	.02227	-.79907	-.27087
	Meeting clients (groups)	-.08352	-.70571	-.00935
	Working alone	-.70046	.39882	-.51416
	Time with Management	.75539	-.20919	-.29211
	Time with programmers	-.41532	-.50808	.36615
	Time alone	-.39332	.41631	-.42941
	Tech. vs. Mgr Socializing	.35252	.07077	-.48964
Dependent Variables	Technical Production	-.93180	.32410	-.08129
	Project Administration	-.15396	-.68775	.57351
	System analysis/design	-.37993	-.67232	-.01061
	Installing hardware	-.22628	-.18656	.16093
	User support	-.28492	.33555	.74223

Table 8.18 Canonical Correlation Analysis of Relationship Between Bureaucratization of System Design and Communication Patterns

between these constructs. Root 1 reflect an association in which high values on predictor variable related to technical production (writing specifications and programming) are related to low scores on involvement with top management and high scores on working alone. This is consistent with the prediction indicated in the model that lower-level technical staff tend to have relatively few opportunities for interaction with others, particularly with individuals involved in higher levels of management, for whom information systems are typically intended.

The second root describes an association in which predictor variables indicating project administration and design and analysis are closely related with communication patterns indicating involvement with users (both individually and in groups), as well as with project staff (programmers). The results indicate that, as predicted, the more one participates in higher- level administrative and design functions, the more likely one is to interact with a diverse group of individuals. These results also underscore the role of senior design professionals as individuals who must communicate across group boundaries - especially those between system users and technical production personnel.

Canonical root 3 indicates a relationship indicating connections between involvement in user support and project administration with communication patterns reflecting a tendency to work closely with others, to have relatively frequent contact with both users and top management, and to socialize often with technical personnel. These results also reflect the need for individuals with responsibility for system performance to have active communication links with various related groups. The connection between the communication patterns of systems personnel and the provision of service to users is again reflected in these results.

All three roots describe components of a relationship between the bureaucratic structure of system design and resultant patterns of communication which is in line with predictions from the model. In particular, differences in communication patterns related to specialization of function within the design process is clearly evident. These results thus indicate a relationship that is conceptually valid, as well as statistically significant. This confirms the empirical validity of the relationship between the two constructs.

V. The Relationship Between Bureaucratization of System Design and Design Tools

In the initial exploration of relationships among constructs, no significant relationship was found between the five composite measures used earlier to denote the "bureaucratization" construct and variables representing the use of specific design tools. On further examination, a relationship was found to hold between a smaller sub-set of the variables originally used to obtain the composite measures and the latter construct. It was decided to employ this smaller set of variables to represent bureaucratization in the present analysis, acknowledging that this would restrict the interpretation placed on any relationship found. Based on suggestions from the model, variables representing bureaucratization were considered to be the predictor set in this analysis, and "tools" variables the dependent set.

The results of this modified analysis are presented in Table 8.19. The results indicate that two significant Canonical roots were found, accounting for a total of 82.5% of the variance in the predictor set. Canonical correlations of .5052 and .4547 for the two roots suggest a moderate relationship between the two variable sets. Squared correlations indicate that a total of 46.1% of the variance between the two variable sets is accounted for by these functions. While this represents only a moderate relationship, multivariate tests of significance indicate that the impact of the predictor set on the dependent set is significant at or beyond the .001 level. While this analysis is based on a restricted set of indicators for one of the constructs, there appears to be at least some basis for the claim that the two are related.

An analysis of this relationship from Part IV of the table indicates a complex set of connections between the two variable sets. Canonical root 1 describes a pattern of design activity associated with low involvement in systems

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.34286	46.91384	.50529	.25532
2	.26066	35.66669	.45471	.20677
3	.12731	17.41947	.33605	.11293

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.57501	2.40085	24	.000
Hotellings	.73083	2.36503	24	.001
Wilks	.52400	2.38911	24	.000

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 3	.52400	2.38919	24	.000
2 to 3	.70365	2.19566	14	.010
3 to 3	.88707	1.71863	6	.127

PART IV. Correlations Between Predictor and Dependent Variables

	Variable	Canonical Root 1	Canonical Root 2	Canonical Root 3
Predictor Variables	Planning Implementation	-.46254	.41998	.78081
	Programming	.58398	-.66160	.47038
	Trouble-shooting/Support	.84342	.53103	.08156
Dependent Variables	Sys vs. Appl programming	.44467	-.70868	.31591
	Maint vs. New programing	.25484	-.81647	.34743
	Programming experience	.53715	-.07632	.26736
	Structured Programming	-.3245	.56821	.12694
	4GL experience	.5494	-.23020	-.19019
	Prototyping	.09448	-.21008	.11168
	Structured Design	-.08559	.02397	-.42664
	Design Focus	-.5118	-.43563	-.23857

Table 8.19 Canonical Correlation Analysis of Relationship Between Bureaucratization of System Design and Design Tools

planning, extensive involvement in software support and trouble shooting, and programming. This corresponds closely with the activities of an individual occupying a lower echelon position with responsibility for user support. This pattern appears to be associated with a relatively high usage of fourth-generation software tools, extensive programing experience but with a fairly narrow focus of design perspective (ie. concentration on localized problems rather than larger organizational concerns), an emphasis on applications development programming, and low usage of structured programming tools. This suggests a tendency for there to be a relatively active use of innovative development tools among individuals actively involved in providing systems support to users, but who do not play an active role in systems planning and development.

Canonical root 2 suggests rather different patterns of design tool use among a different group. This root appears to be related to low levels of programming activity, but an active involvement in both systems planning and trouble shooting and support. This describes activities associated with the role of a higher-level systems planner or analyst. These activities appear related to use of design tools specifically in new system and new application development, but with fairly significant use of structured programming techniques, and little experience with fourth-generation and prototyping tools.

This indicates that individuals who are in positions of responsibility concerning systems design and planning tend to rely on more traditional design tools and have less experience and involvement with newer design techniques. The tendency indicated here for systems planners to have less familiarity with newer design techniques may have some bearing on the problems which users report in getting their information requirements satisfied.

It is evident that some relationship can be demonstrated between a sub-set of the "bureaucratization" variables and those representing the use of specific design tools. Distinct patterns of design tool use are clearly related to different areas of professional responsibility within the design process, as the original model had predicted. The results of this analysis thus indicate a specific relationship between the bureaucratization of systems design and the use of specific design tools. The relationship defined by this analysis thus appears to be both statistically and theoretically valid, and can thus be accepted for further analysis. In confirming this relationship however, limitations imposed by the reduced variable set used in the analysis are acknowledged.

VI. The Relationship Between Design Tools and Communication Patterns

Variable sets representing the two constructs in this analysis were defined previously. Because the model suggests that use of specific design tools may affect patterns of communication between designers and users, indicators for the former construct were identified as the predictor set for this analysis and items representing the latter construct were denoted as dependent. The results of the

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.44829	36.53213	.55636	.30953
2	.37742	30.75701	.52346	.27401
3	.19567	15.94562	.40454	.16365
4	.09117	7.42953	.28905	.08355
5	.05338	4.34969	.22510	.05067
6	.03857	3.14355	.19279	.03714
7	.02261	1.84248	.14869	.02211

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.94066	1.57182	56	.007
Hotellings	1.22711	1.60589	56	.005
Wilks	.34343	1.60412	56	.006

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 7	.34343	1.60412	56	.006
2 to 7	.49739	1.37586	42	.067
3 to 7	.68512	1.02459	30	.435
4 TO 7	.81919	.80469	20	.707
5 TO 7	.89386	.75564	12	.695
6 TO 7	.94157	.81497	6	.560
7 TO 7	.97789	.91568	2	.404

PART IV. Correlations Between Predictor and Dependent Variables

	Covariate	Canonical Root 1	Canonical Root 2
Predictor Variables	Sys vs. Appl programming	-.07583	-.40676
	Maint vs. New programing	-.08036	-.66902
	Programming experience	.28707	-.62279
	Structured Programming	-.29520	.48313
	4GL experience	.41117	-.24349
	Prototyping	-.15620	-.40098
	Structured Design	-.41512	.63794
	Design Focus	-.78799	-.05903
Dependent Variables	Meeting clients (ind.)	-.03719	-.27610
	Meeting clients (groups)	-.07074	-.20844
	Working alone	-.17992	-.41876
	Time with Management	-.44392	-.10117
	Time with programmers	-.31527	-.13977
	Time alone	-.30725	.30838
	Tech. vs. Mgr Socializing	-.14773	-.39297

Table 8.20 Canonical Correlation Analysis of Relationship Between Design Tools and Communication Patterns

The analysis identified seven Canonical roots, of which only the first two appear to represent statistically significant components of relationship. The remaining roots have low eigenvalues and account for a relatively small proportion of variance in the predictor set. The number of roots derived may be an indication of a very complex relationship, with several sources of variance. This is also indicated by the variance statistics, which reveal that only 67.2% of the variance in the predictor set is accounted for.

Canonical correlations of .5563 and .5234 for the two functions suggest a moderate relationship between the two constructs. Statistical tests reveal a significance level of approximately .005, indicating that differences on the design tools variables have a significant impact on differences in communication patterns. Squared correlations of .3095 and .2740 for the two Canonical roots can be interpreted to mean the a total of 58.3% of the variance between the two variable sets is explained by the relationship defined by these functions. These results suggest a relationship between the two constructs that is of moderate strength and importance.

The nature of that relationship is revealed in Part IV of Table 8.20. The first root is strongly associated with design tool variables indicating a broad perspective within the design process, relatively little use of structured design and structured programming, considerable experience with fourth generation software, and a high level of programming experience. This describes the use of non-traditional design tools, and is associated with communication patterns indicating a strong tendency to work directly with other individuals, including both managerial personnel and other technical personnel. As the model predicts, the use of non-traditional design tools appears to be associated with more active and diverse communication contacts.

This interpretation is reinforced by examination of the second root. Design tool variables associated with this root indicate an emphasis on systems/maintenance programming as opposed to application development, a relatively low level of programming experience, significant use of structured tools for programming and design, and little use of prototyping. This clearly describes a traditional pattern of design tool use. This is associated with communication variables denoting primary relationships with other technical personnel, a high tendency to work alone, and very low contact with clients. Those whose work requires use of traditional design tools thus appear to reflect relatively impoverished communication patterns, as the model predicts.

These results indicate a significant relationship between design tool use and communication patterns. The results demonstrate a significant relationship between these constructs, and indicate the theoretical validity of that connection. The results thus provide empirical validation for the relationship in question.

VII. The Relationship Between Design Tools and Communication Outcomes

Although the "design outcomes" construct was only marginally supported by the earlier Discriminant analysis, that construct plays an important role within the original model as an indicator of the impact which communication patterns have within the design process. For that reason, an effort was made to identify at least a portion of the original variable set which would indicate a relationship with other constructs. This was done under the assumption that problems in measuring this construct may lie at the heart of the difficulties encountered earlier.

Attempts to demonstrate a relationship between design outcomes and other constructs using the original variable set (see Table 8.14) proved fruitless. Using a sub-set of variables specifically identified as "Communication Outcomes" however, a relationship of at least marginal import was identified between this set and the design tools construct. It was decided to partition the original Design Outcomes construct into two distinct components, one concerning Communication Outcomes and the other concerning MIS Outcomes. The present analysis reports the results of a Canonical correlation analysis to define the relationship between Communication Outcomes and Design Tools.

Variables for Communication Outcomes were used in the analysis as the dependent variable set. The Design Tools construct was represented by the same variable set as in the previous analysis, and was deemed the predictor set. The results of the analysis are provided in Table 8.21 below. Of three Canonical roots that were derived, one appeared to represent the major proportion of variance in the predictor set (66%). Eigenvalues for the three functions indicated that the remaining roots did not represent any appreciable portion of the variance. This was supported by the dimension reduction analysis (Part III of the table), which suggested that only the first function was even close to being significant. The significance level of .069 indicates that the predictor set has some impact on the dependent variables, but that the relationship is clearly a weak one.

The Canonical correlation of .3852 for the first root also suggests a weak relationship. A squared correlation of .1463 indicates that only a small portion of the variance between the two constructs (ie. 14.6%) is explained by the defined relationship. The connection between the two constructs is therefore only marginally significant. The results do indicate however that some basis for associating the two variable sets is present. Given the likelihood of measurement problems associated with the outcome indicators used here, it is possible that the actual relationship between these constructs is much larger, but is masked here due to inadequate data. There is no direct indication in the data however to suggest that this is actually the case.

