Order Number 9431351

Organizing for information systems quality

Bays, Marianne, Ph.D.

City University of New York, 1994

U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

ORGANIZING FOR INFORMATION SYSTEMS QUALITY

by

MARIANNE BAYS

A dissertation submitted to the Graduate Faculty in Business in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1994

This manuscript has been read and accepted for the Graduate Faculty in Business in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

4/26/94

Date

Chair of Examining Committee

April 26, 1994

Date

Executive Officer

Moshe Banai

David Brinberg

Dorothy Dologite

Supervisory Committee

The City University of New York

Abstract

ORGANIZING FOR INFORMATION SYSTEMS QUALITY

by

Marianne Bays

Advisor: Professor David Dannenbring

This research studied approaches to aligning an organization's information systems (IS) application development activities to its line business needs. It examined the relationship between use of organizing mechanisms and perceptions of IS product/service quality. Two views of quality were measured: that of the IS producer unit; and that of the internal line business unit customer for the IS. Independent variables included: extent to which responsibility for accomplishing IS application development activities were organizationally dispersed vs. concentrated; and use made of coordination mechanisms (i.e., joint application design, service level agreements, inspections, and/or customer staff assignment to the IS project team).

Structural contingency theory provided the research framework. The "IS alignment strategy's" relationship to IS quality was expected to be moderated by the level of uncertainty faced in the business problem being automated. Congruence between level of uncertainty faced and level of alignment mechanism use was expected to yield the highest perceptions of quality.

Thirty-four organizational subunits provided data on actual IS application development/support efforts. Effects were tested through moderated multiple regression analyses. Regression function partial derivatives were graphed to examine change in quality given change in a strategic alignment variable over the range of uncertainty.

Abstract

Uncertainty moderated relationships between alignment strategy and IS quality. Contrary to expectation, under high uncertainty, alignment mechanism use was *negatively* related to quality perceptions. Under low uncertainty conditions, however, use of IS dispersal and IS coordination mechanisms was positively related to quality. Results further suggest that utility of the different alignment strategies depends upon both the level of uncertainty faced and the specific software quality dimensions needing improvement.

The research yielded management guidance on use of organizing mechanisms in the IS application development function and for assessing perceptions of IS quality. It also confirmed the value of the contingency theory framework for investigating impact of work unit structuring decisions on organizational effectiveness, and of analytical techniques that explicitly test form and direction of contingency effects. The major research limitation was the modest number of independent variables that could be subjected to study. Additional variables are suggested for use in future research.

Acknowledgements

I am grateful for the support and assistance of all of those who helped me to complete this research. The people and organizations to whom I owe special thanks are named below:

> My family and friends - who busted me for years about finishing my doctorate, but always believed I might...
>
> Two world class research assistants, Bonnie F. Barrett and Lisa Winter, who brought skill and intelligence as well as enthusiasm and humor to the work.
>
> The members of my dissertation committee, who displayed great flexibility in dealing with a mostly absent, often otherwise engaged student, and provided helpful comments and advice in the preparation of this manuscript.
>
> The many organizations that participated in pilot studies of research measures and methods or that were full participants in the final study.
>
> The *Quality Assurance Institute* of Orlando, Florida for early inspiration, publicity about the research to their membership, and for administrative assistance.

Finally, research grant assistance from the *Lattanze Center for Executive Studies in Information Systems* at Loyola College of Maryland is most gratefully acknowledged.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES - continued

page #

APPENDIX A

LIST OF FIGURES

LIST OF FIGURES - continued

I. INTRODUCTION/PROBLEM STATEMENT

A. Research Question

Development of a dynamic alignment between IS and corporate goals is one of the most formidable management challenges faced in business today. Lack of congruence between application software development efforts and a company's most pressing business needs is perceived by executives as a major barrier to organizational productivity today (Konstadt, 1991; Anthes, 1992). Industry observers generally agree that in order to address this problem, the IS function has to find a way to become more integrated within and coordinated with line business operations.

How will business accomplish this? A variety of IS alignment strategies are in use. Many companies are implementing changes in their organizational structure. While structural change approaches vary, all of them generally involve some degree of IS function *"dispersal"* - that is, movement of some IS activities and staff expertise out of specialized, enterprise level IS units and into line business units. Another category of alignment strategy commonly employed involves the use of mechanisms expected to better coordinate efforts of the IS technical staff and the line business staff during IS application development and support projects. The use of Joint Application Design (JAD) techniques, formal assignment of line business staff to project teams, Service Level Agreements (SLA's) on projects, and involvement of line business staff in requirements definition and design inspections all fit into this *"coordination mechanism"* category.

