# TOWARD THE DEVELOPMENT OF INFORMATION TECHNOLOGY VARIABLES TO HELP PREDICT ORGANIZATIONAL STRUCTURE

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Robert Sweo, B.A., M.A.

Denton, Texas

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Sweo, Robert E., Toward the Development of Information Technology Variables to Help Predict Organizational Structure. Doctor of Philosophy (Organization Theory and Policy), May, 1995, 181 pp., 12 tables, 9 illustrations, bibliography, 148 titles.

There is a growing awareness that information technology plays a critical role in helping determine organizational structure. Unfortunately, that role has not been adequately defined. This study provides a foundation for an increase in our understanding of the relationship between information technology and organizational structure by defining a new set of information technology variables and identifying differences in organizational structure based on these new variables.

Four information technology variables are defined based on the functions information technology serves. Those functions are information dissemination, information storage and retrieval, data transformation and mutual adjustment. The organizational structure measures used include specialization, formalization, vertical span, centralization and configuration. The level of control desired by managers was considered as a moderating variable between information technology and organizational structure.

To test the variables defined and determine their effects on structure, a questionnaire was designed and pretested. The questionnaire was mailed to the Chief

Information Officers of 185 publicly held US banks. Sixty-one usable questionnaires were returned.

Results indicate a significant relationship between faster information dissemination speed and lower vertical span, and flatter configuration. The relationship between information dissemination speed and specialization and centralization is moderated by control. Information storage and retrieval has a significant relationship with specialization, formalization, centralization, and configuration. All the information storage and retrieval relationships are moderated by control. Higher data transformation quality is shown to have a significant relationship with increased specialization and with configuration that is moderated by control. Higher mutual adjustment speed is shown to correspond with lower formalization.

Analysis of the results indicate that the information technology variables defined here are useful tools for analyzing organizational structure. The results also indicate that past literature is not a reliable guide for predicting the effects of these information technology variables on organizational structure. Control is shown to be a critical moderating variable when considering information technology and organizational structure.

ACKNOWLEDGMENTS

I wish to thank my three committee members, Dr. Carl Swanson, Dr. Steve Cobb and Dr. William Brookshire. Each provided valuable insights which made completion of this project possible.

I would especially like to thank my committee chair, Dr. Mary Thibodeaux. She guided me through a very difficult process. Without her constant guidance and assistance I wouldn't have had the emotional strength or know-how needed to finish.

I would be greatly remiss if I did not also thank my wife Jennie. Her patience and consoling helped me remain stable during hard times and allowed me to enjoy the better moments. It was her efforts that made this entire process worthwhile.

TABLE OF CONTENTS

## LIST OF TABLES

## LIST OF FIGURES

# CHAPTER 1

## INTRODUCTION

There is a growing awareness that information technology plays a critical role in helping determine organizational structure (Huber 1990). Unfortunately, however, that role has not been adequately defined. Although twenty-one studies have been undertaken to look at the effects of information technology on structure (Huber 1990; Sung 1988; Zefanne 1992), researchers have taken a very limited view of what information technology is. They all tend to equate information technology with the use of computers.

The focus of this study was not solely on computers as a definition for information technology for two reasons. The first reason is that computers are now so pervasive in business that there are few organizations left without them (Keen 1991). Comparisons based on the presence or absence of computers, therefore, provide little insight into the information technology of the vast majority of companies.

The second reason for not focusing solely on computers is that information technology extends far beyond computers. The printing press, telegraph, telephone, typewriter and photocopier were all revolutions in the type of information technologies used and had major impacts on the organizations of their times (Kasson 1976; Singer, Holmyard, and Hall 1954; Whisler 1970). These technologies drastically altered how the adopting organizations or societies used their information and subsequently altered the organizations themselves. Studying these technologies and finding their commonalties with computers can help in developing a new set of information technology variables. Done accurately, this set of variables can better differentiate organizational structure and yet be independent of any specific technology (e.g. computers, telephones, typewriters, etc.). As a result, these variables have a better chance of remaining meaningful through future shifts in information technology.

Previous studies of operations technology provide a clue as to the gains that can be had by creating a set of variables that are independent of a specific technology to measure a technology construct (Fry 1982; Miller et al. 1991). Operations technology has been defined as "the equipping and sequencing of activities in the workflow" (Hickson, Pugh and Pheysey 1969, 378). The study of operations technology and structure began with Woodward's (1965) descriptions of unit, batch, and process technologies. Woodward's description of operations technology provided a set of variables by which operations technology could be understood without having to rely on descriptions of the specific hardware or procedures being used. This description allowed researchers to group technologies that were used for similar purposes, regardless of whether they used similar hardware configurations.

Woodward's (1965) definition of operations technology quickly gave way to Perrow's (1967) description of routine, craft, engineering and non-routine technologies. Perrow differentiated operations technologies based on the degree of repetitiveness of the tasks. Perrow's variablization of operations technology was completely independent of the specific hardware technology utilized. It was, therefore, used as the basis for a huge mass of studies that show a consistent relationship between operations technologies and organizational structure. The substantial number of studies available is reflected by three independent meta-analyses on the subject (Caufield 1989; Fry 1982; Miller et al. 1991). The consistent relationship between operations technology and structure has been shown even though the specific operations technologies being measured have undergone several revisions over the course of the studies (Miller et al. 1991).

Although the advantages of a set of variables independent of a specific technology to measure operations technologies have been clearly shown (Caufield 1989; Fry 1982; Miller et al. 1991), the need for a better set of information technology variables is just beginning to be recognized (Huber 1990; Sung 1988). Huber (1990), in a conceptual article, and Sung (1988), in a dissertation study have attempted very limited extensions of the operational definition of information technology. The two researchers include a broader array of specific technologies (Huber 1990) and a limited consideration for how the technologies were used, such as Sung's (1988) Extensiveness of Use variable. These two studies, however, fail to measure the broader implications of information technology.

This study is an attempt to define and support a set of information technology variables that adequately capture information technology's relevant features in relationship to organizational structure. Because the need for a new categorization of information technology was addressed in this study, the information technology variables were exploratory. The organizational structure variables, however, have a long history and well-established theoretical foundation; therefore, the effects of information technology on them can be evaluated with a high degree of reliability and validity.

## Purpose of the Research

The purpose of this research is to accomplish two objectives:

1. To use available research to develop information technology variables that can differentiate organizational structure types.
2. To use the new information technology variable set to test specific hypotheses about the relationship between information technology and organizational structure.

## Significance of the Research

Information technology has become a pervasive element of American and international business (Keen 1991). Yet, published research gives an unrealistic picture of the effects of this technology on organizational structure (Huber 1990; Sung 1988). Information technology studies to this point are constrained by their definitions of information technology. A set of information technology variables that is not dependent on specific technologies and is sensitive enough to discern information technologies' effects on organizations would have broad implications for both researchers and practitioners (see Table 1 for an overview of the significance of this research).

Researchers could use the variables to further explain the relationships between information technology and organizational structure. Variables that are not technology specific could aid in comparing results across the broad array of information technologies now available.

*Table 1.--Significance of Research*

| Theory | Practitioners |
| --- | --- |
| • *Allows specific technology independent research* | • *Provides basis for technology comparisons* |
| • *Organization is information* | • *Allows to predict changes in technologies affects on structure* |
| • *Provides connection between research streams* | |

The ability to compare several information technologies is very important to organizational theory. In many researchers' view, organizations are information processing systems (Burns and Wholey 1993; Daft and Weick 1989; Egelhoff 1991; Smith, Dykman, and Davis 1985). The ability to compare a broad set of effects due to information technologies, therefore, not only provides an important link in building a comprehensive model of organizations, but also offers the potential to finally allow researchers to tie together organizational variables such as strategy, structure, leadership, organization size and operations technology (Daft 1992; Miller 1987; Miller et al. 1991; Pfeffer 1981) that are known to affect organizations. If information processing is the basis of organizations, then an understanding of the information technologies through which the processing occurs and its relationship to structure could illuminate the framework upon which organizations are built.

For practitioners, this research provides the variables needed to understand and predict the effects of information technology changes in their organizational structures. Because the fit between technology and structure is considered key to organizational success (Caufield 1989; Daft 1992; Miller et al 1991; Perrow 1967), it is imperative that companies be able to predict the structural effects of adopting various information technologies.

## Theoretical Foundations

The great breadth of research which considers the influences on organizational structure makes development of a complete model for the foundations of structure difficult. Yet such a model is needed in order to understand the effect of information technology on organizational structure. Thus, the theoretical foundations for this study are broken into two sections. First, a brief review of the factors that influence structure are presented to develop a context in which information technology's relationship can be understood. Then, a narrowed focus on information technology and organizational structure are presented to preview potential variables. This section concludes with a model which describes the relationship between information technology and organizational structure.

## Influences on Organizational Structure

Organizational structure can be simply defined as "the sum total of the ways in which an organization divides its labor into distinct tasks and then achieves coordination among them" (Mintzberg 1979, 2). Several variables have been considered as influences on organizational structure (Daft 1992; Mintzberg 1989). The variables that have received the widest support include operations technology (Caufield 1988; Fry 1982; Miller et al. 1991), environment (Burns and Stalker 1961; Keats and Hitt 1988), strategy (Ansoff 1965; Chandler 1982; Miller 1987), power and politics (Pfeffer 1981; Stephenson 1985), and organizational size (Lal 1991; Pugh et al. 1968). Each variable is discussed separately. A particularly close scrutinization is made of the operations technology and structure relationship. That relationship covers most of the structural variables considered in the other sections of this chapter and encompasses the subset of primary interest, information technology. This section concludes with a model that describes the major influences on organizational structure.

## Operations Technology

Operations technology is one of the most frequently considered variables when looking at what causes a particular organizational structure to develop (Caufield 1989; Fry 1982). It is the variable that was first used to describe why organizational structures differ (Woodward 1965) and is still considered to play a key role (Caufield 1989; Fry 1982; Huber 1990).

Many Researchers have attempted to link organizational structure and operations technology; so many, in fact, that there are now several meta-analyses that combine the results (Caufield 1989; Fry 1982; Miller et al. 1991). Results of these studies indicate that many structural measures are affected by operations technology, including job specialization, formalization, vertical span, centralization, configuration, and others.

## Operations Technology and Job Specialization

The structural measure most frequently linked to operations technology is job specialization. Job specialization is an indication of how many different positions exist in the division of labor (Mintzberg 1979). The effect of operations technology on job specialization has, for the most part, been decided by the way in which operations technology is defined. From research in operations technology, several authors found that as operations technology is used to create larger quantities of identical items, ranging from small batch to mass production, jobs are more specialized (Blau, et al. 1976; Woodward 1965).

When defining operations technology by how routine it is, however, researchers have found a more complex relationship. Their studies show that the associations between routineness and specialization depend on the industrial sector heterogeneity of the set of organizations studied and on the average size of the organizations used in the analysis (Miller et al. 1991). Their findings suggest that the relationship between technology routineness and structure is industry dependent and is influenced by the size of the organizations measured. Unfortunately, the meta-analytical techniques used by Miller et al. (1991) provide information only on the size of the effects of industrial sector heterogeneity and other control factors on structure and not on the direction of the influence.

## Operations Technology and Job Formalization

Formalization is another factor which is strongly affected by operations technology (Fry 1982; Woodward 1965). Formalization is a measure of how regulated the jobs, work flow, and rules of an organization are

(Mintzberg 1979). The relationship between operations technologies and formalization has been consistent across several studies. Findings show that as operations technology becomes more routine, formalization increases (Blau, et al. 1976; Hetherington 1991). The only modifications found to this simple rule are that the associations between routineness and formalization depend on the industrial sector heterogeneity of the set of units being studied (industry mix), on the definition of routineness assessed (routineness operationalization) and on the professionalization of the work force (percentage of professional employees in the organization)(Miller et al. 1991). None of these modifications are trivial, but all can be controlled through rigorous definition of variables and careful selection of subjects in a study.

Formalization in relation to other categorizations of operations technologies has shown similar results. As the tasks in which operations technologies are implemented become consistently repeatable, formalization increases (Caufield 1989; Fry 1982).

## Operations Technology and Vertical Span

Vertical span or, as it is sometimes called, vertical complexity refers to the number of levels of managerial hierarchy in a firm (Hickson et al. 1969). Vertical span has consistently been shown to increase as operations technologies become more routine (Caufield 1989).

## Operations Technology and Centralization

Centralization refers to the hierarchical level that has authority to make a decision (Daft 1992). The relationship between centralization and operations technologies is more complex than is the relationship between operations technologies and the other structural variables. The relationship shows that increasing operations technology has a curvilinear relationship with centralization. At lower levels of operations technology, centralization increases as operations technology increases. Eventually, operations technology becomes intricate enough that further operations technology increases decrease centralization because higher level managers cannot understand the processes (Blau, et al. 1976; Fry 1982; Woodward 1965). Tests in which routineness of an operations technology is used instead of the amount of operations technology show that the associations between routineness and centralization depend upon the industrial sector homogeneity of the sets of units studied and on the average size of the units of analysis (Miller et al. 1991).

## Operations Technology and Configuration

Configuration is a composite variable that attempts to combine various dimensions that show the shape of an organization (Caufield 1989; Pugh et al. 1968). Configuration is most frequently represented by a graph that is similar to an organizational chart. Variables commonly used in configuration include the following (Caufield 1989):

chief executive officer (CEO) span of control
supervisors' span of control
percentage of direct workers
percentage of workflow supervisors
percentage of nonworkflow personnel
percentage of clerical personnel

The effect of operations technology on the configuration of a firm depends on the method of categorizing operations technology.

When complexity is used to categorize operations technologies, high-complexity firms have fewer vertical levels and a broader base of direct workers. Low-complexity firms tend to have more vertical levels and fewer direct workers (Caufield 1989; Fry 1982; Woodward 1965). When dividing operations technologies by routineness of task, more routine task firms tend to have more vertical levels and fewer direct workers. Non-routine task firms tend to have fewer vertical levels and a broader base of direct workers (Miller et al. 1991).

Operations Technology and Other Structural Variables

Researchers have evaluated many other structural variables, such as the level of training and development, unit groupings, and liaison devices in relationship to operations technology. Results on these variables are mixed. Variables that have been studied and their results are considered in the following paragraphs.

A structural variable with mixed results when considered with operations technology is the level of training and development. Although one study shows that increased operations technology complexity decreases the need for operations training (Blau, et al. 1976), another study directly contradicts that result (Hayes and Jaikumar 1988). No resolution to the issue has been reached because the meta-analyses considering operations technology did not include enough studies to consider training and development as a structural variable (Caufield 1989; Fry 1982; Miller et al. 1991).

Another structural variable that has not found strong support is unit groupings. Although one researcher reports that increases in operations technology complexity increase functional grouping (Barley 1990), the effect was weak and has not been supported in other studies.

Other variables have received anecdotal support; however, little empirical evidence exists to substantiate a relationship with operations technology. Those variables include planning and control systems (Kaestle 1990), liaison devices (Ciborra and Olson 1989), and horizontal decentralization (Ashburner 1990).

### Summary of Operations Technology

There is strong support for the argument that operations technology affects the organizational structural components of specialization, formalization, vertical span, centralization, and configuration. Variables such as the heterogeneity of subject industries, firm size, professionalization of the work force and the definition of operations technology used appear to mediate some of the relationships. There is very weak evidence for a relationship between operations technology and the structural variables of training and development, unit grouping, planning and control systems, liaison devices and horizontal decentralization.

Environment

The arguments for a strong relationship between the environment of a firm and the firm's structure arose in the same period as Woodward's (1965) early discussions of the operations technology--structure relationship. In these discussions, Woodward proposed that more dynamic environments require organic structural configurations, whereas stable environments encourage mechanistic configurations (Burns and Stalker 1961). The use of a stable or dynamic description to describe the environment's effects on structure remains consistent with current literature (Daft 1992; Duncan 1972; Mintzberg 1979). Most researchers also include a breakdown of the environment into a simple-complex dimension that describes how many different environmental factors a firm typically has to deal with at any given time (Duncan 1972; Keats and Hitt 1988).

The two-by-two matrix described by the interaction of environmental stability and complexity is, thus, used by most researchers to describe the environment's effects on organizational structure. Most authors agree that a simple and stable environment coincides with rigid, mechanistic structures, Whereas unstable complex environments tend to breed more organic structures (Daft 1992; Duncan 1972; Keats and Hitt 1988).

The relationship between environment and structure, however, is affected by many of the same moderating variables as operations technology and structure. There appears to be a significant interaction with strategy (Miller 1990) and a measurable industry effect (Lenz and Engledow 1986).

### Strategy

Although strategy has been discussed as a moderator to the previous variables, many researchers see it as more than that. They argue that strategy itself is a primary determinant of structure (Ansoff 1965; Chandler 1962; Porter 1980), and suggest that structure is derived through the planned activities of managers allocating resources and setting goals based on a strategic plan. In their model of the derivation of structure, it is specific planned acts of managers that create a given structure. Thus, the structure of a firm can be distinguished by strategic breakdowns such as those offered by Porter (1980) and Miles and Snow (1978).

The use of strategy as a structural determinant can be difficult because of the wide variety of strategies available (Miller 1987). The problem is made more difficult by the iterative relationship between strategy, operations technology and the environment (Itami and Numagami 1992). Yet, it is important to consider strategy whenever looking at organizational structure because its strong moderating effects and potential main effects add substantial variability to data if not adequately controlled.

Power and Politics

Most researchers who analyze the relationship between power and politics and structure consider one or more of the five types of power: reward, coercive, legitimate, referent and expert (French and Raven 1959; Pfeffer 1981; Stephenson 1985). These studies follow two courses. The first course is to try to show how power and politics affect structure by affecting the strategic process (Mintzberg 1979; Pfeffer 1981). The second course is to reverse the relationship between power and structure to show how organizational structure controls power and politics (Pfeffer 1981; Stephenson 1985).

Few researchers recognize any relationship between power and structure that could not be captured by strategy or did not flow in the direction of structure to power (Pfeffer 1981; Pfeffer 1992; Stephenson 1985). It thus appears safe to ignore power and politics in a study of the causes of structure if strategy is considered.

## Organizational Size

The last variable that has received a good deal of attention as a contributing factor to organizational structure is firm size. Several researchers have suggested that as a firm grows larger, it becomes more bureaucratic (Chapin 1951; Pugh et al. 1968). The relationship between size and such bureaucratic features as high specialization and formalization, however, has not received a great deal of empirical support (Ford 1980; Hall 1963; Moham 1991). Revisionary reports of early size-related studies show that most of the findings are attributable to methodological problems or uncontrolled factors, such as operations technology (Ford 1980).

The size of firms is easily categorized by such features as number of employees or sales volume (Kimberly 1976). Even with such easily attained and compared figures, however, little has been done in size and organizational structure research.

## Model of Influences on Organizational Structure

Given all the research conducted on the influences over organizational structure, a model combining their effects is needed in order to understand the influence of any one variable. Such a model is suggested in Figure 1. There is a great deal of controversy in organization theory as to exactly what the key influences on organizational structure are. Therefore, it is unlikely that all researchers would agree on the model. But the specific strengths and positions of the variables for this discussion are not critical. It is enough to note the various influences so that their effects can be controlled for when measuring the variable of concern, information technology.

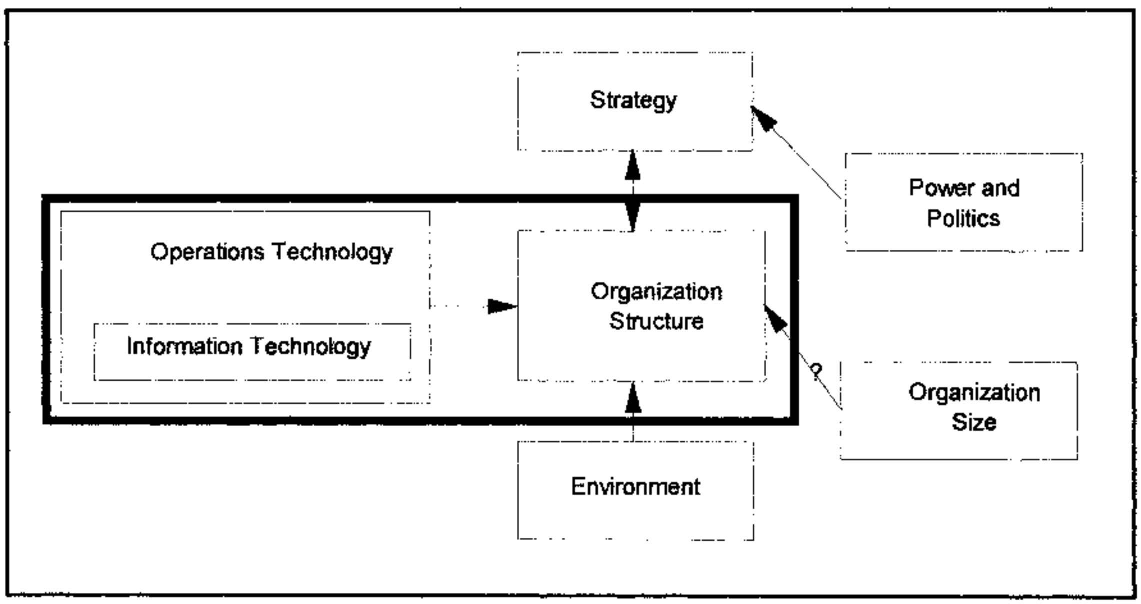


Figure 1. Model of Influences on Organizational Structure (Variables in the bold box are the key variables for this study.)

The model portrays the relationships between the various influences on organizational structure that have reasonable support in the literature. The elements contained in the bold box, namely information technology and organizational structure, are of primary concern to this study, and therefore, are considered throughout most of the remainder of this research. The other variables, however, still have an influence on organizational structure and are considered in the methodology to make sure their effects are adequately controlled. The focus of this study on companies, such as information service companies, that use information technologies as their dominant operations technologies, so that there is no confounding due to other operations technology variables.

## Information Technology and Organizational Structure

Because previous researchers of information technology and organization structure all used very limited definitions of information technology, it is necessary to look to other sources to develop a set of variables for information technology that sufficiently distinguishes its effects on organizational structure. This section of the theoretical foundations review, therefore, begins with a review of the few studies by researchers who try to link information technology and structure directly. The discussion then moves to a review of mostly non-empirical pieces to build a more thorough foundation for variables that describe information technology. Finally, a general model of the effects of information technology on structure is derived from what is known about information technology, the relationship between operations technologies and organizational structure and expert opinion on the relationship between information technology and organizational structure.

Information Technology and Structure

Because of the large number of studies of the effect of operations technology on structure and the importance of information technology in the workplace, one might expect a broad set of studies about the effect of information technology on structure. Unfortunately that is not the case. Researchers have tried to link information technology to structure (Huber 1990; Sung 1988; Zefanne 1992). Almost all of these researchers use the same narrow definition of information technology; that is, they equate information technology with computers.

Because of this lack of research, most of what is "known" about the relationship between the broader definition of information technology and structure is based on conjecture and extrapolation from studies that do not directly address the relationship. Although this type of information cannot be used to describe the relationship between information technology and organizational structure definitively, it can provide some insight into knowledgeable individuals' expectations of the relationship and help in model building.

Several such observations are, therefore, considered. The observations are divided into three groups. First, factors that generally support a relationship between a broad definition of information technology and structure are considered. Next, two studies of the relationship that use slightly broadened variables are analyzed. Finally factors that imply a specific relationship with a structural design variable are considered.

## General Support

Several sources provide general support for a broad information technology/organizational structure relationship (Liu et al. 1990; Nash 1987; Rossetti and DeZoort 1989). The sources typically suggest the criticality of adjusting structure and information technologies together. One study even suggests that failing to adjust structure to the effects of new information technologies can threaten an organization's viability (Rossetti and DeZoort 1989). Another study indicates that advanced information technologies reduce work force requirements, thus altering the size and entire configuration of a company (Nash 1987).

The results of still other studies suggest that information technology is altering the fundamental processes of firms and is irrevocably changing the firms structures. For instance, one study shows that because of advanced information technologies, organizations are designed more to manage complexity now than to reduce it (Liu et al. 1990), thus modifying the goals of organizational structure. These strong, but general, indications for a relationship between a broad definition of information technology and structure highlight the importance of study in this area. More detailed findings are needed to identify exact relationships.

Information Technology and Structure Publications

Only two recent publications specifically address the relationship between a broader definition of information technology and organizational structure. In the first study, a single organization is used to test hypotheses based on little theoretical support. The second is an attempt to develop hypotheses about the relationship between information technology and structure without testing them.

In the first publication, a dissertation, Tae Kyung Sung (1988) defines information technology using three dimensions: growth of capacity, extensiveness of use and information technology sophistication. Sung uses organizational control as an intervening variable. Measures of centralization, formalization, and specialization are used as structural variables. Sung collected data using a survey and in-depth interviews in one large Korean conglomerate. He found that control had an important moderating effect and that there was little difference in structural data collected by survey, interview, or through archival methods. The different variables of information technology, however, showed little unique differentiation between structural measures.

The research presented illustrates the inadequacies of the variables used for information technology. Sung suggests that one problem is the lack of differentiation between the availability of technology and its actual use. His "extensiveness of use" variable only measured the technology available to the users, not how much it was used. Other problems were likely attributable to the use of only one company for measurement. Although using one company controls for all the other variables that influence structure, it also reduces the variability in structure to such a low level that significant differences are difficult to detect.

Sung's (1988) study did provide one key piece of evidence. It showed that the level of organizational control is a key moderator for information technology's effects. The moderating effect could be synonymous with the strategy moderating effect already anticipated, however. Sung's research also substantiated the need for a better set of information technology variables, but it failed to explain the relationship between information technology and structure.

The second recent publication is an article by George Huber (1990), who provides a brief review of the literature that touches on the structure/information technology relationship and attempts to derive hypotheses from it. Based on the hypotheses offered, it is apparent that Huber breaks information technologies into the following six categories: transaction monitoring technologies, information processing technologies, information storage and acquisition technologies, computer assisted communication technologies, decision support technologies and expert systems.

Because Huber (1990) links the various types of technologies to dependent variables that are combinations of traditional structural factors, such as self-managed work teams, his expectations are difficult to compare with other findings. His information technology variables are also specifically dependent on advanced information technologies, and thus, are hard to relate to early studies. Huber does provide an interesting division of the tasks for which information technologies are used and provides some useful insight into how to create a set of variables that is not specifically tied to computers.

## Specific Relationships

Several researchers on information technology suggest specific business outcomes that indicate effects on organizational structure. For example, one study revealed that increases in information and management technology complexity increase market grouping (Bahrami and Evans 1989). This finding suggests that high information technology complexity increases market-oriented unit groupings. Another study revealed that increased information technology complexity allows freer control over unit size decisions (Gurbaxani and Whang 1991). This finding implies that decisions on unit size affect other variables once information technology reaches a certain level of complexity.

Other researchers who suggest an information technology/structure relationship include several who have found that increased information technology provides opportunities for increased control (Er 1987; Howard 1987; Rockart and Short 1989). Further research suggests that increased information technology substitutes for other liaison devices (Ciborra and Olson 1989) and that increased information technology increases total liaison activity (Feldman 1987; Goldstein and Zack 1989). Finally, researchers have found that increased information technology decreases vertical span by shrinking the number of management levels needed (Keen 1991; Sorge 1989).

## Information Technology

Given the strong anecdotal indications of a relationship between a broader definition of information technology and structure, the lack of published attempts to create such a variable set is surprising. In this section, therefore, several historical and empirical reviews of information technology are analyzed to develop a set of variables that reflect the breadth of information technologies features and impacts. The section is divided into three subsections: historical analyses of information processing, modern information processing analyses, and a model for information technology variables.

### Historical Information Technology Analysis

In most studies of information technologies, information technology and computers have been considered to be equivalent terms (Sung 1988). Yet, a long history of improvements in information technology is ignored by this narrow definition. By comparing the similarities in the effects of early information technology changes and more modern ones, insight can be gained regarding the features that are most relevant about a change in all information technologies.

Technologies rarely leap forward in a single step. New developments are invariably built upon previous uses. This is the case for information technologies as well.

The development of speech could easily be considered the first information technology. It helped its early adopters store and convey meaningful ideas and data to others. With that prehistoric beginning, information technologies have flowed through many forms. The adoption of writing was a major breakthrough in information storage and transmittal, as were such developments as paper and filing systems (Singer, Holmyard and Hall 1954). Yet, the real dawn of the information explosion did not occur until the mid-fifteenth century.

Until the invention and adoption of the printing press in 1438, information could only be duplicated through handwritten reproduction. The printing press allowed a single work to be reproduced much more quickly and at a much lower cost (Kasson 1976), and vastly reduced the time and cost of information dissemination. The printing press also reduced the time required to retrieve information, because copies could be kept in more geographic locations, thus reducing the time required to obtain a particular piece of data.

The development of the printing press foreshadowed several other information technologies. Developments such as the typewriter and photocopier served the same function as the printing press. All of these technologies allowed for faster and cheaper dissemination of information.

The production of so much information, however, caused a serious problem. Unless the information could be stored and retrieved, its reproduction was of limited use. Thus several information systems, such as libraries and organizational filing systems, were developed to store and provide access to information (Singer, Holmyard and Hall 1954). The more efficient storage systems allowed a greater accumulation of a breadth of data. Less efficient ones required far more departmentalization, specialization, and formalization.

The accumulation of information brought on other problems as well. The need to transform all the data collected into useful knowledge required an entirely new set of information technologies. Developments such as adding machines and calculators were developed to help in accumulating numeric information; systems such as decision models and decision trees were developed to help individuals to use the incoming information (Whisler 1970). The calculating devices and decision trees worked as information accumulators and filters to guide users through information analysis.

A final set of information technology systems with a long stream of development was made up of mutual adjustment technologies. These technologies worked to provide fast, iterative communication between a small group of individuals (usually two). This class began with simple, face to face communications, but quickly moved to signaling techniques such as smoke signals. Mutual adjustment eventually moved to technologies such as the telegraph and telephone, which enabled individuals to communicate over vast distances in short periods of time (Lyon 1988). All of the mutual adjustment technologies allowed individuals to adjust their behaviors to current information.

From the collection of information technologies that lead up to the development of computers, one can see a stream of consistency that may provide a basis for analyzing modern information technologies. This stream suggests that information technologies serve four main functions: information dissemination, information storage and retrieval, data transformation, and mutual adjustment. All are functions which modern information technologies also seem to reflect.

Modern Information Technologies

When most authors discuss modern, or advanced, information technologies, they are referring to technologies based on digital transmission, primarily computers and digital phone systems (Huber 1990; Sung 1988). These systems created such a drastic increase in speed and reduction in cost of the traditional information technology functions that they became recognized as an entirely different technology. Yet a re-analysis of earlier studies of organizational structure and information technology suggests that the functional breakdown (information dissemination, storage and retrieval, data transformation and mutual adjustment) offered here could eliminate many related problems, such as the lack of comparability between specific technology dependent studies.

Most early researchers of information technology and organizational structure used computer-use or lack of use as the independent variable. Those who stuck with such a limited differentiation tended to have weak results (Pfeffer and Leblebici, 1977). Some researchers broke computer use down into specific computer products, such as E-mail, decision support systems and so forth. (Boddy and Buchnaon 1984; Child 1984; Warner 1984). These researchers found a stronger impact of information technology on structure. This impact might have appeared because the product categories overlapped somewhat with the information technology functions defined here. For example, E-mail systems could be considered an information dissemination and mutual adjustment device and decision support systems could be considered a data transformation tool. Although the overlap is at best rough, the added variability could explain the weak results.

It appears that even the modern analyses of information technology and structure could have benefited from a functional breakdown of information technologies. Sung's (1988) information technology sophistication and growth of capacity measures lack support because they fail to differentiate between the functions played by technology. Further, Huber's (1990) hypotheses which are based on technology types, are too general because the technology types cross several functions and mix their effects on structural variables.

Thus, there is at least circumstantial support for a functional breakdown of information technology in modern information systems. The researchers in several non-structure related studies have considered each function in relation to modern information technologies, but have offered little insight into the breakdown of information technology in relation to structure (Bates 1990; Coates 1993; Gauch and Smith 1993; Silver 1988; Walz, Elam and

Curtis 1993). These studies are reviewed in Chapter 2 in a section on the development of the information technology measures.

Information Technology Model

The analysis of the relationship between traditional and modern information technologies and organizational structure suggests that the following four variables offer the best division of information technology: information dissemination, information storage and retrieval, data transformation, and mutual adjustment

Assessment of information dissemination, information storage and retrieval, and mutual adjustment can all be based on the cost and speed with which the organization can complete the function. Data transformation can also be considered in relation to cost and speed, but a quality consideration is another critical factor in its assessment.

## This Study's Model

A model of the influences on organizational structure is presented in Figure 1. The focus of this study is on the part of the model that relates information technology and organizational structure. Based on the structural variables developed in the sections on the influences on organizational structure, and the functional breakdown of information technology, a more detailed model of the relationship between information technology and organizational structure can be presented. This new model is shown in Figure 2.

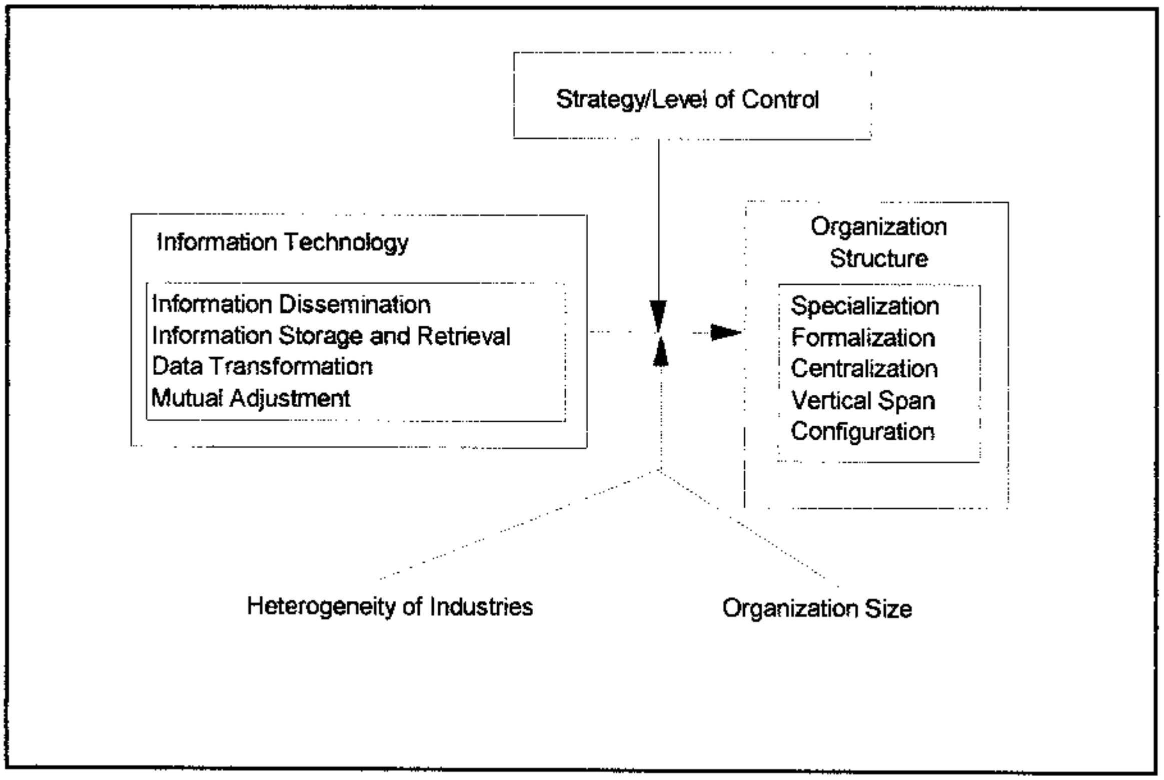


Figure 2. Model of the Relationship Between Information Technology and Organizational Structure

The model specifies the variables to be tested and compared. The specific measures and directions for the relationships are developed and presented in Chapter 2.

## Methodology Overview

The objectives of this study are to use measures of organizational structure to validate the set of information technology variables developed and to test hypotheses on the relationship between the information technology variables with organizational structure. Data were collected to help meet objectives one and two through a questionnaire which was mailed to 183 banks.

The mailed questionnaire included questions on organizational structure and control taken from previous studies (Miller 1986) and new questions designed to measure information technology variables. MANOVA was used to test the hypotheses.

## Chapter Summary

For this study a set of information technology variables was developed and their effectiveness in differentiating organizational structure was tested. A set of specific information technology independent variables would be of great use in understanding organizational structure. To be effective this study considered operations technology, environment, strategy, power and politics, and organizational size, which might also affect organizational structure. The information technology variables of information dissemination, information storage and retrieval, data transformation, and mutual adjustment show good potential as specific technology independent information technology variables. Their effectiveness was tested using a mailed questionnaire survey of bank chief information officers.

CHAPTER 2

# LITERATURE REVIEW

This review of the literature is divided into five sections. The first section includes the variables that are used to define information technology. The second section covers variables used to measure organizational structure. The third section provides a look at the measurement of control as a moderating variable. The fourth section ties the previous sections together by considering variable interactions. Finally, the fifth section presents a comprehensive set of hypotheses that relate the variables to one another.

## Information Technology Variables

As stated in the model for this study (Figure 2 from Chapter 1), it appears as if information technology can be categorized by measuring four variables: information dissemination, information storage and retrieval, data transformation, and mutual adjustment. Based on previous studies, considerations of these variables are analyzed in the sections below.

## Information Dissemination

Information dissemination is the act of spreading information (Burns and Wholey 1993). Unlike mutual adjustment, information dissemination is uni-directional. Iterative responses to the information being disseminated are not expected. While information dissemination has been made far faster and easier by electronic means such as electronic memos, newspapers, journals, and even corporate rumor mills, are all information dissemination techniques.

Increased speed and reduced cost of information dissemination are frequently cited as reasons for shifting to advanced information systems (Nievelt and Augustus 1993; Sulek and Marucheck 1992; Williams and Clark 1992). Yet, there is still not a clear operationalization of information dissemination. Some authors equate information dissemination with the speed of information transportation (Nievelt and Augustus 1993; Sulek and Marucheck 1992), while others measure it as the rate of diffusion of new information (Bredehoft and Kleiner 1991; Williams and Clark 1992). Although the definitions appear very similar, the variance in the definitions has lead to different conclusions in from research into information dissemination.

When information dissemination is defined as the rate of information transportation, the primary concern for the researcher becomes the type of technology used to spread information. Researchers using this definition have thus considered the effects of new technologies such as E-Mail (Rappaport 1992; Sulek and Marucheck 1992) and Electronic Data Interchange (Sheombar 1992).

In order to measure information dissemination researchers often compare whether companies or workgroups use or did not use a particular technology (Nievelt and Augustus 1993; Sulek and Marucheck 1992; Rappaport 1992). For example, groups using E-Mail might be compared to similar groups not using E-Mail. This approach provides researchers with a variable that is easy to evaluate, but the conclusions are frequently unclear. The different ways in which technologies are implemented create substantial differences in the outcomes (Nievelt and Augustus 1993). This ambiguity most likely occurs because the presence or absence of a technology tells researchers little about the effect of the technology. For example, if workers infrequently log into their computers, E-Mail might deliver a message slower than conventional mail.

Some researchers who consider information dissemination to be equal to information transportation speed have used the electronic throughput capacity of various instruments as a measure (Kranch 1989; Randhawa and Rucker 1988). These authors consider information dissemination speed to be constrained primarily by the transmission equipment through which the information passes. They, therefore, considered it acceptable to measure information dissemination by the maximum transmission capacity of the equipment used. These analyses are best considered a special case, however, because they are based on system designs such as global information systems (Kranch 1989) and geographically dispersed expert systems (Randhawa and Rucker 1988) in which data throughput is a major constraint. In most other systems there is a great deal of spare capacity in the transmission system that would make a measure of information dissemination based on capacity significantly overvalued.

Researchers who have used the rate of information diffusion as a definition of information dissemination have had greater success in evaluating broad dissemination effects. These authors have measured information dissemination by looking at the rate at which information multiplies (Williams and Clark 1992). They have considered how long it takes for a piece of information to be duplicated in several other places. Thus, they have looked at the rate in which an original piece of data published at one source was adopted and included in other sources.

Information multiplication works very well as a measure of information dissemination when looking at published sources. It is difficult to use, however, as a measure of dissemination for information within a company because the record of diffusion is not nearly as clear or permanent. Other diffusion measures must, therefore, be considered.

One such diffusion measure is the time it takes for a piece of information to get from a defined starting point to a desired target or set of targets (Bredehoft and Kleiner 1991). An advantage of this measure is that it can be used in any setting in which desired beginning and end points can be defined. An added advantage is that it is independent of the technologies being used and thus allows easier comparisons across technologies. The major drawback to this measure of information dissemination, however, is that it only records dissemination in the specified directions and to specific sources.

Given this study's aim to measure the information dissemination effects within corporations, an information multiplication measure would be very difficult to obtain. Therefore, the speed of transmission from a specific starting point to various other points in the company is used as the measure of information dissemination for this study.

## Information Storage and Retrieval

For this study, information storage and retrieval refers to the process of storing information and the process of collecting needed information from that storage system

(Losee 1991). The term information storage and retrieval has been used so frequently in terms of computerized databases that the two are considered almost synonymous. Information systems such as libraries and filing cabinets also fall within information storage and retrieval's definition, however, and must be considered in order to understand fully information storage and retrieval in an organization.

Information storage and retrieval has been studied in several different ways. A large number of computer science researchers have considered information storage and retrieval problems in terms of how fast data can be written to and extracted from a database (Bell et al. 1993; Chung 1992; Glinka 1993; Martin et al. 1990; Tavakoli and Ray 1992). Other researchers focusing on computers have been more concerned with the time it takes to formulate a query which correctly extracts the desired data from a database (Bates 1990; Gauch and Smith 1993). A third body of literature considers the time required to store and extract data without concern for the particular technology used (Losee 1991; Bookstein 1983; Swets 1969). Each view of information storage and retrieval comes with a unique set of measurement instruments and capabilities.

When information storage and retrieval is seen as the writing and extraction of data from a database, the primary measurement concern becomes hardware and software access times (Glinka 1993; Martin et al. 1990). Researchers have also concerned themselves with hardware measurements such as disk settling time, the time needed for a disk read-write head to settle on track, the time from arrival at the target track to the time the head can start reading or writing properly, and other related data reading and writing times (Glinka 1993; Ferelli 1993; Kennedy 1993; Song 1992; Carson and Setia 1992).

Beyond just hardware read and write times, several authors have studied software designs that influence access speed. Substantial research has been conducted to examine software tools such as disk caching strategies (Martin et al. 1990), data compression (Bell et al. 1993), software signature approaches to data storage (Travakoli and Ray 1992), and indexed extendible hashing (Chung 1992). All of these techniques are intended to store information in a smaller and more accessible format, and thus to speed storage and retrieval. All also provide a strong, consistently comparable measure for information storage and retrieval times.

The use of hardware and software measures of information storage and retrieval times has several problems, however. The biggest problem is that they only measure the computer processing time required to store or access a specific piece of data (Losee 1991). They ignore the time a person uses in developing the query needed to ask the computer for the data. The following example illustrates the problem with this technique. If a computer software measurement were used for storage and retrieval times, a system could be built that required users to print out a document list and, each time they needed information, force them to enter a document request using a system assigned document identification number. When compared to a system allowing users to search for a document by using an on-line keyword search, the system requiring the printout would show a much lower document access time. The time users spent would not be considered. Because the goal for this study is to try to access the total time effects of information storage and retrieval, such measures appear inadequate, even though they have been the most common type of information storage and retrieval measures used (Glinka 1993).

To get around the limitations of hardware and software information storage and retrieval measures, several measures have been developed which also include users' time in forming database queries (Bailey 1982; Bates 1990; Gauch and Smith 1993). The investigators of these studies have tried to develop techniques that speed the entire data storage and retrieval process. The measures contain hardware and software access times but also include how long it takes to form the database query (Bates 1990) and the interaction needed to sort for the correct piece of data, rather than just all of the data that matched a particular query (Gauch and Smith 1993). These measures ultimately measure the entire time required for the process of extracting a needed piece of data from a database (Bailey 1982).

The broader scope of the measures that include human interaction with the system help in defining a measure of information storage and retrieval that encompasses the entire retrieval task. Unfortunately, however, they are still tied to only database search tasks. Because corporate information systems include far more than just electronic databases, other measures must be considered.

A third body of research exists which, although most frequently applied to database systems, is generalized enough to be applied to any information storage and retrieval task (Bookstein 1983; Losee 1991; Swets 1969). These measures include total retrieval time, but also consider other factors. For example, precision, defined as the number of relevant documents available divided by the total number of documents returned (Losee 1991), is frequently considered. Similarly, recall, defined as the percentage of relevant documents retrieved, is often used (Losee 1991; Swets 1969).

The measure used in most information storage and retrieval studies depends upon the type of study being carried out. When a researcher is trying to measure how long it takes a user to find a specific piece of data with unclear parameters, for example an article in which the user can only remember the basic subject and authors first name, total time to retrieve the data is used (Bailey 1982; Bookstein 1983; Swets 1969). When a researcher is trying to measure how long it takes to find an unspecified group of targets that provide information on a certain topic, for example the strategic position of companies in the automotive industry, then measures of precision and recall are also considered relevant (Losee 1991; Swets 1969).

The use of precision and rate of return can add a great deal of meaning to the evaluation of information retrieval. The extra precision, however, comes at a price. Precision and rate of return can only be measured when there is a known target or set of targets for the search. This eliminates them from use as organizational-wide measures of retrieval.

## Data Transformation

The process of data transformation is the method through which data is converted to another form, presumably to create a greater potential for useful information or knowledge. Data transformation includes everything from simple addition and subtraction to create pooled numbers, through expert systems to diagnose solutions, all the way to automated information systems such as self-correcting robotics systems (Bullers and Reid 1990; Miller and Nilakanta 1993; Schantz 1992; Silver 1988; Suer and Dagli 1992). Of these systems, advanced computer systems such as decision support systems and expert systems are the most frequently written about (Arinze, Igbaria and Young 1992; Miller and Nilakanta 1993); however, even simple calculators and paper-and-pencil decision trees play a part in data transformation.

Unlike the previous information technology categories, data transformation is very difficult to assess independent of the technologies used to perform it (Silver 1988). This is because transformation quality is at least as important as transformation speed. Thus, two strategies have developed for measuring data transformation. One strategy is to measure the use of various data transformation technologies (Arinze, Igbaria and Young 1992; Bullers and Reid 1990; Liang, Moskowitz, and Yih 1992; Miller and Nilakanta 1993; Schantz 1992; Suer and Dagli 1992). The other is to measure workers' estimations of the availability of needed information (Silver 1988; Walz, Elam and Curtis 1993).

When measuring data transformation by the technology used, several key technologies need to be considered. These technologies differentiate the type of data transformation made by the sophistication of the systems used to make them. Technologies that need to be considered include Automated Report Generation (Sung 1988), Decision Support Systems (Arinze Igbaria and Young 1992; Huber 1990; Miller and Nilkanta 1993; Silver 1988; Walz, Elam and Curtis 1993), Expert Systems (Huber 1990; Lawrence 1992; Suer and Dagli 1992), Neural Networks (Schantz 1991; Ting-Peng, Moskowitz and Yih 1992), and Computer Integrated Manufacturing (Bullers and Reid 1990).

When measuring data transformation based on the technology used, it is also important to consider the extensiveness of the technology's use and the applications for which it is being used (Huber 1990; Sung 1988). Without such information, a company's expected results can be skewed by technologies that exist in the company but are infrequently used.

The major advantage of using the type of technology used as a measure of data transformation is that it provides a fairly complete scale of transformation sophistication. The major disadvantage is that it is tied exclusively to specific technical systems.

The other group of measures used to measure data transformation is workers' estimation of the availability of information they need (Silver 1988; Walz, Elam and Curtis 1993). Some researchers argue that if workers throughout an organization have all the relevant information they need to make required decisions, the available data must be successfully converted to the information they need (Walz, Elam and Curtis 1993). Where data transformation fails, workers are left with incomplete information.

This type of data transformation measure has several problems. The biggest problem is that data availability and access are not addressed. It does, however, provide a rough estimate of the ability of an organization's system to create needed knowledge from available data.

The technology use measure provides a good indication of the sophistication of the data transformation system, and the availability of needed information suggests whether it fulfills workers' needs. Combined, the two measures provide a much clearer picture of the quality of an organization's data transformation capabilities. Because neither the technology used nor the availability of needed information measures can provide a complete analysis of data transformation, both are included in this study.

## Mutual Adjustment

Mutual adjustment is a difficult variable to quantify because it is considered both a measure of technology use and a measure of organizational coordination (Mintzberg 1979; Sheombar 1992; Smith et al. 1992). Both measures consider mutual adjustment to be fundamentally the same thing--a means to "achieve the coordination of work by the simple process of informal communication" (Mintzberg 1979, 3). Researchers differ in the way they apply the definition.

Researchers who are most concerned with organizational theory consider mutual adjustment to be a measure of the process of coordination. In mutual adjustment, coordination of work is left to those who are doing the work (Mintzberg 1979). Thus, measures of mutual adjustment focus on the presence or absence of communication between workers and between workers and supervisors (Smith et al. 1992).

Those who consider mutual adjustment a measure of technology use pay more attention to how mutual adjustment is facilitated. They consider how technologies such as advanced telephone systems (Coates 1993; Ugbah and Dewine 1989), E-mail (Bikson and Law 1993; Rappaport 1992; Sulek and Marucheck 1992), group support software (Gopal, Bostrom and Chin 1992; Jessup and Kukalis 1990; Pinsonneault and

Kraemer 1989; Weston 1993;) and electronic data interchange (Sheombar 1992) enhance mutual adjustment.

These studies focus on the communications enhancements available from an individual technology. The measurements used for mutual adjustment vary based on the technologies used. Because E-mail, group support systems and electronic data interchange leave complete records of their use, researchers tend to measure mutual adjustment based on the two-way traffic over the information network. Measures include values such as the total number of bytes transmitted and the number of messages sent (Gopal, Bostrom and Chin 1992; Jessup and Kukalis 1990; Pinsonneault and Kraemer 1989; Shoembar 1992; Sulek and Marucheck 1992; Weston 1993).

Measures such as the number of messages sent provide a strictly quantitative value. Although there is appeal to such a firm number, such indices present some problems when used to measure mutual adjustment. One problem is that they include messages that are strictly one-way communications--messages that fit far better into the information dissemination variable. The bigger problem, however, is that they provide no indication as to the quality of the mutual adjustments. Increased message traffic can be an indication that the technology is making it more difficult to convey a message clearly, rather than indicating an increase in the amount of information being exchanged (Ugbah and Dewine 1989).

Given the problems inherent in the machine recorded measures of mutual adjustment, many researchers have shifted to measures more like those used by organizational theorists (Bikson and Law 1993; Coates 1993; Ugbah and Dewine 1989). These researchers have used questionnaires to discover the level of communication between coworkers and have frequently phrased the communications questions in terms of the specific technology in which they are interested. The questions are used in an attempt to discover how much communication occurs between workers, and between workers and supervisors, and how important the communications exchanged are to completing the task at hand. The higher the flow of informal communication and the higher its relevance to the task, the higher the score on mutual adjustment (Smith et al. 1992).

The ability of a survey technique to capture the level of mutual adjustment supported by technology but not tied to any one specific technology is important to this study. Therefore, a questionnaire approach is to measure mutual adjustment in this study.

## Organizational Structure Variables

As early as 1978, organizational structure considered one of the most measured dependent variables in management research (Sathe 1978). Its continued popularity provides a large range of studies upon which to draw to develop appropriate definitions of structural variables. The structural measures that have received the greatest attention include specialization, formalization, vertical span, centralization, and configuration. The definitions and measures that have been used for each are discussed in the following sections.

### Specialization

Specialization has been defined in many ways. Many authors disagree over the specific measurement of the variable, but most agree with its basic dimension. Specialization is the extent to which an organization's tasks are divided into narrow domains and assigned to specific individuals and departments (Miller et al. 1991; Caufield 1989; Blau et al. 1976). The refinement of this definition frequently comes down to the measures used to evaluate specialization.

The measurement of specialization has taken many different forms. Those forms can be differentiated by two dimensions. The first dimension divides studies by whether they measure specialization based on functional specialization or the division of labor. The second dimension divides studies by whether they measure specialization with questionnaire type instruments or through institutional measures such as organization charts.

Several researchers have used functional specialization as their primary measurement for specialization (Blau et al. 1976; Caufield 1989). Most of these researchers based their definitions of functional specialization on the definition used in the Aston studies. The Aston studies' definition is based upon a scale of the extent to which sixteen activities, such as transportation, marketing and training, are performed by at least one specialist. A specialist is someone who performs nothing except one of those sixteen activities. No count of the number of specialists who perform each function is made, only whether a specialist for each category exists (Pugh et al. 1968).

Using the definition of functional specialization provided in the Aston studies has many strong points. It differentiates organizations based on a predefined, and therefore comparable, basis across companies. Thus one is not left to decide whether a position labeled as marketing in one organization is equivalent to a position labeled sales in another. The Aston studies definition can also be measured with a short series of simple questions which simplifies data collection.

Several problems are associated with the definition used in the Aston studies definition. The Aston approach to functional specialization has been criticized for being too dependent on overly generalized definitions of functional specializations and for being too sensitive to size deviations between companies (Ford and Slocum 1977). Other approaches that count just the number of divisions or sections in a company have similar size and redundancy concerns (Blau et al. 1976).

The other dimension frequently used to measure specialization is the division of labor. Division of labor is often measured by numbers such as the total number of job titles in an organization (Blau and Schoenherr 1971; Caufield 1989). This type of measurement for specialization eliminates much of the need for researchers to equate roles or types of specializations but is even more prone to over-counting redundancies than is functional specialization. Fortunately, measures of functional specialization and division of labor are usually very highly correlated; therefore, the selection of one type over the other is unlikely to affect results (Caufield 1989; Miller et al. 1991).

Once a decision is made on whether to use functional specialization or division of labor to measure specialization, a choice still must be made between questionnaire and institutional measures. Questionnaire-type measures ascertain specialization through a series of questions asked either in a written questionnaire or through an interview. Institutional measures use written documents such as organizational charts to gain similar information.

Both questionnaire and institutional measures of specialization are common. The forty-four studies reviewed by Caufield (1988), were almost equally split between the use of institutional (19) and questionnaire techniques (25). Of the few studies using both techniques, correlations were not particularly strong (ranging from .27 to .44) between institutional and questionnaire techniques (Sathe 1977). This is not overly surprising, because the two techniques have different focuses.

Institutional data reflect only the formal organization, whereas questionnaires capture the emergent or perceived organization. Although questionnaires are more prone to perceptual bias, they can be more accurate in a rapidly changing organization (Miller et al. 1991). Even though questionnaire and institutional measures of specialization have not always correlated highly, meta-analyses comparing questionnaire and institutional measures of specialization have shown that the measurement techniques used have not had any effect on the results of the studies undertaken (Caufield 1989; Miller et al. 1991).

## Formalization

There is more agreement on the definition of formalization than of specialization. Most authors suggest that formalization is the degree to which an employee's role is formally defined by official documents such as job descriptions, standard operating procedures manuals, and the like (Dewar, Whetten and Boje 1980; Hage and Aiken 1969; Hickson, Pugh and Pheysey 1969; Inkson et al. 1970; Miller 1986; Pugh et. al. 1968; Reimann 1980; Sathe 1978; Sung 1988).

The major disagreements between authors writing on formalization are whether standardization should be considered separately from formalization and exactly what questions should be used to measure formalization. The debate over whether standardization is a separate entity began early in organizational structure research (Hage and Aiken 1969; Hickson, Pugh and Pheysey 1969; Inkson et al. 1970; Pugh et. al. 1968).

The Aston studies defined standardization as the degree to which work procedures are standardized (Pugh and Pheysey 1969; Pugh et. al. 1968). Later researchers, however, suggested that to be standardized, jobs had to be formalized (Hage and Aiken 1969; Inkson et al. 1970). More recent researchers appear to have adopted the second opinion, because although the word standardization is still frequently used in later publications, its measurement has become synonymous with formalization (Dewar, Whetten, and Boje 1980; Miller 1986; Reimann 1980; Sathe 1978; Sung 1988). The debate was formally put to rest, however, when a meta-analysis showed that no differences was detectable based on the separate definitions (Miller et al. 1991).

The measurement of formalization has been fairly consistent throughout its use. Measurement techniques have focused on how much documentation exists to constrict the procedures of work (Dewar, Whetten, and Boje 1980; Hage and Aiken 1969; Hickson, Pugh, and Pheysey 1969; Inkson et al. 1970; Miller 1986; Pugh et. al. 1968; Reimann 1980; Sathe 1978; Sung 1988). Two approaches have been used to measure formalization. Both have been based on questionnaires.

One technique is to quantify the type and the number of pages of documentation that applies to a job (Miller 1986; Pugh and Pheysey 1969; Pugh et. al. 1968). The advantage of this technique is that it is direct and verifiable; however, it does not capture some of the more informal documentation. For example, computer systems now function as formalization devices by controlling the process and available routes through which work can be completed (Bailey 1982), but formalization caused by computerization would not show up in a document count. This technique also looks only at the number of pages of documentation, not how much they are used.

The second technique for measuring formalization uses less direct questions to decide how constricted a job is. These questions are used to determine how documented a job is by asking how often workers need to refer to an external source such as a manual, supervisor, or computer structured procedure to decide what they are supposed to do (Dewar, Whetten, and Boje 1980; Hage and Aiken 1969; Sung 1988). This questioning technique has the advantage of being able to detect the degree to which formalization mandates a worker's behavior, which is the critical question when considering formalization in relationship to information technology.

## Vertical Span

Vertical span is a measure of the number of hierarchical levels in an organization. It is used to indicate the level of supervision of lower offices by higher ones (Blau et al. 1976; Caufield 1989; Hickson, Pugh, and Pheysey 1969; Reimann 1980).

There have been many minor variances in how vertical span is measured. One measure used is simply to count the number of levels from CEO down to the lowest operant, inclusive (Hickson, Pugh, and Pheysey 1969). Another is to use the same measure but to exclude "assistant-to" levels on the assumption that those levels do not have direct supervisory responsibilities (Child 1972). Still another is to used the average number of levels in all the channels of authority (Blau & Schoenherr 1971).

The specific measure used for vertical span does not appear to have any differential effects. In three different meta-analyses researchers have looked at operations technologies' effect on organization structure and found that the definition of vertical span used did not affect the results (Caufield 1989; Donaldson and Robertson 1986; Miller et al. 1991). It therefore seems appropriate for researchers to use whichever of the definitions that best fits their particular circumstances.

## Centralization

Centralization is difficult to analyze in the literature on organizational structure because authors disagree on the use of the term. Many use and define the term centralization (Caufield 1989; Dewar, Whetten and Boje 1980; Hage and Aiken 1969; Miller et al. 1991; Pugh et al.

1968; Sathe 1978). Others, however, reverse the term and define and measure decentralization (Blau et al. 1976; Miller 1986; Mintzberg 1979).

Researchers from both viewpoints agree that whether using centralization or decentralization, their emphasis is on the location of the locus to make decisions (Blau et al. 1976; Miller 1986; Miller et al. 1991). The difference in their measures, therefore, can easily be accommodated by reversing their scales (Caufield 1989; Miller et al. 1991).

The measures used for both centralization and decentralization have been fairly consistent across a large number of studies. These measures are based on determining the highest level of authority that makes a decision on specific types of questions (Blau et al. 1976; Dewar, Whetten and Boje 1980; Hage and Aiken 1969; Miller 1986; Pugh et al. 1968; Sathe 1978). The higher the average level a question has to go to get a decision, the more centralized the firm is said to be.

Based on the consistency with which centralization has been measured it was an easy decision to measure centralization in the same way for this study. By doing so, the results can be easily compared to other technology and organizational structure studies.

## Personnel Configuration

Personnel configuration (hereafter called configuration) is a composite variable that attempts to give a holistic shape to an organization (Child 1972; Pugh et al. 1968). It combines various ratios in a hierarchical tree to show the shape administration in relationship to workers. There has been some disagreement as to exactly which ratios belong in configuration and exactly how they should be measured, but agreement among authors is generally strong (Blau et al. 1976; Caufield 1989; Child 1972; Miller et al. 1991; Pugh et al. 1968). The variables that all researchers looking at configuration agree on include: CEO span of control, supervisors' span of control, percentage of direct workers, percentage of workflow supervisors, percentage of nonworkflow personnel, and percentage of clerical personnel (Caufield 1989).

CEOs' span of control is measured as the total number of individuals who report directly to the CEO. The supervisors' span of control is measured as the average number of workers per supervisor. Supervisor is generally defined as the lowest level employee whose job does not include prescribed direct work (Child 1972; Pugh et al. 1968). There is some disagreement, however. One author defines supervisors specifically as the personnel on the second rung from the bottom of an organization chart (Blau and Schoenherr 1971). The two definitions frequently agreed, but did not when an organization used working supervisors. No significant differences were found between the results of studies using differing definitions (Caufield 1989).

In almost all studies of configurations researchers have used the same numerators for their ratios (Blau et al. 1976; Caufield 1989; Child 1972; Pugh et al. 1968). There has been some disagreement as to the denominator, however. Some researchers have used total number of employees for the denominator (Caufield 1989; Blau et al. 1976; Pugh et al. 1968), while others have used only the total number of employees in the workflow (Child 1972). Though the ratios end up with different numbers depending on which denominator is chosen, no differential effect is evident when the studies are compared (Caufield 1989). Because the total number of employees has been the more frequently used number in previous studies (Caufield 1989; Miller et al. 1991), it was used in this study as well, to maintain comparability.

With the denominator set, all that is needed to complete the ratios is definitions for the numerator. Fortunately researchers tend to agree on these (Caufield 1989). The following are the definitions for each of the numerator values as defined by Caufield (1988, 54-55):

Direct workers: Those workers who are directly involved in the production of goods and services.

Workflow supervisors: Those supervisors and managers who have responsibility for the workflow, but have no prescribed direct work on the throughput.

Nonworkflow personnel: All persons other than direct workers or workflow supervisors.

Supervisors: The lowest job that does not include prescribed direct work.

Clerical workers: non-workflow personnel with no supervisory responsibility, whose primary assigned task is writing and recording. It includes typists, stenographers, secretaries, and so forth. It does not include administrative staff personnel who often fall under the broad definition of clerical.

Because there is strong agreement among researchers on these definitions, they were used in this study.

## Management Control as a Moderating Variable

The level of control that managers exert over a firm has frequently been considered as a direct function of the firm's strategy (Coombs, Knights and Willmott 1992; Daft 1992; Daft and Macintosh 1984; Pinsonneault 1990). Because of the strong support for the effect strategy has on organizational structure (Ansoff 1965; Chandler 1962; Daft 1992; Porter 1980) one would expect control to be a significant moderator of the effects of information technology on structure. This appears to be the case

(Burkhardt and Brass 1990; Coombs, Knights, and Willmott 1992; Pinsonneault 1990; Sung 1988; Zeffane 1992).

The moderating effect of control creates a need to measure and evaluate control when considering the relationship between information technology and organizational structure. In the following discussion, therefore, the ways in which control has been measured in previous studies is considered.

The word control is used in several ways in the management literature (Blau and Scott 1963; Eilon 1962; Fayol 1949; Holden, Fish, and Smith 1941; Ouchi 1977; Taylor 1947). Early theorists used the term control to integrate the entire management function. Control was said to encompass the concepts of planning, organizing, command and coordination (Fayol 1949; Taylor 1947). This broad definition was narrowed by later theorists to make the concept of control more measurable. These later theorists defined control as the definition of work performance standards, the providing of rules, procedures, and supervisory direction; and the appraising of behavior and performance (Eilon 1962; Holden, Fish and Smith 1941).

Even the narrower second definition of control was too broad for researchers studying organizational structure, however. It unfortunately contained components that were highly correlated with the measures of structure (Blau and

Scott 1963; Ouchi 1977). These theorists, therefore, developed a third, even narrower definition of control. They defined control as a process of evaluation that is based on the monitoring and evaluation of performance (Ouchi 1977). This third definition has been adopted by researchers studying the moderating effect of control on the information technologies organizational structure relationship (Pinsonneault 1990; Sung 1988; Zeffane 1992).

Measurements using this third definition of control, which have been performed fairly consistently, have consisted of a sequence of questions using a Likert-type scale in a attempt to discover how much work is controlled through behavioral guidelines and performance standards (Coombs, Knight and Willmott 1992; Pinsonneault 1990; Sung 1988; Zefanne 1992). There has been some disagreement, however, regarding the exact content of the questions. Some researchers have preferred generalized questions of control (Pinsonneault 1990; Zeffane 1992), while others have preferred to follow a structure of questions based on Ouchi's (1977) behavioral guidelines and work performance standards list (Coombs, Knight and Willmott 1992; Sung 1988). Because all of the studies led to the same conclusion--that control moderates the relationship between information technology and organizational structure--there does not appear to be a substantial difference between the two formats.

## Variable Relationships

To this point each variable in this study has been considered in isolation. In this section, what has been learned about individual variables is expanded by considering the interaction among the three major variable sets: information technology, organizational structure and control.

The twenty-one studies in which researchers have tried to relate information technology to organizational structure have all equated information technology with computers (Blau et al. 1976; Burkhardt and Brass 1990; Carter 1984; Danzinger 1977; Hill 1966; Hofer 1970; Hoos 1960a; Hoos 1960b; Huber 1990; Klatzsky 1970; Lipstreu and Reed 1965; Mann and Williams 1960; Meyer 1968; Pfeffer and Leblebici 1977; Pinsonneault 1990; Robey 1981; Rourke and Brooks 1966; Smith et al. 1992; Sung 1988; Zefanne 1992; Zmud 1982). Just as computer technology has changed over the years, so have some trends in the results of research comparing information technology and organizational structure (see Table 2). This change in the trend of results again points to the need for a less specific,

Table 2--Overview of Information Technology and Organization Structure Research

| Author | Year | Structural Variables Spec. | Form. | Cent. | Span | Config |
|---|---|---|---|---|---|---|
| Smith et al. | 1992 | + | + | - | | |
| Zefanne | 1992 | + | + | - | | + |
| Burkhardt and Brass | 1990 | | | | | + |
| Huber | 1990 | | | - | - | + |
| Pinsonneault | 1990 | | | | C | C |
| Sung | 1988 | C | C | | | |
| Carter | 1984 | N | | N | + | |
| Zmud | 1982 | | + | + | | |
| Robey | 1981 | | | N | + | |
| Danzinger | 1977 | + | | | + | |
| Pfeffer and Leblebici | 1977 | | - | - | + | |
| Blau et al. | 1976 | + | | + | + | |
| Hofer | 1970 | + | + | - | | |
| Klatzsky | 1970 | | | - | | |
| Meyer | 1968 | | + | | + | |
| Hill | 1966 | + | | | | |
| Rourke and Brooks | 1966 | | | + | | |
| Lipstreu and Reed | 1965 | | | + | - | |
| Hoos | 1960a | + | | + | | |
| Hoos | 1960b | | | + | | |
| Mann and Williams | 1960 | | + | + | + | |

Note:
Spec. = Specialization, Form. = Formalization, Cent. = Centralization
Span = Vertical Span, Config. = Configuration
A (+) -- more specialized, formalized, centralized, higher span, fatter configuration
A (-) -- less specialized, formalized, centralized, lower span, thinner configuration
A (C) -- the relationship was dependant on control
A (N) -- no measureable effect on the variable

technology-independent method for evaluating information technology.

The results of analyzing the impact of the introduction of computers on organizational structure does not fully reveal the relationship between information technology and structure. It does, however, provide insight into how information technology, as defined here, affects structure. At this point a brief review of the effects of computer introduction on each structural variable appears appropriate.

A total of nine studies have been conducted to consider the effects of introducing computerization on specialization (Blau et al. 1976; Carter 1984; Danzinger 1977; Hill 1966; Hofer 1970; Hoos 1960a; Smith et al. 1992; Sung 1988; Zefanne 1992). Seven of the nine studies indicated that computerization increased specialization (Blau et al. 1976; Danzinger 1977; Hill 1966; Hofer 1970; Hoos 1960a; Smith et al. 1992; Zefanne 1992). One revealed no effect on specialization (Carter 1984,) and one showed that the relationship depended on control. When control was high, specialization increased; when it was low, specialization showed no significant movement (Sung 1988). These studies clearly indicate that computerization increases specialization.

In eight studies researchers have considered the effects of introducing computers on formalization (Hofer 1970; Mann and Williams 1960; Meyer 1968; Pfeffer and Leblebici 1977; Smith et al. 1992; Sung 1988; Zefanne 1992; Zmud 1982). Six of the eight studies revealed that formalization increased when computers where introduced (Hofer 1970; Mann and Williams 1960; Meyer 1968; Smith et al. 1992; Zefanne 1992; Zmud 1982). One study indicated that the relationship depended on the level of control. High control was said to increase formalization, whereas low control was said to decrease it (Sung 1988). The results of one study contradicted the others and indicated that computerization decreased formalization (Pfeffer and Leblebici 1977). It is possible that this occurred because the researchers used the broadest view of computerization and included electronic phone switching equipment.

The results of studies looking at computerization and centralization are far more mixed. Of the fifteen studies in which researchers have considered the relationship, seven have revealed that computerization increased centralization (Blau et al. 1976; Hoos 1960a; Hoos 1960b; Lipstreu and Reed 1965; Mann and Williams 1960; Rourke and Brooks 1966; Zmud 1982), six have revealed that computerization decreased centralization (Hofer 1970; Huber 1990; Klatzsky 1970; Pfeffer and Leblebici 1977; Smith et al. 1992; Zefanne 1992) and two have revealed no significant effects (Carter 1984; Robey 1981).

There are several possible explanations for these mixed results. One possibility is that because most of the early researchers did not consider control (Blau et al. 1976; Hofer 1970; Hoos 1960a; Hoos 1960b; Huber 1990; Klatzsky 1970; Lipstreu and Reed 1965; Mann and Williams 1960; Pfeffer and Leblebici 1977; Rourke and Brooks 1966; Smith et al. 1992; Zmud 1982;), it was control that caused the mixed results. Because one of the researchers who measured control also measured centralization and did not find any interaction effects (Zeffane 1992) the credibility of this explanation is weakened, however.

Two other possible explanations of the mixed results are based on time. Because most of the early researchers found a positive effect (Blau et al. 1976; Hoos 1960a; Hoos 1960b; Lipstreu and Reed 1965; Mann and Williams 1960; Rourke and Brooks 1966), and later researchers found a negative effect (Smith et al. 1992; Zefanne 1992; Huber 1990; Pfeffer and Leblebici 1977; Hofer 1970; Klatzsky 1970), it is possible that something changed in the computer systems being used as a measure. Unfortunately, none of the researchers describe their "computerization" variable in sufficient detail to reveal whether or not this occurred. The inability to determine whether changes in the computer systems measured occurred leaves the possibility that some other factor changed and caused the shift. One possibility is that the attitudes toward control changed around the time of the shift, but other changes cannot be ruled out.

The findings relating computerization to vertical span are also mixed, although not as evenly as centralization. Of the ten studies in which researchers examined computerization and vertical span, seven revealed that computerization increased vertical span (Blau et al. 1976; Carter 1984; Danzinger 1977; Mann and Williams 1960; Meyer 1968; Pfeffer and Leblebici 1977; Robey 1981), two showed that it decreased it (Huber 1990; Lipstreu and Reed 1965), and one indicated that its relationship was based on control (Pinsonneault 1990).

It is possible that control was the differentiating factor between these findings, because none of the studies that revealed directional results included a look at control. Other possible explanations for the mixed results exist. One of the more likely is the type of computerization used. Both of the researchers who found a negative effect on vertical span, considered computers used in advanced automation systems (Huber 1990; Lipstreu and Reed 1965). The other researchers found that computers were used more for their information dissemination capabilities (Blau et al. 1976; Carter 1984; Danzinger 1977; Mann and

Williams 1960; Meyer 1968; Pfeffer and Leblebici 1977; Robey 1981).

The last structural variable that has been considered in relation to computerization is configuration. Because it is a recently defined variable, it does not appear in any of the older studies. Recent researchers that have considered it are almost unanimous in their conclusions. Three researchers found that computerization creates less vertically differentiated configurations with a broader operating core (Burkhardt and Brass 1990; Huber 1990; Zefanne 1992). The only contradiction to this finding is that one researcher found that the relationship was based on control. Yet even that researcher suggested that when the desire for control is low, the configuration flattened with computerization and there is no effect if the desire for control was high (Pinsonneault 1990). These combined studies make a strong argument for the notion that computerization flattens organizational configuration.

In summary, the findings of researchers who have considered the relationship between computerization and organizational structure suggest several things. One suggestion is that computerization increases specialization and formalization, although control may affect the relationships. Another is that the results on centralization and vertical span are mixed. A final indication is that computerization flattens organizational configuration.

## Hypotheses

Today, information technology has come to mean a great deal more than computerization. The expanded definition of information technology makes studies that only compare companies with computers against those that do not have them appear limited. Research that compares computerized and non-computerized organizations to form its hypotheses was, thus, not used exclusively to form this studies hypotheses, even though the research did provide a valuable guide.

The following hypotheses address the differences found in organizational structures based on the presence of computers. The findings are expanded by estimating which functions of computer use affects each structural variable. The hypotheses are broken into four groups. One group for each of the information technology variables measured. A model is presented (see Figure 3) which provides an overview of the hypotheses.

### Information Dissemination Hypotheses

Hypothesis 1 is based on the ability of executives to use increased information dissemination speed to centralize their control and issue edicts on procedure more rapidly when they desire high control. If executives do not desire more control, then faster information dissemination should make their organization more responsive to outside influences and thus less formalized and centralized.

| Information Technology Variables \ Structure Variables | Specialization | Formalization | Centralization | Vertical Span | Configuration |
|---|---|---|---|---|---|
| Information Dissemination | | C | C | + | F |
| Information Storage and Retrieval | + | + | C | | |
| Data Transformation | + | + | C | - | F |
| Mutual Adjustment | | - | | | |

\+ a positive relationship between info. tech. variable and the structure variable
\- a negative relationship between info. tech. variable and the structure variable
C the relationship depends on the level of control
F in Configurations indicates configuration will flatten

Figure 3. Overview of Hypotheses

Although Hypothesis 2 appears counter-intuitive--one would expect faster information dissemination to eliminate the need for as many managerial levels--it is founded on the consensus of prior research. Most authors studying traditional computer systems that were used primarily for information dissemination have found that they increased vertical span, possibly because the greater speed with which information could be passed required more individuals to be around to analyze it.

Hypothesis 3 is based solely on previous research based on computerization. There is a contradiction between it and Hypothesis 2, but the contradiction is well established in the literature.

H1: As information dissemination speed increases formalization and/or centralization will increase when control is high and decrease when control is low.

H2: As information dissemination speed increases vertical span will increase.

H3: As information dissemination speed increases configurations will flatten.

## Information Storage and Retrieval Hypotheses

Hypothesis 4 is based primarily on computerization literature. There is a strong conceptual argument that faster information storage and retrieval should decrease specialization and formalization because it gives an individual access to a far greater amount of knowledge. Previous research has contradicted this. Earlier studies suggest that faster storage and retrieval only increases the level of detail to which one can perform an analysis, thus requiring even more specialization and formalization.

The indication in Hypothesis 5 that information storage and retrieval's effects on centralization are moderated by control is suggested by the mixed findings in the literature on computerization. A strong argument can be made that increased storage and retrieval speed can either be used by managers to more closely monitor workers and thus increase control or to turn access of that data over to the workers themselves to reduce the need for centralization.

H4: As information storage and retrieval speed increases, specialization and/or formalization will increase.

H5: As information storage and retrieval speed increase, centralization will increase when control is high and decrease when control is low.

## Data Transformation Hypotheses

Specialization should decrease as data transformation quality increases as suggested in Hypothesis 6. As data transformation quality increases, more of the burden for developing new knowledge is passed to the technology, which eliminates the need for as much specialized knowledge and frees workers to perform less specialized tasks. Data transformation also makes possible the complete automation of several tasks, further reducing the need for specializations.

Formalization should increase as data transformation increases, as suggested in Hypothesis 7, because most technologies that process data into knowledge can only do so using a fixed set of methodologies. The fixed methodologies usually require that data be processed by a user in a particular order or into a particular format, and puts the burden on users to format data correctly and increases the need for formalization.

Hypothesis 8 prediction that data transformation's effect on centralization is based on control is indicated by the various forms that data transformation can take. Executives who want to keep tight control can use data transformation to confine environmental analysis to a very small group and can monitor internal operations very closely through compiled reports, and thus increase centralization. Executives who are not as interested in tight control can use data transformation to provide lower level workers whose evaluation skills might not be as highly developed with a greater basis of knowledge, and thus decrease centralization.

Hypothesis 9 is based on the ability of data transformation to lower the need for middle managers by automating many of their data analysis tasks. Hypothesis 10 has a similar basis, although included in configuration is the further flattening caused by the extra direct workers needed to support the data transformation technologies.

H6: As data transformation quality increases, specialization will decrease.

H7: As data transformation quality increases, formalization will increase.

H8: As data transformation quality increases, centralization will increase when control is high and decrease when control is low.

H9: As data transformation quality increases, vertical span will decrease.

H10: As data transformation quality increases, configuration will flatten.

## Mutual Adjustment Hypotheses

Increases in the speed of mutual adjustment should decrease formalization, as predicted in Hypothesis 11. This should occur because increased speed allows more mutual adjustment to occur, thus limiting the need for specific rules to deal with each new situation.

H11: As mutual adjustment speed increases, formalization will decrease.

## Chapter Summary

A review of the literature relevant to this study is presented in this chapter. The chapter begins with a review of each of four information technology variables: information dissemination, information storage and retrieval, data transformation, and mutual adjustment. The structural measures of an organization including specialization, formalization, centralization, vertical span and configuration are then covered. Next, the potential moderating effects of organizational control are covered. The three sets of variables are combined by considering the works of researchers who have looked at computerization and structure. Finally, hypotheses which predict the exact relationships between the variables are provided.

# CHAPTER 3

# METHODOLOGY

In this chapter the methodology used to test the hypotheses of this studies are described. The chapter begins with an analysis of the population and sample used. Then, the data collection techniques used and the variables measured are discussed. Next, the design and reliability of the questionnaire and validity issues in the design are considered. Finally, the data analysis techniques used are presented.

## Research Population and Sample

The population for this study includes organizations that are in information-intense service industries. Information-intense service industries include such service sectors as transportation, travel, banking and insurance, health care, and telecommunications (Pennings and Harianto 1992).

By concentrating on generalization to more information-intense businesses, the focus of this study was on companies in which the effects of information technologies should be pronounced. The effects of other operations technologies are also minimized. It is left to later researchers to extend these findings to manufacturing and less information intense service industries.

The sample for this study was United States based, publicly held banks. A single industry was used because previous studies illustrate substantial risk of inflating error variance in a study of organizational structure if more than one industry is measured at a time (Miller et al. 1991). The banking industry was selected because it is considered a good, representative sample of information-intense service industries (Pennings and Harianto 1992).

Compustat PC+ was consulted for a listing of Banks. Compustat PC+ publishes all Securities and Exchange Commission's 10k reports, therefore the listing is a complete roster of publicly held companies which are large enough to fall under SEC guidelines. Compustat PC+ lists 193 public banks. Of those banks, eight are holding companies for foreign owned banks. Therefore a list of 185 publicly held United States banks made up the sample.

Power analysis using expected means and variance, based on Caufield's (1988) meta-analysis of organizational structure, was performed to ensure that the 185 banks provided an adequate sample. The expected means and variance for centralization were used because centralization had the highest variance in relation to its mean. The power analysis showed a power of .90 (3, 28 d.f.) could be attained using only eight subjects per cell. This figure may be an underestimation because Caufield's meta-analysis provides a truer picture of the population variance than would be available in most cases. The more accurate and thus reduced population variance may have shrunk the number of subjects needed per cell. Use of a conservative .90 power instead of the more traditional .80 reduced the risk of a sample that was too small, however (Keppel 1982).

Of the 185 questionnaires mailed, 72 were returned. Four of the returned questionnaires were returned undelivered because the banks had merged or gone out of business since the last Compustat update. Six of the questionnaires were returned by individuals who declined to take part in the survey. One questionnaire was returned with only the dependent variable questions filled out. Because none of the scores for the independent variables were available, the incomplete questionnaire was removed from the sample. Sixty-one surveys were returned with adequate data to allow their use in data analysis. This resulted in a 34% usable response rate (61 returns from 185 surveys mailed minus 4 banks closed).

Jobber and Saunders (1993) conducted a study of response rates in published business research. They found mail surveys' had an average 39.5% response rate with a 12.5% standard deviation. The 34% response rate found in this study, therefor, appears to be in line with most published work.

Nonresponse bias was tested using a comparison of respondents and nonrespondents publicly available information and comparisons of the returns from three waves of data collection (Kerlinger 1973; Rosenthal and Rosnow 1984; Rosenthal and Rosnow 1969). Response bias was reduced through intense recruitment of subjects (Dilman, 1978; Rosenthal and Rosnow 1984) using the methodology recommended by Dillman (1978). A threat of response bias remains, however. The response bias threat and its handling is discussed in detail in the Data Collection section.

## Data Collection

Data collection was performed through mailed questionnaires which were sent to the Chief Information Officer or Head of Information Systems (or whatever title was used for the person in charge of information systems at each bank). Names and titles for the executives were gathered from various sources, including Standard and Poor's Guide of Directors and Executives (1993), and lists published yearly in Information Week and CIO magazines.

The questionnaire is divided into three parts (see Appendix A). The first part asks questions relating to the information technology variables. The second section requests information on organizational structure. The third section includes questions on general information technology ratings and basic demographics.

The questionnaire was designed and distributed based on the criteria offered by Orlich (1978). The design guidelines include techniques for the layout, scaling, response modes, wording and order of questions. The mailing guidelines include a four-step process for increasing returns.

The exact steps followed for distributing the questionnaire are described below.

1. The first questionnaire was mailed with a persuasive cover letter based on addresses taken from Compustat on July 6, 1994.
2. On July 13, 1994, a reminder postcard was mailed to all non-respondents.
3. There was only a 7% response rate following the first survey and follow-up mailing. Conversations with two of the CIOs who called after receiving the follow-up postcards revealed that mail sent to the Compustat address in most companies was sent to an investors information center and frequently was not forwarded to a specific person. Direct mail addresses were,

therefore, purchased from a commercial mailing list company for the second mailing.

4. A second copy of the questionnaire was mailed with a new persuasive letter to non-respondents at the more specific addresses taken from the commercial mailing list on August 12, 1994.
5. A second reminder postcard was mailed on August 19, 1994.
6. Because the combined returns from the first and second mailings were still below the 30 percent return rate target(27%), follow-up phone calls were made to several banks to solicit a response. The criteria for selecting which banks to call are presented in the following paragraphs. Individuals who agreed to participate were faxed new copies of the survey and were asked to return their replies by fax. Phone solicitations were made on September 2 and 5-7, 1994.

Because three different solicitations were made over the course of data collection, there was a concern of biases being introduced. An analysis of the response groups was made to ascertain any differences.

After the returns of the first two mailings were collected, an analysis was made between banks that responded and those banks that did not. The size (number of employees) of responding and nonresponding banks were compared. Size was chosen as the variable for comparison because it, along with technology, environment, and power, is considered a potential influence on organizational structure measures (Daft 1992, Mintzberg 1979). Technology could not be used since it is the independent variable in this study. Environment and power could not be used because there are no publicly available measures for either.

A significant difference was found between responding and non-responding banks ($F = 1.9$, $p = .042$). The banks that responded were generally smaller (fewer employees). To help correct this situation, phone solicitations were focused on the largest thirty banks. After returns from the phone solicitations were added to the total dataset, no significant difference was evident between the banks that returned or failed to return surveys ($F = 1.62$, $p = .125$). Further, there were no significant differences between the first, second, or third groups of response on any of the dependent variables, thus suggesting that any response bias introduced had a minimal impact on the variables of interest.

## Variables

A review of previous researchers' thoughts on each of the variables in this study was provided in chapter 2. This section describes the specific ways each information technology, organizational structure and control variable was measured. An overview of the constructs and variable operationalizations is provided in Table 3.

The organizational structure variables served as the dependent variables in this study. Thus, the accuracy of their measurement is the most critical. The organizational structure variables are, therefore, considered first. The questions used to measure each variable are provided in Appendix A.

## Organizational Structure Measures

The organizational structure measures taken in this study include specialization, formalization, centralization, vertical span, and configuration. Most of the measures were drawn directly from a questionnaire developed and validated for measuring organizational structure (Miller 1986). The measures used for each variable are discussed in the following sections.

### Specialization

The measure used for specialization was pulled directly from a questionnaire that has established high reliability (Miller 1986). The questionnaire is based on the sixteen specialization categories used in the Aston studies (Hickson, Pugh, and Pheysey 1969; Pugh et. al. 1968). The

Table 3--Overview of Construct and Variable Operationalizations

| Construct | Variable | Var. Type | Measure | Data Type | Scale |
|---|---|---|---|---|---|
| Information | Dissemination | IV | Estimated Dissemination Time | 8 Fill-in Question | CG |
| Technology | Storage & Retrieval | IV | Estimated Retrieval Time | 8 Fill-in Questions | CG |
| | Data Transformation | IV | Technology Used | 4 Task/Technology ? | OG |
| | | | Available Information | 6 Likert Questions | OG |
| | Mutual Adjustment | IV | Ease of Contact | 5 Likert Questions | OG |
| Control | Organization Control | Cont. | Level of Control | 5 Likert Questions | Diad |
| Org. | Specialization | DV | Areas specialized | 16 Check-off ? | 0-16 |
| Structure | Formalization | DV | Written documentation | 17 Check-off ? | 0-17 |
| | Centralization | DV | Decision Level | 11 Likert Questions | Cont. |
| | Vertical Span | DV | Number of Levels | 1 Fill-in Question | Cont. |
| | Configuration | DV | CEO Span of Control | 1 Fill-in Question | Cont. |
| | | | Supervisors Span of Control | 1 Fill-in Question | Cont. |
| | | | % Direct Workers | 1 Fill-in Question | Cont. |
| | | | % Workflow Supervisors | 1 Fill-in Question | Cont. |
| | | | % Nonworkflow Personnel | 1 Fill-in Question | Cont. |
| | | | % Clerical Personnel | 1 Fill-in Question | Cont. |

Scale Notes:
IV - independent variable
DV - dependent variable
CG - continuous data that was converted into groups
OG - ordinal data that was converted into groups
Diad - ordinal data grouped into diadic data
Cont. - continuous data

questions used in the Aston studies were re-worded by Miller (1986) to make the categories more easily understood.

To score specialization, responses are scaled from zero to sixteen. The score is based upon the number of specialist positions within a company, as indicated by the respondents. The reliability of the measure is .80 (Miller 1986).

Formalization

The measure for formalization, also taken from the Miller (1986) questionnaire, consists of a series of five questions, four of which have sub-questions. The formalization score is scaled between one and sixteen and is based on the number of individuals who receive the specified documents. The reliability of the formalization score is reported as .65 (Miller 1986).

Centralization

The measure for centralization used in this study was the inverse of the decentralization score offered by Miller (1986). Miller (1986) suggests that the score is reversible for centralization.

The score for centralization is based on the level at which eleven decisions are made in a company. Level scores are ranked from zero to five, with zero indicating a decision by the organization's chief executive and five indicating a decision made at the operative level. The scores from the eleven questions were averaged to develop the total score. That average was then be subtracted from five to get the centralization score. The reported reliability for the centralization score was .82 (Miller 1986).

## Vertical Span

Vertical span is the last of the organizational measures drawn from Miller (1986). Vertical span, in Miller's questionnaire, was measured with a single factual question which asked the number of levels in the longest chain of command in the company. This measurement technique is reflected in several other studies, including the Aston studies (Caufield 1988; Hickson, Pugh, and Pheysey 1969; Pugh et al. 1968). The scaling of the variable is from zero to the highest number of levels in any organization. The score used is simply the reported number of levels. No reliability score was reported for vertical span.

## Configuration

The questions used for configuration were developed from the databanks of the Aston study (Pugh et al. 1968). The general approach used by Miller (1986), suggests using the most easily understood set of questions possible, was used to attain the needed data. Because, the configuration data set of the Aston study was very simple, easy-to-understand questions were not difficult to develop.

Reliability measures were not available for the exact set of questions used. The reliability of the Aston data set technique has been evaluated several times, however. It has averaged .84 for configuration measures (Caufield 1988). Because these questions were made to match the Aston databank as closely as possible, their reliability should be near that of the databank.

## Information Technology Variables

The information technology variables in this study include information dissemination, information storage and retrieval, data transformation and mutual adjustment. A ready set of questions was not available for these measures as there was for the organizational structure variables. Many more of the information technology measures, therefore, had to be developed specifically for this study. The measurements used for each are presented in the following sections.

## Information Dissemination

The information dissemination variable was measured based on an information diffusion model (Bredehoft and Kleiner 1991). Eight questions were asked requesting the time required for information to pass from its origin to a desired target. The questions included two each of upward, downward, vertical, and external data passing. Upward data passing is data going from a subordinate to a superior. Downward data passing is the opposite of upward. Vertical data passing is data being passed between peers. External data passing is data being sent or received to or from external organizations.

The scores from the eight questions were averaged and the companies were ranked based on their average scores. The companies were then divided into three groups based on their scores. The groups represented the top, middle and bottom third of companies based on information dissemination speed.

## Information Storage and Retrieval

Information storage and retrieval was measured based on information retrieval times. Because information storage times are considered a small part of total storage and retrieval measures and a fixed function of retrieval time, their collection is redundant (Bates 1990; Gauch and Smith 1993).

A series of eight questions were used to determine the retrieval times. The questions requested the approximate times needed to locate information used for various banking decisions. The scores from the eight questions were averaged and the companies were ranked according to their average scores. The companies were then divided into three groups. The groups represented the top, middle and bottom third of the companies based on their information storage and retrieval speed.

The measurement of information retrieval without precision and return rates is less than optimal. Unfortunately, it is unavoidable. Because precision and return rates can only be calculated when a known target is being searched, they are meaningless as organization-wide measures. Most of their effects should be captured in an analysis of total retrieval time, however.

Data Transformation

Data transformation was measured using a series of questions designed to determine the types of technologies used in transformation and the availability of needed information. The first set of four questions asked which of four key transformation technologies were used in four types of banking decisions. Each type of transformation technology was supported by a unique set of articles on data transformation. These included Automated Report Generation (Sung 1988), Decision Support Systems (Arinze Igbaria and Young 1992; Huber 1990; Miller and Nilkanta 1993; Silver 1988; Walz, Elam and Curtis 1993), Expert Systems (Huber 1990; Lawrence 1992; Suer and Dagli 1992), and Neural Networks (Ting-Peng, Moskowitz and Yih 1992; Schantz 1991). The score for the technology portion of data transformation was the sum of all the technologies used. Scaling was between zero and sixteen.

The second set of questions concerned the availability of information needed to make decisions. This set consisted of a six-item seven-point Likert-type scale. The items measure how much of the needed data are available when various banking decisions are made. The score for these six questions was the average of the scores from the Likert-type scale.

The scores for technology use and data availability were combined by subtracting the average scores of the Likert-type questions from the sum of the technologies score. The combined scores were ranked and the companies were then divided into three groups. The groups represented the top, middle, and bottom third of companies based on data transformation quality.

Mutual Adjustment

The measures used for mutual adjustment mirror those designed by Smith et al. (1992). The measure uses five Likert-type scale questions to find how quickly employees can contact relevant others within the firm for communication. The Likert-type scale is ranked from "always accessible" to "difficult to reach." The score for mutual adjustment is the average ranking on the five questions. As with the other variables, the companies were then divided into three groups. The groups represented the top, middle, and bottom third of companies based on mutual adjustment speed.

## Control as a Variable

The measure for control, which was drawn from a questionnaire validated by Danny Miller (1986), consists of a sequence of six Likert-type scale questions. Participants were asked to rate how frequently various control devices are used within the firm. The score used for control was the average rating from the six questions. An average for control of four or more was considered high control. An average of less than four was considered low control (Sung 1988). Miller (1986) measured the reliability of the control measure as .78.

## Questionnaire Design

As stated earlier, the layout, scaling, response modes, wording, and order of questions of the questionnaire were designed according to guidelines offered by Orlich (1978). The only exception was in instances where measures are taken directly from others' questionnaires. In these cases, the original question wording, scaling and format were maintained to avoid invalidating existing reliability measures.

A first draft of the questionnaire was developed by combining the elements taken from other questionnaires and mixing them with the questions designed specifically for this study based on layout and order recommendations made by Orlich. The questions for this study were developed by combining the subject requirements for each measure with Orlich's style guidelines.

Once the first draft of the questionnaire was designed it was pretested using the methodology offered by Dillman (1978). The questionnaire was pretested by three groups which included:

1. 4 individuals who were familiar with the design of the questionnaire and with the study's hypotheses: the dissertation committee,

2. 4 individuals who were familiar with banking and information technology: select members of the Business Computers and Information Systems department, and
3. 4 members of the subject population: four Dallas area bank chief information officers.

Results of the pretest raised a number of issues. The first two phases suggested the need for several modifications to the questionnaire wording and structure. All of the suggested modifications were made except those affecting sections taken verbatim from established questionnaires. The changes included:

1. The instructions to the information dissemination, and information storage and retrieval sections were simplified to make it clearer that only one of the minutes, hours, or days fields needed to be completed for each question.
2. Separate minutes, hours, and days fields were supplied for each question in the information dissemination and information storage and retrieval sections.
3. The time periods meant to capture records off most firms on-line systems in the information storage and retrieval section were adjusted to better meet more firms current practices.

4. The names of the technologies listed in the first data transformation section were extensively reviewed and adjusted to attain names with the broadest general acceptance.
5. The basic demographics section was extended to gather data that may be useful in later studies.

The third phase of the pretest demonstrated the following items:

1. There was a great deal of interest in the results of the study among the subject population.
2. The instructions and questions in the survey were easily understandable.
3. Some of the information requested in the survey was not readily available. The information available varied by systems used.
4 There were extreme privacy concerns. All of the respondents felt that some of the information divulged could be used to negatively affect their firm.

Modifications were made to the instructions to help eliminate the problem with data that was not easily accessible. Modifications were made to the cover letters to assure respondents that nothing but aggregate data would be made available and that no harm would come to them as a result of their responses.

## Reliability of Measures

The reliability of the complete test is unknown, but reliability measures do exist for many of its components. All of the organization structure measures have established reliabilities between .65 and .85 (Miller 1986). Although .65 can be considered low, the measure that received it has been adopted as a standard for measuring formalization (Caufield 1988; Miller et al. 1991). Furthermore, no other measure that is currently available for formalization exceeds .65 (Caufield 1988), therefore this established measure is the best choice available.

The established reliabilities for organizational structure are important because the structure measures operate as dependent variables in this study. The established, and for the most part high, reliabilities helped minimize variability in the data due to poor dependent measures (Keppel 1982).

Because the information technology measures were developed specifically for this study, their reliability is not established. The reliability of the variables is not as critical as for the dependent variables, however. Because information technology measures were used to create three ordinal categories from the information technology data, there was a far greater tolerance for unreliable measures

(Birley and Westhead 1990; Roth and Morrison 1990; Zeffane 1992).

## Data Analysis

The hypothesis tests were analyzed using a Multivariate Analysis of Variance (MANOVA) for each of the four information technology (independent) variables on all five of the organizational structure (dependent) variables. The control variable was included as a moderating variable in all analyses. The Tukey Honestly Significant Difference (HSD) technique was used for all post hoc analysis to correct for familywise error.

MANOVA was selected because it is the most powerful tool available for comparing multiple independent and dependent variables. While canonical correlations can also be used with multiple dependent variables, it is more appropriate when used with continuous independent variables (Eaton, 1983; Johnson and Wichern, 1992). Since this study's independent variables were broken into categories to correct for low reliability in their measurement, MANOVA was more appropriate. MANOVA also has the advantage of being able to validate variable sets. A significant MANOVA on a set of variables is considered a strong validation of the set of variables (Aldenderfer and Blashfield 1984). This validation is required to meet the first objective of this study. SPSS PC's MANOVA procedure was used for all MANOVA tests.

The Tukey HSD score was used for post hoc analysis because it represents an appropriate middle for this study in terms of how conservative a valuation it puts on significance. Since the Tukey HSD score only corrects for the total error in the specific ANOVA being analyzed (Norusis, 1992), it is less conservative then those post hoc analyses that correct for the entire MANOVA. The large amount of potential familywise error collected throughout all the MANOVAs and ANOVAs in this study, however, required a conservative post hoc correction within each ANOVA to prevent to great an accumulation of familywise error throughout the study.

## Chapter Summary

A mailed questionnaire was used to gather data returns from 185 banks. Organizational structure measures defined primarily by Miller (1986) were used as dependent variables. Newly defined information technology questions served as independent variables. The results of the questionnaire were analyzed using MANOVA for hypothesis tests.

# CHAPTER 4

# RESULTS

The results of the analysis on the data collected are presented in this chapter, which is divided into two parts. In the first part, an analysis of the data characteristics is presented to ensure the assumptions of the MANOVA used were met. In the second part, a statistical analysis of the hypotheses is presented.

## Data Characteristics

The following three assumptions about a dataset must be met to make MANOVA analysis appropriate (Johnson and Wichern 1992; Norusis 1990):

1. The data are a random sample from a population. Random samples from different populations are independent.
2. All populations have a common covariance matrix.
3. Each population is multivariate normal.

As discussed in the population and sample section of chapter 3, the sample was not perfectly random. The biases introduced by the lack of perfect randomness, however, are minimal because the data were from a well-balanced sample that met the characteristics of the overall population. The data collection techniques used were not expected to leave any systematic biases in the data. Because MANOVA is fairly robust against non-systematic violations of assumption one, the analysis was expected to few biases due to the violation of this assumption (Johnson and Wichern 1992).

Two analyses were run to test for a common covariance matrix--assumption two. First a Cochran's C Univariate Homogeneity of Variance Test was run using information dissemination as the independent variable. The lack of any significant results (see Table 4) supports a conclusion of a common covariance matrix.

Table 4--Cochran's C Values

| Variable | df | Value | Probability |
|---|---|---|---|
| Specialization | Cochrans C(19,3) | = .37189, | P = .958 |
| Formalization | Cochrans C(19,3) | = .36296, | P = 1.000 |
| Centralization | Cochrans C(19,3) | = .43232, | P = .397 |
| Levels | Cochrans C(19,3) | = .47412, | P = .180 |

Univariate homogeneity of variance, although necessary, is not sufficient to show a common covariance matrix. For that, a Box's M test for homogeneity of dispersion was used. The Box's M test statistic showed no significant likelihood that there was a common covariance matrix imbalance (Box's M = 19.93796, F (20,3020) df = .86182, P = .637). Therefore, assumption two appears to have been met.

To test assumption three, three unique sets of plots were created to ensure that the data were multivariate normal. The three plot types included a distribution diagram, a normal probability plot and a detrended normal plot. One plot of each type was created for each dependent variable. The plots were analyzed to ensure that each variable was a normal distribution.

The analysis of the plots showed that all of the dependent variables had a normal distribution except the supervisor span of control measure that was a part of the configuration variable. The distribution diagram for the supervisor span of control measure showed that distribution to be bimodal. The normal probability plot was substantially arced, confirming the appearances of the distribution diagram. Likewise, the detrended normal plot showed a very strong pattern to the deviations.

Several transformations were attempted on the supervisor span of control measure to make it a more normal distribution. The measure was transformed using the scores log, natural log, square root, and normalized score. None of the transformations created a normal distribution from the data. Because of the bimodal nature of the span of supervisor control responses and the lack of an adequate a measure from MANOVA analyses. Because it was just one of six measures used to indicated a change in the configuration variable, its loss did not substantially affect the overall analysis of configuration.

Although not a specific concern of MANOVA, common method variance can also negatively influence the results of statistical analysis. To test whether common method variance was a problem in this dataset, a single factorial analysis was run which combined the scores of the independent and dependent variables as suggested by Podsakoff and Organ (1986). The factor analysis showed that at least seven factors were needed to explain this dataset. Further, no two independent or dependent variables were in the same factor, suggesting that no common method variance was present in the data.

## Hypothesis Tests

The hypothesis tests were performed in a series of MANOVA analyses. Each MANOVA analyzed the effects of one of the independent variables combined with the effects of control on all of the dependent variables. The following sections include descriptions of the results from each of the MANOVA analyses.

## Information Dissemination Results

A significant overall result was evident for the MANOVA analysis using information dissemination and control as the independent variables ($F = 6.293$, df = 18,92, $p < .001$). The description of the specific ANOVA which follow help provide a basis for understanding the MANOVA results.

The ANOVA of the effects of information dissemination speed and control on specialization showed a significant interaction between information dissemination and control ($F = 4.326$, df = 2,55, $p = .018$) as well as a significant main effect for information dissemination ($F = 3.55$, df = 2,55, $p = .036$). The foundations for the significant effects are shown in Figure 4.

No hypotheses were made about the relationship between information dissemination and control on specialization so inferences from the relationship should be limited. Post hoc analysis on the interaction showed no significant differences between the high control firms. Slow information dissemination speed companies were significantly more specialized than fast or medium information dissemination speed companies with low control (exceeded Tukey critical value of 3.73).

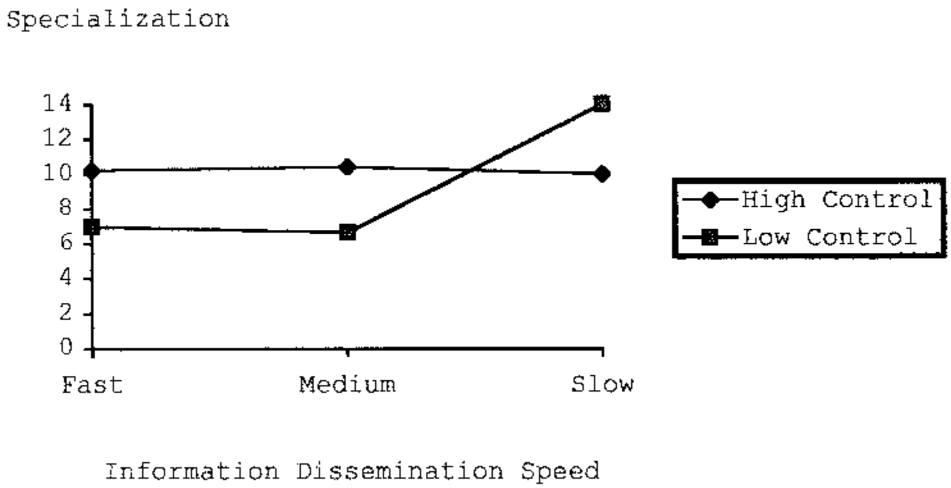


Figure 4. Information Dissemination and Control Means on Specialization

The first half of Hypothesis 1 predicted a significant interaction between information dissemination and control on formalization. No significant interaction was found ($F$ = 1.304, df = 2,55, $p$ = .280). Power analysis suggests that a sample size of at least 95 subjects (power = .80, df = 5,565) would have been necessary to produce significant results from the present cell and overall means. The first half of Hypothesis 1, therefore, received no support.

The second half of Hypothesis 1 predicted a significant interaction between information dissemination speed and control on centralization. Both the interaction ($F$ = 19.26, df = 2,55, $p$ < .001) and the information dissemination main effect ($F$ = 8.32, df = 2,55, $p$ = .001) were significant on centralization. The group means that make up the interaction are shown in Figure 5.

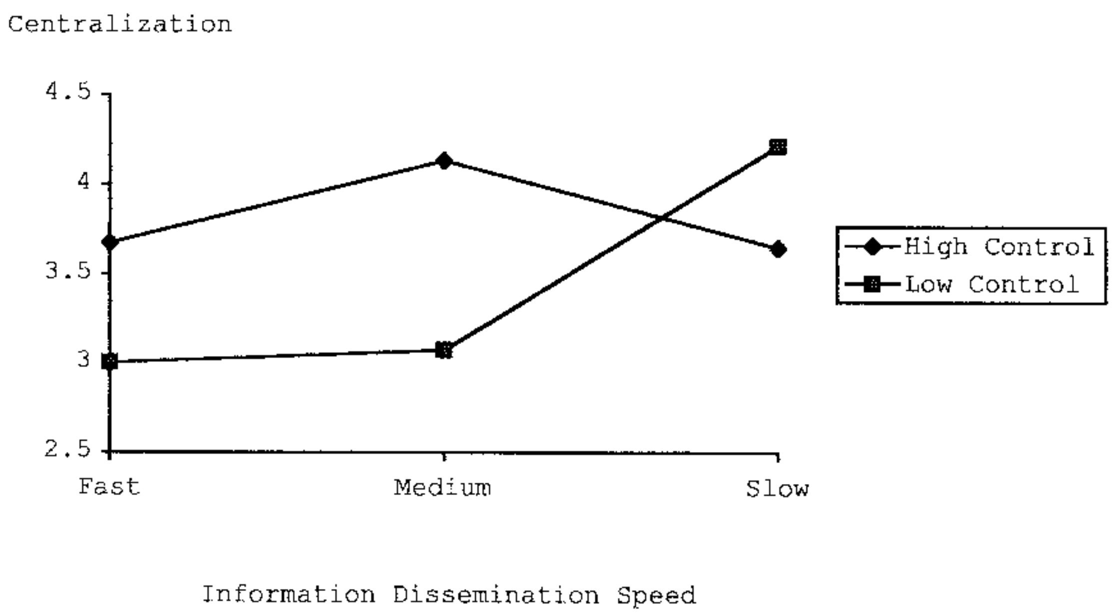


Figure 5. Information Dissemination and Control Means on Centralization

Post hoc analysis shows that for companies with low levels of control, fast and medium information dissemination companies are significantly less centralized than are slow information dissemination companies (exceeded Tukey critical value of 3.43) as predicted in Hypothesis 1. The post hoc analysis for companies at a high level of control is not as clear, however. For companies with a high level of control, companies that had a medium information dissemination speed were significantly more centralized than were companies with fast or slow information dissemination (exceeded Tukey critical value of 3.73). Hypothesis 1 predicted that the companies with the slowest information dissemination would be least centralized.

The findings for low control companies directly support the second half of Hypothesis 1. The findings for high control companies are mixed. These findings, therefore, require the rejection of Hypothesis 1, but suggest that the relationship between information dissemination, control, and centralization is worthy of further study.

Hypothesis 2 predicted a significant main effect for information dissemination on vertical span. A significant main effect was found ($F = 5.05$, $df = 2,55$, $p = .010$). No significant interaction between information dissemination and control was found on vertical span ($F = 1.37$, $df = 2,55$, $p = .263$), thus allowing a direct interpretation of the main effect.

Post hoc analysis showed that companies with fast or medium information dissemination speeds had significantly fewer levels than did companies with slow information dissemination speeds (exceeded Tukey critical value of 3.40). The direction of the main effect was the exact opposite of that predicted in Hypothesis 2, thus creating a direct contraction to Hypothesis 2 (see Table 5 for a list of means and standard deviations).

Table 5--Information Dissemination and the Vertical span in an Organization

| Vertical span | Information Dissemination Speed Fast | Medium | Slow |
|---|---|---|---|
| Mean | 5.1 | 5.1 | 5.95 |
| Standard Deviation | .50 | 1.36 | .894 |

Hypothesis 3 predicted significant main effects on each of the configuration measures for information dissemination. Two of the four measures showed a significant main effect (CEO span of control and percentage of clerical personnel). Three did not (percentage of direct workers, percentage of workflow supervisors and percentage of nonworkflow personnel). None of the interactions between control and information dissemination were significant. The F scores and probabilities for each of the configuration measures and for the interactions with control are shown in Table 6.

Post hoc analysis on the CEO span measure shows that the fast and middle levels of information dissemination had a significantly larger CEO span of control than did the slow level (exceeded Tukey critical value of 3.73). Post hoc analysis on the percentage of support personnel measure shows that all three levels of information dissemination are significantly different from one another (exceeded Tukey critical value of 3.40). The fast information dissemination level had the smallest percentage of support personnel, the slow level had the largest. Both post hoc findings support a flattening organization as information dissemination speed increases.

Table 6--F Tables for Information Dissemination and Control Interactions on the Configuration Measures

| Interactions with Control | F score | Sig. of F | |
|---|---|---|---|
| CEO span of control | 1.08 | .345 | |
| Percentage direct workers | 1.00 | .371 | |
| Percentage workflow supervisors | 1.61 | .209 | |
| Percentage nonworkflow personnel | 2.21 | .119 | |
| Percentage clerical personnel | 2.85 | .066 | |
| **Main Effects** | **F score** | **Sig. of F** | |
| CEO span of control | 3.83 | .028 | * |
| Percentage direct workers | .198 | .820 | |
| Percentage workflow supervisors | .328 | .722 | |
| Percentage nonworkflow personnel | 1.14 | .328 | |
| Percentage clerical personnel | 7.95 | .001 | * |

The finding that two of the configuration measures support Hypothesis 3 while three of the measures fail to support it, requires the rejection of Hypothesis 3. More study is needed for conclusive evidence of a relationship between information dissemination and configuration.

## Information Storage and Retrieval Results

The overall MANOVA result using information storage and retrieval and control as the independent variables was highly significant ($F = 4.50$, $df = 18,92$, $p < .001$). The specific ANOVA results are described in the following paragraphs to help provide a basis for understanding the MANOVA results.

The first half of Hypothesis 4 predicted a significant main effect of information storage and retrieval on specialization. The main effect was not significant ($F = .961$, $df = 2,55$, $p = .389$). The interaction between control and information storage and retrieval was significant ($F = 3.74$, $df = 2,55$, $p = .030$), however.

The means that make up the interaction between information storage and retrieval and control are shown in Figure 6. The companies that make up the high control group support Hypothesis 4, the fast companies are less specialized than are the slow or medium companies. The companies in the low control group reverse the indications of Hypothesis 4, however. The slow companies are less specialized. Unfortunately, none of the interaction effects are substantial enough to show significance in post hoc analysis, further clouding the interpretation of the findings.

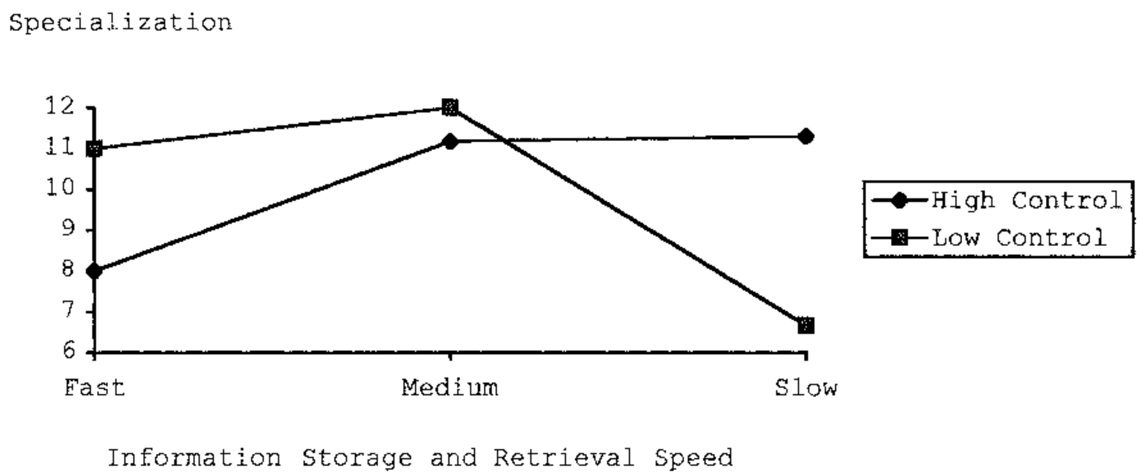


Figure 6. Information Storage and Retrieval and Control Means on Specialization

The second half of Hypothesis 4 indicates a significant main effect of information storage and retrieval on formalization. The main effect for the relationship is significant (F = 3.43, df = 2,55, p = .039). There is a significant interaction between information storage and retrieval and control (F = .6.98, df = 2,55, p = .002) that takes precedence over the main effect, however.

The cell means that demonstrate the interaction between information storage and retrieval and control on formalization are shown in Figure 7. In the high control condition, the fast speed companies are significantly more formalized than are the medium speed companies (exceeded Tukey critical value of 3.43). In the low control condition, the medium speed companies are significantly more formalized than are the slow information storage and retrieval speed companies (exceeded Tukey critical value of 3.73).

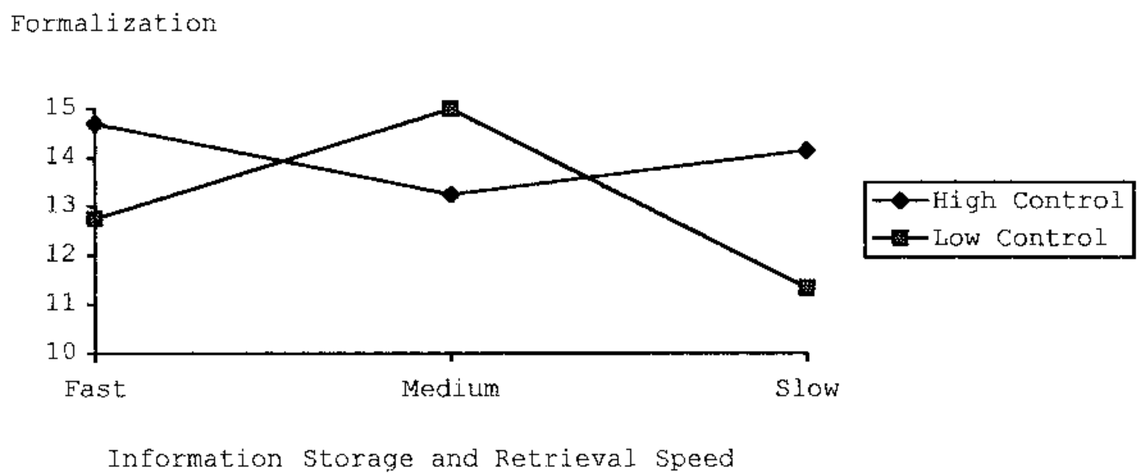


Figure 7. Information Storage and Retrieval and Control Means on Formalization

The high control condition results directly contradict the main effect results predicted in the second half of Hypothesis 4. The low control condition results also contradict the expectations from the main effect hypothesis; however, the low formalization in the fast speed condition confuses even a direct contradiction.

The combined findings from the first and second half of Hypothesis 4 show that the hypothesis is not supported. An interesting relationship between information storage and retrieval speed and control is highlighted by the significant findings, however.

Hypothesis 5 predicted a significant interaction between information storage and retrieval speed and control on centralization. A significant interaction was found ($F = 7.43$, $df = 2,55$, $p = .001$). A graph of the interaction is provided in Figure 8.

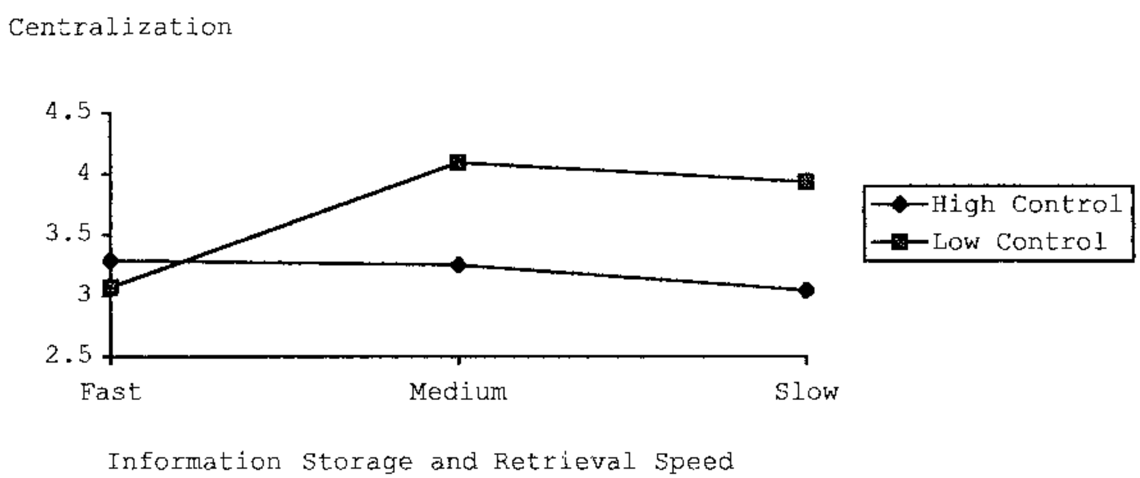


Figure 8. Graph of Information Storage and Retrieval and Control Means on Centralization

Further analysis of the information storage and retrieval interaction with control on centralization using a regular One-way ANOVA revealed that high control companies with fast information storage and retrieval were more centralized than were slow companies. There was not sufficient power to achieve significance using the Tukey correction, however. Among the low control companies, fast companies were less centralized than were medium or slow companies (exceeded Tukey critical value of 3.73). Both directional findings are consistent with Hypothesis 5. The inability of the high control condition to exceed the Tukey limits constrains the relationship a small amount, however, Hypothesis 5 generally received strong support.

There were no hypotheses predicting a relationship between information dissemination speed, control and the vertical span in an organization. No significant interaction ($F = 1.44$, df = 2,55, $p = .246$) or main effects ($F = 0.92$, df = 2,55, $p = .403$) were found.

Although there were also no hypotheses predicting a significant relationship between information dissemination speed and control on configuration, several significant results were found. The findings for each of the configuration variables are provided in Table 7.

The significant main effects for the percentage of non-workflow personnel and percentage of clerical personnel both suggest that the faster information storage and retrieval companies are taller organizations. The significant interactions were too weak to provide significant results on post hoc analyses. Their means suggest that companies that have a fast information storage and retrieval speed and are low on control and have taller organizational configurations.

Table 7--F Tables for Information Storage and Retrieval and Control Interactions on the Configuration Measures.

| Interactions with Control | F score | Sig. of F |
|---|---|---|
| CEO span of Control | 3.19 | .049 |
| Percentage direct workers | 1.34 | .271 |
| Percentage workflow supervisors | 3.57 | .035 |
| Percentage nonworkflow personnel | 3.35 | .042 |
| Percentage clerical personnel | 0.46 | .634 |
| **Main Effects** | **F score** | **Sig. of F** |
| CEO span of Control | 0.77 | .465 |
| Percentage direct workers | 1.14 | .326 |
| Percentage workflow supervisors | 0.95 | .393 |
| Percentage nonworkflow personnel | 5.35 | .008 |
| Percentage clerical personnel | 10.14 | .000 |

## Data Transformation Results

The MANOVA using data transformation and control as independent variables was significant (F = 1.35, df = 18,96, p < .001). The related individual ANOVAs and hypotheses are described in the following paragraphs.

Hypothesis 6 suggested a significant main effect for data transformation quality on specialization. The main effect was significant (F = 5.27, df = 9,55, p = .008). The interaction with control was not significant (F = 0.95, df =

9,55, p = .390) thus making the interpretation of the main effect straightforward.

Post hoc analysis on the main effect of data transformation quality on specialization showed that the high quality group was significantly more specialized than the low or medium quality groups (exceeded Tukey critical value of 3.40). This directly contradicts the prediction of Hypothesis 6 that the low quality group would have the most specialization (quality level means are shown in Table 8).

Table 8--Data Transformation and Specialization in Organizations

| Specialization | Data Transformation Quality Low | Medium | High |
|---|---|---|---|
| Mean | 9.20 | 8.67 | 12.88 |
| Standard Deviation | 3.74 | 3.36 | 2.88 |

Hypothesis 7 predicted a significant main effect of data transformation on formalization. The main effect was not significant ($F = 3.77$, df = 2,55, $p = .054$), although it was very close to significance. The interaction between data transformation and control was not significant ($F = 2.91$, df = 2,55, $p = .063$). The means that went into the main effect are shown in Table 9.

Table 9--Data Transformation and Formalization in Organizations

| Formalization | Data Transformation Quality Low | Medium | High |
| --- | --- | --- | --- |
| Mean | 13.27 | 13.93 | 13.87 |
| Standard Deviation | 1.17 | .905 | 1.15 |

A visual analysis of the cell means suggests that the low quality data transformation companies were less formalized, contrary to Hypothesis 7. Hypothesis 7 is thus left with nearly contradictory results, but ultimately receives no support.

Hypothesis 8 predicted a significant interaction between data transformation quality and control on centralization. No significant interaction was found ($F = 0.54$, $df = 2,55$, $p = .583$); no significant main effect was found ($F = 0.45$, $df = 2,55$, $p = .639$). Hypothesis 8 is, thus, left with no support. Power analysis suggests that at least 290 ($df = 5, 1734$) subjects would be needed to achieve significance with these means and standard deviations.

Hypothesis 9 predicted a significant main effect of data transformation on the vertical span in an organization. The main effect is not significant ($F = 1.13$, $df = 2,55$, $p = .331$), however. Neither is the interaction between data transformation and control ($F = 1.82$, $df = 2,55$, $p = .172$).

Hypothesis 9, thus, lacks support. Power analysis shows that at least 134 (df 5, 804) subjects would be needed to find significance with the means and standard deviation.

Hypothesis 10 predicted a significant main effect for data transformation on configuration. Three of the configuration measures show significant main effects. An equal number of measures, however, show a significant interaction with control (see Table 10).

Table 10--F Tables for Data Transformation and Control Interactions on the Configuration Measures.

| Interactions with Control | F score | Sig. of F | |
|---|---|---|---|
| CEO span of Control | 4.11 | .022 | * |
| Percentage direct workers | 0.30 | .739 | |
| Percentage workflow supervisors | 3.51 | .037 | * |
| Percentage nonworkflow personnel | 0.45 | .643 | |
| Percentage clerical personnel | 6.25 | .004 | * |
| **Main Effects** | **F score** | **Sig. of F** | |
| CEO span of Control | 3.13 | .05 | * |
| Percentage direct workers | 0.99 | .380 | |
| Percentage workflow supervisors | 1.09 | .344 | |
| Percentage nonworkflow personnel | 4.17 | .021 | * |
| Percentage clerical personnel | 5.89 | .005 | * |

Because two of the measures that have significant main effects also show significant interactions, it appears as though most of the configuration variables significance is in the interaction between data transformation and control. The only significant main effect that did not also have a significant interaction was the percentage of nonworkflow personnel. For the percentage of non-workflow personnel, the high quality companies are significantly flatter than are the low quality companies (exceeded Tukey critical value of 3.40), as predicted by Hypothesis 10.

The three measures that had significant interactions, CEO span, percentage of workflow supervisors, and percentage of clerical personnel, all had fairly similar structures to their interactions. For all three interactions, in the high control companies, the low data transformation quality organizations were taller, whereas the high quality companies were flatter. In the low control companies, low quality data transformation companies were flatter, whereas the high quality organizations were taller. The differences between high and low quality were significant (exceeded Tukey critical value of 3.43 high quality and 3.73 low quality) for both high and low control firms in the case of the percentage of clerical personnel. For CEO span and percentage of workflow supervisors, only the low control means overcame the stricter post hoc significance requirements (exceeded Tukey critical value of 3.73).

Although the percentage of non-workflow personnel results support Hypothesis 10, the preponderance of evidence suggests that control is a critical factor when considering the relationship between data transformation and configuration. The suppositions of Hypothesis 10 must therefore be modified to consider control.

## Mutual Adjustment Results

The overall MANOVA for mutual adjustment with control was significant ($F = 3.62$, $df = 9,48$, $p = .002$). The results are described in the following paragraph.

No hypotheses were formulated to suggest a significant relationship between mutual adjustment, control, and the specialization, centralization, vertical span, or configuration dependent variables. No significance was found for any of the variables except the interaction on one of the measures of configuration. The interaction and main effects for all but the formalization dependent variable are shown in Table 11.

The significant interaction between mutual adjustment and control on the percentage of clerical personnel variable is influenced by an anomaly in the data. None of the companies had a middle level of mutual adjustment and low control, thus creating an empty cell in the analysis. The other cell means appear to suggest that faster mutual adjustment corresponds to taller organizations whereas the opposite is true with low control companies. Considering the anomaly in the data and lacking support from other configuration measures, it would be very risky to extrapolate anything from this finding.

Table 11--F Tables for Information Storage and Retrieval and Control Interactions on the Configuration Measures.

| Interactions with Control | F score | Sig. of F |
|---|---|---|
| Specialization | 0.001 | .968 |
| Centralization | 0.653 | .422 |
| Vertical span | 0.804 | .374 |
| CEO span of control | 3.015 | .088 |
| Percentage direct workers | 2.562 | .115 |
| Percentage workflow supervisors | 0.613 | .437 |
| Percentage nonworkflow personnel | 0.366 | .547 |
| Percentage clerical personnel | 11.376 | .001 |
| **Main Effects** | **F score** | **Sig. of F** |
| Specialization | 1.599 | .211 |
| Centralization | 1.008 | .372 |
| Vertical span | 0.689 | .506 |
| CEO span of control | 1.822 | .171 |
| Percentage direct workers | 0.541 | .585 |
| Percentage workflow supervisors | 0.330 | .720 |
| Percentage nonworkflow personnel | 3.030 | .063 |
| Percentage clerical personnel | 1.682 | .195 |

Hypothesis 11, which predicted a relationship between mutual adjustment and one of the dependent variables, suggested there should be a significant main effect of mutual adjustment on formalization. That main effect was significant (F = 5.71, df = 2,56, p = .006). The interaction with control was not significant (F = 0.93, df =

1,56 p = .338), thus allowing direct interpretation of the main effect.

Hypothesis 11 predicted that companies with fast mutual adjustment would be less formalized than would slower companies. In fact, the fast mutual adjustment group was significantly less formalized then both the fast and slow groups (exceeded Tukey critical value of 3.40). As shown in Table 12, the means for the effects of mutual adjustment on formalization strongly support Hypothesis 11.

Table 12--Mutual Adjustment and Formalization in Organizations

| | Mutual Adjustment Speed | | |
|---|---|---|---|
| Formalization | Fast | Medium | Slow |
| Mean | 12.80 | 13.42 | 14.77 |
| Standard Deviation | 1.32 | .56 | 1.97 |

## Summary of Results

The assumptions about the data needed for a MANOVA were met by all of the dependent variables except the supervisors span of control. The supervisors' span of control was removed from further analysis. Tests of the hypotheses were analyzed using MANOVA and post hoc analyses.

Hypotheses 5 and 11 received support. Hypotheses 1, 3, 4, and 10 could not be accepted but significant findings between the variables involved suggest that further study is needed. Hypotheses 2 and 6 were directly contradicted. Hypotheses 7, 8, and 9 received no support. Significant relationships were found between information dissemination speed and specialization, and information storage and retrieval speed and organizational configuration, for which no hypotheses were formulated.

# CHAPTER 5

# DISCUSSION OF FINDINGS

This chapter contains the discussion of the findings from this study. First considered are the findings from the hypotheses tests and general findings from the study. Next is a discussion of the validity of the findings. Finally, an analysis of the implications of findings from this study for practitioners and researchers is presented.

## Discussion of Hypotheses Tests

Both significant and insignificant findings are presented in Chapter 4. A discussion of the implications of each of those findings is provided in this section. The discussion is divided into four sections, with one section for each of the independent variables used in the analysis.

### Discussion of Information Dissemination Results

Three hypotheses were related to the information dissemination variable. Although all three hypotheses were rejected, many of the findings deserve further consideration. The fact that the variables in all three hypotheses showed some level of significant findings indicates that information dissemination speed is a useful tool for segregating the effects of information technology on organizational structure.

Hypothesis 1 predicted that as information dissemination speed increases, formalization and/or centralization should increase when control is high but decrease when control is low. The lack of a significant interaction between information dissemination and formalization provides a strong argument against the first half of the hypothesis. The significant interaction found between centralization and information dissemination supports the second half of the hypothesis.

The significant interaction between centralization and information dissemination has its own problems, however. The banks that had a low control level performed as predicted. The low control companies with fast information dissemination were less centralized than those with slow dissemination. This supports the contention that faster information dissemination allows the low control companies to operate in a less centralized manner because information can travel to the workers who need it with a minimum of delay, thus diminishing the need for higher level oversight. A problem arises, however, in companies with a high control system.

Among the companies with a high level of control, the medium speed information dissemination companies were the most centralized. Considering the hypothesis, the medium speed companies were expected to be more centralized than the slow companies. The medium companies, however, were also more centralized than the fast companies.

One possible explanation for this development is that as information dissemination speed increased from slow to medium, managers were able to control the greater speed of information flow and gain a more centralized structure. The managers might use more easily distributed electronic memos, for instance, to make lower level workers respond more frequently to their wishes and therefore gain more control. For the companies that possessed an information dissemination speed great enough to be in the fast group, however, the speed was fast enough to allow such free access to information that managers lost control of the data flow and thus some decision making control. This alternative explanation appears to have some support in the literature (Tomasko 1992; Zefanne 1992), but the methodology here is not strong enough to support the causal relationships needed to accept such a statement without further research.

Hypothesis 2 predicted that as information dissemination speed increases, vertical span increases. The direction of the significant main effect found between information dissemination and the vertical span directly contradicts the hypothesis. Slow information dissemination companies were found to have a larger vertical span then fast or medium speed companies.

These results support the original expectations about the relationship between the variables, but directly contradict the majority of the previous literature. Seven of ten researchers who have looked at the relationship between information technology and vertical span suggest that computerization should increase vertical span (Blau et al. 1976; Carter 1984; Danzinger 1977; Mann and Williams 1960; Meyer 1968; Pfeffer and Leblebici 1977; Robey 1981). All of their studies were performed prior to 1984 when personal computers began to become a dominant force, however. All that would be needed to make these results consistent with previous research is a finding that today's user friendly systems, built on personal computers, provide faster information dissemination than did the older mainframe based systems. Since the only post-1984 research to consider the relationship between information technology and vertical span also revealed that computerization decreased vertical span (Huber 1990), showing that information dissemination speed has increased over time could provide a basis for a paradigm shift in seemingly disparate research findings.

Hypothesis 3 predicted that as information dissemination speed increases, configuration flattens. Because two of the measures of configuration, CEO span of control and percentage of clerical personnel, support the finding and none of the measures or interactions with control confused or contradicted the findings, some evidence exists for the relationship even though the hypothesis is rejected. Agreement of more of the measures would have been beneficial, but two measures showing a significant flattening suggests that a perceptible difference exists between the organizations that were measured.

This finding is consistent with the findings of researchers who have considered computerization and configuration (Zefanne 1992; Burkhardt and Brass 1990; Huber 1990). The finding suggests an analysis of information dissemination speed could be a useful predictor in estimating configuration. More refinement of the information dissemination measure is needed to show clear results in all the measures of configuration.

## Discussion of Information Storage and Retrieval Results

According to Hypothesis 4, as information storage and retrieval speed increase, specialization and/or formalization also increase. Unfortunately, the prediction in Hypothesis 4 was too simplistic an analysis. The main effect of information storage and retrieval on formalization was significant but so were the interactions on both specialization and formalization. The relationship between information storage and retrieval and specialization and formalization, thus, cannot be considered without also considering control.

To develop an understanding of what these findings imply, it is useful to look at the results of both parts of Hypothesis 4. Doing so shows that for companies that desire high control, fast information storage and retrieval corresponds to low specialization and high formalization. For companies that prefer low control, slow information storage and retrieval corresponds to low specialization and formalization. Therefore, it seems that control has its main impact on formalization.

The relationships might suggest that companies wanting high control use systems that provide fast information storage and retrieval to provide easier access to the rules that create the formalized environment. At the same time, they reduce specialization to allow higher level managers to understand all the functions below them so they can develop a consistent set of rules. Both operations should allow them to increase their level of control.

The implications for companies that prefer low control are less clear. It is unlikely that low control companies specifically slow down their information retrieval systems to achieve the lower specialization and formalization that would be consistent with a low control firm. It is possible, however, that they do not enhance their information storage and retrieval systems because the slower systems they posses meet the needs for maintaining the desired level of control. Firms that enhance their storage and retrieval systems may do so at the cost of pushing themselves up the control spectrum.

Hypothesis 5 predicted that as information storage and retrieval speed increase, centralization increases when control is high and decreases when control is low. The highly significant interaction between information storage and retrieval and control on centralization supports Hypothesis 5. Further, the relationship between the cell means reflects the expected relationships described in Hypothesis 5. Thus Hypothesis 5 is strongly supported from the findings of this study.

This strong support for Hypothesis 5 helps explain inconsistencies found in the current literature. Of the fifteen researchers who have looked at the relationship between computers and centralization, seven have found that computerization increases centralization (Blau et al. 1976;

Hoos 1960a; Hoos 1960b; Lipstreu and Reed 1965; Mann and Williams 1960; Rourke and Brooks 1966; Zmud 1982) and six have found that computerization decreases centralization (Hofer 1970; Huber 1990; Klatzky 1970; Pfeffer and Leblebici 1977; Smith et al. 1992; Zefanne 1992).

By breaking down information technology into the four categories used here, the apparent inconsistency can be explained. The faster a company's information storage and retrieval system, the better its desire for control is met through centralization. A company that prefers high control can provide managers rapid information storage and retrieval to achieve better insights into lower level workers output and at the same time achieve higher centralization. A company that prefers low control can use faster information storage and retrieval to provide lower level workers a better view of the entire organization, thus allowing decisions to be made at a lower level while decreasing centralization.

The apparent inconsistencies in research results on computerization and centralization, therefore can be considered inconsistencies between the studies on the desire for control and information dissemination speed in the firms measured. The fact that studies shifted from computers increasing centralization to computers decreasing centralization as time progressed can be explained if firms being studied increased information dissemination speed and decreased desire for control over time. An increase in information dissemination speed between 1960, when the first study was conducted, and 1992, when the last study was completed, is a given. Database technologies drastically improved over this time period (Kranch 1989). That the desire for control has diminished over the same time period is not as obvious, but the strong movement from management by objective to self-managed workteams (Daft 1992) suggests that the desire for control has diminished.

## Discussion of Data Transformation Results

Hypothesis 6 predicted that as data transformation quality increases, specialization decreases. There was a significant main effect for data transformation on specialization. Post hoc analysis of cell means, however, shows that instead of being supported, Hypothesis 6 is directly contradicted. Companies that had high data transformation quality were more specialized than low or medium quality companies, not less.

This finding contradicts much of what was expected based on current literature. A large body of practitioner oriented publications, beginning with Michael Hammer's (1991) article on business process re-engineering, indicates an increase in data transformation quality to reduce the number of specializations is the primary goal of business process re-engineering. With the popularity of business process re-engineering, more of that goal would be expected to have been met.

The results here indicate that the goal of business process re-engineering has not been met by a majority of companies. In fact, the opposite of business process re-engineering is occurring. Companies are adding specialists as they increase information system complexity rather than using their information systems to decrease the complexity of their worker arrangements.

If these findings are indicative of a trend, an important element of what popular research predict about the future of business could be proven wrong. Much of popular literature suggests that more companies are creating generalists to help increase accountability and the speed at which work is performed (Hammonds, Kelly, and Thurston 1994; Peters 1992; Stalk 1988). A common example is Bank One's creation of a single position supported by various information technologies responsible for the complete evaluation of a loan. Bank One created the position so that loan applications were not delayed by waiting for various specialist to review them. This research indicates that this type of anecdote is the exception rather then the rule. Most companies are increasing specialists while increasing their information technologies data transformation capabilities, rather than reducing them. This calls into question the prediction that there will be an increase in the need for business generalists in the near future (Hammer 1990; Leavitt and Whisler 1958; Wriston 1987).

It is impossible to tell if these finding will be reversed as companies become more experienced at business process re-engineering, but it is a development worth watching closely. If the findings here are not reversed over time, the efforts many companies are putting into business process re-engineering may not only fail to meet their goals, they may be counter-productive.

Hypothesis 7 predicted that as data transformation quality increases, formalization increases. There was a marginally significant main effect for data transformation quality on formalization. The weakness of the main effect left insufficient power available for significance on post hoc tests. A visual analysis of the cell means shows the direction of the cell differences is contradictory to Hypothesis 7. If later studies better support this finding, it will indicate that companies are developing flexible data transformation technologies. Techniques such as natural language systems and flexible database arrangements have been recommended for eliminating the burden of the user in structuring data for computer use (Bailey 1982). Further support for this finding would indicate that practitioners use such techniques to make computer systems more user friendly and organizations, by extension, less formalized.

With the marginal main effect and insignificant post-hoc analyses, it would be dangerous to read to much into these findings. It is more appropriate to suggest that future researchers have a good chance of finding a significant relationship between data transformation and formalization and to leave to future researchers the determination of the shape of that relationship.

Hypothesis 8 predicted that as data transformation quality increases, centralization increases when control is high but decreases when control is low. Hypothesis 9 predicted that as data transformation quality increases, vertical span decreases. No significant results were found in relation to either hypothesis. The lack of significant results probably stems from the limited use of advanced data transformation techniques among the companies in the sample.

Hypotheses 8 and 9 were based on expectations from the effects of advanced decision aids on centralization and vertical span. Unfortunately, advanced decision aids such as neural networks and expert systems were used in a very small proportion of the companies studied. The companies that used them tended to use them for only a limited set of tasks.

The limited use of the advanced decision aids made it unlikely that the effects would be great enough to show a substantial difference in the structure of the entire firm. It is likely that time will effect this result, however. As more advanced neural networking and expert system development environments become available, it is likely that more companies will use them for a broader set of tasks. Their broader use should make their effects pronounced enough to be measurable with a reasonable number of subjects. This is another area that future researchers will need to revisit periodically.

Hypothesis 10 predicted that as data transformation quality increases, configuration flattens. Three of the five configuration measures showed a significant main effect for data transformation on configuration, but three of the measures also showed a significant interaction with control. The significant interaction with control suggests that the effects of data transformation on configuration should only be considered in relationship to control.

The relationship between data transformation, control, and configuration was fairly consistent across all three measures. The measures showed that among high control companies, high quality data transformation corresponded to flatter organizations. The opposite was true for low control companies. These findings may indicate that data transformation counteracts some of the expected structural effects from control.

It is normally expected that managers who want high control create taller organizations, whereas managers who prefer low control create flatter organizations (Daft 1992; Mintzberg 1979). These findings indicate that high quality data transformation helps reverse that effect. To managers who prefer high control, the reversal of that effect is highly desirable. A taller organization is more expensive. If a manager can achieve high control with a flatter organization through high quality data transformation, the investment in data transformation appears to be a good one.

For managers who prefer a low level of control, the investment in high quality data transformation does not appear to be as cost effective. The extra structure needed to support the high quality data transformation appears to make low control firms taller than they would otherwise be without the technology investment. Managers who prefer a low level of control need to consider what other benefits are gained from the high data transformation quality to be sure that the costs of the taller structure are outweighed by the benefits gained.

The strong and consistent interaction between data transformation and control on configuration indicates that Hypothesis 10 was oversimplified. Because it appears as if data transformation counteracts some of the configuration effects of control, data transformation and control should not be considered separately when looking at configuration.

## Discussion of Mutual Adjustment Results

Hypothesis 11 predicted that as mutual adjustment speed increases, formalization decreases. The significant main effect and post hoc analyses of mutual adjustment on formalization provide strong support for Hypothesis 11.

The finding that faster mutual adjustment corresponds to lower formalization is an indication that mutual adjustment technologies can be used to limit the need for strict rules for behavior. Although these findings do not prove causality, combined with other sources (Coates 1993; Bikson and Law 1993; Sheombar 1992; Sulek and Marucheck 1992), these findings give reason to believe that changes in the speed of mutual adjustment can change the level of formalization in an organization.

The closer the interpersonal contact that the mutual adjustment technologies allow, the more reduced is the need to anticipate every situation with a strict policy. This finding is consistent with the popular belief that technologies such as mobile computers combined with E-mail, voice mail, fax machines, and video phones will continue to allow a detachment of workers from a strictly enforced workplace. These findings, thus, support the popular contention that the modern workplace will continue to become a less structured environment (Goslar and Grover 1992).

Although all of these analyses are consistent with the findings, there is clearly not enough evidence to guarantee that they are correct. There are many other explanations that may clarify the data. It must be left to future researchers to determine the exact relationship between many of the variables studied.

## General Discussion of Findings

A discussion of the results from each of the specific hypotheses is presented in the preceding section. The findings of this study have implications beyond the confirmation or refutation of its hypotheses, however. A discussion of general findings follows.

The first objective of this study was to create and validate the usefulness of a set of generic information technology variables. The four significant MANOVAs based on the set of information technology variables defined indicate that the information technology variables defined here are very useful. The importance of this finding, if born out by future research, could be substantial. A set of variables that provides an easy method for comparing specific information technologies could provide a significant boost to both researchers and practitioners in the management and information systems fields. For researchers, the primary gains are in the wide variety of future research that can be spawned from these findings (see Future Research for specifics). For practitioners, several implications that can be used immediately are provided.

The validation of the information technology variables defined here provides practitioners with a new window into their organizations. By analyzing their information technologies by the impact they have on information dissemination speed, storage and retrieval speed, data transformation quality, and mutual adjustment speed rather than just by the speed or capacity of a set of machines, practitioners can gain many new insights into their organizations.

For example, instead of deciding whether a company needs a new computer system based just on the company's current data storage and throughput, a data manager can determine how information dissemination speed and information storage and retrieval speed will be affected by the new system. This will allow the data manager to decide on whether to purchase the system based on its impact on the organization, rather than on just its impact on the capacity of the computer system.

Beyond the validation of the information technology variables, the findings of this study also provide a number of general insights into the relationship between information technology and organizational structure. First, it shows that the overall model defined in Figure 2 is supported. There appears to be a strong relationship between information technology and organizational structure that is modified by control. The specific model of the hypotheses defined in Figure 3 needs to be respecified, however. A new model of specific relationships which reflects current results is shown in Figure 9. This respecified model should be used as the basis for future research.

Another general insight from this research is evident in the fact that as many hypotheses were contradicted as were supported. This suggests that the information technology categories defined here could provide several new insights. An entirely new body of literature which predicts the effects of information technology on structure needs to be developed. Hypotheses about the relationship between information technology and organizational structure based on older literature should not be expected to hold when using the new definition of information technology.

| Information Technology Variables \ Structure Variables | Specialization | Formalization | Centralization | Vertical Span | Configuration |
|---|---|---|---|---|---|
| Information Dissemination | C | | C | - | F |
| Information Storage and Retrieval | C | C | C | | C |
| Data Transformation | + | | | | C |
| Mutual Adjustment | | - | | | |

+ a positive relationship between info. tech. variable and the structure variable
- a negative relationship between info. tech. variable and the structure variable
C the relationship depends on the level of control
F in Configurations indicates configuration will flatten

Figure 9. Model of Variable Relationships

Finally, the high number of interactions between control and information technology suggests that information technology and control cannot be considered separately. It is possible that information technology will become best viewed as an enabling tool that allows users to better emphasize their desires. If so, other strategic issues such as the firms' environment and the type of planning process used are also likely to be highly interactive with information technology. This also suggests another important use of this research for practitioners. If information technology is viewed as an enabler for meeting strategic aims, the information technology categories defined here could become useful tools in implementing strategic shifts. If causal links are shown to exist in later research, practitioners could use knowledge of those links to enact changes in their information technology that creates changes in their structure and thus help implement their strategies.

## Validity of Findings

The validity of this study, as with most mail questionnaires, is suspect. Because there was limited control over who filled out the questionnaires and the circumstances under which this was done, little can be said about the environmental effects on the outcome. Some controls used in this study in relation to the validity issues raised by Cook and Campbell (1979) are considered in the following paragraphs.

The construct validity for this study was reasonably high. The stability of the organization structure variables through a long stream of research lends credibility to the definitions used here. There is a threat of mono-method bias in the questionnaire because all data were collected through questionnaire techniques only. There is also a potential mono-operation bias in the vertical span measure because it was measured using a single question. The threats of inadequate preoperational explication of constructs, hypothesis guessing within experimental conditions, evaluation apprehension, experimenter expectancies, confounding constructs and levels of constructs, interaction of different treatments, and interaction of testing and treatment do not appear to be problems in this study, however, because variables were not manipulated and data collection was unobtrusive.

The internal validity of this study is a concern. Because no treatment was induced, no randomization occurred. Because only a single measurement was taken, most of the internal validity threats such as history and maturation do not apply. That does not mean, however, that this study has high internal validity. This study was designed to give first indications as to the applicability of the information technology variables defined here to the study of organizational structure. It was not designed to show a cause-effect relationship. Internal validity, therefore, is extremely limited.

Although most threats to statistical validity were not a problem in this study, a few were substantial concerns. A major problem was the familywise error accumulated through the study. The number of independent statistical tests that were run substantially increases the odds of a false positive result. The familywise error corrections used in post-hoc analysis helped some, but the familywise correction only considered the familywise error in the specific ANOVA being considered, and not the familywise error for all the MANOVAs. The high level of significance on the overall MANOVAs and many of the ANOVAs reduces the concern for many of the findings. Results that came closer to the .05 level must be considered more suspect, however. There are familywise error correction techniques that could be used to adjust for all four independent MANOVAs and their subsequent ANOVAs but they would prove extremely conservative. With a preliminary study such as this, it is probably better to simply accept the increased false positive risk. Later researchers will have a firmer base on which to build, so that it will be easier for errors to be corrected in their studies.

An obvious threat to external validity faced in this study was the threat of an interaction between selection and treatment. Although no actual treatment was given, the information technology variables used as such. The decision to use public banks as the sample presented a potential problem. The information requirements of public companies may force different information technology decisions to be made than might be made in non-public companies. The need to pursue larger banks to balance the dataset could also pose a problem for the external validity of this study. Although the sample of companies that agreed to participate equaled the overall bank population on several important measures, it was not a truly random collection and, thus, may contain hidden biases.

Beyond the threats to validity identified by Cook and Campbell (1979), a major concern when using a single source to evaluate a set of variables, as done here, is common method variance. Common method variance suggests that a test using individual ratings can be biased by a single factor within the individuals that influences their ratings of all the measures taken (Podsakoff and Organ 1986). Common method variance poses its worst threat when subjects are performing self-reports, however. With less personal data, as requested in this study, the threat of common method variance is minimal. The factorial analysis of all the combined measures performed on this dataset suggests that common method variance is not a problem because at least seven factors were required to explain the data.

## Suggestions for Future Research

Several suggestions for future research were presented in the discussion of the hypotheses results. These suggestions include further research into the interaction between information dissemination speed, control and centralization to determine the causal link in the interaction, a more careful measuring of the relationship between information dissemination and configuration, and a test to determine whether companies fail to increase their storage and retrieval speed when their control needs are being met. Also suggested was further research into the effects of process re-engineering on specialization, the use of user friendly technologies to reduce formalization, the impact of more advanced data transformation technologies as they become more common and the effects of mutual adjustment and control on configuration.

In addition to the research suggested in the discussion of the hypotheses results, two distinct phases of future research need to be performed to answer the issues raised by this research. The first phase is the need to concentrate on further refining this research to develop causal linkages. The second phase is to extend this research into the many areas a causal linkage would suggest as appropriate.

The first step for future research related to this study should be to develop more reliable and generalizable measures of the information technology variables. The measures used here were designed for only one specific audience, banks. A substantial amount of unreliability was allowed because the variables were to be condensed into a small number of categories and measures with greater breadth were desirable in a preliminary study such as this. Now that the variables have been shown to be useful, however, they need greater refinement. This will be particularly true in later research when they will be suggested as dependent as well as independent variables. At that point a consistent and reliable continuous set of measures will be required.

Once a consistent set of measures is developed, it will be important to extend this research to other industries. Banks were chosen for this study because they were considered likely to show the effects of information technology. Future researchers will need to determine whether the relationships shown here hold in industries that are less information intense.

As better measures and a broader set of industries are added to this research, different methodologies should be utilized to develop a causal link between the variables. Research studies that consider information technology and configuration measures before and after large information technology changes in a number of firms should indicate whether it is indeed the changes in information technologies which are driving the changes in structure.

If better measures for the information technology variables are established and a causal link can be shown, then a large number of other studies related to the set of information technology variables is suggested. In this second phase of research it will be important to establish the information technology variables as a middle step between specific information technologies and organizational structure as well as other dependent variables. By using this set of information technology variables as a middle step, researchers will finally be able to eliminate the necessity of researching the effects of every new technology on various independent variables. The relationship between the dependent variables and this set of information technology variables will be established. Each new specific information technology will only need to be assessed for its effects on the set of information technology variables defined here in order to know the effects of the specific information technology and all the dependent variables. To establish this linkage, the information technology variables defined in this study need to be considered both as independent and dependent variables.

A huge body of research could be performed using the information technology variables defined in this study as dependent variables. Each specific information technology in common use could be analyzed in relationship to its effects on this set of variables. By doing so, an avenue could be created for directly comparing very disparate technologies. For instance, the information dissemination effects of an E-mail system could be compared to those of a paper based system. The answer to specific questions such as these will allow practitioners to make more informed choices about which technologies are appropriate for their needs. As an early step in this process, it may be possible to perform a meta-analysis of the specific technology research already performed.

The use of these information technology variables as independent variables will allow researchers to define a more general relationship between information technology and a number of other variables. Beyond showing the relationship between information technology and organizational structure, information technology's effects on strategy, human resources, marketing and a whole host of other issues could be analyzed using these information technology variables. The results from these studies could then be applied to any specific information technology based on the effect of that specific information technology on the variables.

Assuming that a wide body of significant research findings can be developed using these information technology variables, one more major research effort will be possible. By combining the results of the information technology studies with results from strategy and other organizational structure studies it may be possible to develop a complete picture of how organizations function. If organizations are information processing systems as several authors suggest (Burns and Wholey 1993; Daft and Weick 1989; Egelhoff 1991; Smith, Dykman and Davis 1985), then understanding the effects of the technologies through which information is processed may provide the insights and mechanisms needed to build and test a complete model of organizations.

## Summary of Discussions

The results of this study indicate that the information technology variables defined here are useful tools for analyzing organizational structure. The results also indicate that past literature is not necessarily a reliable guide for predicting the effects of the information technology variables on organizational structure. Control is shown to be a critical moderating variable when considering information technology and organizational structure.

Although most of the validity issues raised by Cook and Campbell (1979) are adequately handled by this research, the methodology used does not allow any causal statements to be made. Several steps to both improve and extend this research are suggested for future researchers.

# APPENDIX A

## The Questionnaire

**Survey of Financial Institutions' Information Systems**

**Directions**

1. Please answer all of the following questions based on your knowledge and perceptions of activities within your company.

2. If there are any questions for which you do not have ready access to answers, feel free to forward the questionnaire to someone in your firm who does.

THANK YOU FOR YOUR ASSISTANCE.

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**Section I Characteristics of Your Information System**

For each of the following questions please answer how long it takes (on average) for information to be transmitted through your company. Measure the time from when information is sent to when it is most probable the person(s) listed will see it. Consider electronic as well as other forms (paper, etc.) of information. Enter the appropriate time before the appropriate (use only one scale for each question).

*Information Dissemination*

How long does it take for:

a) a transaction taken at the operating level (deposit, new loan, etc.) to be reflected in a report regularly reviewed by the chief executive
_____ min. or
_____ hours or
_____ days

b) an operating change made at the supervisory level to be conveyed to the highest level executive that reviews it
_____ min. or
_____ hours or
_____ days

c) a policy change made at the chief executive level to be conveyed to workers at the operating level
_____ min. or
_____ hours or
_____ days

d) minutes of board meeting to be conveyed to executives who report directly to your chief executive
_____ min. or
_____ hours or
_____ days

e) a policy change made by a supervisor at one branch, that affects other branches, to be conveyed to supervisors at the other branches
_____ min. or
_____ hours or
_____ days

f) a transaction alteration (deposit correction, etc.) message to be sent from one operations worker to another
_____ min. or
_____ hours or
_____ days

g) a purchase order to be sent to a vendor
_____ min. or
_____ hours or
_____ days

h) a change in earnings expectations to be conveyed to financial markets
_____ min. or
_____ hours or
_____ days

For the following questions please answer how long it takes (on average) to retrieve each of the pieces of information listed below. Consider electronic as well as other forms (paper, etc.) of information. Enter the appropriate time before the appropriate scale.

*Information Storage and Retrieval*

How long does it take to retrieve:

| | | | |
|---|---|---|---|
| a) | a current loan application | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| b) | a loan application rejected 2 years ago | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| c) | a loan applicants' credit report | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| d) | your company's most recent quarterly balance sheet | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| e) | a quarterly balance sheet from 4 years ago | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| f) | a written policy on acceptable sick leave | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| g) | the total number of sick days an employee has taken in the last five years | _____<br>_____<br>_____ | min. or<br>hours or<br>days |
| h) | a complete list of all deposits over $10,000 made in a particular month | _____<br>_____<br>_____ | min. or<br>hours or<br>days |

For each of the following items, circle the number that best describes how much effort is required for employees within your company to contact one another. A (1) on the scale indicates the employees can easily and quickly access one another. A (7) on the scale indicates the listed employee would have to exert a great deal of effort to contact the other employee(s).

*Mutual Adjustment*

| | | Little effort to access | | | | | | High effort to access |
|---|---|---|---|---|---|---|---|---|
| a) | an operating employee contacting their supervisor | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) | an operating employee contacting all other operating employees who have the same supervisor | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) | an operating employee contacting the chief executive | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) | a supervisor contacting all other supervisors | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| e) | a supervisor contacting the chief executive | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

For each of the following decisions indicate which, if any, of the technologies listed are used by your firm to assist in the decision process (check all that apply).

*Data Transformation 1*

Loan evaluation decisions
( ) 1. automated report generator
( ) 2. expert systems
( ) 3. decision support systems
( ) 4. neural networks

Purchasing decisions
( ) 1. automated report generator
( ) 2. expert systems
( ) 3. decision support systems
( ) 4. neural networks

Firm investment mix (portfolio) decisions
( ) 1. automated report generator
( ) 2. expert systems
( ) 3. decision support systems
( ) 4. neural networks

Firm strategic decisions
( ) 1. automated report generator
( ) 2. expert systems
( ) 3. decision support systems
( ) 4. neural networks

For the following items, rate your firm's ability to produce information needed for decisions. A (1) rating indicates your firm can produce all the information needed to make the decision. A (7) indicates most of the information needed is missing when decisions are made.

*Data Transformation 2*

| | All info. available | | | | Most info. missing | | |
|---|---|---|---|---|---|---|---|
| a) Loan evaluation decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) Purchasing decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) Investment mix (portfolio) decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) Strategic decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| e) Employee promotion decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| f) Marketing decisions | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Rate the extent to which the following control devices are used to gather information about the performance of your firm.

*Control*

| | Used rarely or for small part of operations | | | | | the firm | Used frequently or throughout |
|---|---|---|---|---|---|---|---|
| a) A comprehensive management control and information system | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) Use of cost centers for cost control | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) Use of profit centers and profit targets | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) Quality control of operations by using sampling and other techniques | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| e) Formal appraisal of personnel | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

**Section II Characteristics of Your Firm**

Which level in your firm has the authority to make the following decisions?
Mark a score of:
0 if the level is the board of directors
1 if the level is the chief executive
2 if the level a divisional or functional manager
3 if it is a departmental head
4 if it is a first level supervisor
5 if the decision is made by an operative at the shop level

*Centralization*

| Decisions concerning: | Circle the appropriate level | | | | | |
|---|---|---|---|---|---|---|
| a) the number of workers required | 0 | 1 | 2 | 3 | 4 | 5 |
| b) whether to employ a worker | 0 | 1 | 2 | 3 | 4 | 5 |
| c) internal labor disputes | 0 | 1 | 2 | 3 | 4 | 5 |
| d) overtime to be worked at the shop level | 0 | 1 | 2 | 3 | 4 | 5 |
| e) delivery dates and priority of orders | 0 | 1 | 2 | 3 | 4 | 5 |
| f) production plans to be worked on | 0 | 1 | 2 | 3 | 4 | 5 |
| g) dismissal of a worker | 0 | 1 | 2 | 3 | 4 | 5 |
| h) methods of personnel selection | 0 | 1 | 2 | 3 | 4 | 5 |
| i) method of work to be used | 0 | 1 | 2 | 3 | 4 | 5 |
| j) machinery or equipment to be used | 0 | 1 | 2 | 3 | 4 | 5 |
| k) allocation of work among available workers | 0 | 1 | 2 | 3 | 4 | 5 |

Which of the following documents are used in your firm (check one for each)

*Formalization*

a) written contract of employment ( ) No
( ) Yes

b) Information booklets treating, for example, security, working conditions, etc., are given to:
- No one ( ) 0
- Only a few persons ( ) 1
- Many ( ) 2
- All ( ) 3

c) an organization chart is given to:
- Chief executive only ( ) 1
- Top two layers of executives ( ) 2
- Chief exec. and most division or department heads ( ) 3
- All supervisors ( ) 4

d) written job descriptions are made for:

| | |
|---|---|
| Direct production workers | ( ) No<br>( ) Yes |
| Clerical workers | ( ) No<br>( ) Yes |
| Supervisors | ( ) No<br>( ) Yes |
| Specialists | ( ) No<br>( ) Yes |
| Chief executive | ( ) No<br>( ) Yes |

In your firm is there:

| | |
|---|---|
| 1) a written business policy | ( ) No<br>( ) Yes |
| 2) a written manual of procedures and fixed rules? | ( ) No<br>( ) Yes |
| 3) written operating instructions to workers? | ( ) No<br>( ) Yes |

Which of the following activities are dealt with exclusively by at least one full-time person in the firm who:

*Specialization*

| | | |
|---|---|---|
| a) | is responsible for PR, advertising, or promotion | ( ) |
| b) | disposes of, distributes or services your outputs | ( ) |
| c) | carries outputs, resources, and other materials from one place to another | ( ) |
| d) | acquires and allocates human resources | ( ) |
| e) | develops and trains personnel | ( ) |
| f) | takes care of welfare, security or social services | ( ) |
| g) | obtains and controls materials and equipment (buying and stock control) | ( ) |
| h) | maintains and erects buildings and equipment | ( ) |
| i) | records and controls financial resources (accounts) | ( ) |
| j) | controls workflow (planning, scheduling) | ( ) |
| k) | takes care of quality control (inspection) | ( ) |
| l) | assesses and devises ways of producing output (work-study methods, operation study, etc.) | ( ) |
| m) | devises new outputs, equipment and processes (design and development) | ( ) |
| n) | develops and carries out administrative procedures (statistics information systems, filing, etc.) | ( ) |
| o) | deals with legal and insurance requirements | ( ) |
| p) | acquires information on the market-field of the firm (market research) | ( ) |

*Levels*

How many levels are there in your organization? That is, count the number of levels in the longest line between direct worker and the chief executive (inclusive) in the production or service function

____________

*Configuration*

How many persons report directly to your firm's chief executive? ______

On average, how many persons work for each first line supervisor in your firm? ______

How many first line supervisors are there in your firm? Do not count anyone who is responsible for performing direct work ______

How many persons does your firm employ who are not responsible for direct work or supervision? ______

How many persons does your firm employ in clerical positions? ______

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**Section III Comparison with Your Competitors**

In the following questions, give your overall impression of your firms information-handling abilities in relation to your competitors.

*Generalized Categorizations*

Do you believe your firm's ability to transmit information (memos, policy changes, etc.) within your company is (check one):

Faster than competitors' ( )
About the same speed as competitors' ( )
Slower than competitors' ( )

Do you believe your ability to retrieve company information (historical data, personnel reports, etc.) is:

Faster than competitors' ( )
About the same speed as competitors' ( )
Slower than competitors' ( )

How do you believe your company's technologies affect your employees' ability to communicate with each other:

It is easier for them to communicate than at competitors' ( )
They are about the same as competitors' ( )
It is harder for them to communicate than at competitors' ( )

How sophisticated would you say your company's technologies for manipulating data are in comparison to competitors:

They are more sophisticated than competitors' ( )
They are about the same as competitors' ( )
They are less sophisticated than competitors' ( )

---

**Section IV Basic Demographics**

What percentage of your firm's software is developed in-house? ____________%

What percentage of your information technology functions are outsourced? __________%

What percentage of your firms total employees are dedicated to developing and maintaining information systems? __________%

How many total employees are there in your firm? ____________________________

What is your job title? ________________________________________________

How long have you been in your current position? ____________________________

What function were you responsible for in the position you held just prior to your current position?

Marketing _______

Finance _______

Operations _______

Information Systems _______

General Management _______

Other _______ Please specify _______________________________

In what field was your academic training?

Marketing _______

Finance _______

Operations _______

Information Systems _______

General Management _______

Other _______ Please specify _______________________________

Thank you very much for participating in this research.

# APPENDIX B

## Persuasive Letters and Post Card

Cover Letter 1
Management Dept. Letterhead

CIO Name
Bank Address                                                                 Date

Dear (CIO NAME):

More than $1 trillion was spent on information technology in the US during the 1980s. The average bank and savings and loan's share of that investment amounted to more than 1/2 of operating profits. Despite banks and savings and loans' willingness to spend massive amounts of money, little is known about the impact that investment is having on the firms making the investment. The purpose of this study is to develop measures of information technology that are independent of the specific hardware and software used and to evaluate the effect of those information technologies on banks and saving and loans.

I am a doctoral student conducting dissertation research on the effects of information technology on organizational structure. As someone who plays the leading role in your firm's information technology decisions, I am interested in your knowledge and perceptions. In order for the results to truly represent the banking and savings and loan industry, it is important that you complete and return the enclosed questionnaire. A self-addressed, stamped envelope is provided for your convenience. The questionnaire should take no more than 15 minutes to complete.

You response will be given complete confidentiality. The questionnaire has an identification number in the upper right corner of page one for mailing purposes only. The identification number is used so that follow-up mailings can be sent only to those not responding to earlier mailings. Responses will be reported only as statistical summaries, not as individual responses.

A summary of the results can be obtained by writing "Copy of Results Requested" on the back of the return envelope, and printing your name and address below it. Please do not put this information on the questionnaire itself.

I thank you for your assistance with this project. If you have any questions, please feel free to contact me at (214) 484-9941 or (817) 565-3140.

Sincerely,

Robert E. Sweo
Project Director

Enc.

Cover Letter 2
Management Dept. Letterhead

CIO Name
Bank Address                                                    Date

Dear (CIO NAME):

Approximately three weeks ago I wrote to you seeking your opinion on the various activities within your bank or savings and loan. As of today, I have not yet received your completed questionnaire.

This research is being undertaken to better understand the effects of information technology on banks and savings and loans. As the importance of information technology increases, so too must our understanding of its effects.

I am writing to you again because of the significance each questionnaire has on to the usefulness of this study. Your bank or savings and loan was selected because of the significant role information technology is playing in your firm. In order for the results of this study to be truly representative of the knowledge of information technology leaders such as yourself, it is essential that each questionnaire be returned.

Responses will be given complete confidentiality and will be reported only as statistical summaries, not as individual responses. A summary of these results can be obtained by writing "Copy of results requested" on the back of the return envelope, and printing your name and address below it.

Your cooperation is greatly needed and appreciated. In the event that your questionnaire has been misplaced, a replacement is enclosed. If you have any questions, please feel free to contact me at (214) 484-9941.

Sincerely,

Robert E. Sweo
Project Director

Enc.

Follow-Up Postcard

Last week a survey seeking your knowledge about information technology in banks and savings and loans was mailed to you. If you have already completed and returned the survey, please accept my sincere thanks. If not, please do so today.

Because the survey was sent to only a select group of banks and savings and loans, it is extremely important that your responses be included in the study. If you did not receive the survey, or it was misplaced, please call me immediately at (214) 484-9941 and I will send you a replacement survey.

Sincerely,

Robert E. Sweo
Project Director

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