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	.17147	66.01195	.38259	.14637
2	.08674	33.39134	.28252	.07981
3	.00155	.59671	.03934	.00155

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.22774	1.68404	12	.071
Hotellings	.25976	1.70288	12	.067
Wilks	.78428	1.69900	12	.069

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 3	.78428	1.69900	12	.069
2 to 3	.91876	1.16842	6	.326
3 to 3	.99845	.06355	2	.938

PART IV. Correlations Between Predictor and Dependent Variables

	Covariate	Canonical Root 1
Predictor Variables	Sys vs. Appl. Programming	.72429
	Maint. vs. New programming	.44820
	Structured Programming	-.86496
	4GL experience	.78850
Dependent Variables	Client's definition of needs	.66160
	Frequency of disagreement	-.73571

Table 8.21 Canonical Correlation Analysis of Relationship Between Design Tools and Communication Outcomes

One reason for suggesting that the relationship may be larger than the results indicate is the clarity of the theoretical association revealed in Part IV of the results. The predictor variables most closely associated with the canonical root identified above include very low use of structured programming techniques, extensive use of fourth-generation development tools, and considerable emphasis on procedures for new systems and application development. These are strongly correlated with outcome measures indicating a very high rating of clients' ability to define their information requirements and a very low incidence of disagreement between designer and user. In these terms, there appears to be a clear association between the use of recent non-traditional design tools and the presence of positive communication outcomes between designers and users. Conversely, failure to use such tools can be interpreted to be associated with significant problems in defining information needs, and in a high incidence of disagreement. These relations square well with expectations from the model, and offer tentative indication that the relationship defined here, although statistically weak, is consistent with the model.

Lacking strong statistical support, the best that can be said regarding the relationship between design tools and communication outcomes is that it appears to conform to conceptual expectations, and that measurement problems may well mask the presence of a stronger association. Without evidence to assess this supposition however, we can only indicate a weak relationship between these constructs.

VIII. The Relationship Between Communication Outcomes and MIS Outcomes

Having partitioned the Design Outcomes construct into two distinct variable sets in the previous section, it was of interest to determine the extent to which the resulting sub-sets of variables were related. An analysis was conducted using the Communication Outcome variables defined in Table 8.14 as the predictor set, and the remaining MIS Outcome indicators as the dependent set. The results of this analysis are illustrated in Table 8.22.

Two canonical roots were produced in the analysis, accounting for the entire range of variance in the predictor set. While the eigenvalues for the two roots indicate that the first encompasses a considerably larger proportion of variance, the dimension reduction analysis in Part III suggests that both roots are statistically significant. The Canonical correlation of .7282 for the first root demonstrates its considerable importance in defining the association between the two variable sets. The second root reflects a Canonical correlation of only .3699. Squared correlations reveal that the first root accounts for 53% of the variance between the two constructs, while the second explains only 13.6%. Together the two functions account for nearly 70% of the variance between the two

PART I. Eigenvalues and Canonical Correlations

Canonical Root	Eigenvalue	Percent of Variance	Canonical Correlation	Squared Correlation
1	1.12939	87.68646	.72827	.53038
2	.15860	12.31364	.36998	.13689

PART II. Multivariate Tests of Significance

Test	Value	Approx. F	D.F.	Sig. of F
Pillais	.66727	10.26392	8	.000
Hotellings	1.28799	12.87989	8	.000
Wilks	.40533	11.55674	8	.000

PART III. Dimension Reduction Analysis

Roots	Wilks Lambda	F	D.F.	Sig. of F
1 to 2	.405331	11.55674	8	[illegible]
2 to 2	.49739	4.33502	3	.007

PART IV. Correlations Between Predictor and Dependent Variables

	Covariate	Canonical Root 1	Canonical Root 2
Predictor Variables	Clients understanding of design	.95806	-.28656
	Frequency of disagreement	.39971	.91664
Dependent Variables	Clients computer literacy	.84676	-.05443
	clients understanding of systems	.87734	-.36877
	Problems defining user needs	.56726	.73193
	MIS effectiveness	.09631	-.02060

Table 8.22 Canonical Correlation Analysis of Relationship Between Communication Outcomes and MIS Outcomes

variable sets. Statistical tests indicate that the relationship defined between the two constructs is significant beyond the .001 level.

The relationship is dominated by the first Canonical root. Among the predictor variables, the indicator for clients' understanding of the designers' work loads particularly heavily on this root, while the indicator for occurrence of disagreements is substantially lower. High scores on these indicators appear to be associated with similarly high scores on indicators for users' computer literacy and clients' understanding of their systems, and considerably lower scores on the variable for difficulty in defining clients' information needs.

The second root appears to be most strongly associated with the occurance of disagreement, and negatively associated with clients' understanding of the designers' work. Among the dependent variables, these indicators appear related most strongly with high levels of difficulty in defining clients' information needs and low levels of clients' understanding of their systems. The results for both Canonical roots are consistent with the argument presented in developing the original model that the degree to which designers and users are able to understand one anothers' needs will affect the quality of the systems ultimately produced.

There is, in summary, a strong relationship between the two sets variables associated with Communication Outcomes and MIS Outcomes. The relationship appears to be both statistically and theoretically valid, and so will be retained as a further refinement to the model under examination here.

Summary of Phase Two

The series of analyses described above provide, acceptable levels of empirical support for a majority of the expected relationships among major constructs in the model. In adopting an exploratory approach to this portion of the study, we have been able to define and obtain support for several relationships predicted in the model, as well as others which were not originally identified, but which appear consistent with the spirit of the model. This approach thus enables several revisions to be incorporated into the model, while assessing the empirical validity of its component relationships.

Many of the relationships predicted by the model received considerable support from this analysis, providing initial indications of the model's effectiveness in describing underlying relationships in the data. Significantly, the constructs which have been most strongly validated are those most central to the model. Notable among these are relationships between Frame of Reference, Bureaucratization of System Design, and Communication Patterns, which form the central core of the model and describe the fundamental elements of the communication process within the design context. Other relationships in the model describe contextual or secondary forces. Among these, Organizational Context and Design Tools both received weaker support in the analysis, but sufficient to justify continued analysis. One expected relation not supported by the analysis was that between Communication Patterns and Design Outcomes. This is an important linking relation in the model and the failure to find support for it was unfortunate. With other constructs strongly supported, it seemed unlikely that this relationship should not be validated. The suggestion has already been made that measurement problems associated with both communication and systems outcomes may mask any relationship that might exist between these constructs. It was therefore decided to proceed with further testing of the model with this relation tentatively in place, as a means of determining whether, on the whole, the model could still be empirically supported.

The results of this portion of the analysis thus support a refined version of the original model which depicts a number of specific relationships among the principal constructs. The refined model developed on this basis is illustrated in Figure 8.1 below. based on the analysis of relationships described above, the figure describes a complex interaction among the major components, suggesting that individual frames of reference and elements of the organizational context both contribute to the bureaucratic segmentation of design work. Such segmentation, along with the use of specific design tools, contributes to the creation of specific communication patterns, which ultimately affect the outcome of the design process. We turn now to an evaluation of this refined model.

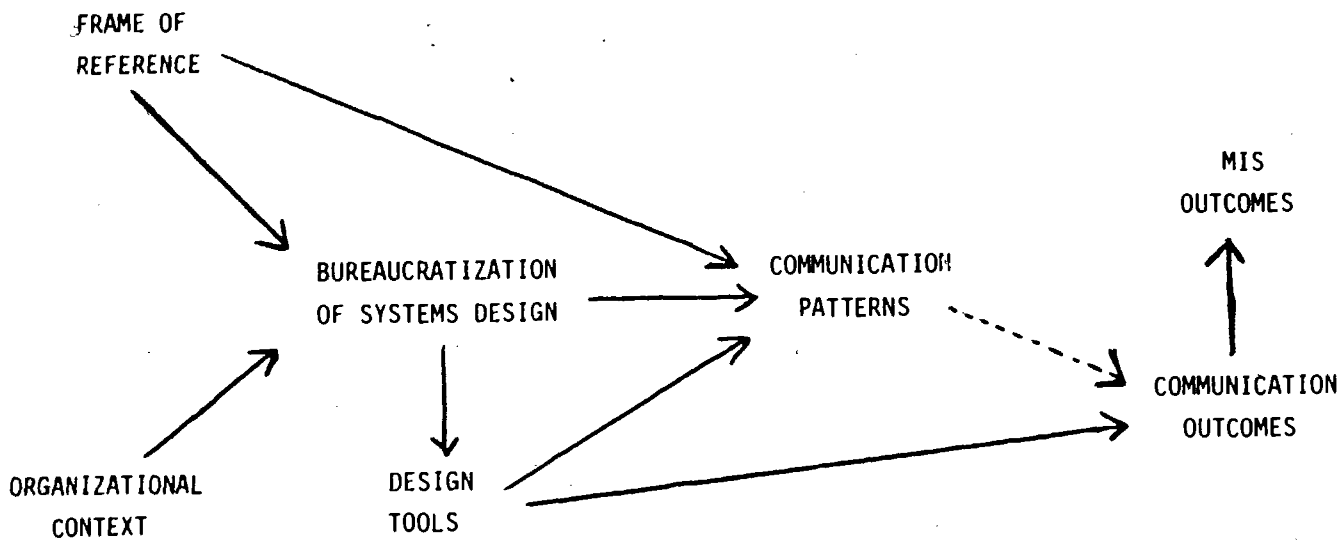


FIGURE 8.1 Major Relationships Between Constructs Confirmed by Phase 2.

Phase Three: Latent Structure Analysis of the Model

Having provided specific operational definitions for each of the major components of the model, and having provided empirical validation for both the constructs and their interrelationships, we have now satisfied the basic prerequisites for Latent Structure Analysis, and are now able to finally assess the effectiveness of the model using that technique. This section reports the results of this final portion of the analysis.

In comparison to the lengthy preparation for this analysis, the assessment of the model using Latent Structure Analysis is a relatively simple task. The computer program used to conduct this analysis was the structural equations program known as "EQS". This program provides estimates of structural parameters for equations describing relationships among sets of interacting variables.

Parameter estimation is conducted on the basis of data provided by the researcher, following a particular specification of pre-defined relationships (ie. a structural model) among the variables involved. The program defines the best possible solution for the specified relationships, and then tests the "goodness of fit" between the solution obtained and the actual data provided. In this way the program provides a basis for assessing how well the specified model describes the underlying structure of the data provided.

The EQS program requires three basic types of information to conduct an analysis. The first is the specification of the model to be tested in the form of a "measurement model" specifying: (1) relationships between observed variables (for which actual data has been collected) and any latent (or un-measured) constructs defined in the model, and (2) the proposed relationships linking various latent constructs. These relationships are specified in terms of equations which describe the structural relationships assumed to hold within the data, and indicate which parameters are to be estimated by the program. Provision of this information translates the model under examination into mathematical form.

For the present analysis, a measurement model was specified as follows: Based on the results of the analysis in Phase 2, variables which loaded heavily on significant cannonical roots were selected as indicators for each of the major constructs. In general, these were the same variables originally defined as indicators for these constructs, but included various refinements suggested by the analyses above. A summary of the specific items used to specify each construct in the measurement model is outlined in Table 8.23.

To conclude specification of the measurement model, each of the relationships assumed in the model (see Figure 8.1) was also defined. Following procedures defined in the EQS manual (Bentler, 1985), these relationships were

Variables	Construct
Type of Education Previous Work Experience Tech vs. Mgr Affiliation Focus of Work	Frame of Reference
Technical Production Project Administration System analysis and design Instaling Hardware User Support	Bureaucratizaton of system design
Time spent with clients (ind.) Working alone Time spent with top management Time spent with programmers Tech. vs Mgr. Socialization	Communication Patterns
Syst. vs. Appl. Programming Structured Programming 4GL Experience Design Focus	Design Tools
Frequency of Disagreement	Communication Outcomes
Difficulty defining user needs	MIS Outcomes

Table 8.23 Measurement Model for Latent Structure Analysis (Based on Results of Phase Two)

specified as additive, linear relations (an assumption of the EQS procedure) in a form similar to regression equations. The structural parameters for these equations (analogous to Beta weights or regression coefficients) were left to be estimated by the procedure. The set of structural equations used to represent the model in Figure 8.1 is described in Figure 8.2 below.