Improvement of information systems and service quality is the major thrust behind current experimentation with various IS alignment strategies. But which, if any, of the various alignment strategies being employed are effective in achieving this end? And under what circumstances are the alignment strategies most successful. These questions have never been specifically studied. Current business theory suggests strongly that there is no one "best" way to organize, however. It also suggests that the effectiveness of any organizational alignment strategy may well be dependent upon the degree to which the information needed to accomplish IS application development work is available and analyzable.

This research focuses on the question of whether the common mechanisms employed to align an organization's information systems (IS) application development function with that of its internal line business can result in improved IS product and service quality. A contingency model is hypothesized, wherein the "alignment strategy's" relationship to product and service quality is moderated by the uncertainty faced in the business problem being automated.

B. Focus on IS Application Development Units:

The research described herein follows the broad tradition of Burns and Stalker

(1961), Chandler (1962), Woodward (1965), Thompson (1967), Lawrence and Lorsch (1967, 1969), Galbraith (1973, 1977), and others in examining the relationship of organizational structure to organizational effectiveness, utilizing a contingency theory model. The contingency theory of organization, unlike earlier organizational theory (i.e., classical theory and the human relations theory) propounds that there is no one best way to organize under all conditions. Instead, the focus of investigation is on the organizational characteristics that lead to effective performance, given the specific demands of an organization's work environment. Schoonhoven (1981) has argued that contingency theory is not a theory at all, lacking the well-developed set of interrelated propositions of theory in the conventional sense. Rather, it is viewed by her, and in this research, as an orienting strategy or framework that suggests ways in which a phenomenon may be conceptualized and investigated.

Much of the early research utilizing the contingency model focused on effective organization of an entire enterprise. Chandler's (1962) research focused on the structures for administering large multidimensional enterprises. Burns and Stalker's (1961) research examined enterprise level organizational characteristics required to deal effectively with different external market and technological conditions, and measured organizational effectiveness in terms of economic criteria. Woodward (1965) also used an enterprise level measure of effectiveness, while restricting her focus to production systems and the effectiveness of different organizational structure variables under circumstances of different levels of production process predictability. Lawrence and Lorsch (1967, 1969) took a somewhat different approach in that they specifically focused on operating differences among subunits within organizations in their investigation of organizational differentiation and integration. However, their major thesis and conclusions still dealt with structural contingency concepts at a macro, enterprise level. Similarly to Galbraith (1973), the current contingency research focuses on organizational subunits, instead of using an enterprise level view. Specifically, this research will focus on organizational subunits that produce and support information systems (IS) software applications for use in conducting the line business of the enterprise. Support for this approach is found in the work of Fry & Slocum (1984) who reviewed workgroup level studies of technology and structure and concluded from this and their own empirical research that contingency theory constructs and propositions could be fruitfully adapted to the study of workgroup effectiveness. It is also found in the writings of Galbraith (1977), who suggested that studies of within-organization structure variation have great value because they can add to the generalizability of the findings from other contingency theory research.

The narrowed perspective of this organizational contingency research has also been chosen, in part, for its practical value. In an era where the concept of "business autonomy" is pervasive and competitive need has driven most larger organizations to formally decentralize many aspects of their decision making structure, decisions about IS application development function alignment are rarely being made on an enterprise level. Witness the discussion of "hybrid" structures in the IS literature today (Von Simson, 1990). A research model that seeks to examine the value of different structural and coordination mechanisms employed at the organizational subunit level in different organizational circumstances, therefore, has greater practical value to management than would one focused broadly at the enterprise level.

A distinction must be made here between organizational subunits that produce, implement and support application software and those that provide other aspects of information technology to internal organizational customers (e.g., telecommunications and operating system hardware and software). The former will be called IS Application Development Units and are the focus of this research. These units are typically staffed with project teams that employ a mix of both technical skills and business analysis skills in their work process.

The IS application development process consists of a series of work phases that have to be accomplished in order to produce a system likely to meet business needs. There are many different models of the system development process, using different terminology and incorporating a variety of different methodologies and specific work steps (See, for example, Yourdon, 1982; Head, 1984; Davis and Olson, 1985). However, all models of the development process have in common a sequence of activities that begins with some general expressed business need for an information system and which ends with a completed system and support structure delivered to the business customer.

