THE CONSTRUCT VALIDITY OF SELECTED TECHNOLOGY AND STRUCTURE MEASURES, AND METHODOLOGICAL FACTORS THAT MAY AFFECT THEIR VALIDITY

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

General Overview

This paper examines the adequacy of selected measures of two important organizational variables, technology and structure. The paper addresses measurement issues that have been discussed in the literature and that may explain some of the contradictory results that have been reported for these variables. For example, several authors (Ford and Slocum, 1977; James and Jones, 1976; Hitt and Middlemist, 1978; Rousseau, 1979) have suggested that the units of measurement may not be appropriate for the level of analysis being represented, that different scales of measurement have been used without questionning their validity, and that the dimensions of the concepts are not well defined, all of which may explain differences among the results found in various studies.

The question of adequacy here refers to the degree to which the instruments selected for the present study are able to represent the distinct concepts of technology and structure. The question is addressed in two basic ways.

First, two characteristics of internal adequacy are assessed for each of the instruments: (a) the reliability or consistency of the scales in each instrument, and (b) the factor structure of each instrument, i.e., the empirical separation of each instrument into its expected factors. Second, the construct validity of the complete set of instruments is evaluated, i.e., the degree to which all of the scales purporting to measure the same concept are similar and distinct from all of the scales purporting to measure different concepts.

Importance of Issues Addressed in this Study

This study is important for several reasons. First, important relationships between technology and structure have been proposed at several levels of analysis: (a) societal (Ellul, 1964), (b) organizational (Fry, 1982; Galbraith, 1977; Galbraith and Nathanson, 1978; Lawrence and Lorsch, 1969; Perrow, 1967; Thompson, 1967; Woodward, 1965), (c) organizational subunit (Fry, 1982; Rousseau, 1979; Trist and Bamforth, 1951), and (d) individual levels (Pierce and Dunham, 1978; Rousseau, 1979). The present study evaluates the ability of measures to represent the subunit and individual levels of analysis.

Second, there have been very few studies that question what the instruments used at any of these levels actually measure. A construct validity study performed here can answer the question "What do the instruments measure?" in relative terms. That is, a construct validity analysis does not establish what is actually being measured. It does, however, allow two possible statements: (a) these instruments are similar and probably measure the same concept (whatever the concept is), and (b) these instruments are different and probably do not measure the same concepts (whatever the concepts are).

At this point it is difficult to interpret or compare the empirical results from different studies. A better understanding of the instruments may allow more precise statements to be made about the relationships between technology and structure reported in previous studies.

The Aggregation Problem

Several authors (Ford and Slocum, 1977; Fry, 1982; Pennings, 1974; Sathe, 1978) note that what Lazerfeld and Menzel (1969) call global and analytic variables are the predominate types used to measure the concepts of organizational technology and organizational structure. Global variables, sometimes referred to as institutional variables, describe organizational characteristics without reference to information about properties of individual organizational members. Global organizational variables, for example, may be ascertained by observing the number of divisions represented on the organizational chart, or by observing that the organization uses a mass production type technology, or by asking the chief executive "How routine is the work in the organization?"

Analytic variables, sometimes inappropriately referred to as questionnaire variables, describe organizational characteristics as a composite by performing some mathematical operation on properties of individual organizational members. Analytic organizational variables, for example, may be ascertained by calculating the mean of the responses by organizational members to certain questions, or by calculating the distribution of members with various occupational skills across different organizational subunits.

Often, the aggregation of questionnaire responses across respondents is assumed to create an analytic variable. A detailed discussion of this issue presented later in this paper shows that aggregation itself is not a sufficient criterion by which analytic variables may be recognized.

Limitations in the Study

The present study focuses only on the adequacy of certain questionnaire based measures that are used to represent global or analytic variables. This restriction is the result of a compromise among several issues that have been discussed in the literature. The major issues to reckon with are as follows: (a) it is desirable to compare maximally different measures of a concept to determine how much of the agreement among measures is due to similarities in methods rather than to similarities in the traits represented in the measures (Campbell and Fiske, 1959); (b) two studies have found little agreement between global measures and aggregated measures of organizational structure (Pennings, 1974; Sathe, 1978); (c) using X^2 analysis, Fry (1982) found that the use of unaggregated versus aggregated measures did not account for the differences among 140 relationships between technology and structure reported in the literature (Fry, 1982); and (d) theoretical and operational factors have been cited that may influence the meaning of current global and analytic variables differently, thus leading to the suggestion that each type of measure be treated separately (Sathe, 1978; Roberts et al., 1978).

Sathe's (1978) suggestion of studying the two types of variables separately is followed in the present study. Questionnaire measures purporting to reflect dimensions of organizational technology and structure are examined for the possibility of developing better theoretical definitions for the concepts.[1]

As a result of this focus on questionnaire measures, the study provides information regarding the validity of the relationship between technology and structure reported in the literature using these measures. In following this strategy, however, the study runs the risk of making statements about agreement among measures of traits that may actually represent agreement due to similarities in the methods of measurement. Even with common method variance as a potential factor in the present results, however, future studies can use these results as a basis for improving the measures and for making more precise statements about the ways in which the variables are similar or different.

Organization of the Paper

Chapter II presents a general overview of technology and structure concepts and relationships between them. Particular attention is paid to the concepts on which the measures used in the present study are based. Finally, reports of empirical factors are reviewed.

Chapter III discusses the operational characteristics of the study. The general setting, descriptions of the organizations in which surveys were conducted, the data collection procedures used, and a detailed description of each of the five instruments used in the study are presented.

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[1]See Bagozzi and Phillips (1982) for a more complete discussion of derived concepts, theoretical definitions, and correspondence rules.

Chapter IV discusses the analytical methods used and presents their results. Various potential design weaknesses are discussed and evaluated. The internal reliabilities of each of the scales are determined for both the individual persons and the organizational subunits as units of analysis. The factor structure of each of the instruments are evaluated for the individual unit of analysis. The results of a multitrait-multimethod construct validity analysis treating each of the instruments as a separate method of measurement are presented and discussed for both the individual and subunit units of analysis.

Chapter V discusses relationships among the various analytical methods used in the study and what they contribute to understanding the current measures and concepts. The chapter also presents an integrated summary of the results presented in Chapter IV.

Chapter VI presents conclusions and discusses the consequences of the findings in the study. First, little agreement was found among the measures of either technology or structure used in the study. Second, even when certain instruments demonstrated limited reliability and validity within themselves, the measures were generally not comparable to measures of similar concepts from other instruments. Finally, many of the similarities that were found among the measures from different instruments were probably due largely to common method variance that represented, as of yet, unexplained constructs.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Miller (1978) identified two predominate processes that have been used to explain how organizations function. One process has focused on the handling and conversion of the materials used to produce the products of the organization. The other process has focused on the handling and conversion of information used in making decisions and controlling the activities in the organization. Each process has been thought to interact with the other in determining the state of an organization at a particular point in time.

Taking a similar approach, the following review focuses on concepts of organization technology that describe processes which produce the primary output of an organization. However, under the concepts reviewed here the "materials" being converted may also be information. For example, money may be converted from deposits to loans, data collected by the accounting department may be converted to reports for management. Likewise, the present review focuses on concepts of organization structure that describe decision making and control processes in an organization, what Dalton et al. (1980) categorize as structuring variables.

This chapter first presents a broad overview of conceptual and empirical relationships between two views of organizational technology and structure. Attention is then focused on conceptual dimensions that underlie the measures of organizational technology selected for the present study, particularly Thompson's (1967) and Perrow's (1967) technology dimensions. The empirical factors reported for the measures of technology used in the present study are then contrasted to the conceptual dimensions.

A similar review of the conceptual dimensions and empirical factors related to the measures of structure used in the present study is also presented. Following the separate discussions of the technology and structure concepts and measures, the conceptual differences and particularly the ability of some of the selected measures to discriminate between the concepts is considered. The chapter closes with an extensive discussion of certain methodological issues associated with using aggregated data to represent organization subunits.

Technology and Structure in Organizational Research

The Technological Imperative

Much of the recent interest in the relationship between technology and structure stems from Woodward's (1965) seminal study of 100 English organizations. After many unsuccessful attempts to explain differences in the performance of these organizations, she found that the best predictor of performance was the relationship between an organization's technology and its structure.

Woodward's (1965) study used global variables of technology and structure which were measured by asking an executive in each organization what types of technology and what types of structure were in use. Her analysis indicated that, for each group of organizations using the same type of technology, those organizations that were close to the median scores for structure in the group tended to be financially more successful than were organizations above or below the median. It appeared that for a firm to be financially successful it must use the correct combination of technology and structure. Thus, the label "technological imperative."

Development of the Technology--Structure Relationship

Since Woodward's (1965) study, the technology-structure relationship has been explored in a number of ways. For example, at the organization level of analysis various types of organizations such as manufacturing and service organizations have been studied as units of analysis. At the subunit level of analysis, organizationl subunits such as task groups in manufacturing organizations and departments in hospitals have been used as units of analysis. Finally, at the individual level, manufacturing production jobs and jobs in service organizations have been units of analysis.

Summarizing from Appendix A, Table I shows the different levels of analysis and units of analysis used in 16 selected studies of the relationship between technology and structure. The figure shows that a broad range of organizational types as well as units of analysis have been examined.

TABLE I

LEVELS OF ANALYSIS AND UNITS OF ANALYSIS USED IN THE STUDIES CITED IN APPENDIX A

Levels of Analysis	Units of Analysis
Organizations	Local health and welfare offices (3)[1]
	Local social service agencies (1)
	Manufacturing and service organizations (1)
Organizational Subunits	Task groups in manufacturing organizations (1)
	Task groups in employment agencies (1)
	Departments in manufacturing organizations (3)
	Departments or wards in hospitals (3)
	Departments in libraries (1)
	Departments in service organizations (2)
Individual Members	Jobs in hospital departments or wards (2)
	Production jobs in manufacturing organizations (3)
	Jobs in service organizations (2)

[1]Numbers in parentheses indicate the number of studies using the unit of analysis.

Support for the Technology--

Structure Relationship

Appendix A also summarizes the relationships between technology and structure reported in 16 representative studies. One early study found a significant relationship between technology and structure Aiken and Hage, 1968); other early studies found little or no relationship between the variables (Hickson et al., 1969; Mohr, 1971). Hrebiniak (1974) found a significant relationship only after controlling for supervisor influence. All of the more recent studies in Appendix A report limited relationships between technology and structure.

It appears that the only general statement that can be made about the relationships reported in Appendix A is that, with one exception (Glisson, 1978), consistent relationships are confined to the individual and subunit levels of analysis. Reiman and Inzerilli (1979) supported this conclusion after reviewing 23 studies of the relationship between technology and structure. After critically evaluating the results of the studies they reviewed, Reiman and Inzerilli concluded that studies at the subunit level of analysis "Come up with results that show remarkable agreement with each other" (1979, pp. 171, 173).

Also pursuing the question of consistency, Fry (1982) performed a systematic analysis of 33 studies reporting a total of 140 organizational technology-structure relationships. After noting the considerable diversity in the concepts of technology, he resolved the differences into six categories:

1. Technical complexity,
2. Operations technology,
3. Operations variability,
4. Interdependence,
5. Routine-nonroutine, and
6. Manageability of raw materials (1982, pp. 533, 538).

Fry (1982) then used the categories to determine whether differences in concepts had a systematic effect on the technology-structure relationships. Differences in the percentage of statistically significant technology-structure relationships (he ignored the directions of the relationships) across categories of technology concepts was taken to indicate that different concepts had an effect on the empirical results. Based on the results of his analysis, Fry concluded that, with the exception of the operations technology category, differences among technology concepts did not have an effect on the technology-structure relationship.

The Technology-Structure Relationship: A Question of Meaning

The Fry (1982) study did reduce the potency of previous criticisms which argued that the diversity in concepts of technology may be responsible for the lack of consistency in reported technology-structure relationships (Ford and Slocum, 1977; Reiman and Inzerilli, 1979). Fry's results suggested that the relationship between technology and structure represented a relatively powerful concept. This concept has apparently guided researchers into developing sets of definitions and measures that produced significant empirical relationships.

A major question still remained, however. Even though the sets of measures in the studies Fry (1982) examined produced significant relationships, it is still not clear whether the same concepts underlie all of the relationships. Until the relationships among the various measures are evaluated, this question cannot be answered. An empirical comparison of the measures will help determine their similarities and, thus, the similarities among the relationships reported in the studies. For example, if most of the technology measures are highly similar, it would suggest that the various operationalizations of technology are simply "restatements" of a single concept. If, however, the technology measures are not highly similar, then, to support Fry's (1982) conclusions, each measure must be shown to represent a separate dimension of the technology concept. Otherwise, the differences in the measures may indicate that the measures are not measuring the same concept at all.

A fourth possibility, if technology measures are highly similar, is that the relationship between the technology measures may be the result of one or more unspecified variables such as "uncertainty" that affect some or all of measures in the same way. This fourth possibility is suggested by the results reported in Leatt and Schneck (1981).

A similar set of examples of the value of comparing measures could be developed for the examination of measures of structure or for the examination of differences between measures of technology and structure. For example, if the measures of technology and structure are highly similar, it would suggest that the various operationalizations of the two concepts are actually "restatements" of a single concept and that "differences" in the "relationship" are due to errors in measurements of the concepts.

The meaning of the relationships studied by Fry (1982) have also been questioned at a different level of meaning. Some have argued that the technology-structure relationship represents a technological imperative (Reiman and Inzerilli, 1979). Others have argued that it represents job design factors (Pierce and Dunham, 1978), and others propose that both technology and structure are the product of strategic decisions (Miles et al., 1974; Grinyer and Ardekani, 1981). An examination of the ability of the instruments to measure technology and structure at different levels of analysis will contribute to helping understand the meaning of the relationship at these different levels.

Technology Concepts Underlying Selected Questionnaire Measures of Organization Technology

A General Concept of Technology

Rousseau (1979, p. 531) stated that "technology is generally defined as the application of knowledge to perform work". The concept of technology generally has referred to the activities that are thought to transform or convert the objects of work. When focused only on the conversion process, the concept of technology has described a closed system. That is, the concept has focused only on the actions used to produce the change.

Organization research, however, often has taken an open system view and defined technology as the process of converting inputs into outputs (Reiman, 1977; Rousseau, 1978). Rousseau (1979) summarized the open systems view as follows:

> When treated as an input-output process, an organization's technology represents a sequencing of events involving admission of input (raw materials, people, knowledge) into the organization, conversion of this input into output through the application of skill and energy, and disposal of output into the environment (p. 531).

The distinctions between the open systems and closed systems views are important in evaluating measures of the technology concept. The adequacy of a measure is determined by how well it represents the view it is intended to measure. Thus, adequate measures of the two different views of technology should differ in the same ways that the views themselves are different (Rousseau, 1977, 1979).

Thompson's (1967) and Perrow's (1967) concepts of technology underlie the measures included in the present study. The arguments developed below suggest that both theorists defined the concept of technology as an ideal closed system and the application of technology as an open system. The primary difference between Thompson's and Perrow's concepts is the way each treats the closed systems aspects of technology. These concepts are discussed in detail in the following sections, but a brief overview of each is presented below.

Thompson (1967) focused on the ideological aspects of technology. Thompson's basic argument was that organizational decisions are made on the basis of what a significant number of people believe is possible with a given technology. For example, if a significantly large group of decisions makers (e.g., investors, managers, customers) believe that robots perform better than people on an assembly line, steps will be taken to alter the organization in ways that those decision makers believe will accommodate robots.

Perrow (1967) focused on the concrete and existential aspects of technology. Perrow's basic argument was that people develop and apply a technology to realize some goal or outcome. However, the technology is not understood in terms of the outcomes, but in terms of the process itself. For example, one may build an automobile by a process of trial and error. The same automobile may also be built using a series of highly routine precise operations. The more routine production method would be considered the more highly developed technology.

Thus, Thompson (1967) saw the primary organizational effects of a technology as being a result of the expectations that many associate with that technology. Perrow (1967) saw the primary organizational effects of technology coming from a desire to develop the technology to higher levels of routineness in its operations. Both theorists agreed, however, that when a technology is put into use, it is used in an open system. As an open system the ideal state (expectations or routineness) of a technology may be affected by a number of factors outside of the operations themselves, such as differences in the raw materials used or changes in the use and application of the end product.

The following sections discuss each of these views of technology in detail.

Thompson's Concept of Technology

Thompson (1967, p. 14) defined technology as "a closed system of beliefs about cause effect relationships." This definition and his subsequent discussion emphasized the following three important aspects of technology.

1. The ideological characteristics of technology.
2. Technology as a closed system of understanding of what causes certain events as well as an ability to initiate and alter events.
3. Beliefs as the standard against which technological operations are evaluated.

Thompson (1967) suggested three technology categories:

1. Long-linked--characterized by sequential operations that ideally produce a single standard product, repetitively, at a continuous rate such as assembly line operations.
2. Mediating--characterized by extensive operations (i.e., operations that are widely distributed in time, space, or both) that are operated in standardized ways such as a bank linking lenders with borrowers.

3. Intensive--characterized by localized operations (e.g., operations carried on at a single construction site or on a single patient in a hospital) that are assembled from a stock of readily available procedures operated by the organization. The procedures are selected and applied according to the particular requirements of the object of the work. One might think of this as a "therapeudic" technology.

A Shortcoming of Thompson's Technology Concept

Thompson (1967) did not specifically identify underlying dimensions that cut across his technology categories. A number of researchers have attempted to operationalize his categories in various ways (e.g., Hitt and Middlemist, 1978; Lynch, 1974; Rousseau, 1978), but the lack of underlying dimensions has produced considerable diversity among them. The present study found considerable confounding between technology and structure, some of which can be attributed to the lack of specific dimensions to use as operational guidelines. Several of the following sections present a more detailed discussion of Thompson's concept and Appendix B suggests three underlying dimensions that might be used to describe his technology categories.

Perrow's Concept of Technology

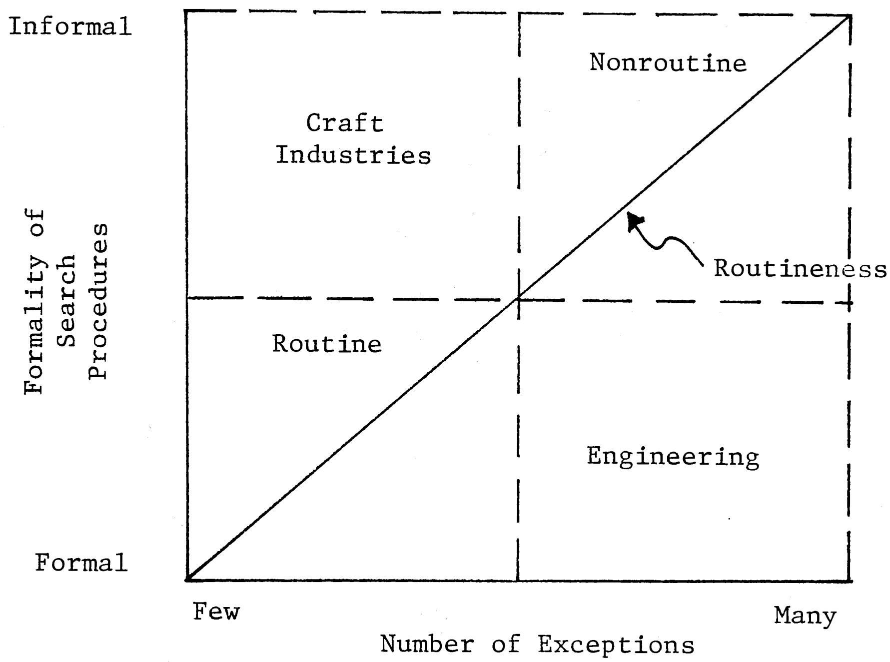
Perrow (1967, p. 165) defined technology as "the actions that an individual performs upon an object." This definition and his subsequent discussion emphasized the following four aspects of technology.

1. The concrete actions (tasks) performed by an individual person are the means by which technological development is understood.
2. The observed closed system of acts performed on an object which are assumed to be the product of knowledge and skill.
3. The characteristics of the object being acted upon.
4. Goal achievement as the standard against which technological output is evaluated.

Perrow argued that a highly developed technology will produce exactly the same desirable outcomes each time the same set of actions are performed. Thus, under Perrow's view, highly developed technologies are made up of highly routine actions. Based on this proposition, Perrow identified the following three dimensions of technology, illustrated in Figure 1, as indicators of the degree of technological development.

1. The number of exceptions encountered in performing the acts.
2. The degree of formal analysis in the search procedures used to deal with these exceptions.
3. Routineness, which is indicated by the combination of the above two independent dimensions.

Perrow used the dimensions to illustrate differences in types of organizational technologies. Organizational technologies on the diagonal are labeled routine or nonroutine types. An example of organizations that employ technologies that encounter a high number of exceptions but have highly formalized procedures to deal with those exceptions are engineering firms. Craft industries such as machine shops encounter relatively few exceptions in their work, but have few formal search procedures, depending on trial and error to deal with exceptions.



Source: Adapted from Perrow (1967, p. 167).

Figure 1. Dimensions of Perrow's Technology Concept and an Organizational Typology Described by the Dimensions

Empirical Factors That Have Been Identified for Technology

Empirical Factors and Conceptual Categories

The empirical factors discussed in the present section are representative of the commonly used self-report questionnaires purporting to measure technology. Fry (1982), as discussed earlier in this chapter, classified studies by the concept underlying the operationalization of each study. He also classified each study by the method of measurement used. Of the 16 self-report questionnaire type measures he found, eight were based on Perrow's (1967) technology concept, and four were based on Thompson's (1967) technology concept. Of the 12 studies based on either Perrow's or Thompson's concept, seven used one of the questionnaire measures of technology included in the present study.

Table II summarizes the empirical factors identified in three studies which directly evaluated three of the measures of organizational technology used in the present study. The empirical factors have been grouped under Perrow's (1967) three conceptual dimensions (number of exceptions, formalization of search, routineness), one dimension attributed to Thompson (1967) labeled "interdependence", and two subdimensions suggested by Rousseau (1979) which are labeled "other".

Although, as noted earlier, Thompson did not specify underlying dimensions for his technology categories, some researchers have identified differences in the form of interdependence as a distinguishing characteristic among the categories and used this characteristic to operationalize the concept (Grimes and Kline, 1973; Hitt and Middlemist, 1978; Rousseau, 1979).

It will be useful to anticipate at this point some of the discussions presented in this paper regarding the concept of interdependence and its operationalization. Both the concept and the operationalization of the interdependence variable have proven to be somewhat of an enigma. First, as will be seen in the discussion of structure concepts, interdependence also has been used as a structural dimension. Second, the results of the present study indicate considerable confounding between measures of technology and measures of structure. Some of the

TABLE II

EMPIRICAL FACTORS THAT HAVE BEEN IDENTIFIED FOR PERROW'S AND THOMPSON'S TECHNOLOGY CONCEPTS

Number of Exceptions	Formalization	Routineness	Interdependence	Other
Lynch (1974) Number of Exceptional cases Predictability of events	Lynch (1974) Insufficient knowledge	Lynch (1974) Routinesness of tasks	Lynch (1974) Internal task interdependence Interdepartmental task inter-dependence	Overton et al. (1977) Use of technical equipment Speed of task obsolesence
Overton et al. (1977) Number of patients requiring frequent observations Frequency of emergencies Predictability of hospital stay	Overton et al. (1977) Specificity of goals for individual patients Difficulty of learning a specialty	Aiken and Hage (1968) Routineness		

Source: Rousseau (1979).

confounding may be due to different views of the concept of interdependence. Appendix B summarizes the nature of the confounding and suggests an approach to the concepts of technology and interdependence that may reduce this confounding.

The three studies listed in Table II directly evaluated three of the technology instruments used in the present study and identified the empirical factors noted there. These three and the other significant studies that have evaluated instruments included in the present study are discussed below.

The Lynch Study

Lynch (1974) identified three factors, "predictability of events", "routineness of operations", and "insufficient knowledge", that, in a second order factor analysis, formed three subfactors of a factor she called the "library technology scale." The "predictability of events" and "routineness of operations" subfactors were meant to operationalize Perrow's (1967) "number of exceptions" and "formalization of search procedures" dimensions.

Lynch (1974) argued that "insufficient knowledge" was an implied dimension of technology in Perrow's (1967) theory. However, due to the poor statistical properties of the "insufficient knowledge" subscale, it was not possible to draw any conclusions regarding the validity of her argument. The other "library technology" subscales, "predictability" and "routineness" did have reasonably good statistical properties, and the relationships were consistent with Perrow's conceptual dimensions.

Lynch (1974) identified a factor which she labeled "overall routineness" that was based on Aiken and Hage's (1968) "routineness" scale. This factor, however, was orthogonal to the subfactors in the library technology scale. That is, the measure did not give any indication of being associated with two subfactors "search procedures" and "number of exceptions" proposed by Perrow (1967). Perrow suggested that routineness was a combination of the two orthogonal dimensions "number of exceptions" and "search procedures". To be consistent with Perrow's argument, Lynch's "overall routineness" scale should have been moderately to highly correlated with both the "search" and "exceptions" dimensions which were, in turn, independent of each other.

Lynch's (1974) analytical technique, principle components analysis with varimax rotation, allowed only solutions with orthogonal factors To adequately represent Perrow's argument an oblique factor rotation which allows dimensions to be correlated is required. If Perrow's argument is adequately represented, an oblique solution should fit the data better than does the orthogonal solution. Lynch (1974) did not report examining the data for oblique factors.

Lynch also identified two othogonal factors taken from Lawrence and Lorsch (1969) labeled "interdepartmental task interdependence" and "internal task interdependence". Although not intended as such, these factors may represent Thompson's (1967) technology concept.

The primary methodological question regarding the Lynch (1974) study is the relatively small number of cases (organizational subunits) to items (4:1) used in the factor analysis. Nunnally (1978) notes that a ratio this small could produce relatively unstable statistical factors that are not representative of the factors that one might expect to find in repeated applications of the instrument.

The Overton et al. and Leatt and Schneck Studies

The Overton et al. (1977) and Leatt and Schneck (1981) studies were both examinations of the same basic instrument. The more recent study used a shortened version that was intended to improve the statistical properties of the original 1977 instrument. Both studies found the same empirical factors for the instrument, therefore, the results of both studies will be treated as a single study in the present discussion.

Overton et al. (1977) adapted Lynch's (1974) library technology scale for use in hospitals. In addition to Lynch's library technology scale, several items and scales were included from other sources. They used Perrow's (1967) technology concept to develop their instrument along the following three dimensions: (1) raw materials, (2) techniques, and (3) task interdependence. It was expected that approximately the same factors Lynch (1974) found in her library technology scale would emerge. Instead, they found three different factors which they labeled as follows: (1) uncertainty, (2) instability, and (3) variability. Thus, the Overton et al. study did not reflect Perrow's (1967) dimensions.

There are several methodological questions with both the Overton et al. (1977) and the Leatt and Schneck (1981) studies that may explain their inconsistency with the Lynch (1974) results. First, as Overton et al. noted, a possible restriction of range problem in the raw materials (all of the "raw materials" were hospital patients) may have allowed most of the variance to appear in other factors. The authors did not, however, report central tendency or dispersion statistics for the items which presumably refer to raw materials. Second, both the original and modified instruments used in the studies incorporated items from a number of instruments in addition to the modified Lynch (1974) items. The difference in items opens the possibility that the Overton-Leatt instrument and the Lynch (1974) instrument are not measuring the same concepts.

Finally, neither of the Overton-Leatt studies report the underlying average inter-item correlations for the scale that presumably measure the unexpected dimensions. Nunnally (1978) points out that due to the properties of factor analysis, it is possible to have high factor loadings on a factor even though the items themselves are not highly correlated. Since many of the reported item communalities are rather low, it is likely that the inter-item correlations are also small. If the inter-item correlations are low, then the factors are not likely to have much practical significance.

The Dewer et al. Study

Dewer et al. (1980) identified a single technology factor in the Aiken and Hage (1968) instrument which they labeled "routineness". This is the same scale which Lynch (1974) identified as "overall routineness".

Dewer et al. (1980) determined that the items used to measure routineness had a higher average intercorrelation with each other than they did with items used to measure other concepts. That is, the routineness scale demonstrated good convergent and discriminate validity. This study is discussed in more detail in the review of structural dimensions.

Conclusion

The four studies reported here have not adequately tested the ability of the instruments to measure the concepts reviewed in this paper. The Lynch (1974) results, however, do suggest that it may be possible to use self-report questionnaire instruments to measure Perrow's (1967) and Thompson's (1967) technology concepts.

The following questions remain unanswered.

1. Do all of the instruments measure the same concept?
2. Do all of the instruments that claim similar dimensions measure the same dimensions?
3. Do the instruments apply in a wide variety of situations?
4. What are the dimensions of these measures?
5. Do the instruments adequately reflect present theories?
6. What is the relationship among the various factors?

The present study addresses these questions.

Structure Concepts Underlying Selected Questionnaire Measures of Organizational Structure

A General Concept of Organization Structure

There are at least two distinct concepts of organizational structure commonly in use in the current literature. One concept of organizational structure refers to physical characteristics of organizations or what both Miller (1978) and Dalton et al. (1980) call structural variables. Physical characteristics have been used frequently in the sociotechnical approach to study organizations. For example, Whyte (1948), in studying New York restaurants, used variables such as the number of waitresses, of cooks, of supervisors, and of managers; the number of customers served per waitress; the distance between the pantry and kitchen; the height of the barrier between waitresses and countermen; and changes in these numbers at different times. Trist and Bamforth (1951) referred to the number of men working in coal mine crews; the number of deputies; the size of the work area as longwall or short-face; the size of the confinement for work crews as 200 yards long by 2 yards wide, by 1 yard high. Recently, Dewar and Hage (1978) proposed a theory of complexity using similar variables.

The other concept of organization structure refers to the decision making and control processes of an organization. Most of these concepts originate with the series of studies on organizational decision making by Simon (1957), March and Simon (1958), and Cyert and March (1963). Certain aspects of Thompson's (1967) and Perrow's (1967) concepts of organization structure were drawn from this line of thought. The measures selected for the current study are based on the organizational decision making aspects of Thompson's (1967) and Perrow's (1967) concepts.

Thompson's Concept of Organization Structure

Thompson (1967) discussed several aspects of organization structure. One aspect of interest in the present study he defined as the social structure of an organization: the differentiation and linkages of the individuals in an organization. Thus, in Thompson's view, the social structure of an organization serves a dual function: (a) separation or specialization, and (b) integration.

The separation function of social structure operates by creating numerous spheres of bounded rationality, i.e., limits on the information one must consider in performing one's job (March and Simon, 1958; Cyert and March, 1963). For example, a job defines the output for which a job holder is responsible as well as the standards of adequacy and efficiency by which the job output will be judged. Jobs also place restrictions on the control a job holder has over resources and other organizational matters. These standards and restrictions then identify and limit the information a job holder is required to consider in performing the job. Requisite information is limited to that which is directly related to the resources and matters affecting the quality and economy of the job output. All other information is associated with factors beyond the direct control of the job holder and is therefore not directly relevant to the job holder's decisions.

The integration function refers to the facilitation of coordinated action among interdependent bounded elements. Interdependence and coordination are the operative terms here which are described as follows and are based on the concepts proposed by March and Simon (1958).

1. Interdependence--the ways in which resources are shared by various bounded elements.
2. Coordination--the methods used to control the timing of the sharing of these resources and maintenance of the quality of the resources.

For example, in a mass production assembly line, each job is a <u>bounded element</u> that is assigned certain equipment and operations that are under the control of the job holder. However, the jobs are <u>sequentially interdependent</u> in that each job depends on the preceeding job for the raw material (a resource) on which operations will be performed. To continue the example, these sequentially interdependent jobs may be <u>coordinated by standardizing</u> the time allowed for each operation.

Thompson (1967) discusses other combinations of interdependence and coordination in addition to those mentioned in the example. However, the example is sufficient for the purposes of the present discussion. First, as noted above, spheres of bounded rationality limit a job holder's information requirements to information from activities directly under the job holder's control. Second, interdependence describes the location of information regarding activities not under a job holder's control, but activities which may affect the ability of the job holder to meet output standards. Third, interdependence also describes the order in which this "external" information must be assembled to make decisions about the total production process. Finally, coordination describes the way decisions are codified to produce concerted action.

Thus, Thompson's concept of social structure may be understood as a description of decision making and control processes in an organization.

Perrow's Concept of Organization Structure

Perrow (1967) defined one aspect of organization structure, task structure, as the relationship between persons with respect to the technology being employed by those persons. Perrow's concept of task structure was very similar to Thompson's concept of social structure, primarily because both concepts drew heavily from the March and Simon (1958), Cyert and March (1963) work. Task structure was described by two dimensions which Perrow labeled (a) control and (b) coordination.

The concept of control focused on the latitude in decision making allowed a person in performing assigned tasks. Control consisted of the following two subdimensions:

1. Discretion--the degree to which choices among means and judgments about the critical and interdependent nature of the tasks are allowed to be made by the job holder, and

2. Power--the degree to which the job holder can mobilize scarce resources and control definitions of various situations (Perrow, 1967, p. 189).

As with Thompson's concept of structure, Perrow's control dimension described the scope of a job holder's sphere of bounded rationality, i.e., the range of activities, resources, and other matters over which the job holder has direct control.

The concept of coordination focused on the type of control used to regulate interdependencies. Controls may range from those based on prior decisions such as rules and policies, to the use of current information (feedback) to make current decisions regarding technological processes. Both Thompson and Perrow drew on March and Simon's (1958) concept of coordination. Perrow quotes March and Simon as follows:

> 'Coordination by planning refers to the programmed interaction of tasks, which interaction is clearly defined by rules or by the very tools and machinery of the logic of the transformation process. Coordination by feedback, on the other hand, refers to negotiated alterations in the nature of sequences of tasks performed by two different units' (Perrow, 1967, p. 199).

Thus, for both Thompson and Perrow, the concept of coordination described the degree of codification in decisions that are intended to produce concerted action. Codification may range from highly formalized decisions, such as rules, to negotiated temporary understandings that are site adequate.

Social Structure and Hierarchy

Coordination is an overriding problem in complex organizations. Thompson (1967) argued that as organizations are divided into smaller rational units (e.g., departments, jobs) the primary contingency becomes one of coordination, i.e., managing the interdependence between the units. Thompson (1967) and Galbraith (1977) both argue that those sets of units (jobs) that are least ameanable to highly formalized coordination are brought together as a work group under the same supervisor. The supervisor is then responsible for the information regarding interdependence among jobs in the workgroup that is not part of the responsibility of individual job holders.

Likewise, those sets of workgroups least ameanable to highly formalized coordination are brought together as departments under the same manager. Each level of management represents a higher level in the information and decision making hierarchy of the organization.

Organizations vary in the number of hierarchical levels they contain. In addition, organizations vary in the scope of decisions that are reserved for, or deferred to various hierarchical levels. For example, the timing of various jobs may be deferred to the highest hierarchical level in some organizations. In other organizations the same timing decisions may be reserved for individual job holders to negotiate among themselves.

Organizational Structure as an Analytic Variable

Through the concepts of interdependence and hierarchy, organizational structure may be described in terms of decision making parameters within and among individual jobs and aggregations of those jobs. A number of attempts have been made to operationalize analytical variables of organizational structure based on aggregations of individual job characteristics. A representative sample of such attempts is included in the present study.

The Concepts of Structure vs. the Concepts of Technology

It is somewhat difficult to distinguish clearly between the concepts of technology and structure. As noted earlier, this difficulty is particularly evident in the concept of interdependence. However, for both Thompson (1967) and Perrow (1967), the primary distinction between the concepts of technology and structure is that technology refers to the transformation of objects into the output of the organization while structure refers to the transformation of information related to the technology. Or as Perrow (1967) puts it in somewhat different terms:

> The distinction between technology and structure . . . basically is the difference between an individual acting directly upon a material that is to be changed and an individual interacting with other individuals in the course of trying to change that material (p. 195).

Empirical Factors That Have Been Identified for Organizational Structure

Empirical Factors and Conceptual Dimensions

Unlike the thinking and research on technology where little agreement exists, there is growing agreement in the literature (Dalton et al., 1980; Ford and Slocum, 1977; Fry, 1982) on the basic dimensions of structure. Table III lists the major theoretical dimensions incorporated in the present study.

TABLE III

DIMENSIONS OF STRUCTURE USED IN THE PRESENT STUDY AND THEIR DEFINITIONS

Centralization	Concentration of the locus of formal control or power within a system (Ford and Slocum, 1977, p. 562).
Formalization/Standardization	The extent to which limits on behavior and procedures of organizational components are described in writing (Dalton et al., 1980, p. 58). Some researchers have used these as separate dimensions.
Discretion	Judgments related to choices among means and to determination of critical aspects of problems (Perrow, 1967, p. 198).

The centralization and discretion dimensions refer to Perrow's (1967) control dimension, i.e., the scope of a sphere of bounded rationality. The formalization/standardization dimension refers to both Thompson's (1967) and Perrow's (1967) coordination dimensions. As noted above, these dimensions have gained some acceptance in the literature.

Thompson's (1967) concept of interdependence was presented as a dimension of structure in the above discussion. This is consistent with the view presented by James and Jones (1976). However, the interdependence dimension does not appear in Table III. Since the instruments included in the present study view interdependence as both technology or structure, the dimension is excluded from the table. Although difficulties with the interdependence concept are highlighted in the present paper, the resolution of these difficulties is left for future conceptual and empirical development.

Empirical Factors and Subfactors of Structure

Table IV summarizes the empirical factors and subfactors of structure found in two studies that examined instruments used in the present study. Dewer et al. (1980) suggested several subfactors for the concepts of centralization and formalization based on Aiken and Hage's (1968) instrument. Lynch (1974) developed a measure for "job autonomy" which she found to be distinct from her measure for rules. Each of these studies is discussed below.

TABLE IV

EMPIRICAL FACTORS THAT HAVE BEEN IDENTIFIED FOR PERROW'S AND THOMPSON'S ORGANIZATION STRUCTURE CONCEPTS

Study	Centralization	Formalization/ Standardization	Discretion/ Autonomy
Comstock and Scott (1977)	Centralization of ward decision making	Standardization of ward policies	
Dewer et al. (1980)	Participation; Hierarchy	Job codification; Job specificity; Rules observation	
Lynch (1974)		Rules	Job autonomy

<u>The Dewer et al. Study</u>

Dewer et al. (1980) examined the Aiken and Hage (1968; 1969) instrument for possible subfactors. Aiken and Hage (1968), using factor analysis to evaluate their newly constructed instrument, identified factors which they labeled "centralization" and "formalization". Dewer et al. reexamined the scale items logically and suggested that the following subscales or subdimensions would better describe the structure of the instrument.

Centralization

Participation
Hierarchy of Authority

Formalization

Job Codification
Job Specificity
Rules Observation

The Dewer et al. study used three waves of data collected in social service organizations (Hage and Aiken, 1964, 1968, 1969) plus data collected in one study of manpower organizations (Whetten, 1974) to evaluate the adequacy of their proposed subscales.

Analysis and Results. As shown in Table V, with the exception of the job specificity subscale in the manpower data, all of the suggested subscales demonstrated good reliability using Cronbach's (1951) coefficient alpha (an indicator of the internal consistency of a scale).

The convergence and discrimination among the Dewer et al. (1980) subscales was evaluated using the median inter-item Pearson correlations among the items. Convergence is indicated in Table V by a high median inter-item correlation among items on each of the subscales. Discrimination is indicated by a low median inter-item correlation among items from different subscales, reported in the table as off-diagonal correlations. The table indicates the following results:

1. The participation and the hierarchy subscales of centralization each had good item convergence and each had good discrimination from other subscales.
2. The rules subscale of the formalization dimension had good item convergence but poor discrimination from other subscales.
3. The job codification and job specificity subscales of formalization each had moderate item convergence. Both had poor discrimination from other subscales.

Conclusions. The lack of convergence and discrimination among some of the subscales could indicate that the subscales proposed by Dewer et al. (1980) are not adequate and therefore do not provide any

TABLE V

MEDIAN INTERITEM AND MEDIAN OFF-DIAGONAL CORRELATION COEFFICIENTS AND RELIABILITY COEFFICIENTS OF SUBSCALES PROPOSED FOR THE AIKEN AND HAGE (1968) INSTRUMENT BY DEWER ET AL.

Scales	1964 N = 16 Inter-item	Off-Diag.	1967 N = 16 Inter-item	Off-Diag.	1970 N = 16 Inter-item	Off-Diag.	Manpower Organizations N = 72 Inter-item	Off-Diag.
1. Centralization, participation	.885	.420	.847	.612	.813	.447	.658	.216
4 items	α = .95		α = .92		α = .93		α = .81	
2. Centralization, hierarchy	.519	.302	.858	.311	.757	.322	.371	.197
5 items	α = .79		α = .96		α = .93		α = .70	
3. Formalization, job codification	.439	.200	.338	.312	.681	.322	.464	.204
5 items	α = .72		α = .76		α = .85		α = .67	
4. Formalization, job specificity	(Not measured		.392	.324	.386	.278	.223	.190
6 items	in this wave)		α = .76		α = .76		α = .45	
5. Formalization, rule observation	.916	.693	.962	.642	.916	.691	.815	.460
2 items	α = .88		α = .93		α = .92		α = .73	

Source: Dewer, Whetten, and Boje (1980).

appreciable increase in the information gained from the original Aiken and Hage (1968) centralization and formalization dimensions. However, in discussing the results, Dewer et al. suggested two alternative explanations. First, the moderate convergence in the job codification subscale may have been due to the presence of two items that seem closer to the concept of autonomy, a subdimension not included in their analysis. Second, they suggested that the poor discrimination of the job specificity subscale may have been due to the presence of two items that appear closer to the concept of centralization than to formalization.

Methodological Questions. There are several methodological questions in the Dewer et al. (1980) study. First, the original Aiken and Hage (1968) scales and dimensions were not reevaluated using the complete data available in the Dewer et al. study. Thus, it is not possible to directly compare the adequacy of the Dewer et al. subscales with the adequacy of the original Aiken and Hage scales on the same data set.

The second question is a result of constraints imposed by one purpose of the Dewer et al. (1980) study and the available data. A major purpose of the study was to evaluate the ability of the instrument to measure organizational level characteristics. The small sample size (16 social service organizations, 72 manpower organizations) relative to the number of items analyzed (26 items) made factor analysis inappropriate. Nunnally (1978) suggested that a factor analysis should have a ratio of at least 8:1 respondents to items. Therefore, the authors used the median of Pearson correlations among items to evaluate the structure of the instrument.

The strategy of using Pearson correlations did avoid some of the idiosyncrasies of the factor analysis model. However, the use of Pearson correlations did not significantly reduce the likelihood that a number of the 676 correlations required for the analysis were spurious. To compound the problem, the authors did not report significance levels for any of the correlations. Thus, it seems likely that the factors evaluated on the basis of these few respondents are unstable.

Dewer et al. (1980) did not evaluate the usefulness of the Aiken and Hage (1968) scales or their own proposed subscales in measuring characteristics of structure within various subunits of the organizations. Although this is not a methodological deficiency in their study, it is an important and interesting question. When decision making is decentralized in complex organizations, it is probably not reasonable to assume that the decision making structure of each organization subunit is the same. Thus, it would be useful to determine which instruments are able to describe differences in the structure of subunits.

The Lynch Study

The Lynch (1974) study, discussed earlier in the review on empirical factors of technology, also included two scales intended to measure structure. Principal components factor analysis was used to analyze the responses for library departments. Two of the empirical factors were labeled "rules" and "job autonomy". The scales for these factors had adequate reliabilities (alpha = .7, .7 respectively). Both of the scales were unidimensional[1] and independent.[2]

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[1]Unidimensionality in factor analysis is indicated when all items on a scale load on one single factor.

[2]By mathematical definition, all factors in principal components analysis are constructed to be independent.

Summary

Few studies have directly evaluated measures of analytical variables of decision making and control characteristics of organizational structure. Of the measures that have been constructed, centralization and formalization are the most frequently operationalized dimensions.

The Dewer et al. results suggested that both the centralization and formalization dimensions may contain useful subdimensions. However, because of the low respondent to items ratio in their study, the suggestion remains very tentative. The Lynch (1974) results showed that autonomy could be an additional subdimension of centralization. Finally, the relatively poor results Lynch found with her interdependence scales pointed out the difficulties that can result from the ambiguity in the concept of interdependence as it relates to organization technology and structure.

Evidence of Construct Validity Among Technology and Structure Instruments

Four studies have performed some type of construct validity analysis using the instruments incorporated in the present study. Three levels of analysis within organizations were considered in these studies, the individual job incumbent, organizational subunits, and organizations as a whole. None of the studies have compared the same instruments at the same levels of analysis. Thus, it is difficult to draw very many conclusions regarding the overall validity of the dimensions presented here. Table VI summarizes the results presented in this section. Each row shows the dimensions that were evaluated in the study. Overall, the

TABLE VI

EMPIRICAL EVIDENCE FOR CONSTRUCT VALIDITY AMONG MEASURES OF ORGANIZATIONAL TECHNOLOGY AND STRUCTURE

	Structure Scales Which Converge and Which Discriminate from Technology Scales	Technology Scales Which Converge and Which also Converge with Structure Scales	Technology Scales Which Converge and Which Discriminate from Scales in Columns 1 and 2
Individual Level:			
Pierce and Dunham (1978)	Formalization Centralization Autonomy		Routineness Variability Skill Variety
Comstock and Scott (1977)	Standardization		Task Predictiability
Subunit Level:			
Lynch (1974)	Rules	Interdepartmental task interdependence	Library technology
Comstock and Scott (1977)	Standardization		Workflow predictability
Organization Level:			
Dewer et al. (1980)	Centralization Rules		Routineness

table presents a fairly strong argument for the validity of measures of technology relative to measures of structure. In four studies performed at three levels of analysis, only one scale, Lynch's (1974) interdepartmental task interdependence scale, did not converge with the dimension it purported to measure. In addition, the structure scales consistently discriminated from technology scales. Each of the levels of analysis and each of the studies is discussed below.

The Individual Level

There is some evidence of construct validity among technology and structure scales at the individual job incumbent level of analysis. Pierce and Dunham (1978) studied Aiken and Hage's (1968) instrument along with Van de Ven and Delbecq's (1974) variability and predictability of technology scales and three measures of job characteristics (Hackman and Oldham, 1975; Schuler, 1973; Sims et al., 1976). Pierce and Dunham (1978) used oblique factor analysis and a multitrait-multimethod matrix to determine the convergent and discriminate characteristics among the scale. Scales measuring the structural dimensions "formalization", "centralization", and "autonomy" converged to form a single dimension that was distinct from a technology dimension. The technology dimension consisted of scales purporting to measure routineness, variability, and skill variety.

Also at the individual level of analysis, Comstock and Scott (1977) used partial correlation analysis to demonstrate that their technology scale, "task predictability", was not directly related to one of their structure scales, "standardization".

The Subunit Level

Evidence of construct validity among measurement scales used at the organizational subunit level of analysis is not as consistent as that presented above for the individual level. Lynch (1974) aggregated individual responses within library departments (organizational subunits) to produce a subunit score which was then analyzed as a single response. In a second order factor analysis, three subfactors combined to form a single factor which she labeled library technology. The library technology factor was orthogonal to (i.e., independent from) another second order factor identified as a structural dimension that was made up of her "rules" and "interdepartmental task interdependence" scales.

The Lynch (1974) result was not completely consistent with the concepts presented in the present paper.

The Lynch (1974) results reinforce the earlier discussions in the present paper regarding inconsistencies in the treatment of the concept of interdependence. Rules are a characteristic of structure and, as was the case with Lynch's findings, should be distinct from the technology scales. However, "internal task interdependence" and "interdepartmental task interdependence" are often thought of as characteristics of technology and should not combine with a structure variable, the "rules" scale.

In the Lynch (1974) study, the "internal task interdependence" scale did not load significantly on any of the second order factors and was excluded from further analysis. This lack of significance may indicate that "internal task interdependence" was measuring an individual level factor that was not closely related to the subunit level factors measured by most of her other scales. Another explanation may be that the "internal task interdependence" scale was simply a poorly designed scale that produced mostly random error and did not measure anything.

A more interesting result found in the Lynch (1974) study was the convergence between the "rules" scale and the "interdepartmental task interdependence" scale. It is possible that the second order factor convergence between these two scales was an artifact of the 15 library departments included in Lynch's study. It may also be possible that the item reading "In my job there is emphasis on the actual production records" on the interdependence scale was too similar to items on the "rules" scale such as "There are a lot of rules, policies, procedures, and standard practices one has to know in order to do his work well in this department" (Lynch, 1974, pp. 355-356), to clearly measure interdependence. Finally, it may be that this particular interdependence scale measures a characteristic of structure rather than technology.

Comstock and Scott (1977) showed that their measure of subunit level technology, "workflow predictability", was not directly related to one of their measures of structure, "standardization". Although the partial correlation analysis they used does not clearly establish these two measures as representing separate dimensions by indicating how individual items load on separate factors, it does indicate that the measures are different. A more complete analysis of the Comstock and Scott scales would be desirable.

The Organization Level

At the organization level of aggregation[3], Dewer et al. (1980),

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[3]At the organization level of aggregation, all respondents' scores in the whole organization are aggregated to produce a single score.

using median inter-item correlations showed that Aiken and Hage's (1968) "routineness" scale had a high degree of discrimination from Aiken and Hage's structure dimensions. The Dewer et al. study has already been discussed in detail in the review of empirical factors of structure. The present result simply adds additional support to the possibility that valid measures exist or may be developed to measure technology and structure as distinct concepts.

Summary

Results from the studies discussed in the present section suggest that general dimensions for both technology and structure have been operationalized and that these dimensions are distinct. It should be recognized, however, that this statement is based largely on the Aiken and Hage (1968) scales. Two of the three studies cited in Table VI (p. 41) directly examined the Aiken and Hage instrument or adaptations of it.

The Comstock and Scott (1977) study is the only validity study that did not use scales from the Aiken and Hage instrument. However, the Comstock and Scott study does not compare their measures to the Aiken and Hage scales. Thus, it is not possible to determine to what extent the two instruments are measuring similar concepts.

The primary conclusion that can be drawn from the results presented in the present section is that there is evidence for the validity of the Aiken and Hage (1968) instrument. However, it is not possible to make any statements about how other measures of technology and structure included in the present study compare with each other at any level of analysis.

The Validity of Measures of Technology and Structure Across Different Levels of Aggregation and Levels of Analysis[4]

Two Views of Levels of Analysis

There are two views of what is meant by levels of analysis. Presently, the most widely accepted view in the organization literature treats units at each level of analysis as wholes that are qualitatively different from units at any other level and whose characteristics are not dependent on the characteristics of units at any other level of analysis. An influence of the holistic view on current methodology is seen in the repeated call for researchers to improve current measures by making the subunit the object of questions intended to measure subunits and to avoid questions where reference is made to the individual's job (Comstock and Scott, 1977; Dewer et al., 1980; Rousseau, 1978; Sathe, 1978).

A less frequently held view that has recently been proposed for organization research is more compositional, treating units at each level of analysis as synergistic wholes.[5] Under this view, the characteristics of subunits are largely a result of the composite

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[4]Level of aggregation refers to the aggregation methods used to represent analytical variables at different levels of analysis. The individual level does not aggregate responses across respondents. The subunit level aggregates responses across respondents within the same organizational subunit. The organization level aggregates responses across all respondents within the same organization.

[5]For a comprehensive discussion of the need to develop theories and methodologies that address compositional issues see Roberts, Karlene H., Hulin, Charles L., and Rousseau, Denise M., Developing an Interdisciplinary Science of Organizations, San Francisco, California, Jossey-Bass, 1978.

characteristics of their component parts. However, because the composite is synergistic, the subunit is more than the sum of its parts, having characteristics that are not found in the individual components. Thus, the compositional view is not totally reductionist, but is closer to what Simon (1969) describes as nearly decomposable systems.

Each of these views may produce useful information about organizations. However, the adequacy of measures intended to reflect the different views must be judged by different criteria. The following example may help clarify the issues involved in the two views.

Tasks of an academic department (subunit level) may be routine depending upon the number of disciplines contained within the department. A department of organizational behavior may have very routine tasks if the same schedule of courses and the same kinds of research projects are carried out every year. However, individual professors within the department may experience considerable variety if they teach different courses each semester and frequently start research projects or consulting relationships in new areas.

If the holistic view is applied to the above example, an aggregated variable of subunit technology could be measured by the mean of department members'responses to the question: "How much does the department change its course offerings from one semester to the next?" An adequate holistic measure of subunit technology would indicate that the subunit has a highly routine technology (i.e., the same courses are taught every semester).

However, if the compositional view is applied to the above example, an aggregated variable of subunit technology could be measured by the mean of the department members' responses to the question: "How many of the courses you teach are different from one semester to the next?" A valid compositional measure of subunit technology would indicate a relatively low degree of routineness (i.e., many of the courses individual members teach are different from one semester to another).

It is likely that holistic measures of subunit technology in the above example would relate to holistic measures of structure differently than they would relate to compositional measures of structure. Likewise, compositional measures of technology probably relate differently to holistic measures than to compositional measures of structure. How these various measures should relate to each other is a matter for theory development and is not the subject of the present paper. Here the need is to identify the view being represented by a measure and the adequacy of the measure to represent that view.

Aggregated Data and the Differences Between Global and Analytic Variables

As discussed earlier in the paper, global variables are ones which are not divisible across individuals. Thus, global variables represent the holistic view. Analytic variables were described previously as being based on aggregations of individual characteristics which is consistent with the compositional view.

In the preceding example, however, aggregated measures were suggested for both global variables in the holistic view and analytic variables in the compositional view. Roberts (1978, p. 84) points out that "when several global data are combined (regardless of how), we have aggregate data." However, the variable is still global. The aggregation process alone cannot be used to identify or distinguish between analytic and global variables.

When a respondent answers a question that refers to the subunit of which he or she is a member, as opposed to a question about his or her job, that is a global datum. When the answers of several respondents to this same question are averaged to form a single subunit response, that is an aggregated global datum. The empirical question then, is which of these two global datum is most useful? All of the measures in the present study that were originally intended to measure the subunit level of analysis were presumed to be aggregated global measures by their authors. Thus, differences in the adequacy of aggregated global measures is an issue in the present study.

The primary argument for aggregating global responses is that it will reduce bias in measures of subunit characteristics. The argument assumes that any single judge will be somewhat biased in his or her evaluation. It further assumes that the different biases are randomly distributed and that by averaging the responses of several judges the biases will cancel each other. The resulting score then is presumed to be an unbiased measure of the characteristic of interest (Roberts et al., 1978).

The primary argument against using global aggregations is that they ignore potentially important information and make interpretation of results difficult (Roberts et al., 1978). When the judges are members of the subunit being evaluated, it is likely that the biases in their judgments are, in part, associated with differences among the different jobs they perform.

As noted, the aggregation of a global datum treats biases associated with different individual jobs as random error, thus overlooking potentially important information. Furthermore, when the subunit characteristics are used to describe various subunit behaviors, the characteristicis of individual jobs treated as error variance may have a greater influence on the behavior than do the "true" characteristics. If both individual and global data are not available, the case in the present study, it is difficult to interpret what the aggregated global data alone mean. That is, one cannot determine to what extent the results are actually due to a systematic bias that was treated as error variance.

Thus, in the present study, the level of aggregation issue is reduced to evaluating the homogeneity of responses and to determining whether there is potentially a systematic bias in the various aggregated global measures.

Aggregation Questions in the Current Literature

Units Used to Study Levels of Analysis. Rousseau (1979) identified three general levels of analysis that have been used in organizational studies: the individual, the subunit, and the organization levels. Appendix A lists some of the organizational units that have been studied at the three levels of analysis. Table VII summarizes the results from Appendix A by the types of units used at each level.

The organizational level of classification focuses on units that contain the highest level decision makers of a firm, or on autonomous units in a firm. The subunit level classification focuses on units that contain no one above the intermediate decision making level. The individual level focuses on individual job holders, usually at the lowest decision making level.

TABLE VII

UNITS USED IN PAST STUDIES TO REPRESENT THREE LEVELS OF ANALYSIS

Levels of Analysis	Types of Units
Organization	Independently owned organizations Geographically remote divisions under a common ownership Local offices of federal agencies
Subunit	Departments in relatively close geographic proximity Hospital wards Various kinds of workgroups
Individual	Members of organizations Members of departments Members in similar jobs within a workgroup, a department, or organization Individuals with individual differences

Many of the units studied within these levels of aggregation are not comparable. For example, workgroups, sections, departments and divisions could all be considered organizational subunits. Yet, the technology performed or decisions made within each of these subunits may be quite different. In terms of Salancik and Pfeffer (1978), the enacted environments and social relationships in each of these subunits are likely to create patterns and meanings associated with those patterns that are quite different.[6]

[6] Enacted environments describe the meaningful external relationships an individual recognizes as a result of the actions he or she pursues. When a person is asked about their workgroup rather than the division they are in, vastly different sets of experiences and relationships may be recalled.

For example, the enacted environments of individual workers and their supervisor may be, but are not necessarily different. For some supervisors, the primary enacted environment may be the individual workers' jobs. If all the workers in the workgroup perform the same set of routine tasks under close supervision, all workers and supervisors are likely to share highly similar meanings toward the tasks.

When the enacted environments of all respondents are highly similar, one would expect very little difference among responses. Thus, in highly homogeneous environments individual jobs should not produce systematic biases among the respondents in their global assessments of the subunit. This does not, of course, rule out the possibility of systematic biases due to individual differences among subunit members.

Methods of Aggregation. Lynch (1974) and Comstock and Scott (1977) discussed the importance of giving proper weights to supervisors' versus workers' responses in constructing analytical or aggregated global variables of organizational subunits. Lynch (1974) approached the problem by arguing that only those members of a subunit who actually perform the tasks are in a position to understand the technology of the subunit. Therefore, she argued, the appropriate aggregation is an unweighted average of workers' responses.

Comstock and Scott (1977) reasoned that supervisors also provide important global information about subunit technology and that this information should be considered in a measure of the subunit. However, the authors pointed out that there is insufficient empirical research to indicate the relative weight that should be given to the different respondents. Therefore, they weighted the supervisor's response equal to the average of all the individual members' responses.

The underlying assumption of these discussions is that there is not complete, or even a high degree of homogeniety in the positions of the respondents being asked to judge an organizational subunit. As both Comstock and Scott (1977) and Roberts et al. (1978) noted, the critical empirical question here is the degree of heterogeniety of responses within a subunit relative to the heterogeniety of responses between subunits. When the responses within a subunit are highly similar, the question of weighting becomes irrelevant.

However, as the heterogeniety of responses within a subunit becomes greater, and especially when the heterogeniety of responses within a subunit is greater than that between subunits, the aggregation question becomes critical. Comstock and Scott (1977) and Roberts et al. (1978) have suggested different solutions to this problem. When greater heterogeniety occurs, Comstock and Scott suggested seeking weighting methods that produce the most useful data. Roberts et al., however, argued that under great heterogeniety, too much information is lost through aggregation and suggested that the investigator should use the individual data unaggregated and seek other methods of constructing global measures.

Thus, in the present study, the homogeniety or heterogeniety of responses within and between units at the individual and subunit levels of analysis is a critical question in evaluating the adequacy of certain measures.

Adequacy of Measures. Pierce and Dunham (1978) compared instruments intended to measure individual level job characteristics, with the unaggregated responses to instruments intended as measures of aggregated global variables of technology and structure. A construct validity analysis showed that the unaggregated responses intended to create aggregated global variables produced the same results as the responses to the job characteristics items. That is, it appeared that the unaggregated responses for subunit level variables actually measured individual job characteristics. Pierce and Dunham (1978) however, did not evaluate the aggregated responses or compare aggregated responses to the individual level responses.

Rousseau (1978), using a construct validity analysis, compared aggregated responses of subunit members to global technology variables, with unaggregated global evaluations of the same subunits made by expert judges. The aggregated global variables produced the same results as the unaggregated global variables. In addition, the aggregated global variables did not explain any additional variance already explained by the unaggregated variables. The author concluded that the two types of variables measured the same concepts and that the interpretation of the unaggregated variables was less ambiguous.

Finally, Comstock and Scott (1977) constructed two sets of measures to assess technology and structure concepts at the individual and subunit levels of analysis. Using partial correlation analysis, the authors determined that the individual level measures were not directly related to the subunit level measures. That is, the individual level measures apparently measured something other than what was measured by the subunit level measures.

Summary

Questions have been raised regarding the meaning and adequacy of measures of similar concepts observed at different levels of analysis. It has been shown that the process of aggregation itself does not necessarily produce analytic variables and that many of the questionnaire based subunit measures currently in use are actually aggregated global variables. Some authors question whether it is proper to use aggregated global variables under any condition. The empirical question remains open. There is still very little information on the relative meaning or adequacy of unaggregated versus aggregated global variables. The present study does not answer all of these questions, but it does provide more information about characteristics of aggregated global variables.

CHAPTER III

OPERATIONALIZATION

Introduction

The present chapter discusses issues that were considered in the design and implementation of this study. As stated in Chapter I, the purpose of the study was to evaluate the adequacy of selected measures of technology and structure. Thus, the focus of the study was on characteristics of the instruments rather than on traits of the individuals and organization units used in the study. For example, the relationships among the scales that measured routineness and centralization were of prime importance. However, unlike studies of the traits themselves, the relationship between routineness and centralization in organization subunits was not of direct interest.

The earlier chapters of this paper raised a number of questions about the instruments used in previous studies and about the designs of studies evaluating those instruments. Based on those questions and the purpose of the study, it was considered desirable to make the instruments used in this study comparable to those used in the previous studies.

The design of the present study was chosen to evaluate the range over which the instruments could measure technology and structure. Resource limitations required that the instruments be examined only at the individual and organization subunit levels of analysis. Thus, maximizing the variance in the technologies and structures among the individual jobs and subunits in the study was of greatest importance.

The primary inference question turned on the issue of whether the range of technologies (e.g., routine-nonroutine) and structures (e.g., centralized-decentralized) were representative of the range of jobs and subunits in which the instruments might be applied. The present study incorporated a wide range of individual and subunit technologies and structures as shown in the response characteristics to the questionnaire items listed in Appendix D and the ranges of scale scores reported in this chapter.

The remaining inference question was whether there was some factor that altered the relationships among the instruments from what might be expected in other studies? Since jobs and subunits were the units of interest, differences in organizations could have contributed an unwanted source of variance. This variation was kept to a minimum in two ways. First, when possible, analyses were performed within organizations. Second, the same type of organization, hospitals, was used in all cases.

For analytical reasons, this restriction in organization type was a strength in the design. However, this strength may also have been a weakness. There may have been some unique characteristic among hospitals that altered the meanings of the scales from what they would have been in other settings. Considering the wide variety of work units included in the present study, (e.g., housekeeping, intensive care, medical labs, accounting, etc.) it seems unlikely that such is the case. It is more likely that the differences in the nature of the individual and subunit tasks rather than the general tasks of the organization as a whole were the primary source of variance.

Five instruments were selected for the present study. Some of the instruments contained companion scales for both technology and structure. Comparison of the companion scales within a single instrument permitted conclusions regarding one study's operationalizations of the concepts. Comparison of similar scales across different instruments permitted conclusions regarding the degree of agreement that exists among different operationalizations of the same concepts from different studies. It was thought that such comparisons may help explain some of the inconsistent results reported in the studies cited in the previous chapters.

The following sections discuss the general setting of the study, the characteristics of the sample, and the survey design. Finally, each of the instruments selected for the present study is discussed in detail.

The General Setting

The theories discussed in Chapter II were intended to apply to all types of organizations. However, practical limitations in time and money made direct inference to all organizations impossible. Considering the relatively primitive state-of-the-art of current measures and theory in this area, such a comprehensive study would probably have been an inadvisable use of resources if they had been available. Therefore, the present study concentrated on assessing current instruments and measures at the individual and subunit levels of analysis. A few specific complex organizations that presumably contained a wide variety of technologies, raw materials, and structures at the individual and subunit levels were used. The results of this study may then be used to indicate the potential adequacy of the instruments and possible directions to take to improve their usefulness.

Hospitals were chosen as the setting of this study for the following reasons.

1. The author had a particular interest in health care organizations in general and hospitals in particular.
2. Hospitals contained many kinds of technologies which operated on a variety of raw materials. For example, both nursing units and medical laboratories used some highly sophisticated mechanical technologies yet the raw materials (e.g., people, tissue) were quite different; psychological care units used sophisticated social technologies on people; engineering and maintenance units used a variety of techniques on buildings and equipment.
3. Instruments were available in the current literature. Some were specifically designed to evaluate technology and structure in nursing wards. Several of these specialized instruments were modifications of more general instruments. By using general and specialized instruments in the same study, some conclusions were possible about the range of usefulness of the general measures, and the gain achieved by the specialized instruments in specific settings.
4. Three hospitals in the immediate area agreed to participate in the present study.
5. Hospitals were labor intensive. This concentration of people made the collection of a relatively large number of individual responses more efficient.

The Research Setting

Three general acute care hospitals located in two cities in the same region of Oklahoma participated in the present study. Two were community hospitals of 110 and 140 beds respectively. The third hospital was a 90 bed private osteopathic hospital located in the same city as the smaller community hospital. Table VIII summarizes some of the important characteristics of these organizations as well as response rates experienced in each.

TABLE VIII

CHARACTERISTICS OF RESPONDENTS

Hospital	Number of Departments	Number of Individual Respondents	Total Number of Employees	Response Rate (Percent)
1	31	116	346	33.5
2	27	96	282	34.0
3	19	69	211	32.7
Total	77	281	839	33.5

A census of all hospital departments and personnel was taken in each hospital. Forty-three different types of hospital departments and 281 individuals were represented in the study. Departments included such diverse units as intensive care, housekeeping, medical laboratory, and accounting. Appendic C lists the kinds of departments included in the study, their number, and the number of employeed responding from each.[1] The variety of departments and employees included in the present study presented a greater degree of variance in the concepts being measured than was found in previous studies. The number of respondents at both levels of analysis was large enough to meet the objectives of the study.

The Questionnaire Design

The questionnaire used in the present study was titled the Organizational Characteristics Survey. The questionnaire was divided into seven sections. The first section requested personal data from the respondent. The last section asked the respondent to describe some of the duties of him or her job and to list the names of the people who reported to him or her as well as the names of the persons to whom he or she reported.

Each of the remaining five sections contained one of the five instruments evaluated in the present study. Items from these instruments and summaries of the responses to each item are listed in Appendix D. Each of the five instrument sections contained a separate set of instructions advising the respondent about the content of the section and how to register his or her responses. When required by the instruments, sections were subdivided into parts with labels and appropriate instructions for each part.

Two forms of the questionnaire were constructed: one was administered only to nursing personnel; the other was administered to all

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[1] It was not possible to determine the nonresponse rate from specific departments because of restrictions placed on the data collection phase of the research.

other personnel. The same instruments were contained on both forms. However, items referring specifically to nursing, nursing units, and nursing procedures on the nurses' form were modified to be consistent with the situations and experiences of non-nursing personnel on the other form.

Two versions of the questionnaire were also constructed. The first and last sections were the same in both versions. However, the instruments were randomly assigned among the remaining five sections in each version. That is, the order in which the instruments were presented to different respondents was different in each version. For example, the Hage and Aiken (1969) instrument appeared first in one version and fifth in the other version. This arrangement permitted the evaluation of an order effect.[2] Each form was produced in both versions and each respondent received only one version of one form.

Data Collection

Data were collected over a seven month period. However, data collection in each hospital was completed within seven days. Questionnaires were distributed in 7 1/4 by 10 1/2 inch envelopes through the hospital mail along with the employees' paychecks. Envelopes were labeled either "Nurses" or "General Support Personnel" and carried instructions on where the employee could exchange his or her envelope for a proper one as needed.

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[2] An order effect occurs when the order in which an instrument is presented in a questionnaire has an effect on the measurement characteristics of the instrument.

Each envelope contained a cover letter and questionnaire. Appendix E contains a copy of the cover letter.

Respondents were asked to put their name on the questionnaire and were assured that individual responses returned in the sealed 7 1/4 by 10 1/2 inch envelope would be kept confidential and would be seen only by the principal investigator. To encourage participation, employees returning their questionnaires before a specified time were eligible for a lottery. Dinner for two and $20 worth of groceries were given as prizes at a drawing held at the deadline for eligible returns one week after the questionnaires were distributed. The cover letter was signed by the principal investigator with an endorsement by the administrator of the hospital.

Employees completed the questionnaires on their own time and returned them to one of at least two centrally located collection boxes in the hospital. A reminder letter was sent to each employee through the hospital mail three days after the questionnaires had been distributed. A follow-up of the non-respondents was not possible under the conditions agreed to by the principal investigator.

Measurement Instruments Used in the Present Study

Two primary criteria were used to select the instruments included in the present study. The first criterion was that the instruments should represent a diverse sample of the questionnaire measures currently used for technology and structure concepts. This criterion was important because, to be effective, the multitrait-multimethod (M-M) matrix analysis (Campbell and Fiske, 1968) employed in the present study required a maximal difference among methods.[3] The second criterion was that a continuing interest in the instrument be demonstrated by its repeated use in the literature.

Technology Scales and Subscales

Four of the five instruments included in the present study contained technology scales. Table IX lists these four instruments and the seven scales and eight subscales included in them. The table also contains pertinent information about each scale or subscale including the number of items, the number of points in the response format, the range and type of reliability statistics reported and whether the scale or subscale was originally intended for use in all organizations or restricted to use in only a specific type of organization or organization subunit.

One objective of the present design was to make the results comparable with those from the studies cited in Chapter II. The results would have been most comparable if the respondents were presented with exactly the same questions and response choices used in the original scales. With the exceptions discussed below, the scales used in the present study did retain the same response formats and wording as the original scales.

Response Formats. Retaining the original response formats involved a trade-off. Using the original formats, rather than devising a uniform format, made it more difficult for respondents to locate their desired response. This inconvenience was a significant consideration. It took

[3]See Chapter IV in the present paper for a discussion of the (M-M) matrix method and its design requirements.

TABLE IX

CHARACTERISTICS OF TECHNOLOGY SCALES AND SUBSCALES[1]

Instrument	Scale/Subscales	Number of Items	Number of Points in Response Scale	Range of Reported Reliability Statistics: Coefficient Alpha	Range of Reported Reliability Statistics: Test-Retest	Target Population
Aiken and Hage (1968)	Task Routineness	4	5	.74 - .94	n.a.	General
Lynch (1974)	Library Technology/ Predictability of Events	2	9	.5	n.a.	Library Dept.
	Routinesness of Operations	2	9	.7	n.a.	"
	Insufficient Knowledge	3	9	.3	n.a.	"
	Overall Routineness	12	9	.9	n.a.	"
	Interdepartmental Task Inter-dependence	2	9	.5	n.a.	"
Overton et al. (1977)	Hospital Technology/ Uncertainty				n.a.	Nursing Care Units
	Instability				n.a.	"
	Variability				n.a.	"

TABLE IX (Continued)

Instrument	Scale/Subscales	Number of Items	Number of Points in Response Scale	Range of Reported Reliability Statistics: Coefficient Alpha	Range of Reported Reliability Statistics: Test-Retest	Target Population
Hitt and Middlemist (1978)	Technology Measurement Instrument					
	Time Perspective	1		n.a.	.88	General
	Task Complexity	6		.65	.75	"

[1] n.a. indicates the statistic is not available.

the average respondent about 40 minutes to complete the entire questionnaire. Such a lengthy and difficult questionnaire (some respondents thought the questions were hard to understand) required considerable concentration and effort from a respondent and having to adjust to different response formats increased the respondent's burden. It was reasoned that the primary effect of fatigue on the results would be to (1) reduce the number of completed items, and (2) increase response errors, reducing reliability estimates (Lin, 1976). However, it was thought that fatigue would have little effect on the basic factor structure of the instruments.

Another potential problem with using different response formats was avoided in the present study. The original formats were quite different in the possible values they could take. For example, the maximum value for one Aiken and Hage (1968) scale item was four while the maximum value for one of the Lynch (1974) scale items was nine. Thus, the values of the two scales were not directly comparable unless standard scores were calculated. In the present study, only correlation and factor analysis procedures were used in which standardization is part of each procedure. Thus, the need to calculate separate standard scores for the scales was avoided.

Wording of Questions. The scales originally intended for specialized target populations were modified in the following ways. As noted earlier, two questionnaire forms were used; one for nurses, the other for general support personnel. The Nurses Form retained the original wording on all of the scales except those items in the Lynch (1974) instrument that referred specifically to libraries. On those items, all references to libraries were changed to refer to hospitals.

More extensive changes were made to items on the General Support Personnel Form. The changes to the Lynch (1974) items were retained as they appeared on the Nurses Form. However, all references to nurses, Comstock and Scott (1977) items were changed to be consistent with the situations and experiences of personnel in the other units being surveyed. A comparison of the two versions of the Overton et al. (1977) and Comstock and Scott (1977) items permitted an estimate of the gain that can be realized from the use of specialized items.

Additional characteristics of the technology scales and subscales from each instrument are discussed below.

The Aiken and Hage Technology Scale. The Aiken and Hage (1968) routineness scale was based on the routineness dimension of Perrow's technology concept. The Aiken and Hage (1968) instrument, including the routineness scale, has received more use and attention than the other instruments in the present study and, therefore, is better understood and more widely accepted.

Hage and Aiken (1967, 1969) used two different aggregation schemes to score organizations and organizational subunits. All individual members' scores were aggregated by "social positions". However, "social position" was defined in two ways: (a) as the same occupational specialty at the same hierarchical level in the organization, and (b) as the same hierarchical level in a department (Hage and Aiken, 1969). Social position scores were the mean of the individual scores of people in a speciality or department. Thus, there was one score for each social position in an organization or subunit regardless of how many people occupied that position. Social position scores were aggregated for the organizations or subunits to produce an overall score. Both definitions of social position were used in the present study.

The Lynch Technology Scales. Lynch (1974) constructed two scales (library technology, overall routineness) based on dimensions of Perrow's (1967) technology concept. Two additional scales (internal task interdependence, interdepartmental task interdependence) were based on the Lawrence and Lorsch (1967) concept of task interdependence as a technology characteristic.

The "overall routineness" scale was adapted from the Aiken and Hage (1968) "routineness" scale. "The "library routineness" scale contained three subscales (predictability of events, routineness of operations, insufficient knowledge) that were based on characteristics of Perrow's (1967) technology concept. The "task interdependence" scales were adapted from the Lawrence and Lorsch (1969) instrument.

Lynch's (1974) "insufficient knowledge" subscale had poor reliability (alpha = .3) and probably contributed little to the measurement of library technology. The low reliability estimate suggests that either the subscale contained a great deal of random error (e.g., people didn't understand the questions) or that all of the items were not measuring the same concept. It was not possible to determine from Lynch's (1974) analysis which of the explanations was more probable. However, examination of the items suggested that the latter explanation may have been the major cause of the low estimate. Therefore, in an attempt to increase the scale's reliability, the subscale was modified by eliminating two of the original items and replacing them with two new items.

Four of Lynch's (1974) items did not load cleanly on any factor. Two of these items were eliminated in the present study, two others were retained with the expectation that they may be significant in the present study.

Lynch (1974) calculated individual level scale scores by summing the item scores. Organizational subunit scores were an unweighted average of the individual scale scores of full-time professional and clerical personnel in the subunit. The present study used the same scoring procedure.

The Overton et al. Hospital Technology Instrument. The Overton et al. (1977) technology instrument was a 34 item questionnaire that sought to reproduce Lynch's (1974) dimensions of task predictability, routineness of operations and task interdependence. The instrument was intended to measure the technology of hospital wards. A number of the items were adapted from Lynch's (1974) library technology scale and other sources specifically interested in hospitals (Kovner, 1966; Hasenfeld and English, 1974). Individual level scale scores were the sum of a respondent's item scores. Ward scores were the mean of the scale scores of staff personnel in a ward. The present study used Lynch's procedure to score this instrument.

As noted earlier, items in this instrument referring specifically to nursing, nursing units, or nursing procedures were modified on the General Support Personnel Form to be consistent with the other hospital subunits being surveyed.

The Hitt and Middlemist Technology Measurement Instrument. The Hitt and Middlemist (1978) Technology Measurement Instrument (TMI) was a seven item questionnaire that sought to measure technology in organizational subunits along two dimensions: (a) the time perspective of the tasks, and (b) the complexity of subunit's tasks. Time perspectives referred to the immediacy of the impact of an individual's tasks on departmental achievement. Task complexity was evaluated by the following characteristics:

1. personal job discretion,
2. the standardization and repetitiveness of the job, and
3. the task interdependence among jobs in the unit.

An interesting observation should be noted here. In Chapter II discretion and autonomy were used to describe characteristics of organization structure. However, the TMI and several other instruments not included in the present study (Hrebiniak, 1974; Mahoney and Frost, 1974; Rousseau, 1977), used discretion as an indicator of technology. It is likely that the sharing of this indicator between measures of technology and structure contributed to the lack of discriminate validity between this and other instruments in the present study.

The Hitt and Middlemist (1978) instrument drew on a slightly different line of development in measuring technology (Grimes and Kline, 1973; Mahoney and Frost, 1974) that was based more directly on Thompson's (1967) technology concept. Rousseau (1977, 1979) discussed the development of this perspective at some length. Thus, the Hitt and Middlemist instrument was the most different approach to measuring technology in the present study.

The Hitt and Middlemist (1978) instrument was unusual in another way also. The authors were primarily interested in measuring a composite of subunit characteristics that were associated with technology. That composite was then compared with another composite variable "climate" to predict individual and organizational behaviors. The authors made no attempt to evaluate the subdimensions of the instrument or to construct subscales. The instrument score was simply the total of the item scores.

The TMI represented the most extreme example of an aggregated global variable found in the present study. As noted earlier, the usefulness of such measures and variables is an empirical question that ultimately must be answered in the context of the studies in which they are used.

The original response format and scoring procedure for the time perspectives scale treated the scale as a single item. A respondent indicated what percentage of his or her time was spent working on matters in which results would be known in six increasingly lengthly time periods. This was an ipsative measure in that individuals were required to make their responses total 100 percent of their time. Individual level scores for this item were calculated by multiplying the response percentage by a value of one to six, assigned in increasing order to the longer time periods, and summing the result. Table X illustrates the scoring procedure.

No instructions were given on how to handle cases where responses did not total 100 percent. The original response format and scoring procedure was used in the present study. When percentages did not sum to 100, the "correct" figures were interpolated. For example, if a respondent gave the answers 60, 25, 25, they were interpolated 54, 23, 23, to total 100 percent.

TABLE X

SCORING PROCEDURE FOR THE TMI TIME PERSPECTIVES SCALE

Multiply the percentages by the numbers on the right and sum the resulting numbers. For example:

1 day to 1 week	10% x 1 = .1
1 week to 1 month	20% x 2 = .4
1 month to 6 months	40% x 3 = 1.2
6 months to 1 year	20% x 4 = .8
1 year to 2 years	10% x 5 = .5
2 years or more	0% x 6 = 0.0

Source: Hitt and Middlemist (1978).

To evaluate the reliability of the time perspectives scale, the scale was expanded in the present study by adding three new items to the original item. The scoring procedure for the modified scale was altered. Each of the item scores was standardized using the sample mean and standard deviation. The standardized scores were then summed for the individual, and the mean of the subunit members' individual scores were used to indicate the subunit score.

The task complexity scale contained six items, five of which use a six point Likert-type response format. A sixth item asked the respondent to indicate the amount of discretion he or she had over six listed activities, or to indicate that no discretion was allowed. A score of zero was given for the response "no discretion is allowed". Otherwise, the item was scored by giving one point to each discretionary activity and summing the points to indicate the item score. An individual's task complexity scale score was the average of the six item scores. Since five items on this scale had six possible points and one item had seven possible points, each of the item scores was standardized using sample means and standard deviations before individual scores were calculated in the present study.

The TMI score representing the level of technology in a unit was the sum of the average time perspectives scores and task complexity scores for the unit.

Structure Scales and Subscales

Three of the five instruments included in the present study contained structure scales. Table XI lists the three instruments and the six scales and seven subscales included in them. The table also contains information about the scales or subscales including the number of items, the number of points in the response format, the range and type of reliability statistics reported, and whether the scale or subscale was originally intended for use in all organizations or restricted to use in only a specific type of organization or organizational subunit.

The Aiken and Hage (1968) and Lynch (1974) scales and subscales were the companion structure scales to the technology scales listed in Table X for these instruments. The use of these two instruments allowed two evaluations of validity: (1) the convergence and discrimination among items within each instrument, and (b) the convergence and discrimination among scales and subscales between instruments. These comparisons gave some indication of the usefulness of each instrument by itself, as well as an indication of the degree to which the two instruments were measuring the same concepts. The

TABLE XI

CHARACTERISTICS OF STRUCTURE SCALES AND SUBSCALES*

Instrument	Scale/Subscales	Number of Items	Number of Points in Response Scale	Range of Reported Reliability Statistics: Coefficient Alpha	Range of Reported Reliability Statistics: Test-Retest	Target Population
Dewer et al. (1980) from Aiken and Hage (1968)	Centralization/ Participation	4	4	.81 - .95	n.a.	General
	Hierarchy	5	5	.70 - .96	n.a.	"
	Formalization/ Job Codification	6	5	.67 - .85	n.a.	"
	Job Specificity	5	5	.45 - .76	n.a.	"
	Rules Observation	2	5	.73 - .93	n.a.	"
Lynch (1974)	Rules	4		.7	n.a.	Library Dept.
	Job Autonomy	5		.7	n.a.	"
Comstock and Scott (1977)	Centralization of Ward Decision Making/ Routine Decisions	6	5	$\bar{r}_{ij} = .69$**	n.a.	Hospital Wards
	Policy Decisions	2	5	n.a.	n.a.	"

TABLE XI (Continued)

Instrument	Scale/Subscales	Number of Items	Number of Points in Response Scale	Range of Reported Reliability Statistics: Coefficient Alpha	Range of Reported Reliability Statistics: Test-Retest	Target Population
Comstock and Scott (1977)	Standardization of Ward Policies	8	5	$\bar{r}_{ij} = .$ **	n.a.	Hospital Wards

*n.a. indicates the statistic is not available.

**$\bar{r}_{ij}$ refers to the average interitem correlation, a statistic on which coefficient alpha is based (Nunnally, 1978).

Comstock and Scott (1977) instrument presented a somewhat different approach to measuring structure from the others included here.

As with the specialized technology scales and subscales used in the present study, the wording in the specialized structure scales was modified to be consistent with the units to which they were administered. A more detailed description of the scales is presented in the following discussion.

The Dewer et al. Subscales. Aiken and Hage (1968) originally proposed two dimensions of structure, centralization and formalization. Dewer et al. (1980) reevaluated the original Aiken and Hage (1968) instrument and proposed two centralization subscales (participation, hierarchy of authority) and three formalization subscales (job codification, job specificity, rules observation). The present study evaluated the adequacy of both the original Aiken and Hage dimensions and the subscale structure suggested by Dewer et al. (1980).

The same scoring procedure and definitions for social positions described earlier for Aiken and Hage's routineness scale also apply to the structure scales and are used in the present study.

The Aiken and Hage scales predated Perrow's (1967) and Thompson's (1967) concepts of structure. However, Perrow, Thompson, and Aiken and Hage drew heavily from the same concepts (Blau, 1964, 1965; Cyert and March, 1963; Hall, 1962; Homans, 1961; Jacques, 1956). The Aiken and Hage scales are highly consistent with the structure concepts attributed to Perrow and Thompson in Chapter II and in this sense may be recognized as measures of those concepts.

The Lynch Structure Scales. Lynch (1974) proposed and identified factors for two measures of structure: rules usage and job autonomy. The measures were constructed as companion structure scales to her technology scales. The structure scales used the same scoring procedures as described earlier for the Lynch technology scales. These procedures were retained in the present study.

The Lynch (1974) structure scales were conceptually similar to the rules observation and hierarchy of authority subscales identified by Dewer et al. (1980). The empirical similarity between the Lynch (1974) and Dewer et al. (1980) scales and subscales was evaluated in the present study.

The Comstock and Scott Structure Scales. Comstock and Scott (1977) used Aiken and Hage's (1968) definitions of centralization and formalization as a basis for their own indices. Although the definitions of the concepts were similar, the way Comstock and Scott (1977) measured them was quite different. Thus, the scales met the "different approach" criteria for inclusion in the present study. However, the Comstock and Scott scales were the only scales included in the present study that did not meet the second criteria, i.e., they had not been used in multiple studies. Since the scales were an interesting approach to measuring the centralization and formalization concepts and since the scales seemed to be potentially useful in the future, they were included in the present study.

The Centralization of Hospital Ward Decisions Index sought to measure the concentration of influence in hospital wards. The index was based on a four item scale that referred to four decision issues on a hospital ward (hiring, disciplinary action, adding staff positions, changing procedures). Two sets of data were compiled from the item, one for staff nurse influence and one for supervisor influence. Staff nurses and their supervisor responded to each item twice using Likert-type response formats. One response indicated the amount of influence staff nurses had regarding each issue. The other response indicated the influence supervisors had on the same issues.

The score for each of the four items in each data set were determined by combining the mean of the staff nurses' responses with the supervisor's response, weighting the nurses' mean response (n/2):1 with the supervisor's response where "n" is the number of staff nurses in the unit. The authors noted that this weighting scheme was a compromise between possibly underweighting the supervisor's perceptions by weighting all responses equally, and possibly overweighting the supervisor's response by weighting it equally with the mean of the nurses' responses.

The above procedure resulted in four composite influence scores for staff nurses and four composite influence scores for supervisors. Nurses' influence scores were subtracted from the supervisor's scores, then the differences were standardized and summed to indicate the centralization of decision making in the ward. The present study used the same scoring procedure at the subunit level of analysis. The decision issues were modified in the General Support Personnel Form to be consistent with the other hospital units surveyed.

The scale used for the centralization index was intended to be unidimensional. However, its low reliability in their study forced the authors to divide the scale into two dimensions. The first three items (hiring, discipline, adding staff) were highly intercorrelated

(.548, .600, .739) and were summed to indicate a single dimension labeled "routine decisions". The fourth item (changing procedures) was not highly correlated with the others (.114, .282, .349) and was treated as a second dimension labeled "policy decisions". The factor structure of the scale was evaluated in the present study using all four items. The final index was constructed on the basis of the resulting scale structure.

Comstock and Scott's (1977) Standardization of Ward Policies Index sought to measure the explicitness of procedures used in hospital wards. The index was based on responses to eight issues regarding the explicitness of procedures governing such things as attire, returing after illness, and giving baths. The issues were intended to relate to the conduct of activities of the ward as a whole or tasks that were highly interdependent with others on the ward rather than to the performance of individual tasks.

The index was administered and scored in much the same way as the centralization index. Each item score was determined by combining the means of the nurses' responses to the item with the supervisor's response to the item, giving a weight of (n/2):1 to the mean of the nurses' responses. This weighting scheme was used at the subunit level in the present study. All eight item scores were then summed to indicate the degree of standardization for the ward. The present study followed the same summation procedure at both the individual and subunit levels of analysis. Some items were modified on the <u>General Support Personnel Form</u> to make them consistent with the tasks performed in the other hospital units.

Summary

The five instruments discussed in this chapter served the purpose of the study. Several of the instruments contained companion scales for both technology and structure. However each also represented a somewhat different questionnaire approach to measuring the concepts. The companion scales permitted evaluation of the adequacy of single operationalizations of the concepts of technology and structure. Comparing the different instruments permitted evaluation of the consistency with which different researchers measure the same concepts. Finally, the different approaches used by the various instruments permitted evaluation of the relative usefulness of each approach under a variety of conditions. Administering both general and specialized scales to the same individuals and subunits permitted evaluation of the gain that might be expected from a more specific focus.

CHAPTER IV

ANALYSIS AND RESULTS

Introduction

Two sets of data were analyzed in the present study. One data set contained the responses of individual job incumbents in the organizations. The other data were the subunit responses that were constructed by aggregating the individual responses. Analyses for each set are reported separately in this chapter.

The individual level data were analyzed in four stages. Each stage of analysis focused on a particular issue. The following points indicate the issue addressed at each stage of analysis.

1. Design Issues--Several potential sources of unwanted or confounding variance were present in the research design. These factors were analyzed for their probable effect on the results in the following stages of analysis.
2. Reliability--Coefficient alpha (Cronbach, 1951; Nunnally, 1978) was used to evaluate the reliability or internal consistency of every scale or subscale.
3. Internal Factor Structure--The internal factor structure of each instrument was evaluated using various factor analytic procedures.
4. Construct Validity--The convergent and discriminate characteristics among the scales or subscales (not the individual

items) across the different instruments were evaluated using multitrait-multimethod matrices.

The subunit level data were analyzed in three stages: design issues, reliability, and construct validity. The same analytic techniques used to address these issues at the individual level of analysis were applied to the subunit level data. Because of the relatively few subunits (77) compared to the large number of items on some of the instruments (32), factor analysis was not performed on the subunit level data.

The relationship between each stage of analysis and either the preceeding or following stage is discussed in some detail in each of the following sections. The basic arguments and results are as follows.

1. Some statistically significant systematic variance from unwanted factors was found in the study. However, the analyses indicated that this variance was limited to a few scales and represented a very small percentage of the total variance in those scales. Overall, the analyses in the first stage indicated that unwanted factors probably did not have a significant impact on the interpretation of the results in the following stages.
2. Only about one half of the scales or subscales demonstrated adequate reliability in the present study. However, due to certain assumptions underlying the coefficient alpha statistic, the interpretation of those results was ambiguous.
3. The internal factor structures of the instruments ranged from excellent to poor. That is, some of the instruments reproduced the expected factors quite well, others did not. It was also evident in a variety of ways that many of the scales did not

adequately meet the assumptions underlying the coefficient alpha statistic.

4. The construct validity of the scales in the present study was relatively poor. Some of the lack of convergence among scales purporting to measure the same traits was attributed to differences in the ways the concepts have been operationalized. The pervasive presence of common method variance was attributed to two factors, a lack of clearly focused precise scales and the presence of underlying factors that have not yet been defined in the literature.

None of the analyses were able to stand on their own. It was necessary to interpret the results of an analysis at any one stage in terms of analyses performed at both the preceeding and the following stages. This approach led to a somewhat circular reasoning that may be particularly unsatisfying to some people and that produced almost as many questions as answers. An advantage of the approach, however, was that it also produced considerable insight into the current state-of-the-art of both the measurement and analytical techniques as well as insights into how measures of technology and structure might be improved.

Potential Design Weaknesses

There were three obvious sources of unwanted variance in the present study: (a) differences associated with hospitals, (b) the order in which instruments were presented to respondents, and (c) differences in forms (i.e., the different translations of items that made them relevant to different respondent's circumstances).

Multivariate analysis of variance (MANOVA) is an appropriate statistical technique to determine the effect of an independent variable on several dependent variables as a whole. In the present study, MANOVA was used to determine whether each of the potential sources of unwanted variance had an effect on each of the instruments expressed as a set of scales. The null hypothesis for each analysis was that there was no difference in the set of scales as a whole due to order, form, or hospital. The alternative hypothesis was that at least one of the scales on the instrument was different.

Wilk's criterion (Morrison, 1976) is an appropriate statistic to test for significant multivariate differences. An advantage of Wilk's criterion over similar multivariate statistics is that it can be exactly expressed as an F statistic.

If a significant effect is found for an independent variable in MANOVA, the next step is to determine which of the dependent variables have been affected and the magnitude of the effect. Bivariate analysis of variance (ANOVA) is the appropriate method of determining the individual effects. A significant F statistic in an ANOVA indicates the presence of a systematic effect while the R^2 indicates the magnitude of the effect and its potential importance in interpreting the results of subsequent analyses.

Table XII lists the MANOVA results for the effects of each of the independent variables at the individual level of analysis for each instrument. Using an alpha = .10 probability of a type I error, the table shows the following results.

1. Two instruments showed a significant order effect.
2. Two instruments showed an effect due to the form of translation.

TABLE XII

MANOVA RESULTS FOR INDEPENDENT ORDER, FORM, AND ORGANIZATION EFFECTS ON INSTRUMENTS

Instrument	Wilk's Criterion	$F_{(p, (NE+Q-P))}$		Prob. > F
	Order Effect			
Aiken and Hage	.91617	(6, 264)	4.03	.0007
Lynch	.98172	(8, 267)	.62	.7595
Hitt and Middlemist	.98880	(2, 200)	1.13	.3241
Comstock and Scott	.97542	(3, 265)	2.23	.0841
Overton	.98881	(4, 255)	.72	.5779
	Form Effect			
Aiken and Hage	.96335	(6, 264)	1.67	.1275
Lynch	.91461	(8, 267)	3.12	.0022
Hitt and Middlemist	.98753	(2, 200)	1.26	.2872
Comstock and Scott	.76740	(3, 265)	26.77	.0001
Overton	.97411	(4, 255)	1.69	.1518
	Organization Effect			
Aiken and Hage	.92009	(12, 528)	1.87	.0349
Lynch	.91881	(16, 534)	1.44	.1163
Hitt and Middlemist	.90131	(4, 398)	5.31	.0004
Comstock and Scott	.96910	(6, 530)	1.40	.2136
Overton	.94613	(8, 510)	1.79	.0766

3. Three instruments showed an effect due to differences among hospitals.

The purpose of the MANOVA analysis was to evaluate the potential of the independent variables as an alternative explanation for the results found in this study. Since these variables were not the focus of the study, the alpha = .10 criterion was a conservative test. This criterion level increased the likelihood that an independent variable such as form differences would be erroneously mistakenly accepted as having an effect on an instrument when it did not have an effect.

The significant effects reported in Table XII can be explained as follows. First, the Aiken and Hage (1968) instrument showed the most significant order effect. This instrument also had the greatest change in placement on the questionnaire, from first to fifth. Thus, the order effect on this instrument seems reasonable. The significant order effect on the Comstock and Scott (1977) is more difficult to explain since, on both forms of the questionnaire, this instrument followed the Lynch (1974) instrument and had a very small change in placement, from second to third. Thus, the order effect may be a spurious effect in the Comstock and Scott instrument.

Second, the Comstock and Scott (1977) instrument showed the most significant form effect. This effect seems reasonable since the Comstock and Scott scales also received a radical modification. Accounting for the significant form effect on the Lynch (1974) instrument is less straight forward, however. Although the original Lynch items were modified for the present study, the items used for this instrument on both forms in the present questionnaire were identical. Thus, the form effect requires another explanation.

The significant form effect on the Lynch (1974) instrument, and the nearly significant form effects on the Aiken and Hage (1968) and Hitt and Middlemist (1978) instruments (none of these items were modified), may have been due to differences between nurses and general support personnel rather than differences in the items. Unfortunately, the form effect was confounded with the differences in the respondents, making it impossible to evaluate each separately. Thus, although differences in the respondents probably explain the significant form effect on the Comstock and Scott (1977) instrument, differences in the items could be responsible for the effect.

To better understand the magnitude and extent of the above effects, Table XIII lists the ANOVA results for the scales affected by the independent variables. Only those scales with a $p \leq .10$ probability of a type I error are presented. R^2's are extremely low even when the effect achieved high statistical significance. The median amount of variance explained by the independent variables was 3 percent, the largest amount of variance explained by a variable was 13 percent. The low R^2's are not conclusive proof but suggest that the analyses in this chapter were not influenced greatly by differences among orders, forms, or hospitals. The MANOVA results do support the argument that most of the variance in scales was due to differences in the items themselves and not due to artifacts of the design.

Scale Reliabilities

Individual Level Scales

Reliability is generally thought of as the lack of random error in a measurement instrument (Nunnally, 1978). Coefficient alpha

TABLE XIII

SIGNIFICANT ONEWAY ANOVAS FOR SIGNIFICANT MANOVA EFFECTS (PROB > .10)

Instrument/Scale	DF	SS	MS	F	Prob > F	R^2
	--------------- Order Effect ---------------					
Aiken and Hage/Participation						
Model	1	16.1016	16.1016	16.24	.0001	.0529
Error	269	266.7028	0.9914			
Corrected Total	270	282.8044				
Hierarchy of Authority						
Model	1	5.7848	5.7848	10.24	.0014	.0373
Error	269	149.3544	0.5552			
Corrected Total	270	155.1392				
Job Codification						
Model	1	3.1595	3.1595	8.85	.0032	.0318
Error	269	96.0457	0.3570			
Corrected Total	270	99.2052				
Job Specificity						
Model	1	2.1008	2.1008	3.25	.0721	.0120
Error	269	173.3807	0.6445			
Corrected Total	270	175.4815				
Rule Observation						
Model	1	1.3635	1.3635	6.04	.0146	.0220
Error	269	60.7180	0.2257			
Corrected Total	270	62.0815				
Comstock and Scott/Staff Influence						
Model	1	4.2293	4.2293	3.58	.0596	.0132
Error	267	315.4785	1.1816			
Corrected Total	268	319.7078				
Formalization						
Model	1	1.9939	1.9939	2.77	.0974	.0103
Error	267	192.3690	0.7205			
Corrected Total	268	194.3629				
	--------------- Form Effect ---------------					
Lynch/Overall Routineness						
Model	1	7.1179	7.1179	9.79	.0019	.0345
Error	274	199.1204	0.7267			
Corrected Total	275	206.2384				

TABLE XIII (Continued)

Instrument/Scale	DF	SS	MS	F	Prob > F	R^2
	---------------- Form Effect ----------------					
Lynch/RULES						
Model	1	10.2384	10.2384	11.30	.0009	.0396
Error	274	248.1665	0.9057			
Corrected Total	275	258.4049				
Comstock and Scott/Staff Influence						
Model	1	23.0326	23.0326	20.73	.0001	.0720
Error	267	296.6752	1.1111			
Corrected Total	268	319.7078				
Supervisor Influence						
Model	1	21.5079	21.5079	21.09	.0001	.0732
Error	267	272.2456	1.0196			
Corrected Total	268	293.7536				
Formalization						
Model	1	25.4865	25.4865	40.30	.0001	.1311
Error	267	168.8764	0.5325			
Corrected Total	268	194.3627				
	-------------- Hospital Effect -------------					
Aiken and Hage/Participation						
Model	2	6.3322	3.1661	3.07	.0480	.0223
Error	269	277.3406	1.0310			
Corrected Total	271	283.6728				
Rules Observation						
Model	2	1.2561	.6280	2.77	.0644	.0202
Error	269	60.9610	.2266			
Corrected Total	271	62.2171				
Hitt and Middlemist/Task Complexity						
Model	2	3.6835	1.8418	4.40	.0135	.0422
Error	200	83.7062	.4185			
Corrected Total	202	87.3897				
TIME						
Model	2	7.2761	3.6381	7.01	.0011	.0655
Error	200	103.8074	.5190			
Corrected Total	202	111.0836				
Overton/Instability						
Model	2	3.1582	1.5791	3.21	.0421	.0243
Error	258	127.0641	.4925			
Corrected Total	260	130.2224				

(Cronbach, 1951) is a widely accepted estimate of reliability that is based on the domain-sampling model (Nunnally, 1978).[1] Since a scale is a set of items intended to measure or represent the same logical domain of a specific concept, coefficient alpha should be applied to individual scales rather than whole instruments.

Coefficient alpha is also frequently referred to as an estimate of the internal consistency of a scale, i.e., the degree to which the items represent the same domain. To the extent that scales on an instrument measure different concepts, the internal consistency of an instrument will be lower than that of its scales. Methods are available for evaluating the reliability of instruments as linear combinations of scales, i.e., scales are added together to produce a single instrument score. These methods do not apply to the present study since, with the exception of TMI, single scores are not calculated for an instrument. The methods do not apply to the TMI because the TMI does not specify what are the individual scales within the instrument.

The present study chooses as the most reliable instruments, those that contained the highest number of reliable scales.

Coefficient alpha is a function of the average interitem correlation and the number of items in the scale. In the most restrictive case, if the items are assumed to come from a common domain of items representing the same concept, then any average interitem correlation less than unity can be interpreted as the presence of random error of measurement. A correction factor recognizes that with a large number

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[1]The formula for coefficient alpha is $r_{kk} = \frac{k}{k-1}\left(\frac{\sigma_y^2 - \Sigma\sigma_i^2}{\sigma_y^2}\right)$, where k is the number of items, σ_i^2 is the variance of each item, and σ_y^2 is the variance of the scale score (Nunnally, 1978, p. 214).

of items in the scale, the ratio between the true score being estimated and the random error present in the scale should be less. Meaningful values of coefficient alpha range from zero to one. Table XIV illustrates the relationship between the number of items, the average intercorrelation among items and coefficient alpha.

TABLE XIV

VALUES OF CRONBACH'S ALPHA FOR VARIOUS COMBINATIONS OF A DIFFERENT NUMBER OF ITEMS AND DIFFERENT AVERAGE INTERITEM CORRELATIONS

Number of Items	Average Interitem Correlation					
	.0	.2	.4	.6	.8	1.0
2	.000	.333	.572	.750	.889	1.000
4	.000	.500	.727	.857	.941	1.000
6	.000	.600	.800	.900	.960	1.000
8	.000	.666	.842	.924	.970	1.000
10	.000	.714	.870	.938	.976	1.000

Source: Carmines and Zeller (1979).

Table XV presents coefficient alpha reliability estimates for each of the scales at the individual level of analysis. Nunnally (1978) suggests that reliabilities of .70 or higher will suffice for basic research. However, any reliability standard is somewhat arbitrary, and levels as low as .50 have been considered adequate for basic research in the past (Nunnally, 1967).

Using .70 as an indication of adequacy, only 38 percent of the scales at the individual level of analysis were adequate. In addition, it was disappointing to note that the three scales with ten items or

TABLE XV

SCALE RELIABILITIES FOR THE INDIVIDUAL LEVEL OF ANALYSIS

Instrument/Scale	Number of Items	Coefficient Alpha
Aiken and Hage		
Centralization-Participation	4	.88
-Hierarchy	5	.85
Formalization-Job Codification	6	.72
-Job Specificity	5	.82
-Rule Observation	2	.67
Routineness	4	.76
Lynch		
Task Routineness	2	.54
Predictability	2	.46
Knowledge	2	.50
Overall Routineness	12	.76
Interdepartmental Task Interdependence	3	.47
Internal Task Interdependence	2	.55
Rules	5	.61
Autonomy	5	.69
Comstock and Scott		
Centralization	1	--
Staff Influence	4	.87
Supervisor Influence	4	.87
Formalization	8	.66
Overton et al.		
Uncertainty	14	.70
Instability	10	.69
Variety	4	.57
Interdependence	2	.60
Hitt and Middlemist		
Task Complexity	6	.29
TimeB (new items)	3	.40
Time (original and new items)	4	.39

more had alphas between only .69 and .76. From Table XIV, this result indicates that these three scales had average interitem correlations of less than .20. If the random error on these long scales was relatively low as suggested by alpha, then the scales must represent a rather broad domain. The principles of parsimony and of precision (Dubin, 1969) and the practical consideration of the costs of administering and analyzing additional items all argue for selecting the scale with the fewer items and the most precision (narrowest domain) that can measure the concept, given equal reliability.

The preferred instruments based on the scale reliabilities in Table XV are the Aiken and Hage (1968) and Comstock and Scott (1977) instruments. Apparently the significant order effect on the Aiken and Hage instrument and the significant form effect on the Comstock and Scott instrument noted in the MANOVA results presented earlier did not seriously affect the reliability of the scales on these instruments. It is possible that the effect of alternative forms may have adversely affected the Lynch (1974) instrument. Based on analyses presented later in this paper, explanations will be offered that might account for the other low reliabilities reported in Table XV.

Subunit Level Scales

Table XVI presents coefficient alpha reliability estimates for each of the scales representing an aggregated global variable at the subunit level of analysis. In this analysis, a subunit item score was an aggregation of subunit members' responses to the item. Subunit scale scores were aggregations of the appropriate subunit item scores as discussed in Chapter III. The coefficient alpha of a subunit level

TABLE XVI

SCALE RELIABILITIES FOR THE SUBUNIT LEVEL OF ANALYSIS

Instrument/Scale	Number of Items	Coefficient Alpha Department	Coefficient Alpha Occupation
Aiken and Hage			
Centralization-Participation	4	.89	.96
-Hierarchy	5	.83	.94
Formalization-Job Codification	6	.85	.78
-Job Specificity	5	.91	.79
-Rule Observation	2	.85	.72
Routineness	4	.86	.76
Lynch			
Task Routineness	2		.90
Predictability	2		.41
Knowledge	2		.81
Overall Routineness	12		.83
Interdepartmental Task Interdependence	3		.48
Internal Task Interdependence	2		.49
Rules	5		.71
Autonomy	5		.80
Comstock and Scott			
Centralization	1		--
Supervisor Influence	4		.98
Staff Influence	4		.93
Formalization	8		.84
Overton et al.			
Uncertainty	14		.80
Instability	10		.71
Variety	4		.09
External Interdependence	2		.69
Hitt and Middlemist			
Task Complexity	6		.49
TimeB (new items)	3		.48
Time (original and new items)	4		.31

scale indicates the reliability of the scale in measuring concepts at the subunit level of analysis.

At first thought, one might expect that by using the mean of individual responses random error would tend to cancel out and thus increase reliability. The large number of scales that had higher coefficient alphas in Table XVI than in Table XV seems to support this expectation. However, the "predictability", "internal task interdependence", "variety", and "time perspectives" scales all had lower coefficient alphas at the subunit level of analysis. The number of items on all of the scales was the same at both levels of analysis. Thus, the lower reliabilities indicate that these four scales had lower interitem correlations at the subunit level than at the individual level of analysis.

Mathematically, this reduction in reliability means that the variance among the composite item scores relative to the variance in the subunit scale scores was greater than the variance in individual item scores relative to the individual scale scores. In other words, for these four scales, there appears to have been something unique to different subunits that caused respondents from one subunit to interpret the meaning of the items within a scale differently from respondents in other subunits. For example, the phrase "sameness of problems" may have meant a boring job to people in housekeeping while it may have meant the challenge of problems in operating sensitive test procedures to people who worked in the medical laboratory. Of course, it may be that the lower alphas were simply random events, the result of making a large number of contrasts.

Two aggregation methods were used for the Aiken and Hage (1968) scales as described in the previous chapter. A set of alpha coefficients is presented for each method. The column labeled "department" reports coefficients for items aggregated across staff members within a subunit. The column labeled "occupation" reports coefficients for items aggregated across staff members in the same occupation.

At the subunit level of analysis, approximately 70 percent of the scales met the .70 criterion for adequacy. In addition, there were substantial increases in the reliability of some of the scales at the subunit level (e.g., "task routineness", "predictability", "autonomy"). The indication is that these scales may be adequate for and quite useful in measuring the subunit level of analysis they were originally created to measure even though their adequacy is, at best, marginal at the individual level.

Relationships Among Factor Analysis, Reliability and Construct Validity

Factor Analysis and Reliability

Nunnally (1978) notes that coefficient alpha is an upper limit of reliability under the domain-sampling model. However, the domain-sampling model assumes that all of the items in a scale are parallel and measure a single phenomenon equally, i.e., that the average correlation of each item with all the others is the same for all items (Nunnally, 1978). Armor (1974) observes that there are two conditions under which the assumptions may be violated in practice:

1. if the items measure a single concept unequally; or
2. if the items measure more than one concept equally or unequally.

Factor analysis can address both of these reliability issues. The first type of violation may be evaluated by inspecting the factor loadings. Factor loadings are the correlation between items and the factor with which they are associated. The first type of violation can be refuted to the extent that all of the items on a scale load equally on the same factor.

Second, under coefficient alpha, items are grouped according to *a priori* assumptions of association, factor analysis does not make *a priori* assumptions of association. Thus, factor analysis allows us to test whether the coefficient alpha assumption is met by indicating whether a set of items load on a single factor (i.e., whether the scale is unidimensional). The assumption is violated by the extent to which items load on more than one factor.

Reliability vs. Construct Validity

Campbell and Fiske (1959) refer to the difference between reliability and construct validity as follows:

> Reliability is the agreement between two efforts to measure the same trait through maximally similar methods. [Construct][2] validity is represented in the agreement between two attempts to measure the same trait through maximally different methods (p. 83).

This quote embodies the essential differences between reliability and construct validity assessment. Reliability assessment attempts to determine the degree of error variance in a measure that may cause inconsistent results in repeated applications of that measure to the same object. Construct validity assessment, however, attempts to evaluate the systematic variance contained in various measures.

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[2] Added for emphasis.

Construct validity requires the presence of two characteristics.

1. Convergence--indicated when different methods purporting to measure the same trait produce the same results, i.e., the systematic variance in each measure is the same, the measures are measuring the same trait.
2. Discrimination--indicated when two methods purporting to measure different traits produce different results, i.e., the systematic variance in each measure is different, the measures are measuring different traits.

Factor Analysis and Construct Validity

If each item is viewed as a different method of measurement, then factor analysis will describe the convergent and discriminate properties of the items. The adequacy of a measure as a reflection of various concepts is supported by the degree to which the items form factors in the manner intended when the measures were constructed.

Principal Components Analysis

Principal components factor analysis with varimax rotation was the basic method used in this study to evaluate the reliability and validity issues discussed above. An advantage of principal components (PC) analysis was that it produced orthogonal factors that were linear combinations of the actual items. Each factor successively explained the maximum amount of variance remaining among the items (Nunnally, 1978). Varimax rotation aided in the interpretation of an initial PC factor solution by optimizing a function based on the classical definition of a simple factor structure matrix as having only ones and zeroes in the columns (Nunnally, 1978). Oblique rotations using delta = 0 were performed in the present study but did not add to understanding the factor structure matrix. The same factors found by varimax rotation were reproduced by the oblique rotations, but the factor structure matrices were less simple. Only PC solutions and varimax rotations are reported here.

Factor analysis results for each of the instruments are presented below. Since the response rates varied for each of the instruments, the number of respondents is reported for each analysis. The lowest respondents to variables ratio encountered in any of the individual level factor analyses is a minimally acceptable 8:1 with other ratios ranging as high as 20:1 (Nunnally, 1978). Factor analysis was not performed for the subunit level of analysis since the number of subunits to the number of variables ratio was unacceptably low.

The Aiken and Hage Instrument

The Dewer et al. Solution. Table XVII presents a factor structure matrix after varimax rotation for the Aiken and Hage instrument. The six factors met the inclusion criterion of a minimum eigenvalue of one ($\lambda = 1$), that is, all of the factors explained at least one percent of the variance in the instrument. There were two strong arguments for excluding factors that explained less than one percent of the variance (Nunnally, 1978). First, after having successively extracted the largest remaining portion of variance with each succeeding factor, the small amount of variance left probably represented primarily random error. Second, even if the excluded factors had some theoretical meaning, the variance they accounted for probably had little practical significance.

TABLE XVII

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR AIKEN AND HAGE'S INSTRUMENT

	Centralization Hierarchy	Centralization Participation	Routine-ness	Formalization Job Codification	Formalization Rules Observation	Formalization Job Specificity	Commun-alities
A1	-.13	.83	-.09	-.14	-.05	.06	.74
A2	.12	.80	.03	.02	.04	-.01	.65
A3	.13	.85	.04	.04	-.06	.04	.75
A4	-.15	.88	-.04	-.11	-.02	.03	.81
B1	.69	.17	.01	.15	.05	.05	.53
B2	.58	-.10	.28	.01	.20	-.16	.49
B3	.74	.09	.10	.15	.24	.09	.65
B4	.71	-.04	.20	.11	.32	-.09	.65
B5	.82	.06	.10	.20	.20	.04	.76
B6	-.68	.24	-.05	-.06	-.04	.15	.56
B7	.78	.07	.06	-.07	.07	.23	.68
B8	.42	.11	.04	.04	-.07	.57	.52
B9	-.29	-.00	.06	-.12	.01	.80	.74
B10	.07	.03	.06	.21	.07	.79	.68
B11	.21	-.13	-.07	.18	.83	-.05	.80
B12	.32	.04	.05	.03	.85	-.03	.83
B13	.08	-.05	.05	.64	-.05	-.12	.44
B14	.01	.05	.14	.74	-.16	.03	.59
B15	.27	-.04	-.20	.54	.18	-.07	.44
B16	.03	.01	.19	.50	.20	-.09	.34
B17	.24	-.04	-.07	.64	.31	-.22	.61
B18	.30	.00	.07	.38	.09	.27	.32

TABLE XVII (Continued)

	Centralization Hierarchy	Centralization Participation	Routine-ness	Formalization Job Codification	Formalization Rules Observation	Formalization Job Specificity	Commun-alities
B19	.23	.05	$\boxed{.58}$	.28	.04	.10	.48
B20	.13	-.03	$\boxed{.72}$	-.12	.01	-.06	.55
B21	.02	.08	$\boxed{.84}$	-.08	-.03	.02	.72
B22	.04	-.06	$\boxed{.87}$	-.04	.03	-.03	.76
Percent of σ^2	24.2	10.2	9.6	6.6	6.4	4.8	61.9
$\bar{r}_{ij}$	.51	.64	.45	.25	.70	.42	
N = 273							

With the exception of two items, B6 and B7, the varimax solution presented in Table XVII exactly reproduced the subscales suggested by Dewer et al. (1980) used to estimate the coefficient alphas above. The solution contained a reasonably simple factor structure with high loadings on the primary factors and low loadings on alternative factors.[3] Overall, the factor structure demonstrated excellent convergent and discriminate validity.

The symbol $\bar{r}_{ij}$ in Table XVII and throughout the rest of this paper indicates the average interitem correlation among the items on a scale (Nunnally, 1978).[4] Nunnally (1978) argued that errors in interpreting factor analysis can be reduced if average interitem correlations are always reported with the results. The primary error this information will reduce is the over-interpretation of high factor loadings. The error occurs because with the factor analysis model it is possible for items to correlate highly with a factor without being highly correlated with each other. In order not to over-interpret factor loadings, the loadings should be equivalent to the underlying correlations among items. Nunnally's suggestion is followed throughout the present paper.

With the exception of factor 4, the item correlations underlying each of the factors shown in Table XVII had a substantial $\bar{r}_{ij}$. This underlying support suggests that the high factor loadings were not spurious. Most of the communalities were reasonably high indicating that the factors should have been able to reproduce the original

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[3]Factor loadings are the correlation of an item with a factor.

[4]This symbol underlies the r_{kk} symbol for coefficient alpha, and is equivalent to coefficient alpha without a correction factor.

correlations fairly accurately.[5] The relatively low communalities for items that loaded primarily on factor 4 (formalization/job codification) and the low $\bar{r}_{ij}$ for these items were indications that the loadings on this factor were overstated and may contain a sizable random error component. If the loadings were overstated, the factor may not be stable in other studies or significant when used for other analyses.

Finally, each of the factors accounted for a substantial amount of interpretable variance and the six factors together accounted for almost 62 percent of the variance in the instrument. Taken together, the Dewer et al. solution presented a picture of a sound instrument that had good reliability and good internal construct validity among its scales.

The Aiken and Hage Solution. As noted in the previous chapter, Aiken and Hage (1968) originally conceived three dimensions for their instrument (centralization, formalization, routineness) rather than the six factors presented in Table XVII. Appendix F shows the varimax rotation of a three factor solution for the Aiken and Hage instrument. The three factor solution here does not match the one suggested originally. The technology items did converge as expected to form factor 3. Centralization items, however, did not converge as expected. The centralization/participation items did form factor 2, but the centralization/hierarchy items combined with the formalization items to form factor one.

Thus, the construct validity of the original Aiken and Hage (1968) solution was not supported. There was a serious lack of discrimination

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[5] A communality is the percentage of an item's variance that is explained by the factors.

between the centralization and formalization scales. The Dewer et al. (1980) subscale structure proposed for the Aiken and Hage instrument was found to be more construct valid than the original scales. The poor discrimination between the centralization and formalization found in the three factor solution was eliminated in the six factor solution.

The Lynch Instrument

Lynch identified eight scales that were included in the present study. Table XVIII presents a varimax rotation of an eight factor solution. Except for the interdependence scales, the *a priori* scales were essentially reproduced in the eight factors. The items had generally high factor loadings, indicating good convergent validity. Items A16, A18, and A29 did not converge on the factors hypothesized for them. Finally, Lynch's hypothesized dimensions of "interdepartmental interdependence" and "internal task interdependence" combined in the present study to form a single factor labeled "interdependence" in the table.

Discrimination among the Lynch scales was not as good as the discrimination in the six factor solution of the Aiken and Hage instrument. That is, the factor structure was not as simple as might be desired, with some overlap (alternative loadings) among several of the factors. For example, item A17 loaded almost equally on factors 1, 5, and 7.

The reasonably fair convergence of items as proposed in the *a priori* scales supported the assumption that the items within the scales belonged to the same domain. This convergence also supported the conclusions suggested earlier that the low individual level

TABLE XVIII

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR LYNCH'S INSTRUMENT

	Overall Routineness	Autonomy	Inter-dependence	Rules	Knowledge	Library Routineness	Factor 7	Predict-ability	Commun-alties
A1	.04	.09	.21	-.12	-.06	.21	-.16	.60	.50
A2	.13	-.00	-.03	-.00	-.01	.01	.08	.81	.68
A3	.61	-.05	-.04	-.06	-.06	.16	-.13	-.34	.54
A4	.69	.05	.03	-.04	.04	.13	-.08	-.18	.53
A5	.53	-.09	.07	.13	-.21	.13	.26	.38	.58
A6	-.07	.02	.01	.77	-.02	.05	-.11	-.00	.61
A7	-.19	-.07	.11	.55	.22	-.11	-.12	.11	.44
A8	.05	.40	-.01	-.41	.23	-.16	-.18	-.13	.46
A9	.18	.02	.08	-.08	.63	.12	.21	.11	.52
A10	-.06	.09	-.01	.25	.51	-.08	.08	-.14	.36
A11	.07	.18	.00	-.07	.67	.13	-.09	-.10	.53
A12	.74	-.16	.00	-.09	.09	-.14	.10	.09	.63
A13	.73	-.11	.04	-.08	.20	-.16	.07	.09	.63
A14	.61	.10	-.02	.02	.03	.05	-.32	.12	.51
A15	.62	-.21	.11	-.08	.01	-.17	-.27	.07	.56
A16	.19	-.04	-.00	.11	-.21	-.15	-.68	-.07	.58
A17	.43	-.18	-.07	.00	-.42	.16	-.40	.10	.59
A18	.07	-.01	.39	.13	-.02	-.05	.52	-.02	.45
A19	.15	.08	.23	.36	-.07	-.00	.37	-.05	.35
A20	-.06	.64	-.18	.05	-.12	-.11	.18	-.00	.50
A21	-.21	.54	.09	-.31	.20	.01	.18	-.03	.51
A22	-.06	.04	.67	-.03	-.06	.09	.23	-.06	.53
A23	.02	.09	.71	.00	-.05	.05	.10	.12	.54
A24	.05	-.14	.71	.20	.03	-.20	-.03	.02	.61
A25	.09	.01	.66	.11	.14	.00	-.09	.06	.49

TABLE XVIII (Continued)

	Overall Routineness	Autonomy	Inter-dependence	Rules	Knowledge	Library Routineness	Factor 7	Predict-ability	Commun-alities
A26	-.08	-.01	.02	.01	.16	.80	-.01	.01	.67
A27	.16	-.04	.06	.12	-.09	.65	.11	.18	.52
A28	.46	-.09	.03	.00	-.39	.37	-.03	.07	.52
A29	-.27	.10	-.05	.27	.43	-.37	.03	.10	.49
A30	.60	-.06	.00	-.14	-.12	.20	.03	.12	.46
A31	.00	-.14	.16	.69	.10	.12	.17	-.15	.60
A32	.05	.09	.03	.40	-.35	.15	.19	-.15	.38
A33	-.03	.80	.08	.03	-.01	.02	-.02	.06	.66
A34	-.14	.79	.02	-.11	-.03	-.05	-.11	.04	.67
Eigen-Value	14.1	9.1	6.9	6.5	5.0	4.3	4.1	3.7	53.6
$\bar{r}_{ij}$	.33	.31	.35	.25	.21	.37	.18	.30	

N = 261

coefficient alphas were due to the presence of random error in the scales. The presence of a large component of random error was also indicated by the rather low communality estimates and low average interitem correlations reported in Table XVIII.

An "extraneous" factor, labeled factor 7, appeared in the matrix. The factor was not interpretable in terms of current technology and structure concepts and was probably the result of an intervening concept. In any case, the low average interitem correlation ($\bar{r}_{ij}$ = .18) reported for "factor 7" indicated that even though the mathematics of factor analysis produced relatively high loadings on the factor, the loadings were not supported by substantial relationships among the items and therefore did not warrant extensive interpretation.

The above results suggest that, overall, the scales on the Lynch instrument have fair internal construct validity, although they did not discriminate among some factors. The weakness in discrimination indicated a lack of precision either in the construction of the scales or in the concepts being measured.

In anticipation of the results in the final stage of analysis, it is reasonable to expect the lower scale reliabilities to lead to attenuated correlations of these scales with scales in other instruments. The lack of precision can be expected to produce inconclusive results when the Lynch scales are compared with similar measures from other instruments. These expectations were confirmed in analyses reported later in this chapter.

The Overton, Schneck, and Hazlett Instrument

The Overton et al. Solution. The Overton et al. (1977) instrument performed very poorly at the individual level of analysis in the present study. This performance is in sharp contrast to the performance of the instrument in two previous studies conducted at the subunit level of analysis, the level the instrument was originally intended to measure (Overton et al., 1977; Leatt and Schneck, 1981).

Overton et al. found three factors in the first study which were largely reproduced in the Leatt and Schneck (1981) study. The scales represented by the factors were different than the ones Overton et al. (1977) originally expected to find. Table XIX presents a varimax rotation of a three factor solution for the Overton et al. instrument. None of the scales found in the two studies cited above appeared in the table, nor did any of the three scales originally hypothesized by Overton et al. appear here.

An Exploratory Analysis. Standing on their own in a purely exploratory analysis, the results in Table XIX remain poor. The results indicate relatively poor convergent and discriminate validity, they explain only 33 percent of the total variance, and the best average interitem correlation is only $\bar{r}_{ij} = .26$. The primary contribution of Table XIX to the present study is to indicate that the individual level Overton et al. scales for which coefficient alphas were reported were not unidimensional. Thus, the assumptions for the statistic were violated making the alphas more an indicator of poor construct validity than of poor reliability.

Oblique rotations (delta = 0) were applied to both the three factor solution and to a nine factor solution that resulted from an $\lambda = 1$ factor inclusion criterion in attempts to find a meaningful solution. Neither of the oblique roations produced a better solution.

TABLE XIX

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR OVERTON's ET AL. INSTRUMENT

	Factor 1	Factor 2	Factor 3	Communalities
C1	.30	.56	-.03	.40
C2	-.06	.61	-.03	.38
C3	.38	.28	-.01	.22
C4	.34	.41	-.04	.29
C5	.67	.02	-.01	.44
C6	.02	.61	.04	.38
C7	.48	.31	.92	.33
C8	.38	.49	-.05	.38
C9	.02	.33	-.01	.11
C10	.40	.10	.41	.34
C11	.07	.20	-.06	.05
C12	.56	.15	.18	.37
C13	.68	.22	.10	.52
C14	.28	.43	.20	.30
C15	.75	.01	.12	.58
C16	.17	.39	.05	.19
C17	.31	.07	.19	.14
C18	.42	-.01	.16	.20
C19	.03	.69	-.19	.51
C20	.18	-.66	-.17	.50
C21	.55	-.05	.14	.33
C22	.53	.05	.11	.30
C23	.17	-.23	.34	.20
C24	.31	.09	.46	.32
C25	.19	.01	.49	.27
C26	-.11	.11	.69	.50
C27	.02	.34	.45	.31
C28	.17	-.12	.58	.37
C29	.16	.02	.54	.32
C30	-.05	.22	.49	.29
C31	.37	-.03	.41	.31
Percent of σ^2	17.4	8.9	6.5	32.8
$\bar{r}_{ij}$	.26	.19	.19	
N = 254				

A varimax rotation of the nine factor solution is presented in Appendix G. Some of these factors roughly approximated the Leatt and Schneck (1981) scales. For example, three of the four items on factor two (C2, C19, and C20) were the same as the three items reported for the variety scale in Leatt and Schneck (1981). Other scales did not fair nearly so well, however.

Conclusions. It may be that the Overton et al. (1977) instrument is simply not appropriate for the individual level. The reliability analysis above suggested that the instrument may contain considerably less error variance at the subunit level of analysis. However, this hypothesis is not supported by other analyses performed later in this chapter.

As noted in Chapter III, the present study translated the Overton et al. (1977) nursing items into a presumably parallel form that could be administered to general support personnel. Although the MANOVA results presented earlier did not indicate a significant difference between the means of responses on the two forms, it may be that a significant difference in the variance of responses did exist between forms. If such a difference did exist, it should have produced a large single factor indicating variance due to forms, or factors that indicated poor discrimination between a scale factor and a "forms" factor. No such large factors appeared in either the unrotated or rotated versions of any of the factor solutions. The sample size did not permit separate factor analyses on each form.

Even though a difference in the form itself probably did not exert much influence on the present results, it is possible that the greater variance of occupations in the present sample may have produced the different results. Previous samples were restricted to nurses only and may have produced results unique to nursing units.

Regardless of the above speculations, based on the results of the present study, one must conclude that the Overton et al. (1977) instrument is inadequate for general use at the individual level of analysis.

The Comstock and Scott Scales

Evidence for Three Scales. The Comstock and Scott (1977) scales produce two index scores (centralization and formalization) for a subunit. The instrument was not primarily intended for use at the individual level of analysis and no individual level results have been reported previously for it. At the individual level, three scales were hypothesized for the instrument (staff influence, supervisor influence, formalization), the first two of which combine to produce the centralization index value.

Table XX contains results from a varimax rotation of a three factor solution. The results indicated very good convergent and discriminate characteristics among the scales which were reproduced in the factors exactly as hypothesized. Each of the factors explained an appreciable amount of variance, and the average interitem correlations underlying the factor loadings were generally consistent with the size of the respective loadings. The communalities were quite high for the items loading primarily on the staff and supervisor influence factors but marginal for items loading on the formalization factor. Thus, this factor analysis generally supports the unidimensionality assumption underlying coefficient alpha for the Comstock and Scott scales. Therefore, the high reliabilities reported earlier indicate there is probably little random error present in the scales.

TABLE XX

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR COMSTOCK AND SCOTT'S INSTRUMENT

	Factor 1	Factor 2	Factor 3	Communalities
A1	.60	.29	.00	.45
A2	.92	.14	-.05	.87
A3	.87	.19	-.02	.79
A4	.88	.07	.03	.78
B1	.13	.76	.17	.62
B2	.21	.85	-.08	.78
B3	.19	.85	-.03	.76
B4	.02	.85	.13	.75
C1	-.12	.03	.65	.44
C2	-.11	.08	.53	.30
C3	.32	-.11	.54	.41
C4	.01	-.12	.67	.47
C5	.16	.06	.38	.18
C6	-.01	.08	.63	.40
C7	-.02	.18	.58	.37
C8	-.29	-.27	.43	.33
Percent of σ^2	25.9	16.2	12.2	54.3
$\bar{r}_{ij}$	.63	.32	.22	
N = 261				

<u>Evidence for Two Indices</u>. The unrotated three factor solution in Appendix H contains additional pertinent information. The first unrotated factor indicated the presence of a general centralization factor (factor 1) that was distinct from a general formalization factor (factor 2). All of the centralization items loaded positively on the first factor indicating a general centralization of influence factor. The <u>same</u> centralization <u>items</u> loaded either positively or negatively on the third factor indicating a bipolar distribution of

influence between supervisors and staff members. This result was precisely consistent with the concept proposed by Comstock and Scott in constructing the scale.

Methodological Questions. Nunnally (1978) noted a problem in using principal components analysis (where unities are used as the initial communality estimates) with fewer than 20 variables. This problem concerned the tendency to over interpret the meaning of factors with large loadings. Large loadings may be a result of the unities in the diagonal rather than the result of large correlations among the underlying items. This does not seem to have been a problem in the present study. As noted above, the factor loadings are consistent with the average interitem correlations.

Nunnally (1978) also suggests using image analysis as a conservative approach when there are fewer than 10 variables and the average interitem correlation for the matrix is low.[6] Squared multiple correlations are used as the communalities in the diagonal of the correlation matrix. The method is conservative because the communalities used in the diagonals will be between those estimated using common factor analysis and the ones used in principal components analysis.

Although the interitem correlations were adequate in the present case, image analysis was performed on the Comstock and Scott (1977) instrument as an additional precaution. The factor structure produced by the image analysis was identical to the one already reported in

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[6]Image analysis is a factor analysis technique in which the "common" part of a variable in the data matrix is that part which can be predicted by multiple regression from the remaining variables in the matrix (Nunnally, 1978).

Table XX. Since the image solution was identical to the PC solution already reported, and because interpretation is somewhat different from other factor matrices since the values must be interpreted as covariances rather than correlations, the image analysis solution is not reported here.

The results reported here suggest that the Comstock and Scott instrument is valid and reliable for use at the individual level of analysis. The centralization scale appears to be extremely good and not worth the economic costs of trying to improve it further. Although adequate, the somewhat lower loadings, lower communalities, and lower reliability of the formalization scale indicate that it might be improved. Identifying more precise subscales for the formalization scale is one direction that might be taken to improve the scale.

The Hitt and Middlemist Scale

Hitt and Middlemist hypothesized two measurement scales which they combined to indicate the level of technology in an organization subunit. The stated purpose of the instrument was to assess a composite characteristic of organization subunits rather than to reproduce the conceptual dimensions underlying the instrument.

The Two Factor Solution. Table XXI shows the varimax rotation of a two factor solution. With the exception of item B5, scales were reproduced as hypothesized. Discriminate validity was also reasonably good. The low communalities, the low interitem correlations ($\bar{r}_{ij} = .19$, $\bar{r}_{ij} = .14$), and the relatively small amount of variance explained by the two factor solution (34.5) suggested the presence of considerable random error, a conclusion supported by the low coefficient alpha reported earlier.

TABLE XXI

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR HITT AND MIDDLEMIST INSTRUMENT (TWO FACTOR SOLUTION)

	Factor 1	Factor 2	Communalities
B1	.64	-.26	.48
B2	.45	.20	.24
B3	-.30	.15	.11
B4	.65	.28	.50
B5	.17	.40	.19
B6	.02	.83	.69
B7	-.27	.66	.51
B8	.08	.35	.13
B9	.72	.05	.52
TIME	.11	.26	.08
Percent of σ^2	18.1	16.4	34.5
$\bar{r}_{ij}$	.19	.14	
N = 199			

Nunnally's (1978) suggestion of using image analysis when there are fewer than 10 variables and the average interitem correlation for the matrix is low was followed here. An image analysis performed for the two factor solution produced an identical factor structure to the one reported in Table XXI, and is therefore not reported separately here.

<u>An Exploratory Analysis</u>. Table XXII presents a four factor solution resulting from a $\lambda = 1$ inclusion criterion. Note that there was a considerable increase in the communalities, the total variance explained, and the average interitem correlations for the factors. Overall, this was a much improved solution.

TABLE XXII

PRINCIPAL COMPONENT FACTORS WITH VARIMAX ROTATION FOR HITT AND MIDDLEMIST INSTRUMENT (FOUR FACTOR SOLUTION)

	Discretion (Autonomy)	Time	Task Complexity	Performance Appraisal	Communalities
B1	.83	-.04	.00	-.08	.69
B2	.22	.15	.49	-.05	.31
B3	.24	.14	-.81	.06	.74
B4	.30	.11	.67	.12	.58
B5	.09	.10	-.02	.80	.66
B6	-.04	.83	.15	.23	.76
B7	.32	.75	.09	-.11	.68
B8	-.07	-.02	.02	.79	.64
B9	.68	-.03	.28	.11	.55
TIMEA	.23	.41	-.07	-.01	.23
Percent of σ^2	18.1	16.4	13.2	10.6	58.3
$\bar{r}_{ij}$	.37	.21	.21	.31	

N = 199

The factors were labeled for the concepts they seemed to represent. If the labels were correct, the factors represented a diverse set of concepts. In contrast to the conclusion drawn above, the four factor solution suggested that the primary problem with the two factor solution was poor construct validity rather than poor reliability. Improving construct validity by distinguishing among diverse concepts sharpened the focus of the scales by narrowing the domain of items being sampled, thus improving interitem correlations and reliability.

The Hitt and Middlemist instrument is an interesting approach to measuring subunit characteristics and should be worth improving. In its present form, its focus is probably too broad to achieve good discriminate validity relative to other measures of either technology, structure, or performance appraisal, a conclusion supported by analyses performed later in the chapter. However, the instrument may be adequate for its originally intended purpose of representing the general influence of technology in a subunit.

The Expanded Time Perspective Scale. It should be noted that the present analysis identified two general traits that individuals recognize in organizational subunits:

1. "Time perspectives" represented by the three new items (B6, B7, and B8) which combine with the original time scale, and
2. "General task characteristics" represented by the rest of the scale.

This result should be of particular interest to the organizational theorists who are attempting to integrate the results from studies approached from the socio-technological perspective with studies approached from the job design perspective.

The Construct Validity of Current Scales

The previous section evaluated validity in terms of the internal factor structures of five instruments. The present section evaluates the validity of all of the *a priori* scales taken together. Validity is indicated by the extent to which conceptually similar scales converge and conceptually dissimilar scales discriminate. The multitrait-multimethod (M-M) matrix was the analytical method used here (Campbell and Fiske, 1959).

Multitrait-Multimethod Analysis

The M-M matrix is a method of evaluating the convergent and discriminate characteristics of *a priori* scales as well as the presence of common method variance. As noted earlier, Campbell and Fiske (1959) described validity as the agreement between two attempts to measure the same trait through maximally different methods. They also argued that common method variance is often a rival explanation for many of the validity relationships reported in the literature. In the M-M matrix, they addressed the issue of common method variance by assuming that the methods included in a matrix are totally independent of each other.

In the present analysis, each instrument and in some cases each scale was assumed to be a different method of measurement. When an instrument contained more than one scale for the same concept, the scales themselves were treated as different measurement methods.

Campbell and Fiske's assumption of total independence even among instruments, much less among scales within instruments, could not be supported in the present study. This lack of independence among measures is a weakness in the present study, and limits its ability to assess the full effect of method variance. However, the weakness did not invalidate the conclusions drawn from the M-M matrix as will be shown below.

Validity Criteria in M-M Analysis

Campbell and Fiske (1959) specified the following four criteria for evaluating construct validity in an M-M matrix:

1. Validity coefficients (correlations between the same trait measured by different methods) should be large and significant.

2. A validity coefficient should be larger than correlations obtained between that trait and any other trait having neither the object trait nor the method in common.

3. A validity coefficient should be larger than correlations between the object trait and other traits measured by the same method.

4. The pattern of correlations among traits measured by one method should be the same as the pattern among those same traits measured by the other methods (pp. 82-83).

Campbell and Fiske (1959) pointed out that if there was not true independence among the methods used in the study, as was the case in the present study, then all of the correlations among different traits that are measured by different methods would be exaggerated including the validity coefficients. The increases in all coefficients, validity coefficients, and off-diagonal coefficients alike, would be comparable, however, and relative validity could still be evaluated. Thus, the reader should be aware that the size and significance of the validity coefficients in the present study may have been exaggerated but the relationships among the various scales, the primary question in the present study, were reasonably stated in the M-M matrix.

Design Issues in the Present Study

There were several problems in interpreting the results from the M-M matrices in Appendices I and J. First, the repetition of certain scales measuring similar concepts on the same instrument made reading the matrices awkward. Unfortunately, the repetition of these scales on the same instrument also confounded the analyses of common method variance and discrimination. That is, the coefficients that indicated convergence between scales were also the same coefficients that had to be used to evaluate common method variance.

Since the scales were assumed to be independent methods, it was appropriate to interpret the coefficients for these scales as indicators of convergence. No other solution to the dilemma was reasonable. If the scales were not assumed to be independent methods, the validity coefficients would have been meaningless and no further evaluations could have occurred. Thus, the reader should be aware that common method variance remains an especially strong rival explanation to the convergence between similar scales repeated on the same instrument.

Finally, criterion four could not be evaluted in the present study because it required a fully crossed design. That is, to evaluate criterion four, each method (e.g., instrument, scale) had to measure every concept. The authors of these instruments were pursuing other purposes than meeting criterion four in designing their instruments and did not include measures of all the concepts on each of their instruments. This is not a serious limitation in the context of the present study. Once the first three criteria have been satisfied (the primary question here), criterion four evaluates the pattern of relationships among similar scales and the strength of the underlying causal connections among them (Sullivan and Feldman, 1979).

The first three criteria were evaluated, when possible, in the present study and the results are reported in the following two sections.

Interpreting the Summaries of the M-M Matrices

Pearson correlations from the individual level M-M matrix in Appendix I are summarized in Table XXIII. A similar table later summarizes correlations for the subunit level of analysis. Each matrix was also calculated using Spearman correlations, a nonparametric statistic of association. Most of the Spearman coefficients were slightly lower than the Pearson coefficients as expected due to the number of ties in the ranking of the data (Conover, 1971). For a few exceptions, the Spearman correlations were slightly higher, which would occur if there was a nonlinear association among certain scales (Conover, 1971). Because the differences were very slight, only summaries of the Pearson correlation results are presented here.

Convergence Criterion. Column two contains validity coefficients which indicate the degree of convergence between two scales measured by different methods. Under criterion one, Campbell and Fiske (1959) stipulated that the remaining criteria should not be evaluated unless the validity coefficient is large and significant. A simple test of

TABLE XXIII

SUMMARY OF INDIVIDUAL LEVEL OF ANALYSIS CONSTRUCT VALIDITY COEFFICIENTS BY CRITERION[1]

Trait-Instru.	Validity Coefficient	Criterion 2 Coefficients	Criterion 3 Coefficients
A1-A2	.49	.19 .16 .00 .16 .11 .03 .02 .18 .24 .10 .02 .08	.08 .28 .10 .03 .01 .12 .15 .05 .25 .15 .01 .02
A1-A3	.23	.09 .32 .39 .36 .17 .18	.08 .28 .10 .02 .01 .11
A2-A3	.43	.00 .21 .12 .16 .46 .27 .08 .18	.12 .15 .05 .25 .15 .01 .02 .11
B1-B2	.14	.12 .05 .07 .04 .05 .15 .03 .09 .10 .07	same as criterion 2
B1-B3	.03 n.s.[2]		
B1-B4	.06 n.s.		
B1-B5	.07 n.s.		
B1-B6	.23	.06 .07 .02 .08 .06 .02 .07 .09 .15 .11 .17	.12 .05 .07 .04 .05 .02 .02 .09
B2-B3	.07 n.s.		
B2-B4	.03 n.s.		
B2-B5	.01 n.s.		
B2-B6	.08 n.s.		
B3-B4	.23	.25 .06 .03 .03 .19 .15 .11 .03 .06 .02	.05 .00 .00 .06 .09 .26
B3-B5	.03 n.s.		
B3-B6	.06 n.s.		
B4-B5	.64	.26 .31	same as criterion 2
B4-B6	.02 n.s.		
B5-B6	.09 n.s.		
C1-C2	.28	.08 .26 .18 .15 .28 .59 .49 .39	same as criterion 2
C1-C3	.24	.16 .45 .46 .25 .08 .00 .01	.08 .26 .18 .15 .28 .05 .03 .00 .20 .03 .13
C1-C4	.06 n.s.		
C1-C5	.25	.06 .07 .12 .12 .01 .04	.08 .26 .18 .15 .05
C1-C6	.13	.08 .06 .06 .10 .08 .04	.08 .26 .18 .15 .01

TABLE XXIII (Continued)

Trait-Instru.	Validity Coefficient	Criterion 2 Coefficients	Criterion 3 Coefficients
C2-C3	.53	.16 .24 .45 .46 .25 .22 .11 .21 .24 .12 .06 .01	.28 .59 .49 .39 .25 .05 .03 .00 .20 .03 .13
C2-C4	.24	.39 .01 .06 .10 .21 .06	.28 .59 .49 .39 .11
C2-C5	.07 n.s.		
C2-C6	.06 n.s.		
C3-C4	.18	.46 .00 .08 .01 .12 .13 .06 .13	.25 .05 .03 .00 .20 .03 .13 .11
C3-C5	.16	.05 .03 .12 .06 .06 .03 .03 .14	.25 .05 .03 .00 .20 .03 .13 .05
C3-C6	.06 n.s.		
C4-C5	.03 n.s.		
C4-C5	.04 n.s.		
C5-C6	.36	.05 .01	same as criterion 2
D1-D2	.29	.10 .26 .59 .03 .18 .50	same as criterion 2
D1-D3	.32	.10 .25 .59 .01 .15 .39	same as criterion 2
D1-D4	.23	.11 .08 .22 .10 .12 .07 .06 .45 .11 .16	.10 .26 .59 .15 .07 .09 .00 .20 .25 .21
D1-D5	.15	.15 .04 .09 .06 .12	.10 .26 .59 .05 .01
D2-D3	.32	.03 .18 .50 .01 .15 .39	same as criterion 2
D2-D4	.25	.11 .08 .22 .02 .00 .04 .08 .46 .09 .16	.03 .18 .50 .15 .07 .09 .00 .20 .25 .21
D2-D5	.09 n.s.		
D3-D4	.44	.11 .08 .22 .08 .08 .02 .00 .25 .19 .16	.01 .15 .39 .15 .07 .09 .00 .20 .25 .21
D3-D5	.32	.15 .04 .09 .01 .08	.01 .05 .39 .05 .01
D4-D5	.29	.15 .06 .07 .03 .14 .06 .09 .02 .06	.15 .07 .09 .00 .20 .25 .21 .05 .01

TABLE XXIII (Continued)

Trait-Instru.	Validity Coefficient	Criterion 2 Coefficients	Criterion 3 Coefficients
E1-E2	.55	.01 .04 .10 .06 .03 .25 .02 .05 .07 .09 .13 .21	same as criterion 2
E1-E3	.31	.01 .04 .10 .06 .03 .25 .26 .31 .09	.01 .02 .17 .02 .05 .18 .09 .21 .15
E2-E3	.24	.01 .04 .10 .06 .03 .25 .26 .31 .09	.01 .02 .17 .02 .05 .18 .09 .21 .15

[1]Summarized from the multitrait-multimethod matrix reported in Appendix I.

[2]Indicates validity coefficient is not significant. When criterion 2 is not met, other coefficients will not be reported in this table.

significance ($p \leq .05$) was performed on each coefficient, a rather liberal test considering that the validity coefficients were probably overstated due to the lack of complete independence among the scales.

Discrimination Criterion. Column three summarizes the different-trait different-method correlations used to evaluate criterion two. Discriminate validity is indicated when the coefficients in column two are smaller than the validity coefficient.

Common Method Variance Criterion. Column four summarizes the different-trait same-method correlations used to evaluate criterion three. The absence of significant common method variance is indicated when the coefficients in column three are smaller than the validity coefficient.

Individual Level Scales

Five general concepts were identified in earlier sections of the present paper. These concepts and the codes used for them here are as follows:

A - Routineness

B - Technical Ability

C - Centralization

D - Formalization

E - Interdependence

Each concept was classified by the above code in the two summary tables (Table XXIII and XXIV).

General Results

At first look, the state of the construct validity of some of the more popular measures currently used in the field was disappointing. Forty percent of the validity coefficients in Table XXIII were not significant. Only 4 of the 45 scales met all three criteria. Eleven of the scales demonstrated sufficient evidence of discriminate validity. In addition, method variance seemed to dominate many of the scale comparisons in that only 7 of the 45 scales met criterion three.

A closer inspection of Table XXIII reveals more encouraging results. For example, six of the 16 scales not meeting the requirements of criterion two contained only one coefficient that exceeded the validity coefficient. Likewise, six of the 14 scales not meeting criterion three contained only one such coefficient. Each of the concepts (A through E above) are examined below for the extent and limits of the validity of their measures.

Routineness (Concept A)

The technology variable "routineness" had the best overall convergent validity among the measures of concepts included in the present study (.49, .23, .43). Lynch's "overall routineness" scale and Aiken and Hage's "routineness" scale converged to share 24 percent common variance, had good discrimination from the other scales on the instruments, and shared little common method variance. The latter indicated that the shared variance was due to measuring the same concept rather than due to sharing a common measurement method.

The Aiken and Hage "routineness" and Hitt and Middlemist "task complexity" scales shared a common variance of about 5 percent.

However, the relationship is the result of common method variance ($.28^2$ or 7.8 percent) shared through their common association with the "hierarchy" scale. Another concern, these two scales lack discrimination between the "routineness" and "task complexity" scale comparison and other scales. It appears that the Hitt and Middlemist "task complexity" scale may not measure technology. The technology variable "task complexity" had a greater correlation with the Aiken and Hage structure scales "centralization" (.32, .39), and "job specificity" (.36) than with the technology scale "routineness" (.23).

In another Aiken and Hage-Hitt and Middlemist comparison, there was good convergence (.43) and little evidence of common method variance between the "overall routineness" and "task complexity" scales. However, the scales did not discriminate from the structure variable "autonomy" (.46). Another was of interpreting this result is that, when the Hitt and Middlemist "task complexity" scale was compared with the Lynch "autonomy" scale, about 18 percent of the variance in the "task complexity" scale measured technology (routineness) and 21 percent of the variance measured structure (autonomy).

The "task complexity" scale results illustrate the problem with using a composite scale for which the dimensions have not been specified or determined. As intended by the authors, the "task complexity" scale did seem to capture a composite view of a subunit. But, the scale went far beyond what Aiken and Hage measured as the domain of the technology concept. In fact, when compared with the Aiken and Hage technology scale versus various structure scales, the Hitt and Middlemist technology scale measured a large component of what others call structure as well as a component of technology. The composite nature of the scale also explains the low internal consistencies (alpha = .008, .170) for two applications of the scale in an international study (Blanco, 1980) while Hitt and Middlemist (1978) reported a relatively high (.75) test-retest correlation reliability estimate. Thus, more than usual care is required in selecting the measures to be used with the task complexity scale. These results also point out that extraordinary care is required in interpreting the results from applying any composite measures as broad as "task complexity".

Technical Ability (Concept B)

The concept of technical ability demonstrated less convergence among its scales than any of the concepts used in the present study. Of the 18 insignificant validity coefficients reported here, 11 were associated with the technical ability concept.

The technical ability concept was created as a repository for all of the scales that purported to measure some aspect of technology yet had demonstrated in past studies that they were not measuring "routineness". This diversity would be expected to produce the divergent kind of results found here. Thus, the main problem was one of trying to identify what was being measured by this loose assortment of scales.

"Task routineness" produced two significant validity coefficients. The first was with its companion scale on the same instrument, "predictability". The common variance between these two scales, however, was the result of common method variance. The common method variance indicated by the mutual association of both of these scales with "overall routineness" suggests that "overall routineness" may act as a moderating variable between "task routineness" and "predictability".

The association between "task routineness" and "variety" was one of the four comparisons in the present study that met all three criteria, showing moderate convergence (.23), good discrimination, and no appreciable common method variance. This concept seemed to be associated with characteristics of individual tasks that are not the same as "overall routineness", i.e., routineness of subunit operations and variety in one's own tasks are not opposite ends of a continuum.

In addition to "task routineness", the concept of technical ability produced two other significant validity coefficients. The association between "knowledge" and "uncertainty" (.23) did not discriminate from "overall routineness" (.25) and showed evidence of being due to common method variance. The second, and largest validity coefficient for the technical ability concept (.64), was the relationship between "uncertainty" and "instability". This was a spurious relationship, however. Recall that the factor analysis of the Overton et al. instrument indicated that two of the empirical factors are composed of almost an equal number of items from each of these scales. This misspecification of the scales would produce a high correlation without indicating theoretical convergence of the measures.

Centralization (Concept C)

The centralization measures accounted for five of the six insignificant validity coefficients not accounted for by the technical ability measures. The results for criterion two indicated there was generally good discrimination between the centralization measures and others. The results for criterion three, however, were very disappointing, indicating a pervasive common method variance among the measures of centralization.

There were serious problems with the Aiken and Hage instrument. Within their instrument, discrimination was generally good for both of Aiken and Hage's centralization scales. However, clear indications of lack of discrimination for the Aiken and Hage scales appeared in the comparisons between the Aiken and Hage and Lynch scales, and between the Aiken and Hage and Hitt and Middlemist scales. The "participation" and "autonomy" scales did not discriminate from any of the three Aiken and Hage formalization scales. The comparison between "hierarchy" and "time perspectives" scales did not discriminate from the "task complexity" (technology) scale or the "job specificity" (formalization) scale.

The final indication of insufficient discrimination for centralization measures was found in the comparison between Lynch's "autonomy" and Hitt and Middlemist's "time perspectives" scales. "Autonomy" shared 21 percent variance with the "task complexity" (technology) scale while sharing only 3 percent variance with the "time perspectives" scale. Thus, the comparison between the "participation" and "hierarchy" scales was ambiguous in that both scales were on the same instrument.

<u>Formalization (Concept D)</u>

The formalization scales demonstrated two extremes of adequacy. Two of the four scales that met all three construct validity criteria were formalization scales. However, many of the formalization scales could be characterized as not discriminating from other scales, as being associated through common method variance, or both.

The two comparisons that met all three construct validity criteria were between Aiken and Hage's "job specificity" scale and Lynch's "rules" scale; and between Lynch's "rules" scale and Comstock and Scott's "formalization" index. The comparison between Aiken and Hage's "job specificity" scale and Comstock and Scott's "formalization" index did not meet the common method variance criteria because validity coefficient was not large enough to offset the lack of discrimination among the Aiken and Hage formalization scales.

The lack of discrimination between Aiken and Hage's "rules" scale and their "hierarchy" scale is consistent with the results found in the Dewer et al. factor analysis solution. However, the lack of discrimination between Aiken and Hage's other formalization scales and their hierarchy scale was not obvious in the Dewer et al. factor analysis solution. This lack of discrimination appeared as common method variance in comparisons between Aiken and Hage's formalization scales and Lynch's and Comstock and Scott's formalization scales.

Thus, although the factor analysis results supported the construct validity of Dewer et al.'s solution for the Aiken and Hage instrument, the M-M matrix analysis did not. Apparently the convergence among the Aiken and Hage formalization scales is due to common method variance. Another way of describing the results is that the Aiken and Hage scales are more like each other then they are like the measures of similar concepts measured by the other instruments.

Interdependence (Concept E)

The comparison between Lynch's "internal task interdependence" and "interdepartmental task interdependence" scales confirmed the results of the factor analysis performed above, indicating that the two scales were really a single dimension. Treated as a single dimension, Lynch's interdependence scales showed good convergence with Overton's interdependence scale and good discrimination from the other scales. These comparisons did show rather high common method variance, however, bringing the overall convergence results of these scales into question. "Uncertainty" and "instability" may have served as moderating variables that caused the common method variance.

Summary of Individual M-M Analysis

The general conclusion to be drawn from the individual level M-M matrix analysis discussed above is that there was little agreement among the various measures of similar concepts. What agreement that did appear seemed likely to be the result of "similar" measures sharing a large component of variance with a third unmeasured concept. Much of the common method variance indicated in the present analysis may actually have been the influence of unmeasured variables.[7]

The general picture for discriminate validity based on the above results was that most of the lack of discrimination was between measures of centralization and formalization. It also appeared that "task complexity" may have been more a measure of structure in the present

[7]See Campbell and Fiske (1959), Golding (1977), and Jackson (1977) for extended discussions on the meaning and interpretation of common method variance.

study than it was a measure of technology. By far the most pervasive effect, however, was the presence of common method variance as a rival explanation to convergence among concepts for many of the significant validity coefficients.

Both of the Aiken and Hage centralization scales indicated lack of discrimination from other scales. There was little discrimination between the "participation" (centralization) scale and the three formalization scales (.26, .18, .15). The lack of discrimination between the "hierarchy" (centralization) scale and the other Aiken and Hage scales was even more pervasive, extending to "routineness" (technology) (.28) as well as the three formalization scales (.59, .49, .39). Since the factor analysis discussed earlier indicated reasonably good discrimination among these scales, it appears that common method variance in the Aiken and Hage scales was a more likely explanation of the associations that was lack of discrimination.

Subunit Level Scales

General Results

There were several noteworthy differences between the individual level results presented above and the subunit level results summarized in table XXIV from Appendix J. First, there was an increase in the percentage of insignificant validity coefficients from 40 percent of the individual scale comparisons to 51 percent of the subunit scale comparisons. Even though there was a general increase in the size of the validity coefficients reported in Table XXIV, often the increases were not great enough to offset the effect of the decrease in the sample size, from a sample of about 260 individuals to a sample of

TABLE XXIV

SUMMARY OF SUBUNIT LEVEL OF ANALYSIS VALIDITY COEFFICIENTS BY CRITERION[1]

Trait-Instru.	Validity Coefficient	Criterion 2 Coefficients	Criterion 3 Coefficients
A1-A2	.40	.34 .10 .02 .09 .28	.41 .27 .23 .24 .12
		.02 .12 .12 .09 .41	.14 .25 .04 .08 .22
		.09 .08	.08 .13
A1-A3	.46	.48 .34 .37 .16 .21	.41 .27 .23 .24 .12
		.01	.24
A2-A3	.43	.08 .03 .08 .44 .20	.14 .25 .04 .08 .22
		.03 .16 .15	.08 .13 .24
B1-B2	.56	.14 .25 .04 .08 .22	same as criterion 2
		.25 .08 .14 .16 .06	
B1-B3	.76	.14 .18 .19 .05 .07	same as criterion 2
		.04 .22 .21 .01 .11	
B1-B4	.15 n.s.[2]		
B1-B5	.03 n.s.		
B1-B6	.06 n.s.		
B2-B3	.13 n.s.		
B2-B4	.05 n.s.		
B2-B5	.01 n.s.		
B2-B6	.09 n.s.		
B3-B4	.13 n.s.		
B3-B5	.08 n.s.		
B3-B6	.26	.15 .33 .00 .10 .29	.41 .40 .16 .32 .08
B4-B5	.71	.12 .14	same as criterion 2
B4-B6	.14 n.s.		
B5-B6	.04 n.s.		
C1-C2	.22 n.s.		
C1-C3	.30	.34 .33 .07 .15 .14	.41 .40 .16 .32 .08
		.08 .10 .41 .58 .53	.18 .08 .22 .19 .03
		.42	.05
C1-C4	.12 n.s.		
C1-C5	.27 n.s.		
C2-C3	.56	.41 .58 .53 .42 .10	.27 .64 .51 .43 .08
		.01 .22 .01 .25 .06	.18 .08 .22 .19 .03
		.26	.05
C2-C4	.30	.34 .01 .14 .14 .04	.27 .64 .51 .43 .24

TABLE XXIV (Continued)

Trait-Instru.	Validity Coefficient	Criterion 2 Coefficients	Criterion 3 Coefficients
C2-C5	.13 n.s.		
C3-C4	.28	.44 .15 .12 .13 .21 .09 .03 .01	.08 .18 .08 .22 .19 .03 .05 .24
C3-C5	.10 n.s.		
C4-C5	.22 n.s.		
D1-D2	.45	.23 .40 .64 .24 .16 .51	same as criterion 2
D1-D3	.49	.23 .40 .64 .12 .32 .43	same as criterion 2
D1-D4	.36	.02 .12 .02 .06 .58 .01 .23 .09 .14 .25	.23 .40 .64 .22 .19 .21 .19 .27 .32
D1-D5	.01 n.s.		
D2-D3	.45	.24 .16 .51 .11 .32 .43	same as criterion 2
D2-D4	.39	.09 .06 .05 .09 .53 .06 .25 .09 .14 .25	.24 .16 .51 .22 .19 .14 .21 .19 .32 .27
D2-D5	.04 n.s.		
D3-D4	.49	.28 .03 .15 .05 .42 .07 .23 .09 .14 .25	.11 .32 .43 .22 .19 .14 .21 .19 .32 .27
D3-D5	.08 n.s.		
D4-D5	.03 n.s.		
E1-E2	.58	.08 .05 .16 .01 .03 .32 .13 .07 .06 .11 .05 .27	same as criterion 2
E1-E3	.31	.38 .36 .29 .15 .05 .17 .15 .07 .23	.08 .05 .16 .01 .03 .32 .12 .14 .14
E2-E3	.34	.18 .10 .10 .15 .05 .17 .15 .07 .23	.13 .07 .06 .11 .05 .27 .12 .14 .14

[1]Summarized from the multitrait-multimethod matrix reported in Appendix J.

[2]Indicates validity coefficient is not sufficient. When criterion 2 is not met, other coefficients will not be reported in this table.

about 65 subunits for most comparisons. Second, only two subunit scale comparisons met all three validity criteria as opposed to four individual scale comparisons that met these criteria.

Finally, there was a general shift from common method variance as the primary contaminating factor in scale comparisons at the individual level of analysis to a lack of discrimination among scales as the primary contaminating factor at the subunit level of analysis. Forty-three percent of the significant individual scale comparisons demonstrated adequate discrimination as opposed to only 32 percent of the subunit scale comparisons. However, 68 percent of the significant individual scale comparisons were contaminated by common variance as opposed to only 57 percent of the subunit comparisons. The primary reason for the shift was because a different set of validity coefficients were significant. Most of the increase in insignificant validity coefficients occurred with individual scales comparisons that contained substantial common method variance. Therefore, since the validity coefficients were insignificant, those comparisons were simply not analyzed for common method variance at the subunit level.

The above differences not withstanding, the most striking feature of the significant comparisons summarized in Table XXIV is that the overall results are almost parallel to those at the individual level of analysis. For example, there was a lack of discrimination between the centralization and formalization scales in the Aiken and Hage instrument. The Aiken and Hage instrument also showed evidence of considerable method variance when used with other instruments, the most contaminating scales being the "hierarchy" and the "rules observation" scales.

The "task complexity" scale continued to be strongly related to the concept of structure. The concept of technical ability had even less validity at the subunit level of analysis than it did at the individual level. Finally, the concept of interdependence continued to appear promising, but again, the scale comparisons were contaminated primarily by the Overton et al. instrument.

Routineness (Concept A)

Table XXIV indicates there were serious problems in measuring technology as routineness at the subunit level of analysis. Although the "routineness"-"overall routineness" comparison performed quite well at the individual level of analysis, it was inadequate at the subunit level of analysis. The Aiken and Hage "routineness" scale did not discriminate from the Lynch centralization scale "autonomy" (.41). The comparison also contained considerable common method variance through an association with the Aiken and Hage centralization scale "participation" (.41).

Most of the increase in convergence between the "routineness" and "task complexity" scales was probably due to common method variance (.41) associated with the "participation" scale. Also, the "task complexity" scale did not discriminate from the structure scales "participation" (.48) and "job specificity" (.47).

Finally, in the "overall routineness"-"task complexity" scales comparison (.43), the "task complexity" scale did not discriminate from the centralization scale "autonomy" (.44). Overall, there was a general lack of discrimination between technology and structure at the subunit level of analysis.

Homogeneity of Variance. One additional factor that may have contributed to the degradation in the validity of Aiken and Hage's "routineness" and Lynch's "overall routineness" scales was a loss of information due to aggregation of the individual responses.

Table XXV shows the distribution of within subunit individual scale scores for Aiken and Hage's "routineness" scale. Variances could be calculated for only 53 of the departments included in the present study. The sample variance for the "routineness" scale was .35. For 21 of the departments, the within department variance was higher than the sample variance, the highest was 2.53. This Aiken and Hage scale produced relatively little additional variance when aggregated for the subunit level of analysis.

Table XXVI shows the distribution of within subunit individual scale variances for Lynch's "overall routineness" scale. Variances could be calculated for 53 departments. The sample variance for the "overall routineness" scale was 40.62, the highest within department variance was 2.53. This Lynch scale provides an excellent basis for subunit aggregation since the individual scores within subunits are relatively homogeneous and it produces considerable additional variance at the subunit level.

Technical Ability (Concept B)

Only four of the comparisons in this composite category were significant. The comparisons between Lynch's technology measures "task routineness" and "predictability" (.56) and "task routineness" and "knowledge" (.76) indicated high degrees of convergence for both pairs. They also demonstrated good discrimination from other Lynch scales.

TABLE XXV

WITHIN SUBUNIT VARIANCES FOR THE AIKEN AND HAGE ROUTINENESS SCALE[1]

Hospital	Dept.	σ^2	Hospital	Dept.	σ^2	Hospital	Dept.	σ^2
2	35	2.53	2	37	.27	1	8	n.a.
2	20	1.53	3	1	.27	1	19	n.a.
2	21	1.13	3	25	.27	1	20	n.a.
3	2	1.13	3	13	.24	1	21	n.a.
1	12	.93	2	6	.23	1	25	n.a.
1	10	.78	1	28	.17	1	29	n.a.
3	8	.78	2	8	.10	1	31	n.a.
2	22	.75	1	13	.08	1	34	n.a.
1	8	.69	3	11	.08	1	40	n.a.
1	6	.68	1	32	.08	2	0	n.a.
1	17	.67	2	32	.08	2	7	n.a.
2	10	.61	2	11	.06	2	9	n.a.
3	36	.50	1	37	.04	2	12	n.a.
2	24	.47	1	5	.03	2	19	n.a.
3	6	.46	1	33	.04	2	23	n.a.
1	22	.43	2	42	.03	2	34	n.a.
1	39	.41	3	4	.03	2	36	n.a.
2	2	.39	3	21	.03	2	41	n.a.
3	10	.38	3	27	.03	3	3	n.a.
1	14	.36	2	1	.02	3	20	n.a.
Sample			2	28	.02	3	35	n.a.
Variance =	.35		2	33	.02	3	37	n.a.
1	16	.33	3	28	.02	2	8076	n.a.
1	23	.33	1	1	n.a.			
1	2	.31	1	15	n.a.			
2	25	.29						
1	24	.28						
1	38	.28						
2	27	.28						

[1]n.a. indicates the variance could not be calculated.

TABLE XXVI

WITHIN SUBUNIT VARIANCES FOR THE LYNCH OVERALL ROUTINENESS SCALE[1]

Hospital	Dept.	σ^2	Hospital	Dept.	σ^2	Hospital	Dept.	σ^2
Sample			2	22	.41	2	1	0.00
Variance = 40.62			2	24	.38	1	1	n.a.
			3	10	.38	1	15	n.a.
1	17	2.53	2	10	.35	1	18	n.a.
2	35	1.68	2	28	.35	1	19	n.a.
3	8	1.64	1	14	.33	1	20	n.a.
1	23	1.62	1	28	.33	1	25	n.a.
1	38	1.53	2	32	.31	1	29	n.a.
1	2	1.25	2	11	.29	1	31	n.a.
1	8	1.25	2	27	.92	1	34	n.a.
2	20	1.25	1	12	.27	1	40	n.a.
2	25	1.00	3	28	.26	2	0	n.a.
2	6	.99	2	8	.25	2	7	n.a.
3	2	.89	3	11	.25	2	9	n.a.
1	3	.80	1	37	.20	2	12	n.a.
2	2	.80	1	16	.18	2	19	n.a.
1	13	.72	3	27	.17	2	23	n.a.
3	13	.72	2	1	.15	2	34	n.a.
1	10	.68	2	37	.15	2	34	n.a.
2	13	.63	2	33	.10	2	41	n.a.
1	24	.59	1	33	.09	3	3	n.a.
2	21	.59	2	42	.03	3	20	n.a.
1	22	.57	3	36	.03	3	23	n.a.
1	6	.54	1	5	.01	3	35	n.a.
3	25	.51	1	21	.01	3	37	n.a.
3	6	.49	3	21	.01	3	8076	n.a.
1	32	.47						
1	39	.43						
3	4	.42						

[1]n.a. indicates the variance could not be calculated.

It was not possible to evaluate the presence of common method variance as the cause of the association between these four scales. However, nothing in the factor analysis results presented earlier suggested that it should have been present. The reliability estimates presented earlier in Tables XVI and XVII indicated a large increase in reliability for two of the three library technology subunit level scales, "task routineness" (.54 to .90) and "knowledge" (.50 to .81). This increase in reliability combined with the present results suggests that these scales may be quite adequate for use at the subunit level of analysis.

Homogeneity of Variance. Tables XXVII and XXVIII lend additional support to the suggestion that the "task routineness" and "knowledge" scales may be more adequate at the subunit level of analysis. Table XXVII shows the distribution of within subunit individual scale variances for Lynch's "task routineness" scale. The sample variance for the "task routineness" scale was 12.87, while the highest within subunit variance was 29.39. However, only three of the 77 subunits in the study exceeded the sample variance. Most of the individuals within subunits appeared to be relatively homogeneous on this scale, strengthening its value as a measure of technology at the subunit level of analysis.

Table XXVIII shows the distribution of within subunit individual scale variances for Lynch's "knowledge" scale. The sample variance on this scale was 4.70, while the highest within subunit variance was 8.00. Only three of the 77 subunits in the study exceeded the sample variance, however. As with the "task routineness" scale, homogeniety

TABLE XXVII

WITHIN SUBUNIT VARIANCES FOR THE LYNCH TASK ROUTINENESS SCALE[1]

Hospital	Dept.	σ^2	Hospital	Dept.	σ^2	Hospital	Dept.	σ^2
1	5	29.39	2	20	3.13	1	15	n.a.
1	21	22.22	2	37	2.90	1	18	n.a.
1	24	14.22	1	39	2.89	1	19	n.a.
Sample			1	10	2.72	1	20	n.a.
Variance = 12.87			2	35	2.72	1	25	n.a.
2	33	10.71	1	16	2.51	1	29	n.a.
2	25	10.67	2	32	2.46	1	31	n.a.
2	21	10.13	3	28	2.44	1	34	n.a.
2	8	10.08	3	10	2.17	1	40	n.a.
1	22	9.39	3	25	2.07	2	0	n.a.
3	2	8.00	3	4	2.00	2	7	n.a.
1	12	7.83	1	17	1.75	2	9	n.a.
2	10	7.66	2	42	1.68	2	12	n.a.
2	13	7.23	2	24	1.64	2	19	n.a.
1	14	6.65	2	2	1.60	2	23	n.a.
3	13	6.23	1	13	1.39	2	34	n.a.
3	21	6.13	1	28	1.31	2	36	n.a.
3	6	5.98	2	23	1.18	2	41	n.a.
1	8	5.95	1	28	1.15	3	3	n.a.
1	37	5.95	2	1	.26	3	20	n.a.
1	2	5.65	1	3	.23	3	23	n.a.
3	1	5.36	3	27	.06	3	35	n.a.
2	22	4.45	3	11	.03	3	37	n.a.
3	8	4.41	3	36	.01	3	8076	n.a.
2	27	3.83	1	33	.00			
1	6	3.75	1	38	.00			
1	32	3.60	1	1	n.a.			
2	6	3.37						
2	11	3.36						

[a]n.a. indicates the variance could not be calculated.

TABLE XXVIII

WITHIN SUBUNIT VARIANCES FOR THE LYNCH KNOWLEDGE SCALE[1]

Hospital	Dept.	σ^2	Hospital	Dept.	σ^2	Hospital	Dept.	σ^2
3	2	8.00	2	24	1.38	3	4	.00
1	10	5.56	1	16	1.27	1	1	n.a.
1	24	5.56	1	28	1.24	1	15	n.a.
Sample			1	6	1.13	1	18	n.a.
Variance = 4.70			1	12	1.11	1	19	n.a.
2	22	4.04	1	23	1.04	1	20	n.a.
1	8	3.94	2	27	1.03	1	25	n.a.
3	10	3.36	1	22	1.01	1	29	n.a.
2	13	3.34	3	11	.78	1	31	n.a.
2	8	3.33	2	37	.70	1	34	n.a.
2	33	3.29	2	32	.69	1	40	n.a.
3	6	3.04	1	33	.50	2	0	n.a.
3	28	2.92	2	21	.50	2	7	n.a.
1	32	2.48	3	21	.50	2	9	n.a.
2	25	2.30	2	6	.48	2	12	n.a.
3	8	2.14	2	28	.37	2	19	n.a.
2	10	2.13	2	2	.31	2	23	n.a.
3	13	2.04	2	35	.22	2	34	n.a.
2	20	2.00	3	36	.22	3	36	n.a.
1	39	1.94	3	25	.19	2	41	n.a.
2	21	1.81	2	11	.11	3	3	n.a.
1	2	1.70	1	5	.06	3	20	n.a.
1	17	1.44	2	42	.06	3	23	n.a.
3	1	1.44	3	27	.06	3	35	n.a.
1	13	1.39	1	3	.03	3	37	n.a.
1	21	1.39	1	38	.00	3	8076	n.a.
1	37	1.33						
1	14	1.31						

[1]n.a. indicates the variance could not be calculated.

within subunits found for the "knowledge" scale strengthened its value as a measure of subunit technology.

More Technical Ability Factors. Of the last two significant comparisons, the comparison between the "knowledge" and "variety" scales demonstrated moderate convergence (.26). However, the "variety" scale did not discriminate from the "overall routineness" scale (.33) or the "interdepartmental task interdependence" scale (.29).

The comparison between the "uncertainty" and "instability" scales was a enigma. These scales demonstrated a high degree of convergence (.71). Based on the factor analysis reported earlier, the convergence was expected since two of the empirical factors were composed of almost an equal number of items from each of these scales. What was not clear, however, was what the factor created by the pair of scales was measuring. Neither one of the scales was more than moderately associated with any other scale appearing in the whole M-M matrix. The only conclusion possible at the present time is that this factor was a composite of many concepts and therefore is probably of little practical use.

Centralization (Concept C)

Every comparison that included the Aiken and Hage instrument indicated approximately the same lack of discrimination between centralization and formalization scales and approximately the same presence of common method variance that was shown in the individual level analyses. The most notable difference at the subunit level of analysis was the evidence of even less discrimination from and more common method variance associated with technology scales through the "routineness" scale (see all comparisons involving "participation" or "hierarchy" scales).

There was further indication that a large component of variance in the "task complexity" scale measured structure. Every comparison involving the "time perspectives" scale indicated either a lack of discrimination with the "task complexity" scale, or an association with the "task complexity" scale as a source of common method variance.

Formalization (Concept D)

As with the centralization scales, the formalization scales demonstrated almost parallel results at the subunit and individual levels of analysis. None of the Aiken and Hage formalization scales discriminated from their "hierarchy" (centralization) scale and only their "job specialization" scale discriminated from Lynch's "autonomy" scale. Common method variance accounted for the convergence between most of Aiken and Hage's formalization scales and Lynch's formalization scale "rules". An interesting observation here is that Lynch's "rules" scale was more like Aiken and Hage's "job specialization" scale than their "rules" scale. Indeed, the comparison between the "job specificity" scale and Lynch's "rules" scale marginally met all three of the validity criteria.

Interdependence (Concept E)

Lynch's "internal" and "interdepartmental task interdependence" scales demonstrated good convergence (.58), and good discrimination from other scales on the instrument. It was not possible to evaluate the presence of common method variance, however.

Lynch's and Overton et al.'s "interdepartmental interdependence" scales demonstrated moderate convergence (.31) that was probably due to common method variance associated with Lynch's "rules" scale (.32). In this comparison, Lynch's "interdepartmental task interdependence" scale also did not discriminate from the other Overton et al. scales" uncertainty (.38), instability (.36), variety (.29)

The comparison between Lynch's "internal task interdependence" scale and Overton et al.'s "interdepartmental task interdependence" scale is the only subunit level comparison that clearly met all three validity criteria. This result supports the suggestion made at the individual level of analysis that these interdependence scales are a single dimension and the argument that interdependence is a separate concept.

Summary of Subunit M-M Analysis

The general conclusion to be drawn from the subunit level M-M analysis discussed above is that there was even less agreement among subunit level scales as to what was being measured than there was among individual level scales. In addition, what agreement there was results primarily from common method variance. Analyses of the within subunit variance for several scales, however, indicated that the scales were potentially useful at the subunit level of analysis. The most theoretically interesting result of the subunit level of analysis is the indication that interdependence may be a distinct concept from both technology and structure variables.

CHAPTER V

SUMMARY OF RESULTS

Three basic analyses were employed in the present study to determine how the scales included here might be understood. The complementary information produced by these analyses was an important factor in gaining greater understanding of the meaning of the scales. The results of the study are summarized in terms of the contribution each analysis made to the issue being discussed.

Reliability

Coefficient Alpha

Coefficient alpha is intended to evaluate the degree to which an *a priori* scale is meaningless, i.e., the degree to which it produces random error variance. Overall, at both the individual and subunit levels of analysis, the Aiken and Hage (1968) and Comstock and Scott (1977) instruments demonstrated the highest reliability.

There was a substantial increase in the size of most of the reliability estimates at the subunit level of analysis which suggested that the process of aggregation generally reduced random error in the scales. The Lynch (1974) scales showed the greatest improvement at the subunit level and their use should probably be confined to that level.

Some of the low reliabilities reported here seem to have been due to violations of certain assumptions underlying the calculation of coefficient alpha. The assumptions that the items constituting a scale measure a single concept and that the items measure the concept equally were the most common violations.

Factor Analysis

Factor analysis was used to evaluate potential violations of the assumptions underlying coefficient alpha as well as to evaluate the internal structure of the instruments. Principal components factor analysis produced orthogonal linear combinations of the items which were evaluated for the degree to which they reproduced the set of items constituting the *a priori* scales. PC analysis indicated that the Overton et al. (1977) scales were misspecified, with many of the items not loading together as hypothesized. Thus, coefficient alpha indicated a lack of construct validity in the internal structure of the Overton et al. (1977) instrument rather than low reliability.

The Comstock and Scott (1977) instrument produced factors that precisely reproduced the *a priori* scales. With a minor exception, the same was true for the Aiken and Hage (1968) instrument. Thus, the relatively high reliabilities for the scales for both of these instruments appeared accurate and adequate.

The Hitt and Middlemist (1978) scales indicated low reliabilities, not because of error variance or invalidity but because the *a priori* scales were designed to evaluate the general effects of technology on a subunit. Thus, the scales were quite broad in that they contained several concepts on the same scale. The latter conclusion was supported by an exploratory factor solution which indicated that the instrument contained at least four interpretable factors. The instrument would be more useful as a measure of technology and structure if scales measuring different conceptual dimensions were defined and identified in it.

The low alpha coefficients for some of the Lynch (1974) scales indicated the presence of random error at the individual level of analysis since the factors essentially reproduced the *a priori* scales. This conclusion was supported by the relatively low communalities and average interitem correlations for items on those scales.

From the combined results of factor analysis and coefficient alpha, it was shown that coefficient alpha represents a lower limit of reliability. For example, it is very likely that the Hitt and Middlemist (1978) instrument was much more reliable, in terms of being free of random error, than the alpha coefficients indicated. Thus, the results reported here indicated that particular care is required in interpreting reliability estimates reported in research using coefficient alpha.

Internal Construct Validity

Of the instruments in the present study, the Aiken and Hage (1968) and Comstock and Scott (1977) instruments demonstrated the best construct validity in their internal structures, with the Lynch (1974) instrument following closely behind.

Factor analysis indicated the presence of two general factors in the Comstock and Scott instrument. These factors were highly supportive of the theoretical assertion that centralization is a general concept which represents the distribution of influence between supervisors and subordinates within a subunit. Also, centralization was distinct from the degree of formalization in the controls used in the subunit. The Comstock and Scott instrument was an excellent measure of the centralization and formalization dimensions at both levels of analysis.

At the individual and subunit levels of analysis, the Aiken and Hage (1968) instrument was the instrument of choice in terms of its overall reliability and internal construct validity. The six scales identified for this instrument generally discriminated among each other as measures of technology and structure concepts.

The Lynch (1974) instrument appears to be an adequate measure of both technology and structure at the subunit level of analysis only.

Overall Construct Validity

The multitrait-multimethod (M-M) matrix analysis compared all a priori scales included in the study. The validity coefficient in the M-M analysis was the correlation between two scales purporting to measure the same trait and represents the degree of convergence between scales. The large number of insignificant validity coefficients at the individual level of analysis indicated a widespread lack of agreement as to how the concepts of technology and structure should be measured. At the subunit level of analysis there was even less convergence among the scales. The technical ability and centralization scales demonstrated the least convergence at both levels of analysis.

Discrimination in the M-M matrix was indicated when the validity coefficient was higher than the correlation between the trait scale on one instrument with scales for any other trait on the other instrument involved in the comparison. For example, the Hitt and Middlemist (1978) "task complexity" scale (technology) was more highly correlated with Aiken and Hage's (1968) "hierarchy" scale (centralization) than it was with Aiken and Hage's (1968) "routineness" scale (technology), indicating poor discrimination.

At the individual level of analysis, there was some discrimination among concepts. However, the reader should note that 57 percent of the significant individual level validity coefficients involved scales that did not demonstrate adequate discrimination. The situation was even worse at the subunit level of analysis, with 68 percent of the significant validity coefficients involving scales that did not demonstrate adequate discrimination.

Finally, common method variance was indicated when the validity coefficient was lower than the correlation between the trait scale and any other scale on the same instrument. For example, at the individual level, the Aiken and Hage (1968) "routineness" scale (technology" was more highly correlated with their own "hierarchy" scale (structure) than it was with Hitt and Middlemist's (1978) "task complexity" scale (technology), indicating the presence of common method variance. Both of these technology measures were correlated with the same structure measure, suggesting that the significant validity coefficient for the technology scales was more the result of their common association with the structure scale than it was a result of their own mutual association.

An alternative, and more traditional interpretation for common method variance is that the two scales are simply present on the same questionnaire and mutually associated with characteristics of that questionnaire. Such may be the case here. This issue is discussed further in the final chapter.

The presence of common method variance was pervasive at the individual level of analysis. It was likely that 68 percent of the significant validity coefficients were actually due to common method variance rather than substantial direct relationships between measures purporting to measure similar traits. The situation was not much better at the subunit level of analysis, with 57 percent of the significant validity coefficients potentially being due to common method variance.

CHAPTER VI

CONCLUSIONS AND IMPLICATIONS

The results of this study suggest two general conclusions regarding the measurement of organization technology and structure. First, there do appear to be internally adequate measures of what isolated investigators have called technology and structure. The Aiken and Hage (1968) and Comstock and Scott (1977) instruments appear to have adequate reliability and internal validity at the individual and subunit levels of analysis. The Lynch (1974) instrument joins these two at the subunit level of analysis as being an instrument of choice.

Second, at both levels of analysis, there is a general lack of agreement among measures offered by different investigators purporting to measure similar constructs. In addition, much of the agreement that is present is due to the mutual association of "similar" scales with unspecified constructs. This mutual association shows up as common method variance.

The Comparison of Results

The results of the present study appear to contradict those of Fry (1982). Fry (1982) used meta-analysis to show that there was a consistent relationship between technology and structure across a large number of studies. The present results indicate a general lack of agreement among measures of the variables used in many of those studies.

However, the present results do partially support Fry's (1982) findings. The present study found that a number of instruments, when used by themselves, adequately represented the difference between technology and structure. Thus, the relationships within many of Fry's studies appear to represent valid differences in the traits within the context of the instrument used.

The implication from Fry's (1982) study that there is a consistent relationship between technology and structure is not supported here. The present study shows that it is not yet possible to specify what the studies that use different instruments have in common. We do not know what they have in common because, taken as a group, the different measures of technology as well as the different measures of structure do not measure the same things. If the measures purporting to measure the same trait have no common basis, then the studies that used different measures of that trait have nothing in common. Under this interpretation, studies using different instruments must be treated as addressing different concepts.

However, even if the scales from different instruments have nothing in common, the present study indicates that some of the instruments are reliable and have internal validity. Different studies using the same instrument, if it is reliable and valid, may be compared. The primary drawback to this latter strategy is that cumulative results are likely to be method bound.

Things That Go Bump in the Night

The present study has found a large component of common method variance that unites certain scales. This common method variance may be the result of poor instrument construction. That is, the scales may encourage lying, socially desirable responses, or a tendency toward positive or negative response bias across the different instruments. Analyzing these kinds of variables as a source of common method variance among the instruments and removing their effect could produce a gain in the construct validity of those instruments.

Unspecified Constructs

The chapter has noted and discussed the considerable overlap found among measures of technology and structure. This overlap may occur because respondents in different circumstances interpret the same questions differently. For example, some technology questions may elicit structure responses from some people. The solution to this type of overlap is to create items that are associated with universal ideologies, ideas that are accepted and understood the same way in all situations.

However, in Chapter II, it was suggested that some of the overlap in measures may be due to overlaps in the conceptual dimensions that underlie the measures. Discussion in the rest of this section is based on the assumption that present concepts lack adequate precision and clarity which in turn leads to imprecise measures.

Following Dubin's (1969) argument, it may be time for the present concepts to take on a more pedagogical character as they are replaced by more precise concepts. Common method variance may represent the presence of unspecified constructs that should be represented in the theory and that should be measured directly. If much of the common method variance is the result of lack of precision in specifying the variables, then an increase in precision will increase the construct validity of the measures and possibly their ability to predict outcomes.

For example, the concept of "task complexity" measured by the Hitt and Middlemist (1978) instrument is a summative unit.[1] A summative unit creates breadth in a concept and makes it difficult to achieve discrimination among measures. Summative units may also make it difficult for respondents to understand what is being asked of them if the items used to measure the concept are not stated clearly.

Summative units may be useful at early stages of study, but they also tend to conceal important relationships that may create conflicting results in subsequent studies. Measures of summative units can produce the same sum in two different instances for completely different reasons. For example, in the context of the Hitt and Middlemist instrument, tasks may be complex because they contain a lot of variability, because the raw materials vary considerably, because procedures are not well developed, or because one is given great discretion in determining how something is to be done. Each of these sources of task complexity could presumably correlate with the characteristics of technology or structure in quite different ways under different circumstances.

Finally, if a concept such as interdependence is a source of common method variance between technology and structure, it is of

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[1]Summative units are ones in which several concepts (of technology and structure) are combined without specifying how they interact (Dubin, 1969).

potential theoretical significance. By describing and measuring interdependence as a distinct construct and removing references to interdependence from the current measures of technology and structure, it may be possible to improve the construct validity of the set of instruments.

Following the strategy of increasing precision discussed above would produce more complex models of organization technology and structure. An empirical question to be investigated in this regard is "How much increase in construct and predictive validity will result from greater precision in theory and measurement?" In the present situation, the potential for improvement is great.

Interdependence has been suggested here as a potential construct to improve precision. Overton et al. (1977) suggested uncertainty and Rousseau (1979) suggested five system parameters (input control, input characteristics, conversion, output control, output characteristics) as potential constructs to improve precision. Each suggestion is associated with a different agenda and each has given evidence of potential for improving work involving technology and structure variables.

The Selection of Instruments

The present study makes it very clear that instruments used to measure organization technology and structure must be selected carefully, especially at the subunit level of analysis. None of the scales or instruments evaluated in the present study can be assumed to have construct validity.

The presence of common method variance among the instruments used in the present study creates a critical methodological problem. One must be careful in combining these instruments. In combination, there is an increased likelihood that common method variance will be an alternative explanation for the association among traits measured by the instruments. However, this does not mean that only one instrument should be used.

When common method variance is a potential factor in a study, it is important to use multiple measures of each trait. Only in this way will it be possible to apply analytical procedures to evaluate construct validity and the presence of common method variance. In addition, some of the procedures that require multiple measures also make it possible to control for the presence of common method variance in evaluating the relationships among traits.

Thus, the present study points out the need for more precise theories, more precise measures, and greater care in designing studies that evaluate the relationships among technology and structure. Current studies using different instruments are essentially incomparable. Increased concern and attention toward the construct validity of the instruments employed will alleviate similar problems among future studies.

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APPENDICES

APPENDIX A

LEVELS OF ANALYSIS AND THE TECHNOLOGY/ STRUCTURE RELATIONSHIP

TABLE XXIX

LEVELS OF ANALYSIS AND THE TECHNOLOGY/STRUCTURE RELATIONSHIP

Study	Unit(s) of Analysis	Results
---------- Organizational Level ----------		
Aiken and Hage (1968)	health and welfare agencies (local offices)	A significant positive relationship between technology, centralization, and formalization, negative relationship between technology and complexity.
Hickson et al. (1969)	52 organizations or divisions of various kinds in England	Operations technology in not significantly related to structure. Some operations technology variables were significantly related to workflow. Size is a moderating variable in the technology/structure relationship.
Mohr (1971)	local offices of health and welfare agencies	Show a very weak and limited relationship between technology and structure.
Dewer and Hage (1978)	the same data used by Hage and Aiken (1969)	A significant relationship between structure and technology for both change and rate of change in the variables in longitudinal data. Size and rate of change in size have an independent effect from technology on structure.
Glisson (1978)	social services agencies	Path analysis indicates that only division of labor and procedural specification (technology) have significant direct effects on structure.

TABLE XXIX (Continued)

Study	Unit(s) of Analysis	Results
----------	Subunit Level	----------
Grimes and Kline (1973)	tasks groups in a manufacturing corporation (task level); departments in a manufacturing corporation (subsystem level)	Relationship between operations technology and structure are stronger at the task level than the subsystem level. The relationship is stronger between items associated with the same level.
Hrebiniak (1974)	hospital departments	Individual task technology is related to departmental structure after controlling for supervisor influence.
Lynch (1974)	department in three academic libraries	Technology and structure are empirically distinct concepts. Two technology dimensions (overall routineness, library technology) are found. Internal task interdependence is a structural dimension. Technology and structure combined to discriminate between departments.
Mahoney and Frost (1974)	departments in 17 firms in a variety of manufacturing and service industries	Significant but different relationships between certain structure variables and overall effectiveness exist for different technology types.
Van de Ven and Delbecq (1974)	work groups of $3 \geq 10$ individuals in local offices of employment security agencies	Find a significant relationship between subunit technology and subunit structure.

TABLE XXIX (Continued)

Study	Unit(s) of Analysis	Results
Comstock and Scott (1977)	hospital wards in larger size hospitals	Subunit technology was significantly and most strongly related to subunit structure as opposed to individual structure.
Overton et al. (1977)	Bounded administrative and social units identified as geographic inpatient areas in several hospitals.	No structure measures are specified. Empirical technology dimension are labeled uncertainty, instability, and variability and are different from the hypothesized dimensions of raw materials, techniques, and task interdependence. The empirical dimensions discriminate between types of subunits.
Rousseau (1977)	Production departments	Subunit technology has a significant effect on individual job characteristics.
Hitt and Middlemist (1978)	Departments in a variety of manufacturing and service organizations	No structure measures are specified. High agreement exists between judges' ratings and self-report measures of technology. Measures of technology discriminate between subunits.
---------- Individual Level ----------		
Hrebiniak (1974)	Individual workers in hospital departments.	Technology in the job is not related to structural characteristics of the job even after education level and father's occupation are controlled. Control of supervisory characteristics produces a significant relationship between individual technology and individual structure.

TABLE XXIX (Continued)

Study	Unit(s) of Analysis	Results
Comstock and Scott (1977)	Individual nurses within a hospital ward.	Measures of individual technology are significantly and most strongly related to measures of individual structure.
Rousseau (1977)	Individual production jobs	Individual job characteristics are significantly related to departmental technology.
Hitt and Middlemist (1978)	Individual members of departments	Individual characteristics (i.e., education, sex) are significantly related to subunit technology.
Pierce and Dunham (1978)	Individual workers in two regional offices of an insurance company	Technology dimensions of "variability" and "routinization" combine with the job characteristic "variety" as one dimension. Structure dimensions of "centralization" and "formalization" combine with the job characteristic "autonomy" to form another dimension. The technology variable "predictability" combines with the job characteristic "feedback" to form a dimension. Good discrimination validity exists between these dimensions.
Rousseau (1978)	Individual jobs within departments	Job characteristics are most strongly related to departmental technology and structure characteristics. Job characteristics accounted for all of the relationship between positional characteristics, attitudes, and behavior. Job characteristics account for much of the relationship between departmental characteristics, attitudes, and behavior. Job characteristics do not account for the relationship between individual characteristics, attitudes, and behavior.

APPENDIX B

DIMENSIONS OF ORGANIZATION TECHNOLOGY BASED ON THOMPSON'S CATEGORIES

In his seminal work, Thompson (1967) proposed three categories of organization technology without specifying underlying dimensions for them. Thompson's work has received considerable attention since it was first introduced and has been the basis for several empirical studies. However, the lack of specific technology dimensions may have contributed (as was probably his intention) to the wide diversity of ways in which the concept has been used.

There also has been rather wide disagreement on the meaning and operationalization of Thompson's (1967) versus Perrow's (1967) concepts of both technology and structure (Rousseau, 1978, 1979; Fry, 1982). The critical and empirical analyses of operationalizations of Thompson's and Perrow's concepts performed in the accompanying dissertation suggested that the concept of interdependence was one of the major sources of confounding among the operationalizations. Some questionnaire instruments have attempted to measure technology by using items that refer to interdependence (Grimes and Kline, 1973; Hitt and Middlemist, 1978). Others have also attempted to measure structure using items that refer to interdependence (Hage and Aiken, 1969; Lynch, 1974). Empirical evidence in the accompaning dissertation indicated that respondents are not able to distinguish well between the two types of interdependence.

Given the current interest in Thompson's concepts in organizational research (Fry, 1982; Grimes and Kline, 1973; Hitt and Middlemist, 1978; Rousseau, 1979) it is appropriate that his technology categories receive further development.

The present note attempts to resolve some of the confounding among concepts by first identifying interdependence as a distinct concept. Organization technology and organization structure are then identified as distinct sources of interdependence in organizations. The discussion in the balance of the paper then focuses on the concept of technology by identifying a set of underlying dimensions of technology based on Thompson's (1967) technology categories. Thompson's categories and the proposed dimensions are then linked to the different levels of interdependence. Important consequences of the proposed approach are discussed in the conclusion.

Technological Interdependence Versus Structural Interdependence

The Concept of Interdependence

Thompson (1967) identified three forms of interdependence:

1. Pooled--units share only the most general resources of the organization such as its financial strength.

2. Sequential--the output of one unit serves as the input to other units in succession such as in the relationship between mining and smelting operations.

3. Reciprocal--two or more units both receive input from and provide output to each other such as in the relationship between the operations and maintenance divisions of an airline.

The concept of interdependence provides a means of classifying interactions in an organization. These interactions may be between major organizational subunits, work groups, or individual members of an organization. Thompson (1967), Emerson (1962), and many others, have suggested that interdependence is associated with a number of organizational processes. For example, Thompson (1967) suggested that the type of interdependence is associated with the degree of flexibility in a system of interactions. Emerson (1962) and Burt (1977) have suggested that the type of interdependence will affect the relative power relationships among units. For the balance of this note technology and structure are treated as two sources of interdependence among organizational units, with particular attention being given to the concept of technology.

Organization Technology as a Source of Interdependence

Technological interdependence focuses on the interactions among the tasks performed in an organization. The "tasks" may be activities at any level of analysis. Interactions among these tasks can be described by the categories of interdependence enumerated above. For example, some production operations (pooled) may be performed in relatively self-contained units such as custom processing divisions that have little interaction with other organizational units. Other production operations may be sequential such as those in assembly divisions. Yet others may be reciprocally interdependent as in the example of the airline divisions mentioned above. Technological interdependence describes the way in which tasks distributed throughout an organization are required to interact.

Structure as a Source of Interdependence

Dalton et al. (1980) identified two types of variables that have been used to describe organization structure. They labeled one set "structural variables" (e.g., span of control, administrative intensity) which describe the physical relationships in an organization. They labeled the other set "structuring variables" (e.g., formalization, centralization) which describe the decision making relationships in an organization.

Interdependence among structuring variables is the primary concern in the present paper. Thus, the focus is on the interactions among the decisions made in the organization. As with tasks, decisions may be viewed at any level of analysis we choose to consider. The interactions among these decisions can be described by the categories of interdependence cited above. For example, some decisions may be relatively inclusive of all organizational units (pooled), such as decisions affecting the financial strength of an organization. Other decisions may be approached sequentially where the current decision has a direct affect only on the decision that immediately preceeds or succeeds it. For example, a decision to increase the output of a unit may require a decision to increase warehouse space to store the output until succeeding units can process it. The size of the new warehouse will be determined by the increase in output and the rate at which succeeding units will use the output. But, a temporary decrease in the production capacity of a succeeding unit will not affect the initial decision to increase the output from the first unit until it is determined that the warehouse cannot store the additional output that would have been used by the succeeding unit.

In the airline example above, however, a decision to increase the number of flights is constrained by the number of airplanes the maintenance division can make available in a given period of time. Likewise, the number of airplanes to be maintained in a given period of time depends upon the number of flights. In the airline example, both decisions must be made simultaneously rather than sequentially. Thus, interdependence among structuring variables describes the distribution of decision points throughout the organization and the order in which those points must be considered.

Technology Dimensions and Interdependence

Thompson's Organization

Technology Categories

Thompson described three categories of technology.

1. Long-linked--characterized by sequential operations that ideally produce a single standard product, repetitively, at a continuous rate.

2. Mediating--characterized by extensive operations (widely distributed operations) that are operated in standardized ways.

3. Intensive--characterized by localized operations that are selected according to the therapeutic requirements of the object of work from the stock of procedures operated by the organization.

From Thompson's (1967) description of these categories, it is possible to deduce two underlying dimensions. One dimension describes the degree of adaptability required in the pattern of activities. The other dimension describes the degree of adaptability to immediate task information required in performing the activities. Each of these dimensions is discussed below.

Adaptability in the Pattern of Activities

The terms "sequential", "extensive", and "intensive" in Thompson's categories describe patterns of activities. The underlying dimension that these terms have in common is the need for a pattern of activities to adapt to various circumstances. A sequential pattern of activities is the least adaptive. For example, it is difficult to imagine how sanding and finishing operations could take place before cutting and shaping operations.

An extensive pattern of activities is somewhat more adaptive. Subsets of an organization's activities can be grouped at locations where they are most likely to be needed. The activities within a subset may then be operated in any desired order at that location. For example, automatic bank tellers allow a bank's customers to initiate certain transactions with the bank at convenient locations. These transactions may be performed in any order desired by the customer so long as they do not exceed certain limits (e.g., the balance in their checking account). Typically, however, one may not initiate transactions with their trust fund, buy a certificate of deposit, or engage in a number of other transactions offered by the bank. Thus, an extensive pattern of activities allows a high degree of adaptation among limited sets of an organization's activities at diverse locations.

An intensive pattern of activities provides the greatest degree of adaptation in the pattern of activities performed by the organization. For example, a hospital may perform any of its stock of activities in almost any order. The patient is localized in the hospital to make the complete stock of activities immediately accessible. A construction site provides a similar potential for altering the application of activities, it simply requires that the firm move the appropriate equipment to the site. Although certain activities are generally performed before others, (e.g., X-ray before surgery) neither of the activities is absolutely dependent upon the other for either to be performed. Thus, an intensive pattern of activities could in one sense be seen as a random set of independent activities available in an organization that can be organized into any pattern at any time in some particular place.

Adaptability to Immediate Task Information

The terms "repetitive at a constant rate", "standardized", and "therapeutic" in Thompson's categories describe the operation of activities. The underlying dimension that these terms seem to have in common is the need for activities to adapt to individual requirements or immediate changes in the object of work. Repetitive tasks performed at a constant rate are the least responsive to differences in the object of work. For example, wood saws in a mill are set up to saw wood. These machines cannot be used to drill holes and if made to cut a piece of steel, the machine is likely to quit operating. Repetitive tasks tend to respond to all but a single prescribed situation by shutting down. That is, repetitive tasks have a very narrow range of adaptability to immediate task information (e.g., the need to drill a hole or cut steel rather than saw wood).

Standardized activities provide a wider range of adaptability to immediate task information. Objects are classified into certain categories and processed in a particular manner. For example, a bank teller classifies a customer who wishes to save money in a bank as a depositor and performs a deposit transaction to the person's saving account. If the customer then wishes to make a payment on her loan, the teller classifies the person as a borrower and proceeds to perform the appropriate transaction. A turret lathe contains a variety of milling and cutting procedures which are sets of standardized operations available in the same machine. A variety of applications programs on a computer are a set of standardized activities. Thus, with standardized activities, a range of categories are available into which objects can be classified and processed on the basis of immediate task information.

Therapeutic activities provide the greatest range of adaptability to immediate task information. Therapeutic activities respond differentially to different objects or to the same object at different times. These activities operate on a "real time" immediate response basis to changes in the object. The intensive care unit in a hospital and the mission control center for a space flight are extreme examples of therapeutic activities with the ability to respond to immediate task information. The field of robotics is developing machines that sense and respond to a range of differences in the object of the work. Computer systems are being developed that "learn" what activities the user wants to perform. Thus, therapeutic activities are highly adaptive to minute changes in the object of work.

For example, the banking activities processed by a single teller (automatic or human) share one common resource, the teller's time. The teller can only process one transaction at a time. Within the accepted range (a sufficient balance) deposit and withdrawal transactions are not directly interdependent, each can be processed without affecting the other. The amount of teller time available will determine the total number of transactions that can be processed. In a similar manner, every telephone in an exchange can be treated as an independent unit as long as switching capacity is available. When switching capacity is reached all telephones are affected similarly, the total number of calls is limited by the number of switches available.

Figure 3 also suggests that the least amount of technological flexibility, long-linked technology with its sequential repetitive activities, produces sequential interdependence representing a somewhat higher degree of complexity in the interactions. Finally, the highest degree of technological flexibility, intensive technology with intensive therapeutic tasks, often produces reciprocal interdependence.

Conclusion

The present paper has proposed two basic dimensions of technology based on the need for technological flexibility. Flexibility is achieved by (1) making the tasks more adaptive to unique situations and (2) adapting the order in which activities are applied to unique situations.

The present approach allows for a finer grained representation of technology than do Thompson's original categories. His original categories represent only three particular combinations of the two dimensions. By identifying continuous dimensions that describe technologies, it is theoretically possible to identify an infinite number of differences among technologies. Whether this additional detail will be of any practical significance is an empirical question worthy of investigation.

There is considerable conceptual similarity between Perrow's (1967) overall technology dimension "routineness" and the overall technology dimension "technological flexibility" proposed here. Perrow's underlying technology dimensions are based on the concept of variability in the performance of tasks, which is similar to the concept of adaptability in patterns and activities that underlies the dimensions proposed here. To the extent that these concepts are similar, operationalizations based on the dimensions should be similar.

The dimensions proposed here are not based on interdependence and do not suggest or require items referring to interdependence to measure them. This feature should reduce the present confounding that exists between measures of technology and structure.

However, if one wishes to measure interdependence in an organization, it is suggested that the degree of technological flexibility would create one source of interdependence. This feature of the model should be of particular interest to those who are attempting to apply structural variables (Lazersfeld and Menzel, 1969) and techniques such as blockmodeling and networking to research in organizations. The current theory underlying such approaches to organizational research is confined primarily to versions of the population ecology model (Aldrich, 1979; Hannan and Freeman, 1977). However, the number of articles appearing in Administrative Science Quarterly in the last two years that take such approaches indicates an increasing interest on the part of a number of people.

Finally, the dimensions proposed here do not materially alter Thompson's concept. Nor do the dimensions necessarily invalidate previous studies that have used Thompson's categories as global variables (Lazersfeld and Menzel, 1969) to evaluate organization technology. Valid measures of the concept of technological flexibility proposed here should be identical, within the tolerance of measurement error, to the evaluations by expert judges using Thompson's categories.

Thus, the model proposed here does appear to have potential and warrants further investigation.

The Proposed Dimensions and Thompson's Original Categories

Figure 2 illustrates the relationship between the proposed dimensions and Thompson's original categories. The "Pattern Adaptability" dimension ranges from little pattern adaptability described by "sequential" patterns to high pattern adaptability described by "intensive" patterns. The "Adaptability to Immediate Information" dimension ranges from little adaptability to immediate task information described by "repetitive" activities to high adaptability to immediate task information described by "therapeutic" activities.

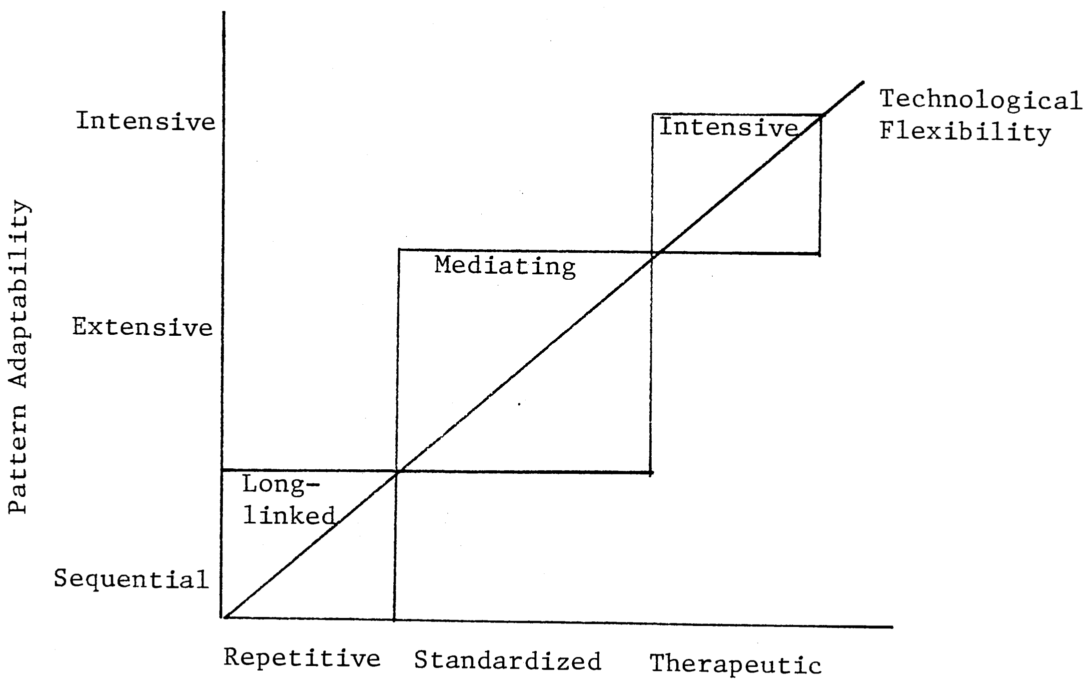

Figure 2. Technology Dimensions

A diagonal dimension labeled "Technological Flexibility" is also included in Figure 2. As illustrated in the figure, Thompson's original organization technology categories can be placed on the diagonal. Mediating technologies are more flexible than long-linked technologies, and intensive technologies are more flexible than mediating technologies.

The Relationship Between Thompson's Technology Categories and Interdependence

The technological flexibility diagonal also represents differing amounts of technological interdependence. However, the relationship between technological flexibility, as indicated by Thompson's technology categories, and interdependence is not linear.

The illustration in Figure 3 suggests a "U" relationship between technological flexibility and interdependence. Using Thompson's categories as indicators of the degree of technological flexibility, Figure 3 indicates that the lowest amount of interdependence is produced by a mediating technology. That is, the extensive standarized activities in a mediating technology contain pooled interdependence.

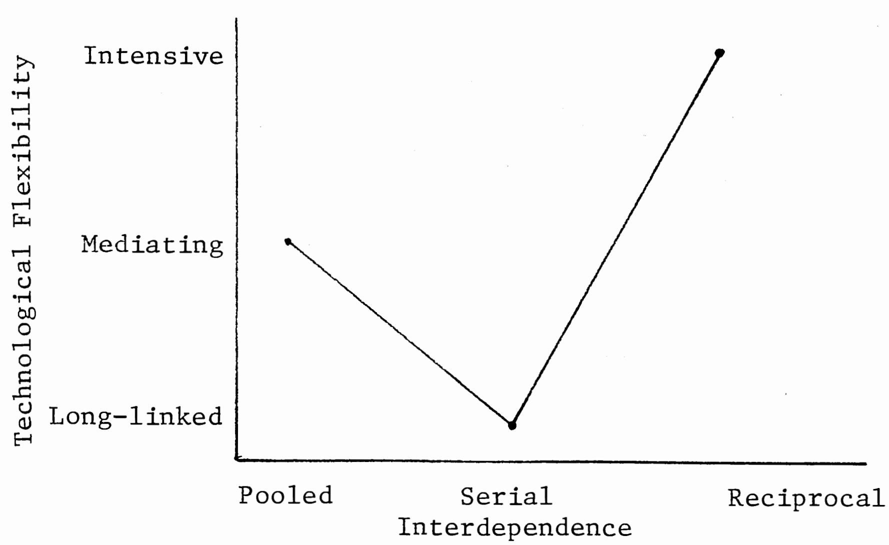

Figure 3. Technological Flexibility and Interdependence

APPENDIX C

SURVEY RESPONDENTS BY HOSPITAL AND DEPARTMENT

TABLE XXX

SURVEY RESPONDENTS BY HOSPITAL AND DEPARTMENT

	Department	Hospital 1	Number of Respondents	Hospital 2	Number of Respondents	Hospital 3	Number of Respondents
1	Administration	yes	1	yes	3	yes	3
2	Business Office	yes	4	yes	5	yes	2
3	Accounting Office	yes	4	no	-	yes	1
4	Purchasing	no	-	yes	1	yes	2
5	Switchboard	yes	2	no	-	no	-
6	Dietary	yes	6	yes	6	yes	10
7	Cafeteria	no	-	yes	1	no	-
8	Housekeeping	yes	12	yes	4	yes	7
9	Linen	no	-	yes	1	no	-
10	Operation of Plant	yes	2	yes	8	yes	4
11	Nursing Administration	no	-	yes	3	yes	3
12	Nursery	yes	4	yes	1	no	-
13	2nd Floor Medical and Surgery	yes	3	yes	14	yes	18
14	3rd Floor Medical and Surgery	yes	11	no	-	no	-
15	4th Floor Medical and Surgery	yes	1	no	-	no	-
16	5th Floor Medical and Surgery	yes	11	no	-	no	-
17	Credit Office	yes	4	no	-	no	-
18	Karman Program	yes	1	no	-	no	-
19	Nursing Education	yes	1	yes	1	no	-
20	Intensive Care Unit	yes	1	yes	2	yes	1
21	Pharmacy	yes	2	yes	2	yes	2
22	Medical Records	yes	6	yes	3	no	-
23	Social Service	yes	3	yes	1	yes	1
24	Operating Room	yes	2	yes	7	no	-
25	Delivery Room	yes	1	yes	6	yes	4
26	Anesthesiology	no	-	no	-	no	-
27	Radiology	no	-	yes	5	yes	2

TABLE XXX (Continued)

	Department	Hospital 1	Number of Respondents	Hospital 2	Number of Respondents	Hospital 3	Number of Respondents
28	Laboratory	yes	10	yes	4	yes	4
29	EKG	yes	1	no	-	no	-
30	EEG	no	-	no	-	no	-
31	Ultrasound	yes	1	no	-	no	-
32	Physical Therapy	yes	5	yes	5	no	-
33	Respiratory Therapy	yes	2	yes	4	no	-
34	Blood Bank	yes	1	yes	1	no	-
35	Recovery Room	no	-	yes	2	yes	1
36	Central Sterile	no	-	yes	1	yes	2
37	Emergency Room	yes	4	yes	3	yes	1
38	Nuclear Medicine	yes	2	no	-	no	-
39	Psychotherapy-Routine	yes	7	no	-	no	-
40	Psychotherapy-Other	yes	1	no	-	no	-
41	Oncology	no	-	yes	1	no	-
42	Pediatrics	no	-	yes	2	no	-
8076	Security	no	-	no	-	yes	1

APPENDIX D

ORGANIZATIONAL CHARACTERISTICS SURVEY ITEMS

AND RESPONSE CHARACTERISTICS

Lynch (1974) Items: Section A, Version 1;

Section B, Version 2

1. Think of all the kinds of events that cause your work. How often would you say you are able to anticipate and predict the nature of these events? (Mean = 4.16; s.d. = 1.48; Min = 1.0; Max = 7.0)

2. How often do you encounter the same kinds of problems in your work? (Mean = 4.46; s.d. = 1.24; Min = 0.0; Max = 7.0)

3. To what extent is your present job a real challenge to what you think you can do? (Mean = 3.86; s.d. = 1.54; Min = 1.0; Max = 7.0)

4. Are the events that cause your work interesting? (Mean = 3.08; s.d. = 1.38; Min = 1.0; Max = 7.0)

5. Do the events that cause your work seem repetitious? (Mean = 3.98; s.d. = 1.44; Min = 1.0; Max = 7.0)

6. How often does a rules manual cover what you are working on? (Mean = 4.38; s.d. = 1.64; Min = 1.0; Max = 7.0)

7. How often do you refer to written manuals or directives? (Mean = 3.14; s.d. = 1.15; Min = 1.0; Max = 7.0)

8. Generally speaking, how frequently does your supervisor check your work? (Mean = 4.42; s.d. = 1.40; Min = 1.0; Max = 7.0)

9. In my kind of job there are parts of the job that many people who work in it never understand. (Mean = 3.50; s.d. = 2.00; Min = 1.0; Max = 7.0)

10. It is impossible to learn enough about this job to handle all of the problems that come up. (Mean = 3.29; s.d. = 2.17; Min = 1.0; Max = 7.0)

11. Most people in my type of job clearly understand how to deal with all of the different kinds of problems that might occur. (Mean = 3.42; s.d. = 1.80; Min = 1.0; Max = 7.0)

12. My job is monotonous; the work itself provides no basic interest. (Mean = 1.84; s.d. = 1.30; Min = 1.0; Max = 7.0)

13. The longer I hold my job the more boring it becomes. (Mean = 2.08; s.d. = 1.54; Min = 1.0; Max = 7.0)

14. In my job there is something new happening every day. (Mean = 2.71; s.d. = 1.72; Min = 1.0; Max = 7.0)

15. My job gives me the chance to do the things I do best. (Mean = 2.69; s.d. = 1.72; Min = 1.0; Max = 7.0)

16. My job is frustrating, but it is never dull. (Mean = 3.41; s.d. = 1.92; Min = 1.0; Max = 7.0)

17. The work I do keeps changing and I have to change to keep up with it. (Mean = . ; s.d. = . ; Min = 1.0; Max = 7.0)

18. In my job there is emphasis on the actual production records. (Mean = 3.93; s.d. = 2.78; Min = 0.0; Max = 7.0)

19. There are a lot of rules, policies, procedures and standard practices one has to know in order to do his work well in this department. (Mean = 5.77; s.d. = 1.69; Min = 1.0; Max = 7.0)

20. I have little control and final say over how I do my job. (Mean = 5.58; s.d. = 1.57; Min = 1.0; Max = 7.0)

21. In this department people are often permitted to use their own judgment as to how to handle various problems. (Mean = 5.35; s.d. = 1.68; Min = 1.0; Max = 7.0)

22. What percent of the tasks you do must be done before someone else in your department can do his work? (Mean = 3.58; s.d. = 2.03; Min = 1.0; Max = 7.0)

23. What percent of the tasks you do must be done before someone else in another department can do his work? (Mean = 3.99; s.d. = 2.00; Min = 1.0; Max = 7.0)

24. What percent of the tasks connected with your job depends on someone else in your department doing his job first? (Mean = 3.37; s.d. = 1.94; Min = 1.0; Max = 7.0)

25. What percent of the tasks connected with your job depends upon someone else in another department? (Mean = 3.61; s.d. = 1.97; Min = 1.0; Max = 7.0)

26. Many jobs require the use of diagnostic procedures on one kind or another to determine how to handle a particular situation. To what extent are the diagnostic procedures you use dissimilar from one day to the next? (Mean = 5.58; s.d. = 1.69; Min = 0.0; Max = 7.0)

27. To what extent are the work decisions you make dissimilar from one day to the next? (Mean = 5.37; s.d. = 1.69; Min = 1.0; Max = 7.0)

28. How would you describe your work? [routine--nonroutine] (Mean = 4.31; s.d. = 1.73; Min = 1.0; Max = 7.0)

29. Regarding your training and skills, would you say you now have [much more than needed for your present job . . . much less than needed for your present job]. (Mean = 3.27; s.d. = 1.59; Min = 1.0; Max = 7.0)

30. How much variety is there in the events that cause your work? [all are the same . . . each event is unique]. (Mean - 3.33; s.d. = 1.73; Min = 1.0; Max = 7.0)

31. About what proportion of your normal daily activities are guided by written manuals or directives that set forth the way in which you are to perform your job? [none . . . every activity] (Mean = 4.68; s.d. = 1.82; Min = 1.0; Max = 7.0)

32. With regard to those tasks that are guided by written rules and manuals, how strict is your supervisor in requiring you to follow these rules? (Mean = 5.27; s.d. = 1.38; Min = 1.0; Max = 7.0)

33. How much responsibility do you have in deciding how your job is to be carried out? [no responsibility . . . complete responsibility] (Mean = 5.46; s.d. = 1.44; Min = 1.0; Max = 7.0)

34. How much freedom do you have in deciding exactly how you do your own work? [none . . . absolute] (Mean = 5.36; s.d. = 1.37; Min = 1.0; Max = 7.0)

Comstock and Scott (1977) Items (Nurses' Forms):

Section 2, Version 1; Section 3, Version 2[1]

Part A

How much influence do staff nurses in your unit have on the following decisions?

1. Changing the nursing care system on the unit. (Mean = 2.10; s.d. = 1.13; Min = 0.0; Max = 4.0)

2. Hiring a replacement staff nurse for the unit. (Mean = 1.16; s.d. = 1.36; Min = 0.0; Max = 4.0)

3. Adding a new staff nurse position to the ward. (Mean = 1.13; s.d. = 1.29; Min = 0.0; Max = 4.0)

4. Determining the appropriate disciplinary action for a staff nurse who has committed a serious medication error. (Mean = 0.98; s.d. = 1.32; Min = 0.0; Max = 4.0)

Part B

How much influence does the head nurse in your unit have on the following decisions?

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[1]Response statistics are for the combined sample of both the Nurses' and General Support Personnel Forms.

1. Changing the nursing care system on the unit. (Mean = 3.03; s.d. = 1.06; Min = 0.0; Max = 5.0)

2. Hiring a replacement staff nurse for the unit. (Mean = 2.74; s.d. = 1.35; Min = 0.0; Max = 5.0)

3. Adding a new staff nurse position to the ward. (Mean = 2.70; s.d. = 1.33; Min = 0.0; Max = 5.0)

4. Determining the appropriate disciplinary action for a staff nurse who had committed a serious medication error. (Mean = 2.99; s.d. = 1.14; Min = 0.0; Max = 5.0)

Part C

How explicit are the rules covering the following activities?

1. Dress or attire on the ward. (Mean = 3.95; s.d. = 1.26; Min = 0,0; Max = 5.0)

2. Returning to work after illness. (Mean = 3.83; s.d. = 1.38; Min = 0.0; Max = 5.0)

3. Conditions under which staff may be requested to work overtime. (Mean = 2.97; s.d. = 1.48; Min = 0.0; Max = 5.0)

4. Arrangements under which nurses can accept verbal orders from physicians. (Mean = 3.38; s.d. = 1.59; Min = 0.0; Max = 5.0)

5. Time by which patients' baths must be completed. (Mean = 2.64; s.d. = 1.61; Min = 0.0; Max = 6.0)

6. Range of time allowed for passing out patients' medication. (Mean = 3.01; s.d. = 1.68; Min = 0.0; Max = 6.0)

7. Information and format for charting nurses' notes. (Mean = 3.38; s.d. = 1.56; Min = 0.0; Max = 5.0)

8. Administration of enemas. (Mean = 1.39; s.d. = 1.99; Min = 0.0; Max = 6.0)

Comstock and Scott (1977) Items (General Support Personnel Form): Section 2, Version 1; Section 3, Version 2[2]

Part A

How much influence do staff members in your unit have on the following decisions:

1. Changing the way tasks are performed in the unit.

2. Hiring a replacement staff member for the unit.

3. Adding a new staff position to the unit.

4. Determining the appropriate disciplinary action for a staff member who has committed a serious error.

Part B

How much influence does the supervisor in your unit have on the following decisions?

1. Changing the way tasks are performed in the unit.

2. Hiring a replacement staff member for the unit.

3. Adding a new staff position to the unit.

4. Determining the appropriate disciplinary action for a staff member who has committed a serious error.

Part C

How explicit are the rules covering the following activities?

1. Dress or attire in the unit.

2. Returning to work after illness.

3. Conditions under which unit members can accept verbal orders from people other than their supervisor.

4. Arrangements under which members can accept verbal orders from people other than their supervisor.

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[2]Response statistics are reported for the combined sample of both the Nurses' and General Support Personnel Forms.

5. Time by which daily maintenance routines (e.g., daily reports, cleaning equipment, checking supplies, etc.) must be completed.

6. Range of time allowed for completing tasks that may affect the work of others in the unit (e.g., preparing food, preparing admission forms, sorting linens, etc.).

7. Information and format for making your reports.

   (Max = 7.0)

Overton et al. (1977) Items (Nurses' Form):

Section 3, Version 1; Section 5, Version 2[3]

1. In your estimation, what percentage of patients on your unit need nursing observations more often than every half hour? (Mean = 3.65; s.d. = 1.51; Min = 0.0; Max = 5.0)

2. How many of the patients would you say have similar health problems (or 1)? (Mean = 3.83; s.d. = 1.12; Min = 0.0; Max = 5.0)

3. Some patients are admitted to hospital because they have one main health problem, others because they have several interrelated health problems. What percentage of the patients on your unit have multiple health problems? (Mean = 3.49; s.d. = 1.23; Min = 0.0; Max = 5.0)

4. For some patients more than others, it is important to know complete details of their previous health history. For how many of the patients on your unit is it critical that the nurse know a detailed history from birth to the present time? (Mean = 3.27; s.d. = 1.44; Min = 0.0; Max = 5.0)

5. What percentage of the patients on your unit have complex problems that are not well understood? (Mean = 2.35; s.d. = 1.21, Min = 0.0; Max = 5.0)

6. For how many of the patients can you predict their length of stay on your unit? (Mean = 3.73, s.d. = 1.17; Min = 0.0; Max = 5.0)

7. What percentage of the nurses' work involves performing technical procedures and special tests? (Mean = 3.23, s.d. = 1.43; Min = 0.0; Max = 5.0)

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[3]Response statistics are for the combined sample of both the Nurses' and General Support Personnel Forms.

8. What percentage of patients require the use of technical equipment (e.g., suctions, cardiac monitors, respirators, etc.)? (Mean = 3.28; s.d. = 1.49; Min = 0.0; Max = 5.0)

9. When there is more than one method available for giving nursing care, what percentage of the time are you free to choose the method you think best? (Mean = 3.79; s.d. = 1.29; Min = 0.0; Max = 5.0)

10. How many of the patients on your unit on an average day require an intraveneous influsion? (Mean = 2.69; s.d. = 1.29; Min = 0.0; Max = 5.0)

11. How many of the decisions made by nursing staff relating to direct patient care are made independent of doctor's orders? (Mean = 2.69; s.d. = 1.34; Min = 0.0; Max = 5.0)

12. Working on some units produces a higher stress environment for nurses. How much of the time would you say there is a high stress environment on your unit? (Mean = 3.12; s.d. = 1.23; Min = 0.0; Max = 5.0)

13. On some units there is a greater pressure to give nursing care quickly, because of patients' critical conditions. What percentage of the time is there a greater time pressure on your unit? (Mean = 2.93; s.d. = 1.29; Min = 0.0; Max = 5.0)

14. What percentage of the time does improvement in patients' conditions really have to depend upon the skillful work and initiative of nursing personnel? (Mean = 3.96; s.d. = 1.12; Min = 0.0; Max = 5.0)

15. How much of your work requires the analysis of complex problems? (Mean = 2.76; s.d. = 1.23; Min = 0.0; Max = 5.0)

16. For how many of the patients are there written goals for individualized care in the Kardex (nursing care plan)? (Mean = 3.01; s.d. = 1.52; Min = 0.0; Max = 6.0)

17. What percentage of the nursing care on your unit is directed at meeting patients' socio-psychological needs (as opposed to physical needs)? (Mean = 2.77; s.d. = 1.33; Min = 0.0; Max = 5.0)

18. What percentage of the nursing care given relies on nurses' intuition rather than on set procedures or routines? (Mean = 2.51; s.d. = 1.18; Min = 0.0; Max = 5.0)

19. How many of the nursing care procedures are similar for most of the patients on your unit? (Mean = 2.46; s.d. = 1.16; Min = 0.0; Max = 5.0)

20. What percentage of the decisions that nurses make during their work are repeated from one day to the next? (Mean = 2.21; s.d. = 1.03; Min = 0.0; Max = 5.0)

21. What percentage of the present nursing care techniques used on your unit become quickly outdated? (Mean = 1.84; s.d. = 0.92; Min = 0.0; Max = 5.0)

22. What percentage of new nurses starting work on your unit would find the nursing care specialty difficult to learn? (Mean = 2.47; s.d. = 1.27; Min = 0.0; Max = 5.0)

23. How many of the patients and/or the families are included in discussions when their nursing care is being planned? (Mean = 2.19; s.d. = 1.31; Min = 0.0; Max = 5.0)

24. How much of your work changes in direct response to changes in patients' conditions or moods? (Mean = 3.16; s.d. = 1.38; Min = 0.0; Max = 5.0)

25. What percentage of the time are you highly dependent upon other nurses in your unit for help and/or are they dependent upon your help? (Mean = 3.02; s.d. = 1.34; Min = 0.0; Max = 5.0)

26. How much of the time is your unit highly dependent upon service departments (lab, x-ray, laundry, dietary, pharmacy, physiotherapy, occupational therapy, etc.) and/or are the service departments dependent upon your unit to provide good patient care? (Mean = 3.43; s.d. = 1.39; Min = 0.0; Max = 5.0)

27. How much of the time is your unit highly dependent upon another nursing unit(s) and/or is another nursing unit(s) dependent upon your unit to complete the required work? (Mean = 2.55; s.d. = 1.47; Min = 0.0; Max = 5.0)

28. How many of the patients on your unit have more than one attending physician simultaneously prescribing care? (Mean = 2.27; s.d. = 1.38; Min = 0.0; Max = 5.0)

29. How frequently do the nurses on your unit have verbal or written communication with medical staff (attending physicians, consultants, medical students, etc.)? (Mean = 3.45; s.d. = 1.49; Min = 0.0; Max = 5.0)

30. Relative to other nusring skills (such as technical or decision-making), how important is it that you have effective communication skills? (Mean = 4.58; s.d. = 0.76; Min = 0.0; Max = 5.0)

31. Approximately how often do "emergencies" happen (i.e., when immediate nursing action must be taken in response to changes in a patient's condition? (Mean = 2.50; s.d. = 1.19; Min = 0.0; Max = 5.0)

Overton et al. (1977) Items (General Support Personnel Form): Section 3, Version 1; Section 5, Version 2[4]

In this section the term "raw material" refers to an object, thing or person that is being changed or improved by the tasks performed by people in your unit. Some examples of a "raw material" might be a patient, an account, a linen, a floor, a specimen, a machine, or a food. In this section, when you see the term "raw material", think of the main object that people in your unit normally change or improve.

1. What percentage of the "raw materials" in your unit need to be checked frequently?

2. What percentage of the "raw materials" in your unit can be treated or handled in a similar manner?

3. Some "raw materials" require one main procedure (e.g., a test, or one posting, or one treatment, or one part replacement, etc.) while other "raw materials" require several procedures. What percentage of the "raw materials" in your unit require several procedures?

4. For some of the "raw materials" in your unit it is important to know the history of those "materials". That history might include what has happened previously to the "material" or how it has been handled or processed. For what percentage of the "raw materials" in your unit is it critical to have a detailed history?

5. What percentage of the "raw materials" in your unit have complexities that are not well understood?

6. Some "raw materials" are such that you can predict how long it will take to complete work on them. For what percentage of the "raw materials" in your unit can you make such a prediction?

7. What percentage of the members' work in your unit involves performing technical procedures and special tests?

8. What percentage of your unit's tasks require the use of specialized machines?

9. When there is more than one way to do the job, what percentage of the time are you free to choose the method you think best?

10. How many of the tasks performed in your unit on an average day involve difficulties that delay the work or require adding extra help?

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[4] Response statistics are reported for the combined sample of both the Nurses' and General Support Personnel Forms.

11. How many of the decisions made by members of your unit relating directly to your tasks are made independent of doctor's orders?

12. How much of the time would you say there is a high stress environment on your unit?

13. What percentage of the time is there great time pressure due to the critical nature of the tasks performed in your unit?

14. What percentage of the time does the successful completion of the tasks depend upon the skillful work and initiative of members of your unit?

15. How much of your work requires the analysis of complex problems?

16. How many of the tasks in your unit have written goals and methods for their performance?

17. What percentage of the tasks in your unit involve social interactions rather than the physical manipulation of objects?

18. What percentage of the tasks performed rely upon members' intuition rather than on set procedures or routines?

19. How many of the tasks are similar for most of the "raw materials" in your unit?

20. What percentage of the decisions that members make during their work are repeated from one day to the next?

21. What percentage of the present methods or techniques used on your unit become quickly outdated?

22. What percentage of new members starting work in your unit would find the tasks difficult to learn?

23. How many people outside your unit are included in discussions when work is being planned?

24. How much of your work changes in direct response to changes in the condition of one of the "raw materials"?

25. What percentage of the time are you highly dependent upon other members of your unit for help and/or are they dependent upon your help?

26. How much of the time is your unit highly dependent upon dissimilar departments (lab, X-ray, laundry, dietary, pharmacy, physiotherapy, occupational therapy, etc.) and/or are dissimilar departments dependent upon your unit to perform your/their tasks?

27. How much of the time is your unit highly dependent upon another similar department and/or is another similar department dependent upon your unit to complete the required work?

28. How many of the tasks on your unit have more than one supervisor simultaneously giving orders?

29. How frequently do the members of your unit have verbal or written communication with medical staff (attending physicians, consultants, medical students, etc.)?

30. How important is it that you have effective communication skills?

31. Approximately how often do "emergencies" happen in your unit?

<u>Hitt and Middlemist (1978) Items:</u>

<u>Section 4, Both Versions</u>

Part A

Persons working in different activities are concerned to different degrees with future and current problems. This part asks how your time is divided between activities which will have an immediate effect on your unit's results and those which are of a longer range nature. Please indicate below that percent of your time which is devoted to working on matters which will affect results within each of the periods indicated. (Mean = 1.92; s.d. = 0.93; Min = 1.0; Max = 4.5)

Part B

1. Complete personal discretion is given to me in accomplishing my task. (Mean = 4.25; s.d. = 1.33; Min = 1.0; Max = 6.0)

2. For doing most of the things required by my task, there are standardized procedures which must be followed. (Mean = 2.19; s.d. = 1.02; Min = 1.0; Max = 6.0)

3. The jobs (tasks) assigned to employees in my program are completely independent of each other. (Mean = 2.92; s.d. = 1.51; Min = 1.0; Max = 6.0)

4. Most of the things which I do in my job are routine and repetitive. (Mean = 3.22; s.d. = 1.35; Min = 1.0; Max = 6.0)

5. The overall complexity of my unit's objectives, assignments, or tasks is quite high. (Mean = 4.26; s.d. = 1.34; Min = 1.0; Max = 6.0)

*6. Months may pass before we know if many of the things we do in this unit are effective. (Mean = 2.82; s.d. = 1.51; Min = 1.0; Max = 6.0)

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*Items added in the present study.

*7. It takes a long time to get results in this unit.

*8. On this unit, most of my work produces an immediate change.

9. Please place a check mark beside the various aspects of your job in which you are allowed personal discretion, i.e., your supervisor does not give you specific instruction. (Mean = 3.10; s.d. = 1.58; Min = 1.0; Max = 6.0)

Aiken and Hage (1968) Items: Section 4, Version 1; Section 1, Version 2

Part A

1. How frequently do you usually participate in decisions on the adoption of new policies? (Mean = 1.66; s.d. = 1.25; Min = 0.0; Max = 4.0)

2. How frequently do you usually participate in decisions on the promotions of any of the professional staff? (Mean = 0.72; s.d. = 1.09; Min = 0.0; Max = 4.0)

3. How frequently do you usually participate in the decision to hire new staff? (Mean = 0.92; s.d. = 1.26; Min = 0.0; Max = 4.0)

4. How frequently do you usually participate in decisions on the adoption of new programs? (Mean = 1.46; s.d. = 1.28; Min = 0.0; Max = 4.0)

Part B

1. There can be little action taken here until a supervisor approves a decision. (Mean = 2.70; s.d. = 0.96; Min = 0.0; Max = 4.0)

2. A person who wants to make his own decision would be quickly discouraged. (Mean = 0.72; s.d. = 1.09; Min = 0.0; Max = 4.0)

3. Even small matters have to be referred to someone higher up for a final answer. (Mean = 2.19; s.d. = 1.03; Min = 0.0; Max = 4.0)

4. I have to ask my boss before I do almost anything. (Mean = 1.74; s.d. = 0.87; Min = 0.0; Max = 4.0)

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*Items added in the present study.

5. Any decision I make has to have my boss' approval. (Mean = 2.10; s.d. = 0.99; Min = 0.0; Max = 4.0)

6. I feel I am my own boss in most matters. (Mean = 2.64; s.d. = 1.03; Min = 0.0; Max = 4.0)

7. A person can make his own decisions without checking with anybody else. (Mean = 2.15; s.d. = 0.89; Min = 0.0; Max = 4.0)

8. How things are done here is left up to persons doing the work. (Mean = 2.44; s.d. = 0.90; Min = 0.0; Max = 4.0)

9. People here are allowed to do almost as they please. (Mean = 1.80; s.d. = 0.84; Min = 0.0; Max = 4.0)

10. Most people here make their own rules on the job. (Mean = 1.56; s.d. = 0.70; Min = 0.0; Max = 4.0)

11. The employees here are constantly being checked for rule violations. (Mean = 1.94; s.d. = 0.88; Min = 0.0; Max = 4.0)

12. People here feel they are constantly being watched to see that they obey all the rules. (Mean = 1.82; s.d. = 0.88; Min = 0.0; Max = 4.0)

13. Whatever situation arises we have procedures to follow in dealing with it. (Mean = 3.10; s.d. = 0.72; Min = 0.0; Max = 4.0)

14. Everyone has a specific job to do. (Mean = 3.30; s.d. = 0.75; Min = 0.0; Max = 4.0)

15. Going through proper channels is constantly stressed. (Mean = 3.13; s.d. = 0.84; Min = 0.0; Max = 4.0)

16. This organization keeps written records of everyone's job performance. (Mean = 3.51; s.d. = 0.72; Min = 0.0; Max = 4.0)

17. We are to follow strict operating procedures at all times. (Mean = 3.04; s.d. = 0.75; Min = 0.0; Max = 4.0)

18. Whenever we have a problem we are supposed to go to the same person for an answer. (Mean = 2.69; s.d. = 0.87; Min = 0.0; Max = 4.0)

19. People here do the same job in the same way every day. (Mean = 2.48; s.d. = 0.91; Min = 0.0; Max = 4.0)

20. One thing people like around here is the variety of work. (Mean = 2.15; s.d. = 0.81; Min = 0.0; Max = 4.0)

21. Most jobs have something new happening every day. (Mean = 2.10; s.d. = 0.83; Min = 0.0; Max = 4.0)

22. There is something different to do every day. (Mean = 2.19; s.d. = 0.85; Min = 0.0; Max = 4.0)

APPENDIX E

COVER LETTER

College of Business
Oklahoma State University
Stillwater, OK 74078
(405) 624-5098

To Employees of Enid Memorial Hospital:

Your participation in the present study will require only a few minutes of your time, and may result in the improvement of working conditions and the effectiveness of medical centers such as yours.

Those of us who are interested in the health care industry realize that working conditions can affect the quality of care our patients and clients receive. The present study asks you to complete a questionnaire on organizational characteristics which may affect working conditions. The study has the endorsement of your administrators and is being conducted under the direction of a dissertation committee of the College of Business at Oklahoma State University.

Complete answers from a large number of employees are needed to provide the statistical information required to analyze current organizational characteristics.

You may also realize an immediate personal benefit from participation in this study. When you return your completed questionnaire, you can also enter a drawing for three prizes. First prize is dinner for two at the PEPPERMILLE, second prize is dinner for two at NATHAN'S A RESTAURANT, and third prize is a $20 gift certificate at a local supermarket. To enter the drawing: (1) put your name on the outside of the sealed envelope containing your completed questionnaire, and (2) place the envelope in the special boxes located in the cafeteria or personnel office before March 19, 2:30 p.m., when the drawing will be held.

All responses will be kept completly confidential. Questionnaires will be seen ONLY by the principal investigator. Results of this study will be reported as average responses for departments or for the medical center as a whole, and will be available to any interested party.

Thank you for your cooperation.

David C. Luther
Principal Investigator

We encourage all employees to cooperate with Mr. Luther in the special study.

Steve Hendley
Administration

DCL:rlh

APPENDIX F

THREE FACTOR PRINCIPAL COMPONENT SOLUTION WITH VARIMAX ROTATION FOR THE AIKEN AND HAGE INSTRUMENT

TABLE XXXI

THREE FACTOR PRINCIPAL COMPONENT SOLUTION WITH VARIMAX ROTATION FOR THE AIKEN AND HAGE INSTRUMENT

	Factor 1	Factor 2	Technology	Communalities
A1	-.16	.83	-.06	.71
A2	-.06	.80	.01	.65
A3	-.08	.86	.02	.74
B1	.61	-.23	.17	.45
B2	.53	-.15	.40	.46
B3	.68	-.15	.28	.56
B4	.70	-.09	.35	.62
B5	.75	-.12	.29	.66
B6	-.58	.30	-.21	.47
B7	-.64	.15	-.14	.46
B8	-.46	.16	-.11	.25
B9	-.48	.02	.08	.24
B10	-.27	.01	.10	.09
B11	.58	-.12	-.08	.36
B12	.58	-.05	.10	.35
B13	.37	-.02	-.09	.14
B14	.27	-.01	-.04	.08
B15	.55	-.04	-.24	.36
B16	.37	.02	-.30	.23
B17	.66	-.01	-.18	.47
B18	.36	.00	.09	.14
B19	.22	-.04	.54	.34
B20	.00	-.04	.72	.51
B21	-.11	.09	.80	.56
B22	-.04	-.05	.81	.66

APPENDIX G

NINE FACTOR PRINCIPAL COMPONENT SOLUTION WITH

VARIMAX ROTATION FOR OVERTON'S INSTRUMENT

TABLE XXXII

NINE FACTOR PRINCIPAL COMPONENT SOLUTION WITH VARIMAX ROTATION FOR OVERTON'S INSTRUMENT

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Communalities
C1	.25	.30	.09	.44	.27	-.35	.12	-.00	.21	.61
C2	-.04	.71	.08	.10	.04	-.13	-.01	-.10	.10	.55
C3	.14	.04	-.02	.74	.17	.03	.04	.00	.01	.60
C4	-.02	.19	.13	.74	.01	.06	-.01	.11	.10	.63
C5	.25	-.10	.48	.51	.01	.06	-.12	-.03	-.07	.58
C6	.05	.66	.06	.12	-.02	-.04	.19	-.11	.31	.61
C7	.45	.27	.13	.21	-.18	.16	.55	-.03	-.05	.70
C8	.52	.29	-.10	.31	.00	-.02	.23	.10	.17	.55
C9	.05	.21	.01	.09	-.05	-.14	-.29	.09	.64	.58
C10	.48	.07	.11	.11	.25	.43	-.18	-.23	.03	.59
C11	.09	.25	.15	-.00	.07	.03	-.58	-.01	.09	.44
C12	.81	-.00	.09	-.05	.06	.10	-.11	.09	.04	.70
C13	.78	.05	.22	.12	-.07	.00	-.01	-.04	.08	.69
C14	.50	.23	-.06	.06	.14	-.03	.24	.23	.25	.50
C15	.55	-.09	.43	.22	-.09	.19	.03	.10	.01	.61
C16	.08	.18	.06	.39	.05	.02	.32	.52	-.21	.62
C17	.11	.01	.39	.03	.01	.02	-.13	.60	.07	.54
C18	.08	.12	.61	.02	-.17	.21	.26	.13	.25	.61
C19	-.14	-.77	.03	-.03	.00	-.21	.17	-.20	.02	.72
C20	-.13	-.71	.17	.07	-.17	-.06	.19	-.21	.18	.69
C21	.17	.03	.66	.16	.11	.04	-.05	-.13	.02	.52
C22	.29	-.05	.47	.18	.14	-.07	-.05	.24	-.10	.44
C23	-.15	-.05	.59	-.23	.15	.07	.28	.19	.05	.58
C24	.20	.12	.22	-.00	.07	.41	.22	.01	.51	.58
C25	.10	.05	.20	.09	.54	.19	.00	.10	-.13	.41

TABLE XXXII (Continued)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9	Commun-alities
C26	-.03	.05	-.05	.02	.71	.30	.04	-.08	.21	.65
C27	.09	.14	.03	.15	.78	-.15	.05	.14	-.02	.71
C28	.10	-.03	.18	-.02	.34	.56	-.03	-.03	-.17	.50
C29	.07	.06	.05	.08	.03	.74	.15	.18	.08	.63
C30	.03	.07	-.08	-.00	.24	.27	-.03	.54	.39	.59
C31	.28	.05	.38	-.09	.23	.22	.35	-.18	.12	.50
Percent of σ^2	17.4	8.9	6.5	6.0	5.2	4.3	3.8	3.5	3.4	58.9
r_{ij}	.34	.40	.22	.31	.30	.26	-.10	.15	.05	

N = 254

APPENDIX H

THREE FACTOR PRINCIPAL COMPONENT SOLUTION WITH NO ROTATION FOR COMSTOCK AND SCOTT'S INSTRUMENT

TABLE XXXIII

THREE FACTOR PRINCIPAL COMPONENT SOLUTION WITH NO ROTATION FOR COMSTOCK AND SCOTT'S INSTRUMENT

	Centralization	Formalization	Distribution
A1	.63	-.06	.20
A2	.75	-.19	.52
A3	.75	-.14	.45
A4	.67	-.11	.56
B1	.63	.25	-.40
B2	.75	.00	-.47
B3	.73	.05	-.47
B4	.66	.22	-.51
C1	-.05	.66	.03
C2	-.01	.54	-.01
C3	.17	.46	.41
C4	-.06	.64	.24
C5	.17	.36	.15
C6	.07	.63	.06
C7	.12	.60	-.01
C8	-.38	.43	.08

APPENDIX I

INDIVIDUAL LEVEL OF ANALYSIS MULTITRAIT-MULTIMETHOD MATRIX

Instrument	Trait/Scale	A1	C1	C2	D1	D2	D3	A2	B1	B2	B3	C3	D4	E1	E2	A3	C4	B4	B5	B6	E3	C5	C6	D5
Aiken and Hage (1968)	A1 Routineness	(.76)																						
	C1 Participation	-.08	(.88)																					
	C2 Hierarchy	.28	-.28	(.85)																				
	D1 Job Codification	-.10	.26	-.59	(.72)																			
	D2 Rules	.03	-.18	.50	-.29	(.67)																		
	D3 Job Specificity	.01	-.15	.39	-.32	.32	(.82)																	
Lynch (1974)	A2 Overall Routineness	.49	-.18	.24	-.10	.02	-.08	(.76)																
	B1 Task Routineness	.19	-.15	.12	-.12	.00	.08	.12	(.54)															
	B2 Predictability	.16	-.07	.06	-.07	.04	-.02	.15	.14	(.46)														
	B3 Knowledge	.00	.05	-.01	.05	.08	-.00	-.05	.03	-.07	(.50)													
	C3 Autonomy	-.16	.24	-.53	.45	-.46	-.25	-.25	-.05	.03	.00	(.69)												
	D4 Rules	-.11	-.08	.22	-.23	.25	.44	-.15	.07	-.09	-.00	-.20	(.61)											
	E1 Interdepartmental Task Interdependence	-.03	.00	.11	-.11	.09	.19	.02	.04	.10	.06	-.03	.25	(.47)										
	E2 Internal Task Interdependence	-.02	-.11	.21	-.16	.16	.16	-.02	-.05	.07	.09	-.13	.21	.55	(.55)									
Hitt and Middlemist (1978)	A3 Task Complexity	-.23	.32	-.30	.36	-.17	-.18	-.43	-.21	-.12	.16	.46	-.27	-.08	-.18	(.29)								
	C4 Time Perspective	.01	.08	.24	-.10	.21	.06	.00	-.08	.01	.12	-.18	-.13	.06	.13	.11	(.39)							
Overton et al. (1977)	B4 Uncertainty	-.09	.17	.03	.02	.17	.15	-.25	-.06	-.03	.23	.03	.19	.15	.11	.14	.14	(.70)						
	B5 Instability	-.09	.05	.12	-.12	.15	.18	-.15	-.07	-.01	-.03	-.04	.25	.21	.12	.02	.09	.64	(.69)					
	B6 Variety	-.19	.01	.06	.09	.10	.01	-.07	-.23	-.08	.06	.02	-.07	-.09	-.15	.11	.17	-.02	-.09	(.57)				
	E3 Interdepartmental Interdependence	-.04	-.10	.20	-.23	.16	.15	-.01	.02	.17	.02	-.05	.18	.31	.24	.06	.06	.26	.31	-.09	(.60)			
Comstock and Scott (1977)	C5 Staff Influence	-.06	.26	-.07	.12	-.12	.01	.05	-.03	-.12	-.06	.16	-.06	-.03	-.03	.13	.03	.00	-.06	.04	.02	(.88)		
	C6 Supervisor Influence	-.08	.13	-.06	.06	-.10	.08	.06	.03	-.13	-.03	.06	.02	.07	-.07	.03	-.04	.05	.05	.04	.01	.36	(.87)	
	D5 Formalization	-.15	-.04	.09	-.15	.09	.32	-.15	-.06	-.07	-.03	-.14	.29	-.06	.09	.13	-.02	.00	-.03	.10	.05	-.05	.01	(.66)

APPENDIX J

SUBUNIT LEVEL OF ANALYSIS MULTITRAIT-
MULTIMETHOD MATRIX

Instrument		Trait/Scale	A1	C1	C2	D1	D2	D3	A2	B1	B2	B3	C3	D4	E1	E2	A3	C4	B4	B5	B6	E3	C5	D5
Aiken and Hage (1968)	A1	Routineness	(.86)																					
	C1	Participation	-.41	(.89)																				
	C2	Hierarchy	.27	-.22	(.83)																			
	D1	Job Codification	-.23	.40	-.64	(.85)																		
	D2	Rules Observation	.24	-.16	.51	-.45	(.91)																	
	D3	Job Specificity	.12	-.32	.43	-.49	.45	(.85)																
Lynch (1974)	A2	Overall Routineness	.40	.34	.10	.02	-.09	-.28	(.83)															
	B1	Task Routineness	-.12	-.33	-.01	-.12	.06	-.03	.14	(.90)														
	B2	Predictability	-.12	-.07	-.22	-.02	-.05	-.14	.25	.56	(.41)													
	B3	Knowledge	-.19	-.15	.01	-.05	.09	.05	-.04	.76	.13	(.81)												
	C3	Autonomy	-.41	.30	-.56	.58	-.53	-.42	-.08	-.18	.08	-.22	(.80)											
	D4	Rules	.09	-.14	.25	-.36	.39	.49	-.22	-.19	-.14	-.21	.19	(.71)										
	E1	Interdepartmental Task Interdependence	-.08	.08	.06	-.01	.06	.07	.08	.05	.16	-.01	.03	.32	(.48)									
	E2	Internal Task Interdependence	.02	-.10	.26	-.23	.25	.24	-.13	-.07	-.06	-.11	-.05	.27	.58	(.49)								
Hitt and Middlemist (1978)	A3	Task Complexity	-.46	.48	-.34	.47	-.16	-.21	-.43	-.08	.03	.08	.44	-.20	-.03	-.16	(.49)							
	C4	Time Perspective	-.01	.11	.30	-.14	.14	.04	-.15	.12	-.13	.21	-.28	-.09	.03	.01	.24	(.98)						
Overton et al. (1977)	B4	Uncertainty	-.16	.25	-.03	.02	.04	-.03	-.21	.16	.05	.13	-.03	.03	.38	.18	.22	.33	(.80)					
	B5	Instability	-.13	.07	-.01	-.11	.01	-.05	-.11	-.03	-.01	-.08	-.05	.20	.36	.10	.10	-.01	.72	(.71)				
	B6	Variety	-.21	.06	-.15	.01	-.01	-.04	-.33	.06	-.10	.26	-.00	-.10	-.29	-.10	.24	.33	.14	-.14	(.09)			
	E3	Interdepartmental Interdependence	.08	-.04	.21	-.30	.07	.17	.15	-.05	.17	-.15	.07	.23	.32	.34	-.03	-.04	.12	.14	-.14	(.69)		
Comstock and Scott (1977)	C5	Centralization	-.14	-.27	.13	-.14	.02	-.03	-.15	.12	.06	.06	-.10	.02	-.20	-.05	-.15	.22	-.09	-.09	.22	.07	(.84)	
	D5	Formalization	-.12	-.27	-.03	.02	-.04	-.08	-.12	.04	-.13	.17	.02	-.03	-.21	-.03	-.08	.20	-.26	-.18	.18	.05	.81	(.31)

VITA

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