Bureaucratization = (*)Frame of Reference + (*)Organizational Context

Communication Patterns = (*)Frame of Reference + (*)Bureaucratization + (*)Design Tools

Design Tools = (*)Bureaucratization

Communication Outcomes = (*)Communication Patterns + (*)Design Tools

MIS Outcomes = (*)Communication OUtcomes

Figure 8.2 Representation of Structural Equations used in Latent Structure Analysis (Based on Model in Figure 8.4)

The second piece of information required to run EQS is an input data set. Several options are available as appropriate input to EQS, including raw data, or correlation or covariance matrices. In the present case, it was decided to use a correlation matrix describing Pearson R coefficients for each of the observed variables specified in Table 8.23, since this was easily generated using SPSS-X output procedures.

The final item of input for the EQS program was the selection of procedural specifications for the analysis. The first of these was the definition of a method by which the program would estimate structural parameters. EQS has a variety of different procedures, each using a somewhat different analytical method. For the present analysis, the most general method - "Generalized Least Squares" - was selected. The second specification involves definition of assumptions regarding the distributional characteristics of the data. The assumption that the data were normally distributed was adopted for this analysis.

With these items specified, it was possible to finally undertake a formal assessment of the model described above. The results of the analysis are described below using three major components of the output from the EQS program.

Since EQS operates under specific assumptions regarding the distributional characteristics of the data set, a first step in reviewing the results of the analysis is to determine if these assumptions have been violated. Any significant departure from the assumed distribution will affect the interpretation of the results. EQS provides information to test distributional assumptions in the form of frequency distributions and statistics describing the range of residuals resulting from the estimation of structural equations. Important criteria here have to do with the distribution of residuals as well as their relative magnitude. In the present case, a distribution of residuals that is approximately normal indicates that the assumption of normality in the data set has not been violated. The magnitude of the residuals also serves to assess departures from normality, as well as to provide an initial indication of the overall effectiveness of the solution that has been developed. Relatively small values among the residuals can be interpreted to indicate that the solution describes the basic structure of the data relatively effectively.

Figure 8.3 below illustrates the distribution of standardized residuals produced by the EQS analysis. The distribution appears close to normal, indicating that distributional assumptions about the data have not been violated. The EQS program also calculated a value for the "average absolute standardized residual" as an estimate of the relative magnitude of the residuals. The value for this statistic was 0.1520, indicating that, on average, differences between the actual values for variables in the analysis and values based on the estimated structural equations model were relatively small. This provides further indication that distributional assumptions have not been violated, and also suggests that the estimated model was relatively successful in describing the basic characteristics of the data set.

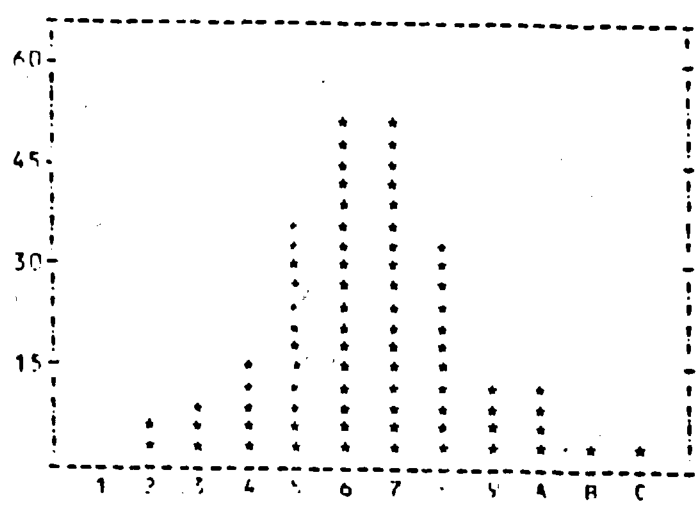


Figure 8.3 Distribution of Residuals from Latent Structure Analysis

The second component of the EQS output describes the Generalized Least Squares solution for the linear equations which constitute model. Part of this output consisted of an "Iterative Summary" describing each of the phases of analysis the program went through in attempting to provide an effective solution. An important criterion here is whether or not the program was actually able to "converge" and provide a complete solution. The iterative summary also contains statistics indicating the absolute degree of change among the parameters being estimated for each iteration. This statistic provides a useful indicator of the extent to which the values of parameters are altered as the program searches for an appropriate solution. In general, the larger the degree of change indicated, the greater the difficulty the program had in obtaining an effective solution. Bentler (1985) suggests that the terminal value of this statistic should remain below .001, if the results are to be trusted. Another statistic, the "alpha" coefficient, can be interpreted as an indicator of whether the program had difficulty in finding a solution. Values departing significantly from 1.00 are generally taken as an indication of difficulty.

The iterative summary from the EQS analysis is reported in Table 8.24 below. As the results show, the program was able to converge to a solution in only two iterations. This suggests that little difficulty was experienced in deriving an effective solution. The terminal value for the absolute parameter change statistic was .000002, well below the cutoff value of .001, indicating that the magnitude of the changes necessary to obtain a solution were very small indeed

Iteration	Parameter Abs. Change	Alpha
1	.055950	1.000
2	.000002	1.000

*Program converged after 2 iterations.

Table 8.24 Iterative Summary of Latent Structure Analysis and that the final solution was arrived at with relative ease. The alpha coefficients for the two iterations were both 1.00, again indicating no difficulties in optimizing the solution.

The solution itself is described in Table 8.25, which describes the parameters assigned to each of the major structural relationships identified in the final solution. These parameters can be interpreted to indicate the relative strength of the relationship in question. Thus, for example, the frame of reference construct has a proportionally larger impact on communication patterns (parameter of 1.015) than do either the bureaucratization of system design or the use of specific design tools (both 0.528). Similarly, the solution indicates that communication patterns affect communication outcomes (0.741) relatively more than does design tool use (0.391). A more graphic representation of these relationships is presented in Figure 8.4, which illustrates the final "Path Diagram" produced by the analysis.

Relationship	Parameter
Frame of Reference X Bureaucratization	1.923
Frame of Reference X Communication Patterns	1.015
Context X Bureaucratization	2.599
Bureaucratization X Communication Patterns	0.528
Bureaucratization X Design Tools	1.000
Design Tools X Communication Patterns	0.528
Communication Patterns X Communication Outcomes	0.741
Communication Outcomes X MIS Outcomes	1.000

Table 8.25 Summary of Generalized Least Squares Solution for Latent Structure Analysis

The most important part of the analysis, of course, is the actual assessment of the effectiveness of this solution in describing the underlying structure of the data. EQS provides two major indicators to assess the "goodness of fit" of the model derived in the analysis. One is a test of fit based on a Chi-Squared statistic. While this test is the most frequently used, it has been criticized as being overly sensitive to the size of the sample relative to the number of parameters being estimated (James. et al, 1984). Bentler (1985) suggests an alternative test, known as the "Bentler-Bonett Normed Fit Index" which is not dependent on sample size and is thought to provide a more effective indicator of the effectiveness of the structural equation solution. The index is devised to indicate increasing degrees of fit as the value of the index approaches 1.000. Bentler (1985) suggests that values in the .90 range are "desirable".

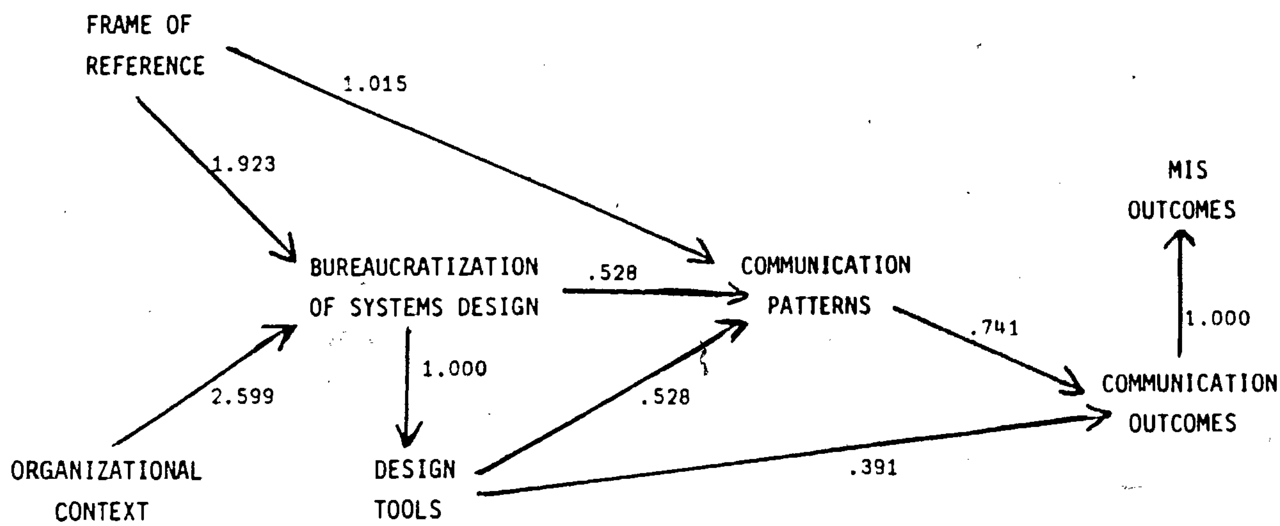


FIGURE 8.4 "Path Diagram" Confirmed by Latent Structure Analysis
(indicating structural parameters)

In the present analysis, both tests indicate a fairly strong fit between the model specified above and the actual structure of the data. The test value for the Chi-squared independence test in this case is 7929.307, based on 231 degrees of freedom. Sample chi-squared statistics below this value indicate a positive fit between the model and the data. The sample value for this analysis was 910.000, based on 219 degrees of freedom. This value indicates a positive fit that is significant beyond the .001 level. This result is confirmed by the Bentler-Bonett fit index of .905, indicating a strong degree of fit between the model and the data. Both tests thus provide strong indications that the model specified above accurately describes the underlying structure of the available data. The pattern of relationships that was proposed to exist among the various constructs can thus be interpreted to provide a relatively good description of factors and processes affecting communication in the design context, at least to the extent that the data used in this study provide valid measures for these constructs.

Summary

The results of the final Latent Structure Analysis indicate considerable support for the model. The analysis indicates that a solution for the structural equations describing the model was achieved with relative ease, and that the solution provided a high degree of fit with the data provided. The results indicate positive support for the model as a description of factors and processes affecting communication within the design context. The various components and relationships defined by that model, while surely not describing the entire set of relevant forces, does appear to reflect significant aspects of the underlying process, and thus may prove useful as a basis for examining specific problems in the OIS design context.

CHAPTER NINE: Conclusions and Implications

Overview

The study documented in this thesis reports the development and empirical evaluation of a conceptual model describing the nature of communication problems in information system design. In the initial portion of the study we identified specific aspects of the systems design context which may affect understanding between designers and users. A model was developed to describe hypothetical relationships among those forces which reveal their mutual influence in affecting communication problems. A study was undertaken to empirically validate that model. The final phase of the study indicates that a modified version of the original model effectively represents underlying patterns in the data collected. Within the limitations specified in the study therefore, we conclude that the model presents a valid description of specific aspects of IS communication problems.

The point of this investigation is not simply to provide empirical support for a particular model however; the motivation for proposing this model was to understand the basis for communication problems in systems design so that suggestions might be advanced to improve the quality of that communication and the effectiveness of the systems which are its products. In other words, the study also has implications of a practical nature. In concluding the study, it will be useful to outline some of the practical implications which stem from the investigation.

We begin by outlining conclusions arising from the empirical study itself. Steps taken in various "preliminary" phases provide insight into several aspects of IS communication problems. We will review these as a way of amplifying the models utility in illuminating the nature of these problems. This is followed by a discussion of broader issues pertaining to problems of IS design and implementation within organizational settings. Based on these discussions, final sections of the chapter deal with the specific practical implications of the study as they relate to improving the quality of communication between system designers and users, to providing a more effective basis for application of information technology, and to the prospect of future research in this area.

Conclusions and Discussion of the Empirical Study

Previous chapters have emphasized the search for evidence to validate the model, often to the exclusion of references to the importance of the results for understanding communication within the design context. Several findings have been revealed which help illuminating the nature of communication problems in this context. The major substantive conclusions of the study are outlined below.

An initial focus was to provide support for each of the major constructs portrayed in the model. To accomplish this, the study identified significant differences between sub-groups in the sample based on specific sets of indicator variables. This provided several important insights concerning aspects of the design context.