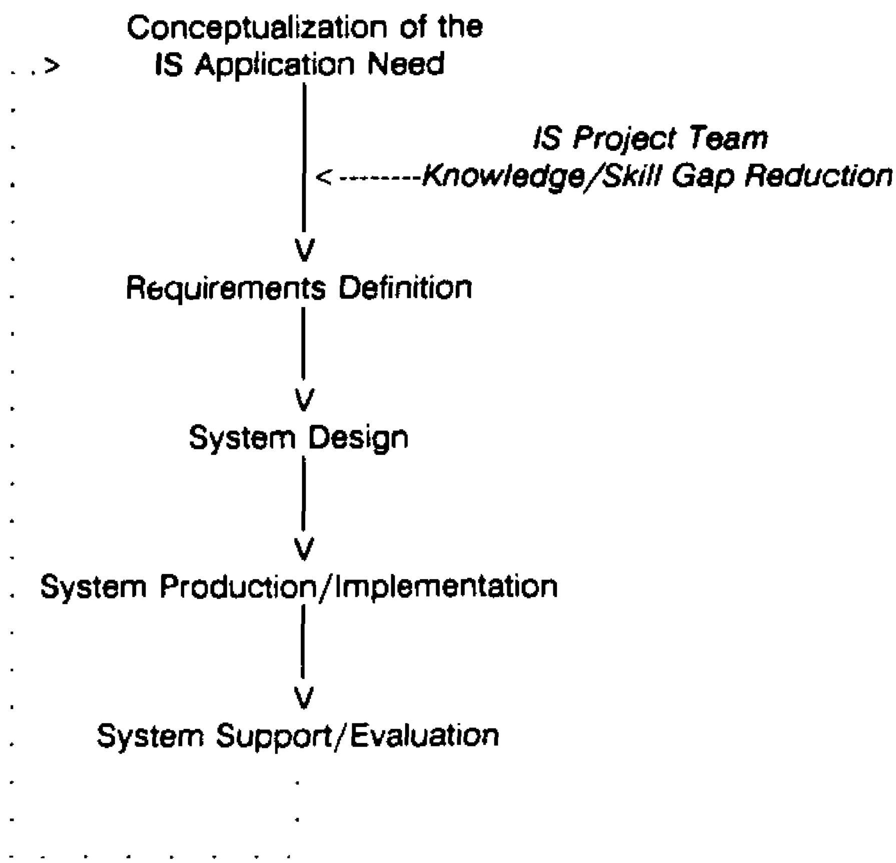
Following the general conceptualization of a need that initiates the project, analysis must be undertaken by the IS application development project team in order to *define the system requirements - i.e., the specific business functionality the system* should provide, the business processing and usage constraints, etc. In this phase, it is the project team's responsibility to gain sufficient understanding of the business process and the business customers' needs to move from the stage where the need is generally conceptualized to a point where the system requirements can be formally specified and an IS application design can be developed to address the needs. Following this, the system is produced according to the design and then, finally, the completed system is moved into production where it should routinely operate to support the business.

Figure 1 is a model of the system development process. The step between conceptualization and completion of system requirements definition is highlighted in this figure to emphasize the important process of *knowledge/skill gap* reduction that must be accomplished here. The magnitude of the gap between what the IS application development team knows about the business system requirements at the time of project initiation and what they need to know about these in order to successfully accomplish their project will vary from project to project. However, in all cases, a gap exists and closure of this gap is of fundamental importance to successful IS product and service delivery. The skill gap to be addressed is related to the organizational ability to analyze and clearly represent the business problem to be addressed in system development and involves both IS application customer and producer unit capabilities brought to bear on the particular IS application requirements and design specification problem. Industry studies show 82% of IS application errors are introduced through incorrect and incomplete requirements specifications (Smith, 1988). The cost of correcting system errors resulting from faulty understanding of business requirements can be almost 100 times more expensive than that for any other kinds of errors detected after system implementation (Poo, 1991).

A useful scheme for understanding the variety of software applications that are the product of the IS application development process has been provided by Madnick (in Scott-Morton, 1991). In this scheme, focus is on the general type(s) of business functionality provided by an application, as opposed to the specific approach used to implement the application or the specific target audience that an application aims to support. A given application may support one or more of the business processes below:

Transaction Processing - i.e., performance of specific operational activities, such as order entry in a manufacturing environment or claims processing in an insurance environment;

FIGURE 1
IS APPLICATION DEVELOPMENT PROCESS



Information Processing - i.e., performance of analysis, calculations, or restructuring of data;

Administrative Processing - i.e., performance of office functions by administrative or managerial personnel required to maintain organizational, procedural or personal information.

IS applications can also be characterized in terms of their operational and strategic impact on the organization (McFarlan and McKenney, 1983). Some are fundamental to day-to-day operations of the organization (e.g., an automated payroll system). Other IS applications have high strategic value - they are fundamental to the achievement of an organization's competitive goals. Several examples of these less routine, more strategic types of applications are provided in Chapter II of this dissertation, in the discussion of factors that contribute to requirements definition uncertainty in application development. Still other IS applications, while useful to organizations, are considered to have neither critical operational nor critical strategic value. An example of one of these might be a correspondence tracking system that allows secretaries to log correspondence receipt, its assignment for response, and response accomplishment date. Such a system helps organize office activities but in the event of its failure, there would be very little negative impact on business.

IS Application Development Units may or may not be part of staff organizations with organization wide responsibility for information systems infrastructure development, delivery and support functions (e.g., telecommunications and operating systems hardware and software, and data resource management). Organizations with these responsibilities are commonly referred to as either Information Systems (IS) or Information Technology (IT) organizations. One of the underlying observations stimulating this research, as well as significant debate in contemporary business and trade literature, is that, more and more, IS application development is becoming integrated with business as a line function.

At the extreme, Deardon (1987) has predicted that business "users" will soon completely control individual systems, with IS application development done almost entirely by outside software specialists or independent IS profit centers or subsidiaries that will compete both inside and outside of the company. Others suggest (e.g., La Belle and Nyce, 1987; Von Simson, 1990; Henderson, 1990), more conservatively, that the effective structuring of the IT organization should be viewed as a balancing act. The aim is to manage the equilibrium - to decide precisely what and how much of the total information technology function to diffuse throughout the organization, understanding that excessive dispersal of IT functions can lead to integration problems in the organization. These writers suggest that while the application development function is often more effectively done as part of the line business responsibility, there is benefit in having an IT organization responsible for the total enterprise's information technology infrastructure.

C. Problem Significance

1. *Theoretical Significance*: A review of the structural contingency literature found no evidence of prior examination of the specific research question to be addressed in this dissertation. Other researchers have focused on organizational subunits, but the specific independent, moderating and dependent variables to be used herein are new. In addition, while a few business writers have previously focused on the structure of an internal information systems organization (see, for example, Galbraith, 1973; La Belle and Nyce, 1987; Redditt and Lohdahl; 1988; and Von Simpson, 1990), the basis for these writings has been largely anecdotal. The current research, therefore, is an initial exploratory study. It aims to apply the structural contingency research framework to a new organizational setting. It also utilizes innovative structure, effectiveness and uncertainty variables, chosen for their greater relevancy to this specific organizational setting than variables previously used by other researchers.

The research perspective also aims to address some of the criticisms that have been leveled at contingency research in the past. It has been suggested that the variables used in contingency approaches need clearer conceptualization and improved measurement and that contingency research models must better specify the relationships among variables. The divergent results of research based on contingency theory are, at least in part, felt to be related to conceptual weaknesses in operationalization of the constructs of effectiveness and uncertainty (Pfeffer, 1982; Schoonhoven, 1981; Tosi and Slocum, 1984). Clearer specification of both the "effectiveness" and the "uncertainty" variables and of their interrelationship should be possible in the current research because the focus here is limited to one type of organizational subunit with a limited function and type of output.

Problems in specification of the appropriate level of analysis in contingency research have also been pointed out (Scott, 1981). It has been suggested that the enterprise level of analysis is often inappropriate because organizations tend to do a variety of different kinds of work, employ a variety of different technologies, and be structurally complex.

Use of organizational averages on variables in enterprise level research can result in overlooking important distinctions among organizational subunits. Further, results of enterprise level analyses cannot answer the questions of operating managers responsible for management practices at an organizational subunit level. Studies utilizing a work unit level of analysis, on the other hand, can also pose problems. When work units are studied that perform a heterogeneous set of work activities, work unit averages on variables can also obscure true differences and lead to inferential errors. The restriction of the current study to IS application development work units in organizations reduces the threat of inferential error by permitting an assumption of work activity homogeneity in the sample.

2. *Practical Significance*: The practical significance of this research is that it focuses on an area of broad concern to businesses today. Both the cost and

the potential strategic and operational significance of information technology have led modern organizations to experiment with a variety of approaches aimed at improving the alignment of their IS functions with their line business functions. The unsystematic nature of these experiments has, however, led to little real understanding of the interrelationships of the phenomena of concern and, Therefore, to little practical guidance for organizations on how they might structure in order to improve effectiveness.

a. *Cost of IT*: Information techology amounts to about half the incremental investment for large firms (Keen, 1991). It is estimated that the IS organization budget in a typical Fortune 500 company has in recent years averaged about 2% of total annual revenue (Davis, 1989; Kroon, 1989), with an additional 1.3% spent annually by end-user organizations (Kroon, 1989). During the first half of the 1990's, spending within the IS organization is expected to rise about 14% annually, with much of the growth occurring after 1991. Meanwhile, spending on information systems technology within end-user departments is expected to increase at a rate of 25% annually. By 1995, this would bring average spending on information systems technology to 6.6% of revenue, with spending increasingly dispersed across all parts of an organization (Kroon, 1989). Clearly, the effectiveness of the investment in information systems technology is a major business concern.

b. *Strategic and Operational Value of IT*: The information systems (IS) application development function is characterized by the need to accommodate both rapid change in technology and changing roles for and value of information technology to total enterprise strategy. According to Scott Morton (1991) IT can be expected to continue to change over the next decade at an annual rate of at least 20 to 30 percent. Its impact will be felt on both the production and the coordination activities of organizations and its potential benefits include greater shrinkage of time and distance effects, greater interconnectedness, and better organizational memory with greater capture of organization "rules".

During the past decade, many have written about the changing role and value of information technology (see, for example, Parsons, 1983; Ives and Learmonth, 1984; Rockart and Scott Morton, 1984; Wiseman, 1985; Bays, 1985; Kanter, 1987; Henderson & Venkatraman, 1990). The general consensus is that: opportunities exist for IT to be used to support businesses in undertaking the full gamut of generic strategies described by Porter (1980); strategic use of IT is being made in a wide range of industries; and IT potential for business is actually strong enough to drive new and effective business strategies, not just respond to and support them.

Sullivan-Trainor's (1989a) report on an interview with Michael E. Porter on the role of information systems in competitive strategy quotes Porter as saying that information technology is becoming one of the principal tools by which firms in every industry are gaining advantage in their markets. Further, according to Porter, its importance in gaining competitive advantage stems from the fact that information technology can affect literally every activity in the firm. However, as Scott Morton (1991) points out, IT by itself does not provide any sustainable competitive advantage. Such advantage only comes from a sustained effort by line management to use IT to get closer to the business customers' real needs (Scott Morton, 1991) and through coupling IT initiatives with organizational process reengineering to reshape the way business is conducted, utilizing improved information quality (Freedman, 1991).

c. *IS Alignment Strategy - Business Literature Review*:

The development of a dynamic alignment between the business strategic context and the information technology strategic context is viewed by many as one of the major management challenges faced in business today. Kanter (1987) writes that the successful Information Age companies will be those that develop strategies to link information and communication so that information is applied appropriately to improving the business. Similarly, a recent survey of 115 senior information systems executives from different companies conducted by CIO magazine (1991) found that the greatest perceived "barrier to productivity" they face today is a lack of congruence between application software development efforts and the company's most pressing business needs.

Rockart and Short (in Scott Morton, 1991) suggest that the need to effectively coordinate the activities of individual organizational subunits is much greater today than it was even a few years ago. Specifically, in terms of IS organizations, they say that as the line role grows with regard to innovative systems, the role of the information systems function is becoming more complex, more demanding, and must become more integrated within the business.

IS professionals are responsible for building a network infrastructure in the organization - what Rockart and Short (in Scott Morton, 1991) call "the vital set of roads and highways through which the networks of shared work, expertise, decision making and so on work." The first step in planning and developing this infrastructure, is in their view, the establishment of a partnership between the line businesses and their IS organizations in designing, developing and implementing new systems.

Rockart and Short and others (see, for example, Konstadt, 1991; Kramer, 1990; Sullivan-Trainor, 1988; Champy and Hammer, 1989; Carlyle, 1989) point out that the necessary degree of partnership places new demands on the IS organization, including the need for IS management to educate line management about its new responsibilities, the need for IS executives to educate themselves and their staffs about all significant aspects of the business, and the need for new linking roles, processes and structures.

The Partnership Strategy: Agreeing that effective delivery of information systems products and services requires an improved working relationship between the two major actors concerned with systems (the line manager and the IT manager), Henderson (1990) further explored the concept of building partnership as a management strategy. Two dimensions of partnership-style relationships were defined and researched: partnership in context (PIC), those factors or elements of partnership that will insure it is sustained over time; and partnership in action (PIA), those factors or elements of partnership that contribute to its effective execution on a day-to-day, week-to-week basis. Actions needed to build and sustain both aspects of partnership between IS and line functions in an organization were also identified in this research.

The resulting model of partnership developed by Henderson (1990) shows partnership in context (PIC) as a function of: articulation and agreement on mutual benefit to partners; commitment to the partnership; and existing predilection in favor of the partnership. Partnership in action (PIA) is seen as a function of: shared knowledge among partners; mutual dependency among partners on each others' distinctive competencies and resources; and intertwined organizational processes.

According to Henderson (1990) the actions needed to build and sustain a partnership between IS and line functions in an organization include: 1. Partner education; 2. Joint planning; 3. Measurement and control; 4. Use of cross-functional teams; 5. Multilevel human resource strategy; and 6. Employment of information technology to support teamwork.

Henderson (1990) points out that the effective management of partnerships, according to this model, implies significant cost to an organization. He suggests that the cost of a partnership strategy may not always be warranted. Use of "transactionlike" or value added service relationships between the IS function and line functions are other options that may be quite viable. The major value of the partnership model at this point may be that it can help managers better understand the characteristics of their current work relationships and provide guidance on how to change them, if change is necessary.

Organization Structure Change Strategy: Others have approached the IS Function-Line Function alignment issue from an organizational structure perspective. Von Simson (1990), for example, has written of the "centrally decentralized" IS organization - what he calls a "hybrid" organizational model. In this model, a central IS organization is responsible for the company's technological infrastructure and for selecting and training technical staff, but the development of new computer applications is handled in a decentralized fashion, following priorities and budgets set by the users.

Hybrid IS organizations, according to Von Simson (1990), are a response to the shortcomings of previous organizational models. In the early days of corporate computing, he writes, companies centralized the IS function to promote cost efficiencies and greater professionalism - but at the price of a bureaucracy prone to stagnation, too remote from business pressures and strategies, and unresponsive to business needs. In an attempt to solve these problems, he observes that many organizations tried a decentralization strategy, where each business unit or function had its own IS department and created its own systems. While this minimized turf battles over budget allocations and ensured closer connection to IS customers, it too often had the result, he contends, of creating a rudderless IS staff.

Von Simson (1990) concludes that the new "hybrid" organizational model delivers the best of both worlds, providing the cost savings and control of centralization with the user-responsiveness and flexibility of decentralization. He notes, however, that "recentralization" won't save central IS groups that ignore the importance of responsiveness to users or refuse to break the rigidly technocratic shell that fostered IS fragmentation in the first place.

Corporate moves illustrating the employment of an organization structure change strategy have been observed in many companies in recent years. The Prudential Insurance Company of America, for example, announced in early 1989 the "downloading of certain application development functions" to business units from the corporate IS organization (MacKinnon, 1989). A memorandum announcing this stated, "The biggest single challenge in application development is establishing meaningful dialogue between developers and users, and both organizational and physical proximity can aid in this process." Further, it contended, with regard to this move, "We believe that the result will be closer communication between business people and systems people, and systems that better solve the problems of the business."

Similarly, Manufacturers Hanover Corporation (MHC), following a reorganization into 5 business sectors intended to have maximum decentralized responsibility for all management and operational functions, sought to reorganize its corporate IT function accordingly. The objective was to reorganize organizational structure in a way that would give sectors maximum control over IT resources and institutionalize the IT function, but do this without ceding technological efficiencies for the corporation as a whole (La Belle and Nyce, 1987). In MHC's view, neither a high degree of IT decentralization, nor a low level of corporate control coupled with little centralized management of IT resources were seen as ideal. Instead, a model for breaking IT into its strategic, tactical and infrastructure functions was developed and these functions were then "distributed" along a continuum which ranged from total corporate control to complete sector control. The functions that moved most under sector control were the tactical: systems development, resource planning and acquisition, and computer and telecommunications operation.

In a variation of this theme, Pacific Mutual Life Insurance Co, recently gave their business units a choice to move the IS application development function into their shops (i.e., create an internally "dedicated" IS application development staff) or to leave the function inside the corporate IS department and let that department handle their applications development (Kirkley, 1988). Two of their largest strategic business units chose the "dedication" option, resulting in roughly one third of the total corporate IS staff being moved into these business units. At the same time, another large business unit which had already absorbed part of its IS application development function staff (i.e., those who performed a business analysis function in support of IS application development), decided to ship this staff back to the corporate IS department.

One cannot help but note the variation in language being used to describe what is happening in cases of IS organizational restructuring aimed at improving alignment between IS and business functions. Variously, organizations have used the terms "centralized", "decentralized", "recentralized", "centrally decentralized", "downloaded", "dedicated", "hybrid" structure, and "distributed" to describe the resulting organizational forms. The term "dispersed" has also been used and is worthy of further exploration.

Redditt and Lohdahl (1988, 1989) have researched and written about a phenomenon that they call "IS dispersion". They define this as the devolution (i.e., passage onward) or transference of control over computing resources to the hands of business unit managers. They distinguish between dispersal and decentralization, saying that the latter term more appropriately describes the breaking up of the central "IS fortress" and replicating it as smaller fortresses in the separate divisions of an enterprise. They contend that, in IS decentralization, formal control may be moved to a smaller unit but the unit typically remains unintegrated with line business functions. IS dispersal, on the other hand, implies a closer integration, with informal and day-to-day interchange possible between the business people who see the competitive opportunity of IS and the technologists who know how to build systems to do something about it.

Mintzberg (1979) also distinguishes between decentralization and dispersion. He notes that the terms centralization and decentralization have been overused and used in so many different ways, that they have almost ceased to have any useful meaning. In an attempt to clarify, he states three different observed uses of the term decentralization, and claims that only the first two of these are properly termed "decentralization":

1. The dispersal of formal power down the chain of line authority ("vertical decentralization")

2. The extent to which nonmanagers control decision processes ("horizontal decentralization")

3. The physical dispersal of services.

The third of these is viewed as an issue of whether service is provided from a "dispersed" vs. a "concentrated" source, not the decentralization issue of locus of decision making power. An example of a concentration vs. dispersion issue in organizational structuring is: Should the corporation have all of its strategic planning personnel in a single unit at headquarters or should the personnel be attached to each division (or both?). Another example of a consolidation vs. dispersion issue in organizational structure is: Should the organization's secretaries be grouped into pools or assigned to individual managers? The primary issues for consideration here, according to Mintzberg (1979), are how many facilities are needed and how dispersed and differentiated need they be? Key to this consideration is the trade off between work flow interdependencies (i.e., the interactions with service users) and the need for specialization and economies of scale (Galbraith, 1973, 1977; Mintzberg, 1979). For example, in the case of IS application development personnel, the concentration of the resources into a central group might better allow for specialization and balancing of personnel, while IS dispersion might allow for closer working relationships with the IS customers.

Similarly, Redditt and Lohdahl (1989) have concluded that IS dispersion is occurring in cases where the capability of IS has become more important than IS efficiency and the control of IS costs. They believe that the increasing competitive use of information systems is the driving force for IS dispersion. According to their research, IS dispersion is often evolutionary, taking place over several years, one event at a time, with the final result being increased user control of IS activities. The natural pressures for IS dispersal in business today that they cite include: business units gaining influence over the systems development agenda and/or budget; bootleg development shops springing up in business units; increasing dissatisfaction from business units about IS costs, poor delivery, and so forth; and business units stepping up their purchases of outside software for either business-critical applications or to meet competition. These are all seen as signs that the IS organization is not meeting the needs of the line business functions and that IS dispersal should be considered as a mechanism to increase differentiation and accessibility of service.

Which IS functions should be dispersed? According to Redditt and Lohdahl (1989), good candidates for dispersal are business systems analysis, systems development and end-user computing. Poor choices are database and network architecture, systems standards, systems security and audit, and any functions with across business unit applicability. In sum, it is recommended that those functions that operate to form the information technology "spinal cord" of the organization (Von Simson, 1990) remain concentrated. Concentration of the IT infrastructure functions has several important advantages. It provides economies of scale to the organization in its hardware and operating software purchase and licensing activities and it makes it easier to create and maintain a consistent technological infrastructure. Concentration of these functions is also likely to better support IS staff specialization and the efficient utilization of resources on information technology efforts with organization wide impact.

Other Alignment Strategies - Coordination Mechanisms: The IS business literature suggests several other strategies that organizations are using in an attempt to improve alignment between their IS and line business functions during IS application development projects. One verv common approach is that of utilizing one or more internal line business customers as members of the development team staff (i.e., having a *"customer on the team"*) in order to better insure creation of systems with business value. Baroudi, Olson, and Ives (1986) conducted research to empirically examine the common assumption of the positive value of user involvement in information systems development. The results of their research demonstrated that customer involvement in the development of information systems tends to enhance both user information satisfaction and system usage. Results also suggested that user information satisfaction itself leads to greater system usage.

Specific processes aimed at facilitating communication between the IS application development and line business functions have also been developed and are more and more commonly employed in the development process. *JAD, or Joint Application Design technique,* is one of these. JAD was originally developed in the early 1980's by IBM and is now in widespread use in its original form as well as in variant forms (e.g., "Requirements Analysis Methodology", "Facilitated Application

Specification Technique"). The technique was developed as an alternative to traditional methods of requirements and design specification which placed full responsibility for developing IS application requirements and design specifications on the IS staff, and typically involved information gathering in one-on-one interviews with the business customers. JAD sessions, instead, involve IS application customers working with systems development specialists as equals to produce these specifications (Godfrey, 1986; Rush, 1986; Kangas, 1987; Wood and Silver, 1989).

The JAD technique involves gathering representatives of the line business function and one or more IS application development staff members into an information exchange and problem solving session supported with an agenda, trained independent facilitator, discussion aids, and discussion recorders or "scribes". Focus in the, typically 2-5 day, JAD session is on the flow of work in the business of concern, both as it exists currently and as it is expected or desired to change in the future. The product of a JAD session is documentation and agreement on the purpose and form of the IS application to be designed.

Companies that have used the JAD technique report that, with proper preparation, the technique can cut software development time, improve productivity, increase the quality of requirements definition and design specifications, and decrease the need for system modifications after implementation (Godfrey, 1986; Rush, 1986; Brown, 1988; Woods and Silver, 1989). They also report that employment of the technique can help close the "we versus they gap" often experienced in IS application development (Wood and Silver, 1989) by opening up communication between IS and line business areas and developing a greater mutual appreciation for the work done by each party. With JAD, the business users may tend to take more responsibility for the resulting system because they have played a part in building it (Kerr, 1989). In addition, because of the customer involvement, such techniques better prepare customers for introduction of new systems and processes and can, therefore, make installation of systems run more smoothly (Godfrey, 1986).

Service Level Agreements (SLA's) have also been suggested as a means of improving communication between the IS application development staff and their line business customers. Service Level Agreements are essentially contracts that are mutually developed and agreed upon by an organization's IS and line business functions which establish targets of performance that appear realistic to IS providers and appear to meet the needs of the IS customer. When actual performance differs from the targeted performance level, corrective action is needed.

While the quality dimensions covered in SLA's vary, common areas of focus in them for operational IS applications include elements such as system reliability, availability, on-line response time, and the accuracy and timeliness of application generated outputs - aspects of IS performance that are negotiable (Layman, 1989;.

Cabrera, 1991). Effective SLA's not only specify the negotiated agreement with regard to expected quality levels of delivered information products and services, and who is responsible for doing what to achieve them; but also specify agreed upon criteria and procedures by which compliance with these will be monitored, judged and reported (Layman, 1989).

Layman (1989) contends that failure to meet IS application customer expectations is very often a communication problem, rather than a performance problem. The service-level agreement is seen as providing an improved communication vehicle that results in more effective management of customer expectations as well as in careful definition of performance expectations for IS. Henderson (1990) found in his research on internal partnerships that the use of formal service level contracts between IS and line organizations seems to reflect deeper working relationship and commitment, even when "safe" service level contracts (i.e., easy to achieve service level expectations) are developed. The real importance of service level agreements, according to his interviews with IS organizations using this approach, is to ensure that everyone is committed to an effective working relationship. Finally, in a discussion of the essentially political nature of software systems design, