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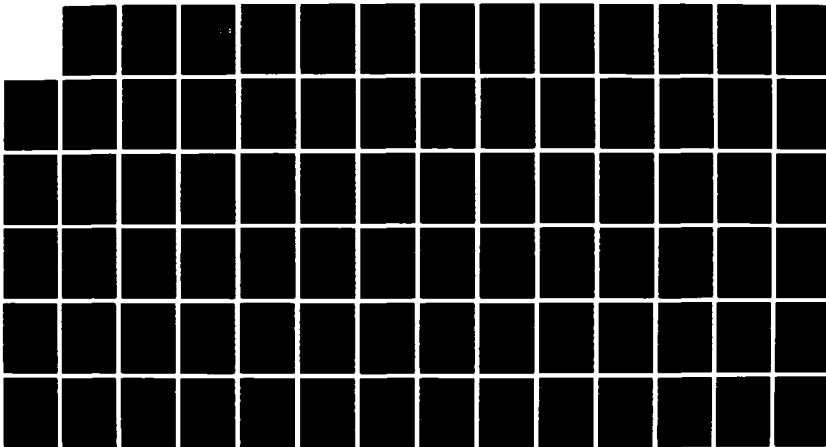
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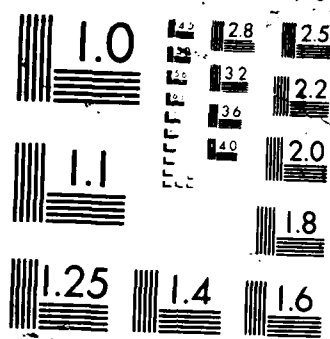
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AN INQUIRY INTO CHANGE

THESIS

Myron E. Ross
Captain, USAF

AFIT/GIR/LSR/87D-6

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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AFIT/GIR/LSR/87D-6

AUTOMATION AND MANAGEMENT: AN INQUIRY INTO CHANGE

THESIS

Presented to the Faculty of the School of Systems and Logistics
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Information Resources Management

Myron E. Ross, B.S.

Captain, USAF

December 1987

Approved for public release; distribution unlimited

Preface

The purpose of this study was to discover what factors influence managers to make changes to their information systems. It also looked for a framework which could integrate those factors. It was hoped that an integrative framework, if found, could aid managers in identifying the need for change.

Some 328 individual factors were uncovered in the sample of literature. These factors were then classified according to a taxonomy adapted from the work of Kwon and Zmud. Then an integrative framework was identified from the work of Nadler and Tushman.

Additional research is recommended to confirm these findings and to develop specific measures of interaction between the factors which influence change and the components of an organization.

This research could not have been accomplished without the support of others. I am deeply indebted to my research advisor Captain Ken Jennings, Ph.D., and to Captain Tom Triscari, Ph.D. [the Information Resources Management Program Manager], for their encouragement and assistance. I am also indebted to others, such as Dr. Charles Fenno, for preparing the way and setting such high standards of academic excellence. Dr. Fenno has carefully reassured his students that scientific research is only one source of knowledge. With that in mind, I thank the Lord Jesus Christ for the opportunity to attend AFIT and for any and all assistance and knowledge He has provided. Finally, I wish to thank my wife Susan for her support and for "running interference" with the kids: Keryn and Eric.

Myron E. Ross

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Abstract

The purpose of this research effort was to discover what factors influence managers to make changes to their information systems. It was also a search for a framework which could integrate those factors. It was hoped that an integrative framework, if found, could aid managers in identifying the need for change. In addition, such a framework should also provide a guide in the change process. The actual process of making change was not addressed because it appears to be adequately covered in the literature.

About 328 individual factors were uncovered in the sample of literature. These factors were then classified according to a taxonomy adapted from the work of Kwon and Zmud. Then an integrative framework was identified from the work of Nadler and Tushman.

The overwhelming factor influencing information systems change is called relative advantage. The other less frequently cited factors include environmental uncertainty, environmental competition, technological compatibility, task uncertainty, and feedback.

This research clearly shows that information systems change is not necessarily a trivial or isolated accomplishment. Because so many factors are involved, managing corporate information systems must include much more circumspection than would be used in replacing worn out lathes or punch presses. Given the problems identified in Chapter One of this thesis with respect to the use of humans as information

processors and the findings reported herein, frameworks for change appear to be essential for guiding innovation and preventing possible disasters.

Finally, this research complements the works of Kwon and Zmud and Nadler and Tushman. This research suggests that the factors influencing change in information systems is consistent with at least one model of organizational assessment.

Two recommendations follow from this research. The first is to continue the research to improve the validity of the findings. The second is to use the factors with an existing framework to study the relationships and develop predictive measures of impact on organizations for a given type of change.

AUTOMATION AND MANAGEMENT: AN INQUIRY INTO CHANGE

I. Introduction

Chapter Overview

This chapter presents the requirement for a research investigation into the nature of change as it affects the decision to acquire and use information systems technologies. This introduction presents the general issue with background and its relevance, defines the specific problem, describes the basis of need, explains the scope and limitations of the research, and states the investigative questions.

General Issue

A need exists for an integrative framework which can identify the necessity for change in an information system and assist managers in effecting meaningful change. As used in this investigation, a framework is defined as a conceptual structure used to bound a problem space and detect variances. Another important word is change--which refers to the process or result of becoming different. As used in this inquiry, change has a generic or incidental component and a deliberate component. Anything which makes things different for an organization, whether incidental or deliberate, is of concern to managers. In the sense that any change can influence the decision to acquire and use automated information systems technologies, it is of concern to this inquiry. Innovation is another word that is used synonymously with change. For other definitions, please see the glossary at Appendix A.

Some Background. Managers deal with change by using various planning methods, invoking successful procedures used in the past, implementing design freezes, and applying any technique that can control change as it occurs.

In information processing, change has occurred so rapidly that many of the rules and regulations used in the past to control change simply do not apply in today's environment. An example is provided by Ilan and Shapira where microcomputers provide information processing resources without: the need for centralized location of computational equipment; the strictures of mainframe computer operations; and the scheduling and use of programmers and systems analysis personnel (21:184). This experience shows one case where an advanced information processing tool has been overmanaged in many ways and undermanaged in others because managers did not have the necessary framework to deal adequately with this advanced technology. They were quick to invoke outmoded rules and control procedures in an effort to "manage the change."

This is a probe for factors that can influence a firm's information systems. It is based upon a need to anticipate required change before the organization encounters a diminished competitive position. James R. Bright has noted that:

Technological change is too serious to be ignored until it descends upon us. We must learn to anticipate. There must be something--some methodology--that is better than random opinion or nothing [7:v].

One historian (43:8) has observed that some research and development pioneers in the business world had the "foresight and courage" to redirect their corporations "before change was forced upon them."

Relevance. Managing change presupposes an awareness of the need for change. A useful assumption is that managers could better perform their controlling roles if they could see the need for change sooner than when it is "forced upon them." A framework, through which to view the merits of change in technology, would be indispensable. Areas of concern, as discussed below, which increase the relevance of this inquiry are: the expanding research into information systems change, the shifting bases for technological decisions, issues of accountability, critical uses of technology such as in national defense, the costs associated with change, and the increasing pace of change.

The expanding research into information systems suggests that there is a significant amount of concern with respect to the integration of information systems with organizations. Some of this concern stems from the numerous failures of early management information systems during the late 1960s and throughout the 1970s.

The bases for technological decisions, about which information tools to acquire, has shifted dramatically due in part to the large productivity increases derived from the use of information tools and the corresponding large reductions in cost. These shifts in bases, increase the managerial need for flexible and accurate frameworks through which better decisions can be made.

Public sector decision making deserves mention as this area faces accountability issues from public scrutiny that is different from that of the private business sector. Decision making about technology support should be at least, if not more, rigorous than that for the private sector. This argues for staying ahead of the need for change and using the best decision aids and tools to minimize waste.

National survival and "warfighting" constraints presents a critical area of need. In this arena, one historian has observed, "American industry, then as now, needed strength in technology as a competitive weapon" (43:6). This association of technology with competitive strength is a driving factor in technological change. Properly employed, frameworks would be invaluable in making the most effective technology choices.

Changes almost always entail costs and often increase the degree of uncertainty associated with the merits of the change. A properly constructed framework would minimize costs by better clarifying the problem space and thereby reducing uncertainties associated with the decision.

The pace of technological change has increased dramatically without a corresponding increase in managerial ability or the means by which to deal with the higher pace. The accelerating pace of change is a natural consequence of technical growth. This consequence is explained by Fraker while summarizing comments by Dominique Hanssens, who is a professor at UCLA's Graduate School of Business. The summarized comments state that product life cycles are decreasing due to the input of newer technology. The shorter life cycles and new technology cause businesses to experience the end of "a growth era" earlier than expected. The "whole process has become so distorted that he [Hanssens] wonders whether the traditional notion of product life cycles will survive the 1980's" (17:62).

In conclusion, this study of change is relevant because change is a pervasive phenomenon and is receiving an increasing amount of research support with respect to the implementation of information systems. In

addition, decision making regarding technology turnover is affected by, among other things, the shifting bases for technological decisions, accountability issues, critical uses of technology such as national defense, the costs associated with change, and the increasing pace of change. Without a way to sense the requirement for change and dimensionalize the amount of change that is needed, a real danger exists that managerial effort to control change may unwittingly exclude the very changes needed to remain competitive, thus this inquiry has relevance for all managers.

Summary of General Issue. The general issue is that of a need to identify factors in change and locate a framework that can sense the requirement for and, if possible, the amount of change that must be made to an organization's information systems. In addition to clarifying the need and relevance of this inquiry, the background discussion shows that the managing of information systems change is typically difficult thus, managers could better perform their roles if they had some framework which could clarify the need for change.

Specific Problem

Topic area. This research deals with the need to find an integrative framework, supported by the current body of organizational research, which can identify the requirement for change in an organization's automated information systems technology base. One necessary goal will be to attempt an understanding of the factors which precipitate change in automated information systems technologies. Then, to apply this understanding to the search for a framework which incorporates those relevant factors by which managers visualize and

dimensionalize the need for change. To be valid, the framework should be able to integrate the various factors of change from an organizational perspective.

Assumptions. That a framework exists or can be synthesized from available information.

That the process of change is a separate but related issue to the antecedent need for change.

That many authors will cite factors which influence their decisions to change where such factors and variables are not perceived as part of any formalized framework.

Limitations. This inquiry does not include managing the change process.

This research effort is largely supported by secondary sources as reported in scientific literature. Selected material from books of various disciplines may be introduced to complement this study.

This research effort is an analysis of literature and does not use a separate survey instrument.

Research Question

What is being said, in the scientific and management literature, about frameworks (and models) that can identify the need for change and aid in the decision to acquire and effectively implement information system technologies?

Basis of Need

Overview. This section answers the question, "Is there a need for a framework?" as justification for this research effort. There are at least six factors which justify the need for an integrative framework.

These factors are the limits on humans as information processors, entropy, the expense of change, the essential nature of information, uncertainty, and an increase in knowledge work.

Justification. One important factor which drives the need for a framework is that humans can be such poor information processors. This clearly affects their perceptions of the need for change and the management of those perceptions or change. The problem with humans as information processors is due to various limitations as related by Davis and Olson (13:263). A short discussion of these limits follows in which the limits are expressed as design goals for information systems and are arbitrarily discussed in sets of four each.

The first limit which is based upon human factors research is that the filtering of information by humans is variable depending upon the degree of stress in the decision environment. The second limit is expressed by the Newell-Simon model of humans as information processors which indicates a need for assistance in defining the problem space and searching for solutions. The third limit is based upon research showing that the magical number 7 ± 2 indicates upper and lower limits to the unaided human processing of symbols. The fourth limit is the law of just noticeable differences which shows a need to highlight any significant variance for humans.

The fifth limit shows that there are problems with humans as intuitive statisticians. This demonstrates that people are not very consistent and tend to impose bias on facts if quantitative information is not available. The sixth limit shows that a need exists for concreteness of data when presented to the human. It is important that superfluous information be removed. The seventh limit shows that there

should be a mechanism for selecting an anchoring point from which to make measurements and to allow accurate adjustments from that point. The eighth limit deals with the cognitive styles which are known to vary significantly among humans therefore, systems which complement human problem solving should accomodate stylistic differences.

The ninth limit comes from learning theory and suggests that there is a need for flexibility in systems designed for interaction with humans to allow for differences in skill levels. The tenth limit on humans as information processors, deals with the need for feedback as an important ergonomic and control consideration. The eleventh limit indicates that humans place an implicit value upon unused data. It is clear that this should be controlled. The twelfth item is based upon the fact that information overload can be a problem therefore, it should be automatically maintained below some threshold.

The final four limits are discussed next. The thirteenth problem with humans as information processors demonstrates that individual differences can be significant therefore, those which are critical for a system's use should be identified and controlled. A related limit is the fourteenth item which reveals that systems designed for humans should consider the presence or absence of nonverbal clues in communication. In addition, because the timing of information processing is important to humans, the fifteenth item says that its presentation should be accomplished in short bursts. Finally, the sixteenth item says that the amount of information compression in communication should be variable at the discretion of the user.

Although this is a rather long list, it does identify significant issues about humans that deal with and process information. The need to

find a good framework is clearly suggested by these limits on humans as information processors.

The second factor which justifies the search for a framework is based upon entropy. Entropy is the phenomenon that without the input of energy and resources into a system, decay is inevitable (13:275). This is one of the laws of thermodynamics and seems to be relevant to all known systems of human enterprise. Because entropy exists, change and disorder are inevitable therefore, a framework for information systems would be useful in sensing changes occurring in both internal and external environments.

The third factor in justifying a framework is based upon expenses associated with change. This can be accepted as an assumption. Because there are costs, controls are necessary which give rise to decision aids and, as proposed here, frameworks which can identify the required changes.

The fourth factor is based on the understanding that information is an essential component of viable decision making systems. The Simon model (42:1), which depicts three phases (intelligence, design and choice) of the decision-making process, relies upon information as an essential ingredient. The intelligence phase searches both the internal and external environment for information clues to identify problems or opportunities. The design phase involves inventing, developing and studying possible problems and solutions. The choice phase provides for a selection of alternatives.

According to Davis and Olson, information systems can promote organizational change by: identifying significant internal or external variables that may signal a basic change in conditions for the organiza-

tion; identifying significant relationships among internal and external variables which may signal a change for the organization; and finally, making use of multiple information channels and evaluation criteria along with incompatible reporting dimensions (13:349).

Since a framework, as defined in this study, is basically a conceptual information system, its construction and use will be essential in describing the changes needed in real information systems.

The fifth factor which is used to justify a search for frameworks is based on the concept of uncertainty. Uncertainty is a factor which is reduced by information (13:205). Since a framework is an information construct, its proper use will help reduce uncertainty.

Finally, the sixth factor rests on the idea that the increasing amount of knowledge work, as opposed to physical work, also increases the need for change to information processing systems. Since the basis for most all human activity is communication, as communication activity becomes enhanced by technology, then changes, in a broad sense, can be expected. It is known that the pace of human communication remained stable for centuries. It is now apparent that during the last 100 years, many changes occurred in the way work and communication are accomplished. As reported by Ginzberg:

The easing of human labor by technology, a process that began in prehistory, is entering a new stage. The acceleration in the pace of technological innovation inaugurated by the Industrial Revolution has until recently resulted mainly in the displacement of human muscle power from the tasks of production. The current revolution in computer technology is causing an equally momentous social change: the expansion of information gathering and information processing as computers extend the reach of the human brain [18:67].

This change from an "industrial-age" economy to an "information-age" economy appears to be a critical element in the force of change which is

affecting information systems. The accelerating pace of change increases the need for managerial tools, such as frameworks, which can sense and measure the requirement for change.

Summary of Need. This concludes the justification for the research effort. These six factors: limits on humans as information processors; entropy; expense of change; the essential nature of information; uncertainty; and an increase in knowledge work, all contribute to the need to find a framework which can sense the amount of change and direct the decision to acquire and use information systems. A comprehensive framework, used proactively for viewing and defining change, should be indispensable to an organization.

Scope of Research

The research was necessarily limited to identifying factors which precipitate change as applied to the acquisition and use of information systems technologies. Scientific and management journals are the basis for information about change. Because information technologies are expanding into most fields of human endeavor, a generic model is sought which can be integrated with the work of organizational researchers.

Investigative Questions

1. What factors influence the decision for change in automated information systems technology?
2. Can these factors support an integrative framework which can identify both the need for change in information systems and insure that the change is effective?

Summary of Chapter I

This introduction has presented some background on the need for a framework. More research is needed to: identify the factors which give rise to change and, identify a framework which can integrate the factors and insure that information systems change is effectively accomplished.

II. Research Methodology

Introduction

This chapter presents a research methodology which was designed to: systematically collect factors which influence change decisions; and identify a framework which can show the need for change. The data for this research included professional journals published by the social, industrial engineering, information, and the management sciences. Included in this chapter are the specific problem, the research question, investigative questions, and the research methodology.

Specific Problem

Topic Area. This research deals with the need to find factors that influence information systems change and the need to locate an integrative framework by which to understand change as a multidisciplinary phenomenon and its effects upon the acquisition and use of information technology. In the sense that any change, incidental or planned, can influence decisions about the acquisition and use of information processing it is of concern to this inquiry.

Research Question. This inquiry seeks to answer the question: "What is being said in the scientific and management literature about information systems change and frameworks for identifying change?"

Investigative Questions

1. What factors influence the decision for change in automated information systems technology?

2. Can these factors support an integrative framework which can identify both the need for change in information systems and insure that the change is effective?

Particular Methodology

General Method. This methodology was a multidisciplinary literature analysis of secondary sources which included literature from the social, industrial engineering, organizational development, information, and the management sciences. To maintain some objectivity, it was necessary to identify the factors or variables, which were cited as influencing the decision to change, without respect to any formal framework or model. After collection, these factors were categorized and then reported.

Particular Steps.

1. Develop a key word list of broader topical areas within the general scientific field to be investigated. For example, since the term model is sometimes used as a synonym for framework, this investigation treated both terms as synonyms for data gathering. The key words were: change, decision making aid, framework, innovation, model, technology forecasting or assessment, technology turnover, initiation, requirements analysis, and benchmark.

2. For each scientific field, a list of periodicals was obtained.

3. A set of research journals was arbitrarily selected for study.

4. A linear search of each table of contents was conducted, paying special attention to the article abstracts for information about the subject of change as it related to the key word list.

4. Xerox copies were made of any relevant article.

5. Specific factors were identified from each article.

6. Each factor was studied against a classification of organizational factors, as presented by Kwon and Zmud (Boland:227+), then coded and keyed into a computerized database.

7. Significant quotes were also typed into a computer database for later inclusion into the text of the thesis.

8. The change factors were sorted by both the classification code and the author then, they were output from the database system to a computer word processing file to form the skeletal basis for chapter three.

9. The classified information was manually grouped, where necessary, into areas concern to facilitate both the summary and presentation of the findings.

10. The narrative was then provided and merged with the significant quotes.

Unusual Aspects/Steps. The most unusual aspect dealt with the impossibility of relying upon article titles for meaningful information about content. Even the abstracts were often inadequate. This resulted in extensive linear searches to find the factors. A small number of authors were very prolific in identifying factors while most authors were selective in presenting factors. Curiously, many authors lamented the lack of attention to the subject of this investigation.

Most Significant Hurdle. The most significant hurdle was trying to find a meaningful way to summarize the many diverse factors.

Summary of Chapter II

This chapter has presented the research methodology used in the investigation of the literature to locate factors which influence managers to make changes to their information systems. More specifically, this chapter has presented the research question, the investigative questions, the methodology used, the most unusual aspect of the investigation, and the most significant hurdle.

III. Analysis of the Literature: First Research Question

Introduction

The two previous chapters presented the requirements to identify factors influencing information systems change and to locate a framework which can integrate the findings with current organizational research. Two research questions were presented to guide this inquiry. This chapter analyzes the literature to answer the first of the two research questions.

The first question directs an examination of "factors" which influence decisions for change and, as such, is concerned with individual things that trigger change decisions. In the presentation which follows, some general comments are necessary before discussing each of the factors.

The First Research Question

What factors influence the decision for change in automated information systems technology?

General Comments

The research literature presents a number of management models which describe the process of decision making. Several of these models will be briefly presented below to orient the reader to the literature and lay some groundwork for a presentation of the research findings.

Perhaps one of the earliest models that is still used extensively is the Lewin model of system change. As reported by Davis and Olson, it consists of three phases which are unfreezing of the organizational climate, changing the organization then, refreezing to institutionalize

the changes (13:348). This thesis effort focuses on the unfreezing phase of organizational change.

Another model is offered by Simon (42:1). This model consists of intelligence, design, and choice phases. The influential change factors which are being studied, correspond to this model's intelligence phase. Davis and Olson say about intelligence, that it: "includes activities to identify problem situations or opportunity situations requiring design and choice. Intelligence entails scanning the environment, either intermittently or continuously, depending on the situation" (13:165).

A third model consists of three stages which are initiation, adoption, and implementation. This is attributed by Kwon and Zmud (26:232) to the work of Thompson (1969) as well as to Pierce and Delbecq (1977). Kwon and Zmud align initiation with Lewin's unfreezing phase and explain: "with initiation, pressure to change can evolve from either need-pull or technology-push forces. In each case, needs and appropriate technologies come together via idea and information exchanges" (26:232).

The conjunction of unfreezing, intelligence, and initiation, provides a basis in literature to examine the factors which influence managers to make changes in technology.

It is perhaps axiomatic that managers can use any rational or irrational basis for making change in their information systems. No research could ever possibly collect all reasons why changes are made. However, Dean has studied this area and proposes four models of the decision process. These models are named the Rational, Bounded Rationality, Political, and Garbage Can. Of interest to this inquiry is

the Rational Model because it defines a more ideal decision process wherein a manager has a global view of the problem, he uses an exhaustive search for alternatives, data are used to make optimal decisions, the information is essentially accurate and unbiased, and the choice preferences are a function of both the information and the organization's goals (14:1+). The Rational Model is arbitrarily chosen for this thesis to describe an ideal manager although, it is recognized that other models have explanatory value and can aid in classifying factors and selecting a framework. Consistent with this realization, it is deemed important to classify and thereby summarize the reasons uncovered in the literature to save time and space. Certain categories of organizational factors occur frequently enough in the literature to allow their adoption for use in the research report which follows.

Kwon and Zmud have endeavored to unify the many organizational factors with an emphasis on information systems (26:227-251). In their work is a chart which depicts the factors (individual, structure, technology, task, and environment) against both Lewin's and Simon's various phases (26:242-243). The purpose for the chart is to show what factors (entity and attribute) have been identified by the research as contributing positively or negatively to each of the various phases of organizational change. The phases of interest to us are unfreezing and initiation. In the chart below, the plus signs (+) indicate positive associations, the minus signs (-) indicate negative associations, and a blank signifies that there is an inadequate amount of coverage by the research community. Their chart is reproduced in part on the next page.

<u>Entity</u>	<u>Attribute</u>	<u>Unfreezing</u> ... <u>Initiation</u> ...
Individual	job tenure	
	cosmopolitanism	+
	(receptivity to change)	
	education	+
	role involvement [sic]	
	attitude toward change	
Structure	Formal:	
	specialization	+
	centralization	-
	formalization	-
	Informal:	
	network	+
Technology	compatibility	
	(with existing techn.)	
	relative advantage	
	(among alternatives)	
	complexity	
Task	task uncertainty	+
	autonomy	+
	responsibility	+
	variety	+
	identity	
	feedback	
Environment	heterogeneity	
	(customer diversity)	
	uncertainty	+
	competition	
	concentration	
	(resource allocation)	
	organizational dependence	+
	(sharing of resources)	

Borrowing the same format as the above chart, the results of the research are presented below in summary form. It should be noted that the individual citations were allocated to the categories (entities and attributes) using a best fit approach. There were some cases that overlapped on two or more categories depending upon their level of abstraction. In these cases a forced choice was made in an effort to best capture the author's intent.

<u>Entity</u>	<u>Attribute</u>	<u>Summary of Factors</u>
Individual	job tenure	0
	cosmopolitanism (receptivity to change)	6
	education	3
	role involvement	5
	attitude toward change	6
Structure	Formal:	
	specialization	2
	centralization	5
	formalization	10
Technology	Informal:	
	network	5
	compatibility (with existing techn.)	21
	relative advantage (among alternatives)	131
Task	complexity	11
	task uncertainty	21
	autonomy	5
	responsibility	4
	variety	4
	identity	5
Environment	feedback	16
	heterogeneity	4
	(customer diversity)	
	uncertainty	28
	competition	25
	concentration	5
	(resource allocation)	
	organizational dependence	6
	(sharing of resources)	
Total		----- 328

This concludes the general comments about the First Research Question. The following discussions present the specific findings which are grouped by the major categories of individual, structure, technology, task, and environment. Each category will be discussed in turn beginning with the category of individual.

Discussion of Individual Factors

The five attributes of the category of individual include job tenure, cosmopolitanism, education, role involvement and attitude. These attributes are presented in turn.

Individual, Job Tenure ["generally related to institutional legitimacy" (26:234)]:

None of the research literature encountered for this thesis addressed job tenure as a significant factor in change decisions.

Individual, Cosmopolitanism ["associated with receptivity to change" (26:234)]:

The factor of cosmopolitanism was considered a significant factor for management decisions. It is shown by: Carroll mentioning resistance to change (10:46), Keen and Woodman discussing adoption based upon a high acceptability towards micros (23:145), Morton mentioning the need for a "change champion" (34:45), Nolan speaking of a budget surplus as necessary for innovation (37:117), and Quinn viewing both the need for personnel's commitment to innovation ideas and the significance of the isolation of management (39:74,76).

Individual, Education [self explanatory]:

The relevance of education as a factor received little mention. Balthasar wrote of the need for the influence of experts' consensus (3:159)--it is presumed that experts possess a relatively high degree of education and/or experience. Daft considers the level of professionalism (11:196) to be important and Hootman cites the lack of management's technological experience (20:21) as relevant to change decisions.

Individual, Role Involvement ["broader involvement in managerial activities" (26:234)]:

An individual's role involvement was of concern to some authors. Bleicher speaks of management involvement with change (5:78) and Daft mentions the need for collaboration with workers on innovation (11:196). Keen and Woodman talk of the quality of work life (23:148) and Quinn discusses both the aggressiveness by change sponsors and implementors and the significance of personal rewards in stimulating increased role involvement with change (39:76).

Individual, Attitude ["the receptivity toward change" (26:233)]:

The attitude of individuals toward change is considered significant. Bleicher mentions the values and attitudes of management in corporate culture (5:73) whereas Dickson speaks of the expectancy of penalty for failure (15:301) as a significant demotivator for change. Quinn lists four attitudinal factors which are: excessive rationalism (39:77), atmosphere and vision (39:77), intolerance of fanatics (39:77), and support for innovators (39:74).

This concludes the discussion of the class of individual factors. These factors have included job tenure, cosmopolitanism, education, role involvement, and attitude. The next classification of factors is that of structure.

Discussion of Structure Factors

Some authors felt that organizational structure had an influence upon the initiation of innovation. Both formal factors (specialization, centralization, formalization) and informal factors (networks) were significant.

Structure, Specialization ["the diversity of specialists within the organization" (26:235)]:

Specialization was mentioned by Daft who discusses the degree of specialization which derives from the size of an organization (11:196).

Miller asserts that:

The basic causes of failure ... [stem] from a failure by managers to carefully examine the implications of design decisions about manufacturing control processes for their companies [31:145].

This is taken here to refer largely to specialization.

Structure, Centralization ["the degree of concentration of decision making activity" (26:235)]:

Centralization within formal structure is important to Bender who speaks of the costs of inadequate planning (4:164). In addition, Bleicher (5:73), Hootman (20:23), Kantrow (22:9), and Quinn (39:78) mention the effects of centralization as significant.

Structure, Formalization ["the degree of functional differentiation" (26:236)]:

The formalization within organization structure is considered worthy of mention. Hootman speaks of both the degree of operating controls and the significance of company goals (20:22). Keen and Woodman are concerned with the negative and positive factors which managers should consider such as: the amount of data inaccessibility resulting from microcomputer use (23:145), the ability to better control data within mainframe environments (23:145), better data integration capability within mainframes (23:145), and the improvement in control over computer usage inherent with a mainframe (23:145). Miller presents the idea that the task or function should dictate the organizational form of the information systems support function (31:154). Miller's

view is construed here to mean that formalization should be used to support whatever organizational structure is necessitated by the task. Quinn speaks of: accounting practices, mandated short time horizons, the inappropriateness of establishing rigid reward processes, and excessive bureaucracy, as impacting change decisions (39:77).

Structure, Informal ["emergent structures or informal networks" (26:236)]:

Finally, the last structural category deals with the effects of an organization's informal network. Bleicher mentions the absence of barriers to communication (5:76) and Dickson discusses the type of organizational climate (15:294) as important. King and Kraemer are concerned with the political demand for IS (information system) services (24:471) and Monger speaks of the need for information about the underlying organizational processes (33:8) which is taken here to be a possible motivator for change. Quinn suggests that support from the informal organization can be significant in change decisions (39:76).

This has been a presentation of structural factors that influence change decisions. This presentation has shown the factors in the formal structure (specialization, centralization, and formalization) as well as the factors related to the informal organizational network. The next major area deals with technology.

Discussion of Technology Factors

Technological factors are the biggest single category of managerial concern. This is not unexpected. The following factors are grouped into issues of compitibility, relative advantage, and complexity.

Technology, Compatibility ["an innovation's organizational 'fit' as well as its impact on individuals' attitudes regarding change, convenience of change, power shifts, etc." (26:237)]:

The issue of the compatibility of new technology with the existing inventory of equipment, is a major concern. The factors discussed here are divided into the aspects of general management, architecture, and time.

The Aspect of General Management. Damanpour and Evan (12:394), Hootman (20:22), and Keen and Woodman (23:145) speak in general about this area. Further, Keen and Woodman are specific about: compatibility problems of microcomputers with existing equipment; that software is poor (23:145); that there is a significant need for integration between both microcomputers and mainframes (23:144); and that microcomputers allow good transportability (23:145) [presumably, this means software].

Keen and Woodman also mention the need for an improved integration of systems within a mainframe (23:145). It is assumed that the internal integration within microcomputers should also be an area of concern. Further, they point out that microcomputers, because of their stand-alone and incompatible natures, tend to restrict the amount of management coordination and control (23:145). Obviously, better integration would address this. Keen and Woodman contrast the microcomputer's limits with the greater communications potential of mainframes (23:145). In line with this concern over integration, McFadden and Suver present the need for data sharing between computers (29:131) while McFarlan refers to possible "inefficiencies" (30:103) due to compatibility problems with interorganizational information systems.

The Aspect of Architecture. Compatibility also has an architectural aspect. Both Hootman (20:22) and Miller (31:147) speak

directly of the need for an IS architecture. This is similar to Morton's concern over the fit of innovation with corporate strategy (34:45) and Quinn's discussion of the need for flexibility and quickness (39:76) [which should derive from a good architecture.] Indeed, Miller refers to possible design impacts upon control processes (31:145) which suggests the importance of architecture on IS compatibility. A good architecture would also support Mann's idea of the need to allow a systems view of automated shop maintenance and control activities (27:32).

The Aspect of Time. There is also a time aspect to technological compatibility. Time figures into the possible work load on systems and networks according to Hootman (20:22). This is due, presumably, to the need for "work arounds" that remedy compatibility problems. In addition, the continuity of support for user-developed microcomputer software, is considered by Keen and Woodman (23:145) to be a problem given the probability of employee turnover. This is closely related to the difficulty of supporting software on mainframes as evidenced by the long lead times for software development (23:145).

To summarize technological compatibility, this research shows there are three aspects which include general management, architecture, and time. The next category of factors deals with the relative advantage of technology.

Technology, Relative Advantage ["the degree to which an innovation is perceived as providing greater organizational benefits than either other innovations or the status quo" (26:237)]:

The relative advantage of technology is the most frequently cited aspect of managerial decision making with respect to information systems. Damanpour and Evan mention relative advantage in general by

citing the work of Rogers and Shoemaker (1971) (12:394). To facilitate this presentation of relative advantage, the following material is grouped into eight major aspects of managerial concern. These aspects are: uncertainty, process, administrative planning and control, cost, time, performance, productivity/efficiency, and competitive edge.

The Aspect of Uncertainty. Managers expend much effort to reduce uncertainty. Quinn recommends that managers compete the innovation proposals in order to reduce uncertainty (39:79). Anderson presents both the use of software simulation modeling as a tool to reduce uncertainty in systems design (2:122), and software performance evaluation as a concept which provides "performance analysis during (rather than after) design and development" (2:120). There is a point, however, when subjective judgment about the strength of any relative benefit can become the dominant decision factor. Mann recognizes this when he says, "there are also intangible benefits which can't be reduced accurately to dollar terms" (27:29). This last point is also echoed by Keen and Woodman (23:147).

Bleicher develops a framework for innovation in high-tech companies which incorporates the problem of uncertainty. He identifies a common denominator of high-tech which is to "operate very close to the state of the art" (5:69). Citing the work of Ansoff and Stewart, he shows that proximity to the state of the art is based upon stability as a measure of distance from the leading edge of technology, predictability as a measure of certainty and uncertainty, and the sparsity of precedents at the state of the art boundary (5:69). These characteristics can be important in defining the environment in which managers make technology decisions. Bleicher says:

The implications of low stability, low predictability, and sparse precedent are substantial for business management. The closer a company operates to the edge, the more likely it is to influence the rate of change itself. An environment characterized by rapid change implies that managerial decisions become obsolescent more rapidly [5:69].

Boehm quotes one information systems analyst as saying, "our job is to provide insurance policies against risk and uncertainty, not blueprints for making major decisions" (6:92). Clearly, a driving factor in good information systems design, is to obtain a relative advantage in technology by reducing risk and uncertainty.

While discussing the origins of technical progress, Bright mentions that the discovery of new technology may be accidental, deliberate, or derive from scientific suggestion (7:32). Clearly, uncertainty has a beneficial component. Keen and Woodman refer to this in speaking of spin-offs as a possible soft benefit (23:148).

The Aspect of Process. A listing of the process concerns begins with Keen and Woodman's mentioning: the possible limits to microcomputer growth and power (23:145), having to use poor mainframe software (23:145), having to rank potential benefits to make judgments of relative worth (23:147), equipment proliferation of microcomputers (23:145), and living with the vulnerability to failure of central mainframe processing (23:145). Hootman speaks of concerns over: the amount of computer input/output volume, which functions (not users) are automated, the system development tools and methods, and the software architecture (20:22). Quinn mentions the influence of management's concern over the quality of people (39:76), while Keen and Woodman bring up the significance of the need for access to corporate data stored on mainframe computers (23:145). Finally, Miller mentions the problems of

achieving inventory reductions as an incentive for making change (31:146).

From the above information, it is evident that improved technology can address these process concerns of management and, therein employed, improve the relative advantage inherent in the use of technology.

The Aspect of Managerial Planning and Control. The relative advantage of technology is also expressed in the literature by what appears to be administrative planning and control concerns. Damanpour and Evan's research indicates that administrative innovations have more of an impact upon technological innovation than vice versa (12:406). Focusing upon technological innovation, Bleicher emphasizes the need to be able to identify technological limits early (5:72), and Bright asserts the importance of assessing the degree of change in technological environments (7:200). Dickson points out that an estimate of some expected outcome versus an ideal outcome can lead to management action to change technology (15:292). It is clear that innovation can be stimulated by recognizing the needs in an organization as often expressed by Bright (7:32) and others.

Management can lose their relative advantage in technology by administrative inertia. This is evidenced by allowing computer software to become outmoded according to Buss (9:113). In addition, the growth rate of computer access has to be monitored as an important factor (9:116). Buss points out a financial twist that, "strict budgetary control limits the funds for investment in new programs needed to replace those that are wearing out" (9:111). Further, to prevent underinvestment in new technology and to retain a company's relative advantage accruing from their information systems, Buss says that data

processing evaluations must go beyond simply looking at financial figures and budgets (9:112).

Management can do some things to improve their planning and control of technology and thereby improve relative advantage. One of these things is to be aware of the age of the computer software's design as mentioned by Buss (9:116). Age is also mentioned by Nolan along with the currency of automated file structures (37:124). It is also important for managers to be able to recognize opportunities according to Bright (7:32). Drucker says that change opportunities can arise from process needs, incongruities in a process, and unexpected occurrences (16:68). Miller mentions that problems in achieving shipping goals may be an early indication of the need for change (31:146). More generally, Hootman says that differences in performance versus some plan can be an indicator of need (20:21). This hints at the need for a connection between technology and plans--indeed, technology's significance to strategic plans is mentioned by Kantrow (22:18). Also Nolan states that variance from strategic goals can be a significant indicator of the need for change (37:126).

The following items are included under planning and control largely because they don't seem to fit any other area of management concern with respect to relative advantage. The activities that can provide a relative advantage include: steering committees which can be an effective force in controlling change as noted by Nolan (37:126); changes in the work force and technological developments as possible stimulæ for innovation as mentioned by Kotter and Schlesinger (25:106); the amount of institutional demand for IS services, and the status (cultural) demand for information systems technology as presented by

King and Kraemer (24:471); the need to simplify human-machine interactions as presented by Monger (33:8); the amount of innovation atmosphere allowed by management and the presence of an innovation champion as mentioned by Morton (34:45); and finally, sensing the point of inflection and decline in the growth of a product or technology as discussed by Moyer (35:57).

The Aspect of Cost. Cost is the next area of managerial concern that is used to determine the amount of relative advantage in decisions about technology. Cost is frequently used because, as Keen and Woodman point out, "the costs of information technology are immediate and tangible, but its benefits are often deferred" (23:147). Because of managerial familiarity with cost as a surrogate measure of the need for change, much of the following discussion will seem intuitively obvious although, some elements of cost management can be potentially disastrous.

Information processing costs in general are mentioned by Hootman (20:23) while a long range view of information system costs are discussed by Buss as an important indicator of the need for change (9:115). Ilan and Shapira mention that costly DP (data processing) services are a motivator for changing to less expensive alternatives (21:188). This is reflected by Keen and Woodman's view that excellent value can be obtained from microcomputers (23:144).

Nolan presents management's age-old concern to look for cost effective opportunities as a positive incentive to make changes to the organization (37:122). According to Keen and Woodman (23:148) and also McFadden and Suver (29:133), costs can reflect reduction or avoidance opportunities. Cost reduction is what Mann means when describing the

potential for cost savings by acquiring a computer system for maintenance management (27:29).

There are a number of reports in the literature that deal with the strategic advantages that can accrue from the proper use and astute investment in information systems. McFarlan warns of potential problems, such as underinvestment in information systems, that derive from tying the IS budget to some percentage value of a major aspect of corporate finance such as sales (30:103). McFarlan specifically cautions of the use of "ROI [return on investment]" (30:101-102) with respect to detecting any relative advantage of information systems. The problem arises from the need for a broad strategic view of IS benefits, where "the potential benefits are very subjective and not easily verified" (30:101), as opposed to the narrow focus inherent in an ROI analysis. Another warning is offered by Nolan who says, "the possibility of a mismatch between expenditure and need should be investigated" (37:124) [as a signal that something is wrong]. A related cost issue involves problems achieving cost goals as mentioned by Miller (31:146). Monger is concerned about the potential strategic values that can accrue to a company by employing artificial intelligence. With this in mind he expresses the need for a firm to evaluate a possible cost leadership role in industry by astute employment of advanced IS (33:8).

The final strategic concern is mentioned by Hootman who warns of excessive amounts of organizational filtering of cost and control information. He says that:

Decisions concerning priorities, project definition, development schedules, and implementation programs significantly affect total IS investments, but rarely involve senior management [20:21].

This strategic gap can significantly affect a firm's relative technological advantage.

Some miscellaneous issues of cost's relative advantage are expressed by: Morton's concern over the size of IS investments and the profitability of innovation (34:45); Quinn's concern over capital availability (39:76); Revsine's focus on differential cash flows generated by both old and new technology (40:307); and the potential for a firm to create cost-effective product substitutes through AI as presented by Monger (33:8).

Computer software is a subtle area wherein the relative advantage of software may be difficult to quantify. Buss addresses the significance of measuring costs that accrue from maintaining old software (9:114). It is understood that an accurate cost assessment may lead directly to a decision to replace the old software with less expensive alternatives. McFadden and Suver are also concerned about software costs, particularly the software conversion costs (29:137).

Personnel issues can also be a factor in assessing relative advantages. This is expressed in McFadden and Suver's concern over the costs for personnel (29:137) and Keen and Woodman's interest in possible savings in personnel that might accrue from the use of technology (23:148). Keen and Woodman also mention the hidden costs of end-user support with respect to microcomputers with a particular emphasis on personnel productivity benefits, overinvestments, and management headaches (23:144-145).

Hardware is a category of concern that receives little coverage in the literature. It is speculated that the high expense of mainframes may result in very few changes once an investment is made and/or the low

expense of microcomputers may raise very little attention by management. Keen and Woodman reflect on this by quoting an unidentified vice president of a major U.S. investment firm as saying:

One could expect a large firm to acquire about a thousand micros over the next three years for some portion of its professional population. This is a cool \$5 million, or the equivalent of two of the largest IBM mainframes on the market today. I am sure that if Data Processing were to request \$5 million in hardware, this would be scrupulously reviewed. Should micros be any different? [23:144].

Keen and Woodman also present the possible excess costs from unmanaged end-user inventory of micros (23:144) and the low cost advantage of micros compared with the high cost disadvantage of mainframes (23:145). McFadden mentions that hardware is one of the principal costs in automating large databases (29:137).

The Aspect of Time. The association of time with the relative advantages of technology is discussed fairly well in the literature. Buss (9:115) and McFarlan (30:102) both speak of the percentage of time spent on software maintenance as an important indicator of the need for change while Ilan and Shapira (21:188), in a similar vein, state that a poor IS response to user needs is responsible for some of the reduced demand for mainframe support and the resulting increase in demand for end-user computing. Keen and Woodman also report that slow development time for mainframe software increases the demand for change (23:145). The use of time savings from technology as a benefit is reported by Keen and Woodman (23:148), and McFadden and Suver (29:137).

There are some other aspects of time. Keen and Woodman report the ability of new technology to reduce the backlog for IS services and, its ability to simultaneously increase the backlog of IS support for end-user computing (23:150). They also report that a negative advantage

of mainframes is the frequently poor response time (23:145) and, that the need to improve turnaround can motivate change (23:148). Microcomputers are also viewed by Keen and Woodman as being able to eliminate some work (23:148) while causing an increased amount of duplication in effort (23:145).

There is a labor savings of both time and effort as reported by Mann (27:32) and is reflected by the need to automatically schedule the use of labor. A similar need to set production priorities and make the most efficient use of labor and machinery is expressed by Miller (31:149).

Finally, one of the crucial elements in successful innovation is the timeliness of the introduction of new technology as presented by Quinn (39:76). A sensitivity to the importance of timeliness can be a significant element in corporate success.

The Aspect of Performance. The next aspect in the relative advantage of technology is its use to improve performance. One of the lessons of technology mentioned by Bleicher is that "if a substantial technical potential in a new technology exists, the company must attack to win or even stay in the game" (5:78). In terms of which technology to adopt, Marcus speaks of the industry's adoption rate of the new technology as a significant indicator of the need for change (28:444). The following performance advantages of technology are roughly divided into internal machine or process improvements and improvements in the human-machine interface.

Some of the machine or process improvements include McFadden and Suver's assertion that a centralized corporate data base could improve marketing, sales, production, purchasing, finance, accounting, and

general management (29:133). Miller sees the need for speed and flexibility as a motivator for change (31:150). Keen and Woodman are concerned with the relative strength of mainframes in storage and processing power as compared to microcomputers which have poor data transfer, possible storage limits, and relatively poor communications ability (23:145). Keen and Woodman's view seems to be dated technologically but it has value in clarifying the transition of managerial thought through rapid technological change. Miller warns of performance degradations that can occur from managerial decisions that fail to consider the impact of design decisions upon production processes (31:145).

A few of the relative advantages of human interface improvements are considered here. Miller mentions the advantages inherent in computers that handle highly routine and complex jobs (31:151). Given a need for remote computer communications, Keen and Woodman suggest that microcomputers can adapt to human interface needs through terminal emulation (23:144). Other factors mentioned by Keen and Woodman include flexibility of micros in support of end-user computing (23:145), the problems that users experience with access to mainframes (23:145), and the improvements in customer service through the use of enhanced technology (23:148)--with the associated benefit of a better corporate image as perceived by customers. Finally, Mann discusses the ability to validate performance standards through the use of historical data as maintained by the computer (27:32).

The Aspect of Productivity and Efficiency. This next area focuses on the relative advantage of technology to enhance productivity and efficiency. McFadden and Suver present both the need to eliminate

duplication of data (29:131) and the potential for improving the productivity of analysts and programmers (29:137). The ability to enhance a company's competitive edge along with the ability to rapidly generate new products with information systems is considered by McFarlan (30:101). In addition, he warns that too much of a managerial emphasis on efficiency in resource allocation may stifle R&D during what he refers to as periods of "technological discontinuity" (30:103).

The benefits of technology to improve productivity are also mentioned by Keen and Woodman (23:144). Also, Monger makes the case that "human expertise is expensive because it is eventually lost [through] employees who eventually retire, resign, or die" (33:7). This drives the need to capture human expertise through artificial intelligence.

The Aspect of Competitive Edge. One intriguing area in which technology can bring strong relative advantages is in competition. McFarlan suggests the exploiting of technology to change the basis of competition (30:100). Specifically, he suggests the use of information systems technology to restrict competition by increasing the costs to customers who would switch to another firm for services or products (30:99). It is also possible to change the balance of power in supplier relationships through creating their dependence upon just-in-time delivery systems, electronic links with other firms to transfer computer assisted design (CAD) information, and the monitoring of a supplier's finished goods inventory and factory scheduling to insure timely deliveries and to create an awareness of potential problems in supply. Both McFarlan (30:100) and Monger (33:8) discuss product and service differentiation as possible competitive strategies.

Nolan discusses "enabling technologies" (37:124-125) as driving the need to use technology to improve both internal corporate data flow and allow more competitive options. Kantrow is careful to point out that the most important discriminator between success and failure in technological innovation was, "the attention given along the way to coupling the development of technology with the needs of the marketplace" (22:7). Keen and Woodman say that "underinvestment [in the technology of microcomputers] may mean a significant loss of business opportunity" (23:150). They say that underinvestment derives from uninformed and uninvolved senior management. Taking Keen and Woodman's comments to heart will clearly provide sufficient motive for change.

Finally, Kotter and Schlesinger present the fact that managers must increasingly deal with new products and its effects upon organizational change (25:106). Presumably, new products refers to both internally developed products and technological innovations which are external to the firm. Both types of products will certainly influence change as managers seek to gain an increased relative advantage by employing these innovations.

This concludes the discussion of the relative advantages of technology. There were eight aspects considered which included uncertainty, process, administrative planning and control, cost, time, performance, productivity and efficiency and finally, competitive edge.

Technology, Complexity ["the degree of difficulty users experience in understanding and using innovation" (26:237)]:

This final technology factor is specifically mentioned by Damanpour and Evan (12:394) as well as Hootman (20:23). Other writers present variations on task complexity as shown below.

Carroll discusses the effect that the degree of change can have upon managers. In his words:

For a small scale systems development, attention to the technical dimension may be adequate. On the other hand, for a large-scale change, other dimensions, such as the cognitive, interpersonal, and political, become important [10:46].

Kantrow, citing Skinner, says:

A persistent pattern seen in the autopsies of the major operating crises of large corporations and of the final failures of many small companies is the inability of one or more key managers to understand and to manage the technological component of their businesses [22:18].

According to Marcus, there is a learning curve effect inherent in the use of technology. As he describes it by citing the work of Arrow (1969):

Efficiency in the use or production of a novel item or technique increases with experience within the firm; moreover, the development of science, the education of engineers, and the availability of particular problem-solving skills interact with economic determinants of technological change to produce results significantly different from what one might expect from purely economic causes [28:446].

It can be inferred from this that low technological complexity may be less efficient in motivating technological change than high complexity. Keen and Woodman speak of the relatively large amount of software available for microcomputers as compared with mainframes (23:145). This positive incentive suggests that the rich repertoire of software options is important when making decisions with respect to information systems--particularly when faced with significant technical complexities e.g. opportunities for application to problems.

Technical complexity is inherent in mainframe operations and is responsible for supportability being a negative incentive for mainframe solutions according to Keen and Woodman (23:145). Counter to this is

the statement that fast installation and development is a positive incentive for microcomputer solutions (23:145). Both software maintenance and support difficulties are management concerns with respect to microcomputers according to Keen and Woodman (23:145).

Finally, McFarlan speaks of security problems for corporate-level plans (30:103). This is included here under technical complexity because of the perception that there is an increased reliance upon information systems to support such requirements thus, there is a strong incentive to change information systems accordingly.

This concludes the presentation of technology factors. The factors were grouped into issues of compatibility, relative advantage, and complexity. The next area of discussion deals with task factors.

Discussion of Task Factors

This report of task factors is divided into issues of uncertainty, autonomy, responsibility, variety, identity, and feedback.

Task, Uncertainty ["the degree of routinization, programmability and exceptions in accomplishing organizational tasks" (26:238)]:

One of the elements of task uncertainty has to do with the speed at which the state-of-the-art boundary is moving as discussed by Bleicher (5:71). Uncertainty is experienced in the need for frequent product and process changes. Damanpour and Evan relate, from the work of Rogers and Shoemaker (1971), the innovation attributes of trialability (or divisibility) and observability (or communicability) to the rate of innovation adoption (12:394). The fact that technological innovations are more tryable and observable than administrative innovations may lead to the greater uncertainty associated with administrative automation according to Damanpour and Evan (12:394). It can be surmised from this

that many benefits of administrative innovation are qualitative. Keen and Woodman also mention that many benefits of innovation are qualitative in nature (23:147).

Nolan presents the idea that, as a company goes through its various stages in adopting innovation, there is a shift from computer management to information management (37:124). Apparently, as the uncertainties associated with high technology (the computer) are reduced through learning, then management becomes more aware of other problems and is able to deal with those uncertainties--such as the actual information flows of the company. This will change the focus of management with respect to the need for change in technology--among other possible areas such as environment, structure, etc.

Two other areas, which are familiar to organizational development researchers, are McFadden and Suver's mentioning that increasing the amount of information reduces task uncertainties (29:137), and Quinn's allusion to the tolerance for ambiguity by innovators:

Technology tends to advance through a series of random--often highly intuitive--insights frequently triggered by gratuitous interactions between the discoverer and the outside world. Only highly committed entrepreneurs can tolerate (and even enjoy) this chaos [39:76].

Risk is mentioned in some of the literature, such as by Hootman (20:23), and is taken here to include uncertainty. Keen and Woodman view the employment of microcomputers as one way to contain risk otherwise inherent in mainframes (23:145). This is understood to mean that the amount of uncertainty with respect to data security and integrity can be reduced by moving to microcomputer support. Obviously, physical security may increase as a concern while data integrity can be easier to manage with highly refined and sophisticated off-the-shelf

microcomputer software. According to Quinn, uncertainty reduction can be attained through the use of multiple approaches to a problem (39:78).

One area of concern with respect to task uncertainty has to do with the ability, or lack thereof, to ascertain a status of some process such as maintenance as discussed by Mann (27:29), or through some reports as mentioned by Keen and Woodman (23:148), and by variance identification as mentioned by Mann (27:32).

The following areas of task uncertainty deal with various elements of strategy and planning. To begin with, King and Kraemer mention the following with respect to planning:

Planning implies the anticipation of consequences, and in its final formulation, the presence of an omniscient actor capable of seeing the future ... since we cannot assume omniscience, the goal of planning is less to provide foresight than to anticipate a bounded set of likely characteristics of the future and to assess options that might improve satisfaction under each anticipated case [24:474].

To continue, Hootman mentions the uncertainties associated with an innovation's impacts on facilities and operations (20:23), and uncertainties associated with the needs of an application area (20:22). Keen and Woodman speak of uncertainty with analysis and planning activities (23:147) as well as that associated with planning for mainframe capacity [understood to mean adequate: main memory size, peripheral storage amount, computational speed, terminal access, etc.] (23:145). Mann says that improving the accuracy of budgets [taken to mean reducing uncertainties] can be a motivator for change or refinement (27:32).

Task, Autonomy ["the degree to which individuals exercise personal control over their assigned tasks" (26:238)]:

In the literature, task autonomy frequently deals with independence from: data processing departments as indicated by Ilan and Shapira (21:188); and mainframe computing environments as identified by Keen and Woodman (23:144-145). McFadden and Suver recognize that "a high degree of independence is possible between application programs and the data base" (29:137). Although McFadden and Suver's point deals more with technical independence, its use leads to increased programmer and analyst efficiency, giving these experts broader functional control hence, more autonomy in application development. Quinn's research shows that for highly innovative firms:

Small teams of engineers, technicians, designers, and model makers were placed together with no intervening organizational or physical barriers to developing a new product from idea to commercial prototype stages [39:79].

This clearly shows a relationship between autonomy and innovative success thus, managers may want to consider task autonomy in designing strategies for change.

Task, Responsibility ["the degree of authority invested in an individual to oversee the completion of a task and to improve existing task behaviors" (26:238)]:

One negative incentive for allowing microcomputer proliferation is the increased amount of management responsibility as reported by Keen and Woodman (23:144). Miller sees a problem with neglecting the role of manufacturing in a company's competitive strategies (31:145). In addition, he sees an important relationship between success and management responsibility: "the pieces of a system must be held together by individuals with responsibility for ensuring its proper

operation or integrity" (31:152). Integral to successful innovation is the amount of authority an individual has in setting the schedule of work according to Morton (34:45).

Task, Variety [the degree of task differentiation]:

Daft suggests that innovative proposals can originate anywhere in the organization hierarchy and may be a function of task differentiation (11:195). This idea provides that technical innovations will originate from the technical core of the organization and administrative proposals will originate from the managerial core. This introduces the idea of a dual core for understanding the origin of innovation. Some of Daft's ideas which follow, touch upon other areas already discussed above but are included here because of the way he integrates the sourcing of innovation with the various structural factors. Of special interest to this inquiry is that "many innovations are adopted because current techniques are perceived as unsatisfactory--when a performance gap exists [citing March and Simon, 1958.] Professionals tend to see problems because of high aspirations and performance standards" (11:196). Daft broadens this discussion of task differentiation even further by relating the dual core concept to the source of innovation. He points out that:

It seems likely that low formalization, decentralization, and high complexity (professionalism) are suited to both initiation and adoption of innovations within the technical core. The opposite structural conditions facilitate innovation in the administrative core. High formalization, centralization, low complexity (professionalism) and tight coupling fit the initiation and adoption of innovations which pertain to the organization itself ... the dual-core concept helps answer the question ... what is the role of top administrators in the innovation process? When innovation and adaptation within the technical core is desired, the advice is relatively straight forward: Acquire highly professional employees for the technical core, and let them handle innovation [11:208].

To continue the discussion of task variety, Keen and Woodman acknowledge the use of computers to automate clerical processes [perceived as routine] (23:147), and Monger suggests that computers can go beyond automating the routine processes to supporting the simultaneous generation of information about underlying organizational processes through the use of artificial intelligence (33:8). Finally, Mann lists as a significant benefit of automation, the freeing of skilled labor from routine work (27:32)--[which should provide a sufficient incentive for change.]

Task, Identity ["an individual 'internalizing' an assigned task" (26:239)]:

Bleicher presents, in the context of relating communication to creativity, that:

The motivation to push the technological frontier forward requires a strong identification of the employees with the organization and its goals. In this regard communication serves the purpose to lessen the need for management by pointing everybody in the right direction and explaining what is happening on all sides of him [5:76].

Buss states that the rate of turnover among analysts and programmers is one key indicator of the:

technical adequacy of the data processing activity, since most DP professionals prefer to work in 'state of the art' environments ... turnover may be related to maintenance problems, since this type of work is boring [9:116].

This is taken to refer to the degree of internalization based upon the relationship between the professional staff and the amount of stimulation provided by the task. Keen and Woodman present one line of argument which deals with quantifiable versus qualifiable benefits (23:147). The argument says that if the user is happy with a technological solution, the benefits of that innovation are real even if not

quantifiable. The evidence gathered here may be insufficient to substantiate this point but, it seems that the more a user likes [internalizes] a technical solution, that there must be something of benefit derived from the innovation hence, the user's state of mind becomes a de facto measure of innovation success--at least in some dimension. It is clear, however, that happiness and productivity may not be correlated phenomena. The point to remember from this is that the degree of task identity can provide some motivation to make a change if it is needed.

An appeal to the mission is suggested by Mann in the context of justifying expenditures for innovation (27:28). It is inferred that such an appeal will somehow help the decision makers to better internalize the importance [in view of the mission] of the prospective innovation. Finally, Quinn speaks of the resourcefulness of innovators who are able to make the most of limited resources and appear to others "as 'possessed' or 'obsessed'" (39:74) because, presumably, they have completely internalized their task and the need for innovation success.

Task, Feedback ["a mechanism for informing individuals of their task performance levels" (26:239)]:

This research uncovered four feedback categories. These are performance, equipment, data/information, and cost.

The category of performance feedback is shown by Keen and Woodman's need for better analysis (23:148) and Mann's need for error reduction and information on project performance (27:32). Mann speaks also of analyzing task methods and evaluating personnel performance (27:32). Marcus mentions the need to measure the efficiency of hardware and software use as a factor in change (28:444). Obviously, such measures

derive from task feedback. In a similar vein, McFadden and Suver see feedback as needed to improve the IS department's productivity (29:131).

The category of equipment feedback is shown by Mann's concern for the managerial ability to: optimize equipment replacement, forecast maintenance requirements, and avoid overmaintenance (27:32).

The category of data feedback relates specifically to information itself. This is shown by the need for faster access to historical information as identified by Mann (27:32), and in general, to improve both information and its timeliness to management as presented by McFadden and Suver (29:131). Finally, Morton speaks of the amount of communication as an important task factor (34:45).

The final task feedback category deals with cost. Morton says that the frequency of cost evaluation is important in change decisions (34:45), and Nolan speaks of variance from some established baseline as a significant indicator of the need for change (37:125).

This has been a presentation of task factors which has included data on uncertainty, autonomy, responsibility, variety, identity, and feedback.

Discussion of Environment Factors

This will be a discussion of environmental factors that will include heterogeneity, uncertainty, competition, concentration, and organizational dependence.

Environment, Heterogeneity ["the similarity of environmental entities, e.g. customer diversity, with which an organization must interact" (26:240)]:

One heterogeneous factor is taken from Hootman's broad view of business and system needs wherein he identifies the importance of

looking at both product and distribution trends of the industry to detect the need for change (20:22). Another factor, which is mentioned by Keen and Woodman, is that of an enhanced competitive image from improved customer services which derive from innovation (23:148). Miller describes the use of technology in manufacturing control systems as being significantly affected by the complexity of the manufacturing environment (31:151). And finally, the type of organization, whether it is service or manufacturing, is considered important by Mills and Moberg (32:475).

Environment, Uncertainty ["the variability of organizational environments" (26:240)]:

The research findings on environmental uncertainty can be divided into approximately four areas of concern which are opportunity, uncertainty, technological, and governmental.

The Opportunity Concern. It is Bright and Shoeman who speak of the need to perform a continuous review and evaluation of the environment in order to detect the need for change (8:239). Altier says that if it "were not for change, there would be no need for management" (1:26). He describes change as consisting of both past and future events. These events have both planned and unplanned aspects. Since past change is history, the focus of management should be on the future. Planned future change is contingent upon "indications ... that something needs to be done" (1:27). Drucker addresses the idea of "innovation opportunities" (16:67) which are external to the company and comprise areas of new knowledge and changes in perception (16:68).

Keen and Woodman address the problem of finding a direct cost justification for microcomputers because the benefits are "often

deferred--even hypothetical" (23:147). They cite one business case where the "strategy was to identify priority areas of opportunity" (23:147)--as in a case where the microcomputer produced no direct cost benefit but would allow a financial planner to examine more alternatives. This is considered significant since financial planning often incorporates elements of environmental uncertainty. In addition, improved decision making with new technology (microcomputers) is listed as one benefit category based on studies by one firm. King and Kraemer speak of "forces of environmental change (e.g., technological change, new external knowledge) that affect the current state of an entity" (24:473-474) and Morton, lists the amount of information exchanged in industry as a main factor affecting innovation adoption (34:45).

The Uncertainty Concern. Balthasar introduces the idea of subjective probabilities to estimate the potential success of new technology. A basis for using probability is the level of uncertainty [including environmental] that managers must deal with in making assessments of benefits for research and development efforts. Implied in his argument is that determining the probable success for a project does in fact supply the necessary reason for making a change in the direction of that potential success (3:160). Both Boehm (6:92) and Miller (31:151) mention the significance of environmental uncertainty. Mills and Moberg mention uncertainty in client problems from a service standpoint and variability in those client problems (32:475).

Finally, Golembiewski's comments, with respect to the plurality of change, are included here because of its implications for the whole gamut of uncertainty issues. Golembiewski identifies at least three types of change: alpha, beta, and gamma.

Alpha change is defined as "a variation in the degree of some existential state, given a reliably calibrated measuring instrument that taps a constant conceptual domain" (19:551). In other words, this is the real amount of change to be measured.

Beta change is "a variation in the degree of some existential state, complicated by the recalibration of some portion of the intervals of the measurement continuum associated with a constant conceptual domain" (19:551). As an example, this type of change occurs when a test taker estimates a value of three for a question that has a scale of values from 1 to 10. The next time he answers that question (with no change in any variables that influence the answers on the test) he selects another value such as five. This difference is not the value to be measured but an unexplained or random change occurring in the mind or manner of the test taker.

Gamma change is defined as "a basic redefinition or reconceptualization of some domain, a restructuring of perceived reality that involves differences in state as well as differences in degree" (19:551). This kind of change would occur if the test taker has developed different meanings for terminology or concepts being measured on a test that were unrelated to the test environment. The differences in perception of reality have occurred between the time the test was conceived and the time of implementation. The change being measured is unrelated to the original purpose of the test. The significance of plural change, as expressed by Golembiewski:

Concerning research, the core implication [of plural change] is consequential: unless one first rejects the possibility of non-alpha, no confident interpretation is possible about the burgeoning literatures dealing with multiple arenas of change--in laboratory experiments,

interventions in organizations, survey/feedback designs, and so on [19:552].

The Technological Concern. On the issue of monitoring the environment for signals of technological change, Bright points out one important element which is searching the environment for signals of change (7:198). McFarlan presents the problem of dealing with technological discontinuity in the environment (30:103) and Morton speaks of the risk of innovation along with the length of time that the innovation has been used by others (34:45). Quinn mentions the length of time horizons with respect to uncertainty (39:74) and Rousseau discusses environmental influences on technological innovation (41:539).

The Governmental Concern. Various concerns about public policy are mentioned in the literature to include: government policy changes, economic outlook, and tax and accounting requirements as mentioned by Hootman (20:22); the government policy effect on social and cultural factors, and channels of communication as presented by Marcus (28:446); and finally, the significance of non-technical events in the environment as presented by Bright (7:198).

Environment, Competition ["is related to environmental capacity (scarcity of resources) and population density" (26:240)]:

For this discussion, competition can be roughly grouped into demand, competition, state of the art, and government concerns.

The Demand Concern. Both customer expectations for prompt service and the expectation of consumer demand are mentioned by Bender (4:164). Bleicher discusses market dynamics with respect to the acceptance of a product (5:71). Various kinds of opportunities are mentioned which include: the opportunity to meet social needs as presented by Boehm (6:97); and the opportunities with respect to

industry, market, and demographic changes as presented by Drucker (16:68). Hootman discusses the significance of both marketing goals and profit plans (20:22). Morton speaks of a sensitivity to the needs of the marketplace (34:45). Finally, Quinn mentions the market orientation (39:78).

The Competition Concern. Competition is an environmental concern which is discussed by both Bleicher (5:78) and Kotter and Schlesinger (25:106). The need for a competitive edge is mentioned by Keen and Woodman (23:148). Both McFarlan (30:99) and Monger (33:8) identify the possibility of establishing competitive barriers to market entry through the astute use of information systems. Finally, both transactional and social factors in client relations are considered significant competitive concerns by Mills and Moberg (32:475).

The State Of The Art Concern. The rapidity of introduction of technological successors is a signal concern to Bright (7:1). Buss discusses the finding that outdated software can help the competition by reducing the firm's ability to compete (9:114). Hootman recommends considering the short and long term needs of both the business and the computer system (20:22). Finally, Marcus sees a significance to the percentage of relevant firms which are adopting a technology (28:444).

The Government Concern. Kotter and Schlesinger deal with the importance of government policy and regulations (25:106). Marcus speaks of government policy effects in general (28:444) and, specifically of the policy effects upon both R&D and economic variables (28:446).

Environment, Concentration/Dispersion ["the extent to which resources are evenly spread throughout the environment" (26:240)]:

This factor includes Bright's concern about the amount of R&D funding (7:2), growth as mentioned by Kotter and Schlesinger (25:106), the potential for growth in the market as presented by McFarlan (30:102), the need to control organizational focus according to Miller (31:150), and finally, the organization's focus on its market niche as discussed by Monger (33:8).

Environment, Inter-organizational Dependence ["the degree to which an organization has a program of sharing resources or exchanging ideas with other organizations" (26:241)]:

This factor is developed by McFarlan who speaks of the fact that "interorganizational information systems have hidden, second-order effects, that is, repercussions in other parts of the business" (30:103). Some of these effects: "pose opportunity for shifts in the balance of power between companies. Sourcing inflexibility, pricing, vulnerability, systems inefficiencies, and excess expense are examples of these secondary effects" (30:103).

Monger develops the idea that information systems, properly and strategically developed, enables a firm to gain power over suppliers and buyers (33:8). Quinn provides an insight into some benefit derivable from dependence on others:

But the best innovators have gone even farther [than interactive learning]. Recognizing that the random, chaotic nature of technological change cuts across organizational and even institutional lines, these companies tap into multiple outside sources of technology as well as their customers' capabilities. Enormous external leverages are possible [39:79].

This concludes the presentation of material supporting the significance of environmental factors with respect to information

systems change. The material presented here included a look at heterogeneity, uncertainty, competition, concentration, and organizational interdependence.

Summary of Chapter III.

This chapter has presented the research findings in support of research question number one. The findings have been classified in terms of the work presented by Kwon and Zmud (26:227-244). The classification has included individual, structure, technology, task, and environmental factors of significance in innovation.

IV. Analysis of the Literature: The Second Research Question

Introduction

The previous chapter was an examination of "factors" which influence decisions for change, and as such, was concerned with individual things that trigger change decisions. This chapter presents the second research question and asks if these factors can support an integrative framework which identifies the need for change in information systems and ensures that the change is effective.

The Second Research Question

Can these factors support an integrative framework which can identify both the need for change in information systems and insure that the change is effective?

Discussion of Findings

The key to this second question is based upon the word integrative. The factors identified above, clearly point to the need for a multi-element framework. An integrative framework should address most, if not all, of the elements or factors identified in the above research. In addition to addressing the above factors, a good framework should be based upon, and congruent with, the recognized and accepted findings of other researchers in various disciplines who are concerned about organizational change. The correlation is needed to enhance the credibility of adapting such a framework to information systems change.

One of the findings evident in the above research is that there is sufficient factor congruence between the information systems concerns and organizational behavior and development concerns to allow the

adaptation of an existing framework for use in detecting and ensuring effective change.

At least one possible framework results from the use of Kwon and Zmud's classification of factors in innovation as used to categorize the findings for the first research question. Although not specifically presented as a framework, their chart might possibly be converted for use as a framework.

Another possibility comes from adapting Nadler and Tushman's Congruence Model for Organizational Assessment (see Figure 1 below). Nadler and Tushman are quick to warn that:

Although it is tempting to consider combining these component parts (such as models of motivation, satisfaction, group process, structure, etc.) in some additive manner, the systems nature of organizations implies that there are properties of the whole that cannot be understood by simply adding together the component parts [36:262].

They go on to present the idea that their congruence model "focuses on the critical system characteristic of interdependence" (36:268). Their model is essentially an open system model consisting of inputs, transformation processes, and outputs.

In order to adapt the congruence model to develop a framework, it is necessary to combine task and technology factors into the single element of task. The nature of inputs, transformations, and outputs is described next.

The inputs consist of environment, resources, history, and strategy. The transformation components include task, individual, organizational (formal structure) and the informal structure. The outputs are classified as an organizational function which is analogous to goal attainment, group behavior, and individual behavior and

attitude. No effort will be made to transform the factors, that were identified from the research for the First Research Question, into the specific elements for this congruence model. However, it is clearly evident, from even a casual examination of the change factors that were uncovered from the research for the First Research Question, that there is a sufficient amount of data from the findings to support this congruence model.

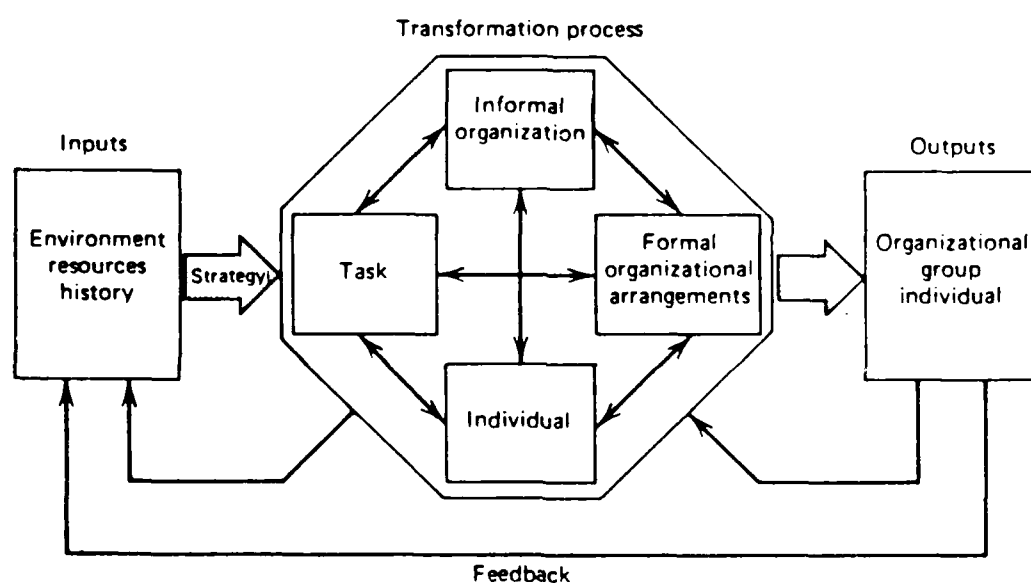


Figure 1. Congruence Model for assessing organizational behavior.
From Nadler and Tushman (36:274).

It is important to note how the Congruence Model works. According to Nadler and Tushman, between each of the inputs there exists what they call a degree of congruence or "fit" (36:274). They define congruence as:

The degree to which the needs, demand, goals, objectives and/or structures of one component are consistent with the needs, demand, goals, objectives and/or structures of another component [36:274].

Therefore, the degree of fit between any specific pairs of components is a critical concept in the successful functioning of the model. A poor fit detracts from effective organizational operation, and a good fit promotes effective and even efficient organizational function. These comments on fit are extended to the aggregate amount of congruence or fit as a system. An underlying hypothesis of the model expresses the relationship between behavior and the nature of fits:

Other things being equal, the greater the total degree of congruence or fit between the various components, the more effective will be organizational behavior at multiple levels. Effective organizational behavior is defined as behavior which leads to higher levels of goal attainment, effective utilization of resources, and adaptation [36:275].

The application of the Congruence Model to this thesis can be derived from the following quotation from Nadler and Tushman:

The implications of the congruence hypothesis is that if the analyst is to adequately assess the system, he or she must determine the ultimate location and nature of inconsistent fits. The model also implies that different configurations of the key components can lead to effective behavior (consistent with the systems characteristic of equifinality). Therefore, the question is not of finding the "one best way" to configure the system, but of determining effective combinations of inputs that lead to congruent fits [36:275].

This congruence model has some benefits which are described by the authors (36:278). One cited benefit is that the model can serve as a guide for data collection by identifying significant variables which need to be in an assessment of the organization. Another benefit is that it can function as a framework for applying more specific organizational models. Finally, it can serve as an integrating device to describe how the various components are supposed to interact.

The relevance of the Congruence Model is that it is one example of an integrative framework which can be supported from the research

findings of this thesis effort. In addition, since there is such a high degree of commonality between this research and the Congruence Model, and because the Congruence Model is based upon multidisciplinary elements and other research findings, it can be argued that such a multidisciplinary model can be used to identify the need for change in information systems--at least to some degree. To the degree that it can be used as such, it satisfies the second research question.

Summary of Chapter IV.

This concludes the presentation of research findings in support of the second investigative question. The Nadler-Tushman Congruence Model was presented as one possible framework for making change to organizational information systems. It was shown that this model is supported by the findings of the first research question and that the model can serve as a guide for data collection about change variables and can also show various integrative relationships between related organizational components.

V. Conclusions and Recommendations

Review

This research effort has been directed at discovering what factors influence managers to make changes to their information systems. It has also looked for a framework which could integrate those factors. It was hoped that an integrative framework, if found, could aid managers in identifying the need for change. In addition, such a framework should also provide a guide in the change process. The actual process of making change was not addressed because it appears to be adequately covered in the literature. So, what has been discovered? About 328 individual factors were uncovered in the sample of literature. These factors were then classified according to a taxonomy adapted from the work of Kwon and Zmud. Finally, an integrative framework was identified from the work of Nadler and Tushman.

Conclusions

The overwhelming factor influencing information systems change is called relative advantage. This single category accounted for about 40% (131/328) of the findings. The factor of environmental uncertainty was a distant second and accounted for about 8.5% (28/328) of the findings. This was closely followed by environmental competition at about 7.6% (25/328), and equally by technological compatibility and task uncertainty at 6.4% (21/328). The need for feedback produced only 4.9% (16/328) of the factors in change.

The relative advantages of technology appear to be easy to quantify given transaction processing environments but this research uncovers many other dimensions and applications which are very difficult to

quantify. This is presumably due to the uses of automated information systems for higher-level and more abstract applications such as strategic planning and environmental scanning. It appears that because the influence of information systems is somewhat pandemic within organizations, information systems may serve as catalysts for political and social action as much as for any inherent technical merit. The Nadler-Tushman Congruence Model clearly identifies multiple areas of impact for any given organizational change--including task and technology.

This research clearly shows that information systems change is not necessarily a trivial or isolated accomplishment. Because so many factors are involved, managing corporate information systems must include much more circumspection than would be used in replacing worn out lathes or punch presses. Given the problems identified in the first chapter of this thesis with respect to the use of humans as information processors and the findings reported herein, frameworks for change appear to be essential for guiding innovation and preventing possible disasters.

Finally, this research has shown that the factors influencing changes in information systems can be classified according to the works of Kwon and Zmud and Nadler and Tushman. This suggests that their work contributes meaningful information with respect to the impact of change upon the organization and shows how such findings as uncovered in this research may be used in organizational assessments and innovation. In other words, the results of this research and that of others cited above are mutually supportive.

Recommendations

It is somewhat axiomatic that there is great value in learning from the mistakes of others. The findings of this thesis can provide some insight into those relevant factors which are used by managers in innovation, and hopefully, help others in the process of innovation. It is to this end that the first recommendation is to continue this research for the purpose of identify other factors, if they exist, and to substantiate the validity of these findings.

The second recommendation is to refine this research into an examination of the interaction of any or all of the factors within a given framework such as the Nadler-Tushman Congruence Model or for some other model of organizational assessment. This would support the goal of providing specific measures of interaction and degrees of effect for a given area of change in an information system. This would help answer such questions as "What would happen if I were to enhance our information system by adding feature X?" or "What possible political effects might be associated with a change in computer security software?" or "What would happen to our organization if the plan to buy new productivity tools for the computer software developers were instead replaced by end-user computing tools?" This second recommendation also helps overall research by validating the other organizational models for use in information systems change.

Appendix A: Glossary of Terms

Benchmarks are selected points of reference used in comparison studies and audits. Benchmarks would be used within a framework to aid in dimensioning the problem space. Benchmarks may also be used in models to measure and control the amount of change.

Change is a word that refers to the process or result of becoming different. As used in this inquiry, change has a generic or incidental component and a deliberate component. Anything which makes things different for an organization, whether incidental or deliberate, is of concern to managers. In the sense that any change can influence the decision to acquire and use automated information systems technologies, it is of concern to this inquiry.

Decision aid is a device or technique that assists a decision maker with the process of defining the problem, clarifying alternative courses of action, and selecting a solution. In a narrow sense, a framework corresponds to the process of defining the problem whereas, clarifying alternatives and selecting a solution are better aligned with the definition of a model.

Decision making is a management control activity which employs various analytic tools, procedures, and heuristics to aid in the process of making decisions. The Simon model (Simon:1) is one such aid which has three phases. These phases are intelligence, design, and choice. By way of contrast, a framework corresponds roughly to the intelligence phase of Simon's model.

Framework is defined by Webster's Dictionary as "a skeletal or structural frame; a basic ideational or narrative structure: a systematic set of relationships: a conceptual scheme, structure, or system." Another useful term is frame of reference. Again from Webster's Dictionary, "a usually systematic set of principles, rules, or presuppositions or a system of laws, mores, or values or an interlocking group of facts or ideas serving to orient or give particular meaning" For the purposes of this research, a framework is defined as a conceptual structure used to bound a problem space and detect variances. A framework is conceived of as a descriptive device which focuses on the functional aspects of a problem rather than the form or model of the solution.

Information system is a phrase that means any device or combination of devices which is used to collect, store, change, and retrieve information. Common automated technologies supporting information systems include, but are not limited to, computers with software and communication networks.

Innovation is an important term. It is defined as the introduction of something new. Change is possible without innovation, but innovation is not possible without change (Nutt:367).

Model is a term sometimes used as a synonym for framework. Webster's Dictionary defines model as "a person or thing that exactly resembles another: copy, image ... structural design: pattern ... archetype ... a description ... or an analogy used to help visualize often in a simplified way something that cannot be directly observed (as an atom)." For the purposes of this inquiry, a model is defined as a prescriptive device which is used to give form to a solution. In other words, a model is an analog of the solution.

Requirements analysis is a phrase which traditionally means a procedure to validate and document the need for internal change. Many procedural models are available to perform a requirements analysis. Requirements analysis is both: a static procedure which is invoked after a need is identified and, it is focused on internal organizational requirements. In both of these respects, it is more closely associated with the definition of a model as explained above. To further clarify the difference, a framework is conceived of as a dynamic tool which detects variances in both external and internal environments. These variances are analyzed for problems and potential solutions to internal needs without, necessarily, a statement of user need.

Technology forecasting refers to efforts to determine trends in technological innovation as an aid in planning. Technology forecasting may have a role as one component of a viable framework.

BIBLIOGRAPHY

1. Altier, William J. "Change: The Name of the Game," Business Horizons, 22: 25-27 (June 1979).
2. Anderson, Gordon E. "The Coordinated Use of Five Performance Evaluation Methodologies," Communications of the ACM, 27: 119-125 (February 1984).
3. Balthasar, Hans Ulrich and others. "Calling the Shots in R & D," Harvard Business Review, 56: 151-160 (May-June 1978).
4. Bender, Paul S. and others. "Practical Modeling For Resource Management," Harvard Business Review, 59: 163-173 (March-April 1981).
5. Bleicher, Knut and others. "Managerial Frameworks for Innovative Responses in High-Tech Organizations," Business Horizons, 26: 69-78 (November-December 1983).
6. Boehm, George A. W. "Shaping Decisions With Systems Analysis," Harvard Business Review, 54: 91-99 (September-October 1976).
7. Bright, James R. Practical Technological Forecasting: Concepts and Exercises. Austin TX: Technology Futures, Inc., 1978.
8. Bright, James R. and Milton E. F. Shoeman. A Guide to Practical Technological Forecasting. Englewood Cliffs NJ: Prentice-Hall Inc., 1973.
9. Buss, Martin D. J. "Penny-wise Approach to Data Processing," Harvard Business Review, 59: 111-117 (July-August 1981).
10. Carroll, Archie B. "Behavioral Aspects of Developing Computer Based- Information Systems," Business Horizons, 25: 42-51 (January-February 1982).
11. Daft, Richard L. "A Dual-Core Model of Organizational Innovation," Academy of Management Journal, 21: 193-210 (June 1978).
12. Damanpour, Fairborz and William M. Evan. "Organizational Innovation and Performance: The Problem of Organizational Lag," Administrative Science Quarterly, 29: 392-409 (September 1984).
13. Davis, Gordon B. and Margrethe H. Olson. Management Information Systems: Conceptual Foundations, Structures, and Development (Second Edition). New York: McGraw-Hill Book Company, 1985.
14. Dean, James W. Jr. "Decision Processes in the Adoption of Advanced Technology." Class handout distributed in ORSC 626, Organizational Development. School of Systems and Logistics, Air Force Institute of Tech. (AU), WPAFB OH, Spring 1987.

15. Dickson, John W. "The Adoption of Innovative Proposals as Risky Choice: A Model and Some Results," Academy of Management Journal, 19: 291-303 (June 1976).
16. Drucker, Peter F. "The Discipline of Innovation," Harvard Business Review, 63: 67-72 (May-June 1985).
17. Fraker, Susan. "High-Speed Management For The High-Tech Age," Fortune, 62-68 (March 5, 1984).
18. Ginzberg, Eli. "The Mechanization of Work," Scientific American, 247: 67-75 (September 1982).
19. Golembiewski, Robert T. "Contours in Social Change: Elemental Graphics and a Surrogate Variable for Gamma Change," Academy of Management Review, 11: 550-566 (July 1986).
20. Hootman, Joseph T. "What Price IS?" Information Strategy, 3: 21-24 (Spring 1987).
21. Ilan, Yael and Zur Shapira. "The Introduction and Use of Microcomputers by Professionals in an Industrial Corporation," Technological Forecasting and Social Change, 29: 183-194 (April 1986).
22. Kantrow, Alan M. "The Strategy-Technology Connection," Harvard Business Review, 58: 6-21 (July-August 1980).
23. Keen, Peter G. W. and Lynda A. Woodman. "What To Do With All Those Micros," Harvard Business Review, 62: 142-150 (September-October 1984).
24. King, John Leslie and Kenneth L. Kraemer. "Evolution and Organizational Information Systems: An Assessment of Nolan's Stage Model," Communications of the ACM, 27: 486-475 (May 1984).
25. Kotter, John P. and Leonard A. Schlesinger. "Choosing Strategies for Change," Harvard Business Review, 57: 106-113 (March-April 1979).
26. Kwon, Tae H. and Robert W. Zmud. "Unifying the Fragmented Models of Information Systems Implementation," Critical Issues In Information Research, edited by R. J. Boland Jr. and R. A. Hirschheim. New York: John Wiley and Sons, 1987.
27. Mann, Lawrence Jr. "Evaluating a Computer for Maintenance Management," Industrial Engineering, 12: 28-32 (February 1980).
28. Marcus, Alfred A. "Policy Uncertainty and Technological Innovation," Academy of Management Review, 6: 443-448 (July 1981).

29. McFadden, Fred R. and James D. Suver. "Costs and Benefits of a Data Base System," Harvard Business Review, 56: 131-139 (January-February 1978).
30. McFarlan, F. Warren. "Information Technology Changes the Way You Compete," Harvard Business Review, 62: 98-103 (May-June 1984).
31. Miller, Jeffrey G. "Fit Production Systems to the Task," Harvard Business Review, 59: 145-154 (January-February 1981).
32. Mills, Peter K. and Dennis J. Moberg. "Perspectives on the Technology of Service Operations," Academy of Management Review, 7: 467-478 (July 1982).
33. Monger, Rod F. "Why Seize the AI Initiative?" Information Strategy: The Executive's Journal, 3: 4-10 (Spring 1987).
34. Morton, Maxwell R. "Technology and Strategy: Creating a Successful Partnership," Business Horizons, 26: 44-48 (November-December 1986).
35. Moyer, Reed. "Forecasting Turning Points," Business Horizons, 24: 57-61 (July-August 1987).
36. Nadler, David A. and Michael L. Tushman. "A Congruence Model for Organizational Assessment," Organizational Assessment, edited by Edward E. Lawler III and others. New York: John Wiley and Sons, 1986.
37. Nolan, Richard L. "Managing the Crises in Data Processing," Harvard Business Review, 57: 115-126 (March-April 1979).
38. Nutt, Paul C. "The Implementation Stage," Planning Methods for Health and Related Organizations. New York: John Wiley and Sons, 1984.
39. Quinn, James Brian. "Managing Innovation: Controlled Chaos," Harvard Business Review, 63: 73-84 (May-June 1985).
40. Revsine, Lawrence. "Technological Changes and Replacement Costs: A Beginning," The Accounting Review, 54: 306-322 (April 1979).
41. Rousseau, Denise M. "Assessment of Technology in Organizations: Closed Versus Open Systems Approaches," Academy of Management Review, 4: 531-542 (October 1979).
42. Simon, Herbert A. The New Science of Management Decision. New York: Harper Row, 1960.
43. "What Our Organization Can Learn From the Historians," Research Management, 29: 6+ (March-April 1986).

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The purpose of this research effort was to discover what factors influence managers to make changes to their information systems. It was also a search for a framework which could integrate those factors. It was hoped that an integrative framework, if found, could aid managers in identifying the need for change. In addition, such a framework should also provide a guide in the change process. The actual process of making change was not addressed because it appears to be adequately covered in the literature. About 328 individual factors were uncovered in the sample of literature. These factors were then classified according to a taxonomy adapted from the work of Kwon and Zmud. Then an integrative framework was identified from the work of Nadler and Tushman. Continued on reverse.					
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Block 19 continued:

The overwhelming factor influencing information systems change is called relative advantage. The other less frequently cited factors include environmental uncertainty, environmental competition, technological compatibility, task uncertainty, and feedback.

This research clearly shows that information systems change is not trivial thus, managing corporate information systems must include much more circumspection than would be used in replacing worn out lathes or punch presses. The findings of this thesis indicate that frameworks for change appear to be essential for guiding innovation and preventing possible disasters.

Finally, this research complements the works of Kwon and Zmud and Nadler and Tushman. This research suggests that the factors influencing change in information systems is consistent with at least one model of organizational assessment.

Two recommendations follow from this research. The first is to continue the research to improve the validity of the findings. The second is to use the factors with an existing framework to study the relationships and develop predictive measures of impact on organizations for a given type of change.

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