Perhaps the most significant finding in this phase was the revelation of the powerful impact which the bureaucratic structure of systems design appeared to have within the sample. In describing the social organization of the design community, the results indicate that substantial differences are apparent which are largely the product of the segmentation of design work into specialized and isolated tasks. Evidence was provided that the sample was composed of groups which paralleled the traditional bureaucratic organization of design work.

The importance of this finding was reinforced as additional constructs were evaluated. Several elements of the model were found to vary in ways which appeared to be directly related to the bureaucratic patterns revealed above. In most cases, the differences indicated were consistent with predictions derived from the model.

For example, the model suggested that differences in "frames of reference" should be evident among individuals occupying distinct roles within the design process. The results indicate this to be true. Individuals who occupy senior positions within the design hierarchy (ie. MIS managers and Senior Analysts) scored consistently higher on indicators suggesting a managerial orientation, while junior personnel (ie. Programmers and Technicians) revealed **a technical** frame of reference. These differences were particularly evident in relation to indicators of managerial or technical focus of work, affiliations with distinct groups within organizations, as well as formal job responsibilities, training and levels of experience. The results are thus consistent with the conclusion that individuals occupying positions at different levels in the system design hierarchy maintain distinct orientations toward the design process, and to affiliate with others who share similar beliefs.

Significant differences in the use of specific design tools and techniques were also revealed in relation to specific sub-groups in the sample. The analysis reveals that groups at the higher end of the bureaucratic spectrum exhibit more frequent use of innovative design tools (ie. fourth-generation languages, prototyping, etc.), while junior personnel tended toward the use of traditional structured techniques. These relationships appear to be related to differences in the two groups' involvement in the design process. Senior designers are frequently concerned with new systems development and thus tend to require tools which facilitate definition and emulation of user needs, while junior personnel are more likely to be assigned maintenance and upgrading duties, requiring more traditional tools and techniques. In this sense, the study demonstrates a relationship between the social organization of design work and the use of specific design tools.

Still another finding in relation to the segmentation of the sample concerns the identification of distinct communication patterns among different groups. The analysis reveals differences between groups concerning their involvement with others in the design setting, as well as in the specific type of activities which define that involvement. For example, programmers and technical personnel work a great deal on their own or in one-on-one relationships with other technicians. MIS managers and senior analysts have a broader pattern of communicative activity, including interaction with end users and top management, as well as with other members of the design team. This group also shows greater likelihood of being involved in group-oriented activities where systems issues are discussed among a variety of interested parties. In other words, allocation to a particular segment of design work appears to impact both the degree and the kind of communication activities one is likely to be involved in.

The relationships outlined above all suggest a relationship between the bureaucratic segmentation of design work and other aspects of the design context. Additional relationships were also noted, though not supported strongly by the analysis. Among several aspects of the organizational context, for example, only a few appeared to be related to differences in design activity. Important among these were the kind of computer technology used and the overall size of the organization. In both cases, the analysis supported the conclusion that extensive bureaucratization was associated with large organizations employing mainframe computer installations.

All of the relationships outlined above suggest the importance of the bureaucratic organization of systems design as a basis for differences within the sample. In the model, differences in frames of reference, in the use of design tools, and in resultant communication patterns were all expected as a consequence of differential involvement in the design process. The results indicate that these predictions hold within the current sample. It is fair to conclude, therefore, that this aspect of the design context is a critical factor affecting patterns of professional activity and interaction.

In addition to describing individual constructs, the study also sought to examine relationships among these and to indicate how these relationship affect specific outcome measures. Phase two of the study provided evidence of significant relationships linking these elements of the model.

A connection was identified between the Frame of Reference construct and communication patterns demonstrated within the sample. The relationship identified by the analysis indicates that factors such as type and level of education, technical or managerial focus of current work, affiliations with specific groups in the work context, and formal job responsibilities all contribute to differences in communication patterns, particularly in terms of the degree of involvement with end users and managers, socialization patterns on the job, and the extent to which one works in relative isolation. The nature of the connection appears to be that individuals with a managerial orientation tend to have communication links with a broader range of groups within the organizational setting, and tend to engage in more frequent and varied types of interaction. As earlier observations suggested, technical personnel have a more restricted range of communication contacts and involvements. The results indicate an association between individuals' frames of reference and their patterns of communicative activity within the design context, as the model predicts.

A relationship was also identified between individuals' communication patterns and their use of specific tools and techniques for systems development. The results suggest that the use of innovative design techniques (eg. prototyping with fourth-generation software) was associated with communication patterns involving direct and active interaction with other groups. Individuals using these tools tend to have more communicative contact with end users and managerial personnel as well as with other technical staff. Individuals using traditional development tools (eg. structured programming and design) appear to operate within a restricted communicative environment where interaction is limited to technical peers. This relationship is predicted in the model, which indicates that lower-level personnel responsible for the technical development of systems tend to have little contact with the ultimate users of those systems, and thus little opportunity to gain direct understanding of their requirements.

The relationships identified above describe elements of the communication context internal to the design process itself. While the study indicates inter-relationships among these elements, only marginal support was available to link these with specific outcome measures. In the original model, a relationship was predicted between patterns of communication behavior and specific outcomes of the design process. Early results showed this relationship to be unsupported. However, problems in the measurement of these outcomes are evident in the study, and may account for the lack of support for this relationship.

A second relationship was identified, however, for which provisional support was suggested. The results indicated that variations in designers' use of particular design tools had some relation to specific communication and systems outcomes. The specific components of this relationships suggest that use of traditional methodologies may be associated with more frequent disagreement between designers and users, as well as with difficulties in identifying users' information requirements. Conversely, the use of innovative techniques was associated with fewer disagreements and less difficulty in specifying users' needs. While these associations were weak, measurement problems discussed above were considered a possible explanation for these results.

A final relationship provided additional evidence of a connection between the communication outcomes suggested above and specific impacts on the products of the design process (ie. OIS systems themselves). The results indicate that communication problems such as disagreement between designers and users and low levels of understanding about each others' jobs are positively associated with indicators of systems problems, including problems in defining clients' information needs, low client understanding of the systems they use, and low assessments of users' computer literacy. The prediction in the original model that ineffective communication would lead to problems in system performance thus appear to be borne out by these results.

In total, the results outlined above indicate support for the idea of a complex interaction involving designers' frames of reference, aspects of the technical and organizational context, forces toward bureaucratization of the design process, and the use of specific design tools. All of these features appear to create a context of forces whose major outcome is to affect the nature and quality of communication underlying the system design process, and ultimately the effectiveness of the systems developed within that process.

The final stage of the analysis set out to determine whether this set of relations, operating as an integrated system, effectively described the basic structure of the data available. The positive results obtained in this analysis provide evidence that the system of relations depicted in the model does describe significant forces affecting the nature and quality of communication in the design context. While these are clearly not the only factors affecting IS success, it can be concluded that the model describes some of the major forces affecting the outcomes of IS design, particularly those arising from barriers to communication and understanding.

The Limitations of the Study

While the conclusions outlined above are supported by specific findings, it is important to bear in mind specific limitations which affect the interpretation of these results. Several facets of the analysis reported above have utilized composite measures for complex, and otherwise un-observable constructs. While this as a legitimate research tactic, it carries with it the potential danger of over-interpreting certain results.

Whenever a construct is represented by one or more surrogate indicators, it is necessary to recall that any conclusions drawn about the construct in question must be interpreted specifically in terms of the components that have been measured. The results of such analyses will always be limited by the definition of the construct implicit in the selection of indicators. Conclusions drawn about the construct will also be limited by the effectiveness with which specific elements of the construct have been measured.

In the present study, considerable effort was taken to ensure the validity of the measures used. Each construct was represented by a variety of indicators representing distinct aspects of the construct. Each indicator was empirically validated by in-depth interviews. In certain phases of the study however, specific indicators were eliminated from the analysis either because they failed to reach computational tolerances for statistical procedures, or because only specific sub-sets of indicators constituted a significant relationship. These changes are clearly indicated within the text.

Because of these concerns, particular care has also been taken in interpreting specific relationships identified in the results. For each relationship, effort has been made to identify the specific indicators which constitute the greatest part of the variance, and to interpret the nature of the relationship in these terms. These specifications should be borne in mind when interpreting the results.

Beyond the composition of measurement for major constructs, more general problems of measurement validity appear to have impacted at least some of the findings of this study. As discussed in Chapter Eight, there was some indication that the effectiveness of measurement for specific "design outcomes" indicators might be suspect. These indicators were measured using self-report questionnaire items, whose effectiveness in obtaining a valid description of outcomes might well be questioned. Suspicion that the ineffectiveness of these measures may be partially responsible for the lack of significant results concerning specific outcomes has already been discussed. Speaking more broadly, the results of other aspects of the analysis are, as usual, subject to the caveat that results are only as good as the measures on which they are based. There are no explicit indications however, that problems of this kind have affected other aspects of the study.

Broader Conclusions Regarding IS Design and Implementation

The conclusions outlined above describe specific aspects of the IS context which affect the nature and quality of communication in that setting. These results represent insights concerning factors affecting the outcomes of the design process. Taken as a whole, these findings help to illuminate the broader nature of IS design viewed as a process of communication, as well as to provide a perspective on problems encountered within that process.

The study as a whole confirms the importance of communication in IS design.

It is widely believed that difficulties in IS development frequently result from barriers to understanding between designers and users. Before this study, little evidence has been proffered to support or elaborate this assumption. This study offers evidence that communication is not only important to the design process, but constitutes the very basis on which that process functions.

IS Design is defined here as a process in which the needs of managers and other employees are translated into a form which other individuals can use to construct a technical system which, at least theoretically, fulfills those needs. The image of a process of translation across two alien cultures aptly captures the essential character of this process. The present study contributes to an understanding of this process by portraying design as a task involving interpretation across two distinct frames of reference, and by describing a variety of forces within the social and organizational contexts of design under which the interpretive process operates. The study attempts to define IS design specifically in terms of communication, and to develop an understanding of how broader contextual forces affect that process.

In describing factors which affect communication within this setting, the emphasis has been to gain an understanding of the social and technical contexts in which design is carried out, and to derive from that an analysis of how these factors affect the products of IS design. Several factors have been identified which influence communication in this setting and appear to impact the systems that are produced. Many of these are related to the bureaucratic structures in which design work is located.

The study shows that problems of understanding between designers and users are consistently reinforced by aspects of bureaucratic organization. Problems of translation across technical and managerial frames of reference are compounded by the tendency to segment design work into isolated and specialized tasks.

Hierarchical structuring of these tasks further removes the producers of systems from contact with users and to impose additional links in an already difficult chain of translations. Bureaucratic procedures promote the use of technical tools which exacerbate problems of understanding, and structure interactions in a way that opportunities to learn about managerial work are denied to those who could most benefit from them. In several respects, therefore, bureaucratic structuring of design work is the most significant factor affecting communication problems in IS design.

A more encouraging note in the study is associated with the availability of innovative tools which positively impact communication in the design setting. Techniques such as the use of fourth-generation development tools and various types of application prototyping appear to short-circuit barriers imposed by bureaucratic structuring and open up important opportunities for technical personnel to gain insight into managerial work. These tools appear to create a more effective basis for system design specifically by facilitating interaction between designer and user, and by providing a basis for rapid feedback and error-checking. The apparent improvement of IS outcomes accompanying such tools further illustrates how communication is fundamental to effective design.

In its broader aspects then, the study offers insight into the nature of the design process and its potential problems. By developing and testing a model of the design process specifically couched in terms of communication, the study provides a basis for conceptualizing important aspects of IS design, and for understanding the potential impact of various contextual factors in determining the effectiveness of that process. In these respects, the study contributes to both conceptual and practical dimensions of the problem at hand.

Implications

The study has a number of practical implications in addition to its conceptual interest. Several implications are apparent concerning the issue of improving communication processes within the IS design context itself. These are outlined in the first section below. The study also has somewhat broader implications regarding the nature and role of information technology within organizations. In particular, the need for organizational policies regarding development and implementation of information technology are discussed in the second section below. Finally, the study presents several implications for further research into the design and implementation of information technology in organizations. These are discussed in the final section.

Implications for Improving Communication Within Systems Design

The study suggests specific implications for improving the quality of communication between designers and users within the design context. The essential barrier to communication in this setting lies in the fact that designers and users operate within distinct frames of reference which define differing orientations and approaches to the design task. The distinction of managerial and technical groups on this basis means that each utilizes a unique set of interpretive categories, values and priorities in defining aspects of the design context. These differences can eventually lead to variances in interpreting the overall goals which a prospective system should fulfill, discord about the specific information needs to be met, and eventual dissatisfaction with completed systems.

An obvious step in overcoming problems of this kind begins with the initial training and education of both systems and managerial personnel. To the extent that we provide widely divergent training to these groups, we increase the potential for communication barriers. While specialization is appropriate, introduction to the nature of the others' work requirements would assist in preventing the initial formation of barriers. This could be accomplished by incorporating technical modules into existing management curricula (and vice versa), creation of educational programs explicitly bridging the two disciplines, and special programs which bring managerial and technical students together to work on single projects. The latter would have the advantage of encouraging direct contact between the two groups, which appears to quicken the socialization process which establishes distinct interpretive frames. Regardless of the method used, the explicit aim of such programs should be to gain an appreciation of the others' orientation as well as to provide an exchange of technical information. Emphasis on the former would be particularly beneficial in preventing the formation of distinct barriers to understanding.

Within the organizational context itself several steps can be taken to prevent the formation of distinct frames of reference and to reduce their impact. A continuation of cross-disciplinary training might be one approach to provide contact between these groups and to prevent crystallization of attitudes and perspectives which contribute to misunderstanding. A specific training or upgrading program might be implemented to ensure that individuals in each group gain exposure to the perspective of the other as well as to specific technical information about their respective tasks. An important consideration again should be the need to encourage informal social as well as direct professional contacts between these groups, to facilitate development of a shared perspective on relevant professional concerns.

Additional steps can be taken regarding the structuring and management of the design process. Generally speaking, we have seen the profound impact which bureaucratic structuring of the design process can have. It both creates and reinforces distinctions which make mutual understanding exceedingly difficult. Several suggestions can be made to prevent this from happening:

(1) effort should be made to broaden the scope of specific system development jobs, particularly at the lower end of the traditional hierarchy. Individuals should be given responsibility for a range of design tasks, including frequent contact with the prospective users of the systems under development. While some degree of specialization will usually be appropriate, sufficient exposure to a range of tasks will enable individuals to develop their skills as design professionals more rapidly, will facilitate the development of a user-oriented perspective, and will prevent the individual from being imbued with a purely technical perspective.

(2) As much as possible the development of a single system should be the responsibility of a single individual or team. A general principle might be to have those individuals who design a system also responsible for its actual production. Communication problems often arise when components of a project are "handed off" from one specialist to another. Continuous involvement with the same project gives the designer increased understanding of the entire system, as well as providing an understanding of the history and development of the whole project. This is also advantageous from a training standpoint, in that junior members of the design team gain familiarity with the entire development life cycle and have opportunity to observe how senior personnel approach and solve complex design challenges.

(3) Design teams should always include the direct participation of user representatives, with formal involvement in decision making about system specifications and functions. This not only ensures that users have direct input into their own systems (which facilitates acceptance and understanding), but also provides ongoing dialogue between technical and managerial staff. Formalized as

part of the design process, this enables initial barriers to be broken down and ensures continued exchange of information and perspectives which enable both groups to overcome limited and biased perspectives.

(4) Senior design personnel should have fundamental training in both managerial and technical fields. Where a team approach is used, some specialization of function will usually be advantageous. However, at least one senior member should have the capability to operate as an expert in both realms and, more importantly, to translate and articulate an understanding of one domain into the language of the other. This is true from the perspective of obtaining an effective outcome of a given system, as well as from a training standpoint. To the extent that the senior member serves as a role model, this would help to foster an environment in which distinct frames of reference are easily bridged.

(5) The organizational unit responsible for system development should maintain a position of high visibility and open access to the remainder of the organization. The traditional image of the "DP Shop" as an isolated and alien entity often contributes to a climate of mistrust and suspicion, often fostering stereotypes of the closed, socially inept technical type. To the extent that these images can be overcome, individuals may feel more willing to break down mis-beliefs about IS staff and to open communication channels. The concept of the "Information Centre" (Martin, 1984) has proven useful in these respects, and can be a useful was to facilitate genuine user interest and acceptance of IS technology.

In addition to the structure and management of the design process, it is evident that communication problems can be partially overcome with the use of newer techniques and methodologies for system design which have an explicit user orientation. The study has pointed out the advantages of using fourth-generation development software, application prototyping, and various kinds of participative design methodologies which seek active user involvement in the design process.

All these techniques help to break down barriers to understanding by providing a direct communication link between designers and users, and by allowing for immediate feedback regarding the effectiveness of a given system or application in meeting the users' needs. In the short term, these tools provide a relatively quick and effective basis for systems development. Over the longer-term, they facilitate the development of an increasingly shared understanding of each groups' needs, and create the basis for more creative utilization of information technologies. Beyond their role as design tools, these also serve an important educational function for both groups.

Use of such tools is, of course not always appropriate, particularly with larger scale mainframe systems which require more careful integration and security of data resources. With such systems, continued use of structured design and programming techniques may continue to be useful. It is advisable in such situations that special attention be given to the potential problems inherent with these techniques, notably the tendency for the developer to work in isolation, to allow technical specifications of information needs supersede the users real requirements, and separation of the producer of the system from its original designer. Some of these impacts can be partially alleviated using a less bureaucratic organization of the design process, as outlined above. In any case, use of these more traditional tools should be carefully managed to ensure that these problems do not occur.

Implication for Organizations: Defining the Role of Technology

While the study addresses issues specifically within the context of IS design, it is clear that the nature of communication processes within that context are affected by the larger organizational context in which they occur. In this respect, the study also has implications concerning the broader role of information technology within the organization as a whole. In particular, it is evident that many of the difficulties which arise in the design process reflect more general choices adopted at an organizational level.

For example, the use of a structure in which to manage the design function is in part an outcome of specific organizational policies concerning the role which information technology is to occupy within the system. Typically, highly bureaucratized structures are associated with a climate of strict managerial supervision and control. Within such a context, information technology is often utilized within the existing organization as a mechanism for managerial control. Under such conditions, the development process itself becomes politically charged and is unlikely to be perceived as serving the interests and needs of end users. In other words, organizational policies which lie behind the implementation of an information system can also be a factor affecting its perception and acceptance by users. Clearly these perceptions will impact communication processes underlying systems design and will affect the quality of the development outcomes.

To the extent that broader organizational policies regarding the role of information technology affect the climate in which the design process is enacted, it is advisable that such policies be carefully examined for potential impact. A policy which views technology as a tool for facilitating employees' access to and use of organizational information resources, and which attempts to carefully integrate such a system into the existing organization, will inevitably create a more effective context for specific design projects. In any case, the specific strategies adopted for organizing and managing the design process should be carefully examined as part of a broader organizational policy determining an appropriate role for the technology within the given organization.

Ideally, such a policy should also include strategic planning regarding how information technology is to be managed on an ongoing basis. In particular, strategies for managing processes of organizational change which accompany the implementation of new technologies should also be explicitly developed. As above, these play a role in setting the broader context in which design processes are carried out, and so have an important impact on the nature and quality of communication in that context.

Implications for Further Research

In addition to specific practical implications, the study also suggests directions for continued research in this area. The present study has been exploratory in the sense that it seeks to develop and empirically test an initial description of major forces acting within the design context. The model examined here provides some indication of important communicative aspects of the design process, but is by no means complete. It is evident from the results of the empirical study that important sources of variance within the sample have gone unexplained. This suggests that considerably more refinement is possible within the model itself.

Some of this refinement could come in the form of improved measurement for various constructs, particularly those concerned with communication and design outcomes. A study based on direct observational or other documentary evidence, would provide a useful addition to the present results. Each of the major constructs in the model could provide the basis for more in-depth and complete study. The specific dimensions identified and measured for the present study undoubtedly provide only a partial definition of these constructs. An effort to further define and clarify these would add to the richness and completeness of the model. It is also likely that other factors not addressed in this study may have an important impact on the processes described in this study. Considerably more work remains, therefore, to further refine and develop the present model.

The model itself is suggestive of several areas in which future research would be beneficial. Each of the relationships between major constructs represents a potential avenue for exploration in which important new insights are likely to be found. Further definition of particular aspects of the association between various constructs would again help to add detail to the broad sketch drawn here. Many of the specific implications of various relationships could be empirically examined. Relationships between specific types of design techniques and their related communication and systems outcomes, for example, could be fruitfully explored in further detail.

Considerable room for ongoing research might also exist in terms of establishing the most effective organizational structure in which to house and manage the design function. Several suggestions from the model could be empirically tested to determine the impact on communication and systems outcomes. The model provides, in other words, several important opportunities to extend and refine our understanding of communication processes within the design context. By opening these avenues for further study, the model provides an important contribution to the research literature and suggests several avenues for further work in this area.

Summary

In the sense that it brings together two distinct areas of study - the technical and the social - the application of information technology in organizations represents a significant area of investigation for scholars in several disciplines. For Communication scholars this area represents a challenge to understand problems and promises associated with bridging these areas. The present focus on systems design, construed as a process of translation between these worlds, represents an initial effort to test some initial ideas about how communication across such boundaries can be accomplished. It is hoped that the investigation described in this work offers some initial understanding of such communication problems, and that it opens the prospect for an effective crossing of the boundary in the future.

APPENDIX A:

A "Typical" Information System Design Methodology

Systems Development Life Cycle

OBJECTIVES

Phase: Systems Planning

- □ To relate the organization's objectives to its information needs.
- □ To assess the effectiveness of current systems and the information provided by them.
- □ To establish an overall strategy of hardware, software and personnel capabilities to meet the total needs of the organization.
- □ To identify specific systems projects and to establish priorities for development.
- □ To establish organizational and management structures to ensure successful completion of the plan.
- □ To provide adequate planning for a single project when a complete systems plan is not developed.

Phase: Preliminary Systems Design

- □ To identify and document all information needs.
- □ To perform the specific work needed to identify all key factors of the system:
  - □ Nature of system operation.
  - □ Cost of system operation.
  - □ Cost of the installation effort.
  - □ Benefits of the system.
  - □ Personnel and hardware resources required.
  - □ Timetable to implement the system.
- □ To assure that all management personnel responsible for using and operating the system understand and agree with the key factors outlined above.
- □ To establish organizational and management structures to ensure successful installation of the system.

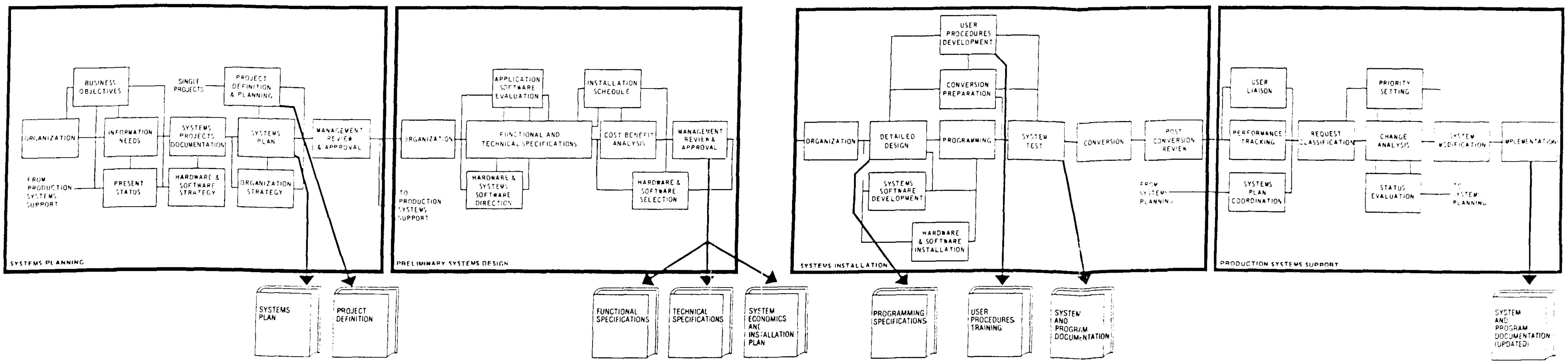
Phase: Systems Installation

- □ To create accurate and reliable detailed computer programs.
- □ To establish all required procedures to operate the system.
- □ To prepare the physical environment necessary for effective operation.
- □ To train personnel to use the system.
- □ To implement the system.
- □ To establish organizational and management structures to ensure successful continuing operation of the system.

Phase: Production Systems Support

- □ To identify and control all potential changes to the systems, computer programs or procedures.
- □ To provide management control over the cost, timetable and sequence of changes made to the systems.
- □ To assess the quality of the structure and performance of the systems to assist in future systems planning activities.
- □ To ensure that changes are properly and effectively implemented.

PLANNING CHARTS



PRODUCTS

Systems Planning

- □ Statement of current and future information requirements related to the strategic plans of the business or organization.
- □ Evaluation of current EDP operations, systems and organization.
- □ Objectives for the organization's EDP department.
- □ Overall systems development strategy.
- □ Strategies for hardware, software and organization of EDP.
- □ Definition of each project:
  - □ Description of scope of project.
  - □ High-level systems concepts.
  - □ Overall project data model.
  - □ Work plan and estimate of effort for next phase.
  - □ Summary of costs and benefits.

Preliminary Systems Design

- □ Management Summary Report:
  - □ System functional design overview.
  - □ System technical design overview.
  - □ Summary of resources and benefits.
  - □ Summary installation plan.
  - □ Recommended course of action.
- □ Functional Specifications Report:
  - □ Description of all functions.
  - □ Input and output descriptions.
  - □ Procedural flows.
  - □ Listing of all data elements.
  - □ Performance criteria.
  - □ Security and control needs.
- □ Technical Specifications Report:
  - □ Technical architecture design.
  - □ Data base design (logical and physical).
  - □ System processes, programs and modules.
  - □ Testing and conversion procedures.
  - □ Resource requirements.

Systems Installation

- □ Programming specifications:
  - □ Structure charts.
  - □ Module narratives.
  - □ Cross-references to logical and physical data base definitions.
  - □ Input form layouts.
  - □ Report layouts and screen layouts.
- □ Fully tested programs.
- □ Procedure manuals.
- □ Trained user and operating personnel.
- □ Fully operational system.
- □ Documentation to support continuing system operation.

Production Systems Support

- □ System modifications:
  - □ Updated programming specifications.
  - □ Fully tested program changes.
  - □ Users trained in the revised procedures.
- □ Periodic status reports:
  - □ Actual performance versus estimates for implementing changes.
  - □ Actual performance versus planned performance and operating cost.
  - □ Overall evaluation of the production system, considering user satisfaction, cost of operation etc.

APPENDIX B:

Interview Protocol

Interview Protocol

Introduction and Overview of Research

General introduction to research project in terms of its focus on OIS "Failure", and its interest in attempting to illuminate the underlying basis for these difficulties. The problem was explicitly not defined as a "communication" problem, since part of the aim was to determine if subjects were used this or equivalent terminology in understanding the problem.

General Questions

1. Subjects were initially asked to discuss their own experience with computer information system and to reflect on the problems they have encountered or been aware of. More specific probes would be used to flesh out details, particularly regarding problems which had a clear "human" element (ie. non-technical problems).

2. Subjects were asked to consider the underlying cause of the problems referred to. This was often be done by asking what IS problems seemed to have in common, what subjects thought was the biggest difficulty or the most central problem, and so on. If it did not arise spontaneously, subjects were asked if there were aware of any specific problems relating to the design process. The specific nature of such problems would be discussed in depth.

3. Subjects were asked to discuss their understanding of the composition of the design community; ie. Who was involved in doing design work, what different types of people contribute to the design effort, what kind of training and experience did these people have, what would an "ideal" individual in each category be like? Do system designers differ in any way from managers; what is the nature of these differences; what is their impact?

4. Subjects were asked to comment specifically on the actual nature of the design process itself -- how the work gets done, what techniques and tools are used, what , if any, problems arise from these?

5. In general, How well do managers and system designers get along? Do they understand each other; do they get in each other's way? How do managers and system developers differ; do they think differently, approach problems differently; do they have different personalities?

Specific Questions for Specialized portions of the Sample

1. For EDP Placement professionals:
   - What qualities would you look for in an "ideal" system design person as opposed to an ideal manager?
   - What specific job categories are involved in design work? define these in terms of concrete activities, formal resining, experience.
   - What are the important differences among different design professionals? (eg. personalty, thinking, specific abilities, etc.)
   - What does a designer need to know to do a good job?
   - What special qualities would you look for in screening for a system

development position as opposed to a management position?

2. For Educators:
   - additional detail regarding the formal qualities of managerial vs technical education; specific examples of differences.
   - The nature of informal relationships among (and between) managerial and technical students. Any basis for diffeences between these groups.

3. For System Consultants and MIS Managers:
   - specific details concerning methods used in design, and problems encountered with these.
   - Special techniques used to facilitate communication and understanding between users and developers?

APPENDIX C:

Questionnaire

The University of Western Ontario

Faculty of Social Science
Centre for Administrative and Information Studies
Social Science Centre
London, Canada
N6A 5C2
(519) 661-3012

SYSTEMS ANALYSIS AND DESIGN QUESTIONNAIRE

Dear Colleague:

The attached questionnaire is being circulated as part of a research project examining the role of communication processes in the design and implementation of office automation and management information systems. The purpose of the research is to gather information about the kind of communication practices which systems design professionals use as part of their normal work. We hope to gain some insight into specific practices which make the design process effective, and so to assist others to become more effective in their design efforts.

We ask your cooperation in answering the questions which follow as completely and as honestly as possible. This information is being gathered for academic purposes only, and will not be used for any commercial venture. Nonetheless, please feel free to withhold any information which you consider to be proprietary; your answers on the remaining items will still be greatly appreciated.

A stamped, self-addressed envelope is provided for you to use in returning the completed questionnaire. Your cooperation in returning the questionnaire as soon as possible is important in obtaining complete and accurate results. Thank-you in advance for your assistance.

You need not identify yourself in any way. All questionnaires and answers will be kept in strictest confidence. The results of this survey will be published in aggregate form only. If you wish to receive a copy of the results, please contact me at the address below:

Ronald E. Sept
Centre for Administrative and Information Studies
The University of Western Ontario
London, Ontario
N6A 5C2

UNIVERSITY OF WESTERN ONTARIO
Systems Analysis and Design Questionnaire

1. As a systems professional, what percentage of your time is spent in activities specifically related to systems design?

   ________ %

2. What is your main area of responsibility within the system design process?

   _____ MIS/Project Management
   _____ System Design and Consulting
   _____ Systems Analysis/Programming
   _____ Systems Engineering/Technical operations
   _____ other (specify) ______________________

3. How many years experience do you have in your current area of work (including other jobs of the same kind and level)?

   _____ years

4. Which type of organization or department are you most closely affiliated with?

   _____ MIS or DP Department within a larger organization
   _____ Other Department within a larger organization
   _____ General Management Consulting Firm
   _____ Accounting/Systems Consulting Firm
   _____ Computer System Vendor
   _____ Private Consultant
   _____ Other (Specify) ______________________

5. Approximately how many people are employed by your firm?

   _____ employees

6. In your normal design duties, do you deal primarily with external clients or with users within your own firm?

   _____ external clients ________ internal users

7. What kind of computing facilities are you most accustomed to working with:

   _____ individual Personal Computers (PC's)
   _____ networked PC's
   _____ minicomputer with several "workstations"
   _____ mainframe computer with several terminals
   _____ other (specify) ______________________

8. In which industry are most of your clients are located?

   _____ Primary Industry (Mining, Forestry, etc.)
   _____ Manufacturing
   _____ Wholesale/Distribution
   _____ Retail/Merchandising
   _____ Public Service/Utilities
   _____ Government
   _____ Voluntary Agencies
   _____ Other (Specify) ______________________
   _____ I work with clients from a variety of industries

9. Which type of systems applications do your clients most often require?

_____ Computer-Assisted Manufacturing/Process Control
_____ Basic Transactions/Record Keeping
_____ Word-processing
_____ Accounting
_____ Office Automation/Communication Networks
_____ Management Decision Support
_____ Other (Specify) ______________________________
_____ varies from client to client

10. In a typical systems development project, what percentage of your time do you spend on each of the following tasks? Please put 0% for any tasks you do not normally take part in.

_____% Analysing clients' information needs
_____% Planning and administering project budgets
_____% Developing plans for system implementation
_____% Meeting with clients and associates to coordinate projects
_____% Training and supervising project staff
_____% Monitoring project progression
_____% Writing software specifications
_____% Installing systems hardware
_____% Programming
_____% Testing and de-bugging systems
_____% Training users to use software
_____% Trouble-shooting and software support
_____% Other (specify) ______________________________
100 %

11. On average, what percentage of your working day do you spend with each of the following groups:

_____% Top Management
_____% End Users
_____% Programmers and Programmer/Analysts
_____% Technical Specialists
_____% Other (specify) ______________________________
_____% Working on Your Own
100 %

12. Rank each of these groups in terms of how much you prefer to work with them. Identify the most preferable group as number 1; the second most preferable as number 2; and so on.

_____ Top Management
_____ End Users
_____ Programmers and Programmer/Analysts
_____ Technical Specialists
_____ Other (specify) ______________________________
_____ I prefer working on my own

For the group you identified as number 1 (most preferred), list two or three qualities which make that group especially attractive. (If you prefer working on your own, explain why).

____

____

____

13. Identify one of these groups you would be most likely to have lunch or coffee with, or socialize with after work.

_____ Top Management
_____ End Users
_____ Programmers and Programmer/Analysts
_____ Technical Specialists
_____ Other (specify) ______________________________

14. How much experience have you had in computer programming? (if none, please skip to Question 19)

1	2	3	4	5
none	very little	some	a fair amount	a great deal

15. Of the programming you normally do:

a) what percentage is:

_______ % systems programming
vs. _______ % applications programming
100 %

b) what percentage is:

_______ % maintenance/upgrading programming
vs. _______ % new systems programming
100 %

16. When you write programs for clients, how often do you use "structured" programming methods (ie. flowcharting, writing formal specifications, etc.)?

1	2	3	4	5
never	seldom	occasionally	frequently	always

17. How much experience have you had with so called "4th generation" programming languages and other software (ie. dBASE III, Focus, Framework, etc.) that allows users to develop their own systems applications?

1	2	3	4	5
none	very little	some	a fair amount	a great deal

18. To what extent have you used 4th generation software directly with users to develop working "prototypes" for specific system applications?

1	2	3	4	5
none	very little	some	a fair amount	a great deal

What is your assessment of this procedure as a basis for systems development?

____

____

19. To what extent do you employ a "structured" methodology for systems design?

1	2	3	4	5
never	seldom	occasionally	frequently	always

In your opinion, what are the main advantages (or disadvantages) of using a structured design methodology?

____

____

____

20. When you develop a new system or systems application, which of the following would you rely upon <u>most</u> to guide your analysis and design?

______ A broad analysis of the organization and its major business objectives and strategies
______ An examination of the overall problem situation in terms of the user's <u>general</u> information needs and resources
______ An analysis of <u>specific</u> information flows and bottlenecks affecting the problem at hand
______ An analysis of the problem in terms of specific technical resources (ie. systems, algorithms, software, etc.) which could serve as a solution

21. In a typical system design project, what percentage of your total time do you spend in each of the following activities?

_____% meeting individually (face-to-face) with clients
_____% meeting in groups with clients
_____% meeting individually with other members of the design team
_____% meeting with the design team as a group
_____% preparing written materials for clients (letters, proposals, documentation, etc.)
_____% working alone on analytical tasks or programming
100%

22. Does your system development methodology incorporate any of the following:

YES
______ 1. On-site Needs Analysis/Feasibility study
______ 2. Strategic planing for clients' information management
______ 3. User-based steering committees
______ 4. Regular review/evaluation checkpoints
______ 5. One-on-one prototyping with end users
______ 6. Software customization
______ 7. User training in software
______ 8. Implementation in modules or phases
______ 9. Assistance in management of organizational change
______ 10. System tests and modifications
______ 11. Detailed documentation of procedures
______ 12. Monitoring organizational impacts
______ 13. Software support after implementation
______ 14. Post-implementation review and evaluation

23. In general, how well do you think your clients understand the nature of the work that you do?

1	2	3	4	5
not at all	quite poorly	just adequately	relatively well	very well

24. What is your assessment of the level of computer literacy of the users you most frequently deal with?

1	2	3	4	5
totally inadequate	poor	barely adequate	quite good	excellent

25. In general, how well do you think your clients understand the capabilities and limitations of their systems?

1	2	3	4	5
not at all	quite poorly	just adequately	relatively well	very well

To what do you attribute this understanding or lack of understanding?

____

____

____

____

26. As a rule, how well do you find users are able define their information needs in a way that is useful to you?

1	2	3	4	5
not at all	quite poorly	just adequately	relatively well	very well

27. To what extent have problems in defining users' information needs created difficulties in designing effective systems?

1	2	3	4	5
none	very little	some	a fair amount	a great deal

28. What special techniques or strategies do you use to obtain an accurate assessment of user information needs, or to ensure that the end product accurately reflects the needs of the end user?

____

____

____

____

____

29. In general, how often do disagreements or misunderstandings arise with your users on systems-related issues?

1	2	3	4	5
never	seldom	occasionally	frequently	always

Identify two or three issues around which such mis-understandings might be most likely to occur.

____

____

____

30. In general, how effective are most MIS development projects in terms of meeting users' information needs?

1	2	3	4	5
totally ineffective	barely adequate	moderately effective	quite effective	totally effective

31. Identify three factors which you consider to be the most likely causes of MIS difficulties:

a) ______________________________

b) ______________________________

c) ______________________________

32. In general, what aspect of the system design process would you say presents the greatest challenge for you?

____

____

____

Can you describe any special techniques or strategies you have found useful in overcoming this challenge?

____

____

____

____

33. What is your age?

__________ years

34. What level of formal education have your completed?

_____ high school
_____ college or technical diploma
_____ university undergraduate degree
_____ graduate or professional degree

35. What *type* of formal training do you have?

_____ General academic program
_____ Technical diploma
_____ Computing Science program
_____ Engineering program
_____ Management program
_____ Accounting program
_____ other (specify) ______________________________

36. Which of the following best describes your work experience *previous* to your present position:

_____ General Management
_____ Accounting/Operations
_____ Programmer or Programmer/Analyst
_____ Systems Engineering/Technical Operation
_____ Management/Systems Consulting
_____ other (specify) ______________________________

37. For each of the items below, indicate whether you agree or disagree with the statement using the following scale:

1 = strongly disagree
2 = moderately disagree
3 = neutral
4 = moderately agree
5 = strongly agree

_____ a) To be effective, organizations must have clearly defined channels of authority and responsibility.
_____ b) Complex tasks can be accomplished most efficiently if they are tackled by groups of people working together.
_____ c) To be successful in an organization, it is better to be a specialist than a generalist.
_____ d) Things generally run smoother if everyone has a specific job to do and people don't have to depend on one another.
_____ e) Organizations work better when everyone knows enough about each others' job to trade places once in a while.
_____ f) If jobs are properly designed, just about anyone with the right basic training should be able to do them.
_____ g) A good manager spends more time interacting with employees than studying and analysing business decisions.
_____ h) Most people are smart enough to figure out how to use a computer without much training.
_____ i) A lot of what managers do on a day-to-day basis could never be computerized.
_____ j) One of the biggest advantages of computer systems is that they help management control the work to be done.
_____ k) To use computers really effectively, it is important to understand how they operate and how they are programmed.
_____ l) Computer systems should be designed with enough flexibility so that people can develop new, more creative ways of doing their jobs.
_____ m) Eventually, computers will be able to take over virtually all of the major functions of an organization.
_____ n) Having good morale in an organization is more important than being highly productive.
_____ o) The more information that managers can get, the better they can do their job.

<u>THANK-YOU FOR YOUR COOPERATION</u>

Please return this questionnaire as soon as possible
in the enclosed envelope.

APPENDIX D:

Results of Initial Cluster Analysis

Part 1: Agglomeration Schedule
Part 2: Classification Table
Part 3: Dendrogram

Results of Initial Cluster Analysis
Part 1: Agglomeration Schedule

Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	27	47	1.0000	0	0	2
2	27	58	.9927	1	0	3
3	12	27	.9853	0	2	87
4	8	78	.9247	0	0	46
5	41	51	.9165	0	0	48
6	72	89	.9123	0	0	37
7	48	77	.9096	0	0	35
8	28	75	.8934	0	0	10
9	67	79	.8787	0	0	45
10	28	90	.8708	8	0	25
11	66	71	.8681	0	0	39
12	64	85	.8668	0	0	57
13	81	84	.8646	0	0	26
14	17	46	.8636	0	0	38
15	10	52	.8622	0	0	29
16	68	82	.8585	0	0	26
17	35	38	.8488	0	0	44
18	1	80	.8464	0	0	52
19	44	62	.8417	0	0	32
20	55	56	.8340	0	0	36
21	4	37	.8316	0	0	81
22	21	61	.8249	0	0	56
23	18	50	.8247	0	0	54
24	9	26	.8092	0	0	35
25	28	74	.8016	10	0	39
26	68	81	.7970	16	13	65
27	5	43	.7712	0	0	58
28	14	65	.7703	0	0	48
29	10	33	.7688	15	0	36
30	13	22	.7670	0	0	74
31	19	60	.7569	0	0	70
32	31	44	.7565	0	19	84
33	7	87	.7559	0	0	53
34	15	42	.7518	0	0	41
35	9	48	.7474	24	7	57
36	10	55	.7443	29	20	47
37	25	72	.7167	0	6	59
38	17	20	.7088	14	0	50
39	28	66	.7026	25	11	45
40	32	73	.6954	0	0	68
41	15	54	.6784	34	0	69
42	36	39	.6697	0	0	73
43	6	30	.6685	0	0	65
44	35	59	.6667	17	0	59
45	28	67	.6644	39	9	62
46	8	23	.6612	4	0	60
47	10	45	.6585	36	0	64

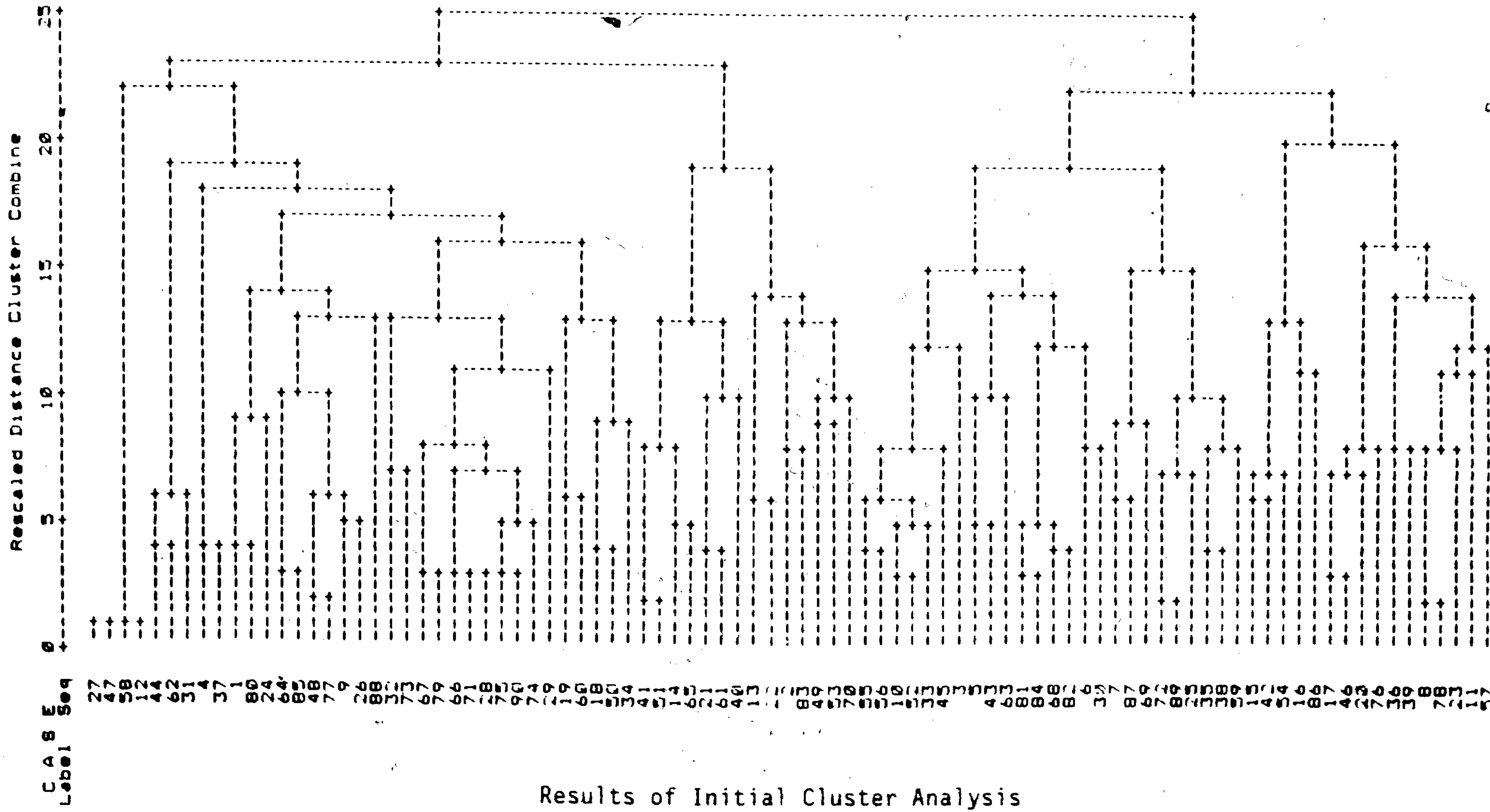
48	14	41	.6532	28	5	66
49	2	83	.6522	0	0	67
50	17	76	.6316	38	0	78
51	49	53	.6279	0	0	55
52	1	24	.6208	18	0	75
53	7	69	.6146	33	0	77
54	18	34	.6002	23	0	70
55	49	70	.5802	51	0	67
56	21	40	.5764	22	0	66
57	9	64	.5562	35	12	71
58	5	63	.5532	27	0	72
59	25	35	.5528	37	44	77
60	8	11	.5279	46	0	63
61	16	86	.5198	0	0	69
62	28	29	.5022	45	0	68
63	8	57	.4854	60	0	73
64	3	10	.4702	0	47	76
65	6	68	.4614	43	26	72
66	14	21	.4419	48	56	82
67	2	49	.4363	49	55	74
68	28	32	.4264	62	40	79
69	15	16	.4250	41	61	85
70	18	19	.4118	54	31	79
71	9	88	.4055	57	0	75
72	5	6	.3976	58	65	76
73	8	36	.3864	63	42	78
74	2	13	.3715	67	30	82
75	1	9	.3593	52	71	80
76	3	5	.3517	64	72	83
77	7	25	.3340	53	59	83
78	8	17	.2830	73	50	85
79	18	28	.2671	70	68	80
80	1	18	.2402	75	79	81
81	1	4	.1850	80	21	84
82	2	14	.1670	74	66	88
83	3	7	.1375	76	77	86
84	1	31	.1340	81	32	87
85	8	15	.0908	78	69	86
86	3	8	.0058	83	85	89
87	1	12	-.0067	84	3	88
88	1	2	-.0362	87	82	89
89	1	3	-.1566	88	86	0

Results of Initial Cluster Analysis
Part 2: Classification Table

Case	3	4	5	6	7	8
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	1	1	1	1	1	1
5	3	3	3	3	3	3
6	3	3	3	3	3	3
7	3	3	3	3	3	4
8	3	3	4	4	4	5
9	1	1	1	1	1	1
10	3	3	3	3	3	3
11	3	3	4	4	4	5
12	1	4	5	5	5	6
13	2	2	2	2	2	2
14	2	2	2	2	2	2
15	3	3	4	6	6	7
16	3	3	4	6	6	7
17	3	3	4	4	4	5
18	1	1	1	1	1	1
19	1	1	1	1	1	1
20	3	3	4	4	4	5
21	2	2	2	2	2	2
22	2	2	2	2	2	2
23	3	3	4	4	4	5
24	1	1	1	1	1	1
25	3	3	3	3	3	4
26	1	1	1	1	1	1
27	1	4	5	5	5	6
28	1	1	1	1	1	1
29	1	1	1	1	1	1
30	3	3	3	3	3	3
31	1	1	1	1	7	8
32	1	1	1	1	1	1
33	3	3	3	3	3	3
34	1	1	1	1	1	1
35	3	3	3	3	3	4
36	3	3	4	4	4	5
37	1	1	1	1	1	1
38	3	3	3	3	3	4
39	3	3	4	4	4	5
40	2	2	2	2	2	2
41	2	2	2	2	2	2
42	3	3	4	6	6	7
43	3	3	3	3	3	3
44	1	1	1	1	7	8
45	3	3	3	3	3	3
46	3	3	4	4	4	5
47	1	4	5	5	5	6
48	1	1	1	1	1	1

Number of Clusters: columns 3–8.

49	2	2	2	2	2	2
50	1	1	1	1	1	1
51	2	2	2	2	2	2
52	3	3	3	3	3	3
53	2	2	2	2	2	2
54	3	3	4	6	6	7
55	3	3	3	3	3	3
56	3	3	3	3	3	3
57	3	3	4	4	4	5
58	1	4	5	5	5	6
59	3	3	3	3	3	4
60	1	1	1	1	1	1
61	2	2	2	2	2	2
62	1	1	1	1	7	8
63	3	3	3	3	3	3
64	1	1	1	1	1	1
65	2	2	2	2	2	2
66	1	1	1	1	1	1
67	1	1	1	1	1	1
68	3	3	3	3	3	3
69	3	3	3	3	3	4
70	2	2	2	2	2	2
71	1	1	1	1	1	1
72	3	3	3	3	3	4
73	1	1	1	1	1	1
74	1	1	1	1	1	1
75	1	1	1	1	1	1
76	3	3	4	4	4	5
77	1	1	1	1	1	1
78	3	3	4	4	4	5
79	1	1	1	1	1	1
80	1	1	1	1	1	1
81	3	3	3	3	3	3
82	3	3	3	3	3	3
83	2	2	2	2	2	2
84	3	3	3	3	3	3
85	1	1	1	1	1	1
86	3	3	4	6	6	7
87	3	3	3	3	3	4
88	1	1	1	1	1	1
89	3	3	3	3	3	4
90	1	1	1	1	1	1



Results of Initial Cluster Analysis
Part 3: Dendrogram

APPENDIX E:

Results of Refined Cluster Analysis

Part 1: Agglomeration Schedule
Part 2: Classification Table
Part 3: Dendrogram

Results of Refined Cluster Analysis
Part 1: Agglomeration Schedule

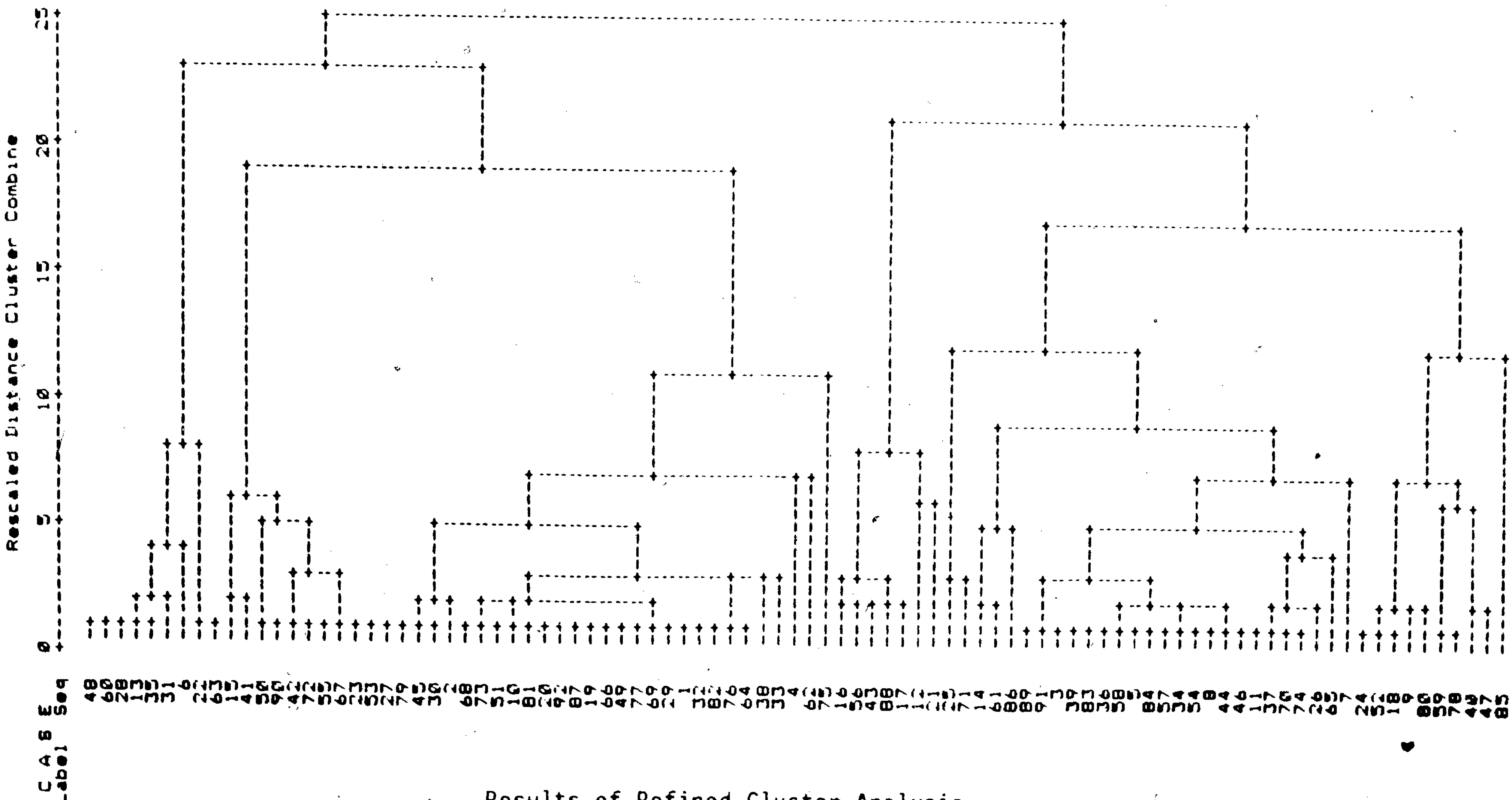
Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	48	60	1.0000	0	0	2
2	28	48	1.0000	0	1	3
3	13	28	.9980	0	2	42
4	20	92	.9974	0	0	8
5	49	77	.9949	0	0	12
6	39	83	.9934	0	0	19
7	27	79	.9930	0	0	24
8	20	87	.9929	4	0	11
9	42	52	.9928	0	0	45
10	55	67	.9923	0	0	30
11	19	20	.9917	0	8	17
12	49	69	.9914	5	0	20
13	10	81	.9907	0	0	46
14	22	63	.9884	0	0	81
15	34	54	.9873	0	0	52
16	42	72	.9865	0	0	62
17	19	66	.9860	11	0	28
18	89	91	.9858	0	0	43
19	36	39	.9857	0	6	22
20	29	49	.9853	0	12	28
21	32	82	.9845	0	0	33
22	36	58	.9844	19	0	37
23	68	73	.9839	0	0	38
24	27	45	.9839	7	0	39
25	8	44	.9836	0	0	35
26	5	34	.9830	0	0	31
27	23	53	.9818	0	0	30
28	19	29	.9814	17	20	34
29	11	37	.9812	0	0	41
30	23	55	.9752	27	10	62
31	5	57	.9743	26	0	37
32	70	74	.9708	0	0	41
33	32	76	.9679	21	0	44
34	1	19	.9661	0	28	46
35	8	46	.9650	25	0	52
36	50	90	.9650	0	0	70
37	5	36	.9639	31	22	58
38	51	68	.9635	0	23	56
39	27	30	.9619	24	0	51
40	59	78	.9577	0	0	75
41	11	70	.9573	29	32	49
42	13	35	.9572	3	0	60
43	3	89	.9551	0	18	63
44	32	64	.9543	33	9	54
45	18	24	.9486	39	9	62
46	1	10	.9479	34	13	56
47	16	56	.9461	0	0	65
48	40	47	.9456	0	0	75

49	11	26	.9431	41	0	68
50	9	80	.9372	0	0	54
51	2	27	.9279	0	39	73
52	8	34	.9274	35	15	58
53	15	41	.9249	0	0	76
54	9	18	.9222	50	45	79
55	43	88	.9194	0	0	59
56	1	51	.9150	46	38	67
57	14	61	.9149	0	0	72
58	5	8	.9125	37	52	63
59	17	43	.9091	0	55	65
60	13	31	.9051	42	0	69
61	32	38	.8958	44	0	64
62	23	42	.8813	30	16	70
63	3	5	.8761	43	58	71
64	32	33	.8639	61	0	67
65	16	17	.8553	47	59	82
66	25	71	.8544	0	0	85
67	1	32	.8510	56	64	73
68	11	65	.8434	49	0	71
69	6	13	.8098	0	60	81
70	32	50	.7880	62	36	76
71	3	11	.7633	63	68	78
72	14	86	.7574	57	0	83
73	1	2	.7468	67	51	80
74	12	21	.7350	0	0	82
75	40	59	.6998	48	40	79
76	15	23	.6944	53	70	88
77	4	62	.6823	0	0	80
78	3	7	.6742	71	0	83
79	9	40	.6668	54	75	86
80	1	4	.6402	73	77	84
81	6	22	.6057	69	14	90
82	12	16	.5918	74	65	89
83	3	14	.5580	78	72	85
84	1	75	.4548	80	0	88
85	3	25	.4141	83	66	87
86	9	85	.3957	79	0	87
87	3	9	.1234	85	86	89
88	1	15	.0489	84	76	90
89	3	12	-.0584	87	82	91
90	1	6	-.1611	88	81	91
91	1	3	-.2967	90	89	0

Results of Refined Cluster Analysis
Part 2: Classification Table

Case	Number of Clusters					
	3	4	5	6	7	8
1	1	1	1	1	1	1
2	1	1	1	1	1	1
3	2	2	2	2	2	2
4	1	1	1	1	1	1
5	2	2	2	2	2	2
6	3	3	3	3	3	3
7	2	2	2	2	2	2
8	2	2	2	2	2	2
9	2	2	2	5	5	5
10	1	1	1	1	1	1
11	2	2	2	2	2	2
12	2	4	4	5	5	5
13	3	3	3	3	3	3
14	2	2	2	2	2	2
15	1	1	5	6	6	6
16	2	4	4	5	5	5
17	2	4	4	5	5	5
18	2	2	2	4	4	4
19	1	1	1	1	1	1
20	1	1	1	1	1	1
21	2	4	4	5	5	5
22	3	3	3	3	3	3
23	1	1	5	6	6	6
24	2	2	2	4	4	4
25	2	2	2	2	2	7
26	2	2	2	2	2	2
27	1	1	1	1	1	1
28	3	3	3	3	3	3
29	1	1	1	1	1	1
30	1	1	1	1	1	1
31	3	3	3	3	3	3
32	1	1	1	1	1	1
33	1	1	1	1	1	1
34	2	2	2	2	2	2
35	3	3	3	3	3	3
36	2	2	2	2	2	2
37	2	2	2	2	2	2
38	1	1	1	1	1	1
39	2	2	2	2	2	2
40	2	2	2	4	4	4
41	1	1	5	6	6	6
42	1	1	5	6	6	6
43	2	4	4	5	5	5
44	2	2	2	2	2	2
45	1	1	1	1	1	1
46	2	2	2	2	2	2
47	2	2	2	4	4	4
48	3	3	3	3	3	3
49	1	1	1	1	1	1

50	1	1	5	6	6	6
51	1	1	1	1	1	1
52	2	2	2	4	4	4
53	1	1	5	6	6	6
54	2	2	2	2	2	2
55	1	1	5	6	6	6
56	2	4	4	5	5	5
57	2	2	2	2	2	2
58	2	2	2	2	2	2
59	2	2	2	4	4	4
60	3	3	3	3	3	3
61	2	2	2	2	2	2
62	1	1	1	1	1	1
63	3	3	3	3	3	3
64	1	1	1	1	1	1
65	2	2	2	2	2	2
66	1	1	1	1	1	1
67	1	1	5	6	6	6
68	1	1	1	1	1	1
69	1	1	1	1	1	1
70	2	2	2	2	2	2
71	2	2	2	2	2	7
72	1	1	5	6	6	6
73	1	1	1	1	1	1
74	2	2	2	2	2	2
75	1	1	1	1	1	1
76	1	1	1	1	1	1
77	1	1	1	1	1	1
78	2	2	2	4	4	4
79	1	1	1	1	1	1
80	2	2	2	4	4	4
81	1	1	1	1	1	1
82	1	1	1	1	1	1
83	2	2	2	2	2	2
84	2	2	2	2	2	2
85	2	2	2	4	7	8
86	2	2	2	2	2	2
87	1	1	1	1	1	1
88	2	4	4	5	5	5
89	2	2	2	2	2	2
90	1	1	5	6	6	6
91	2	2	2	2	2	2
92	1	1	1	1	1	1



Results of Refined Cluster Analysis
Part 3: Dendrogram

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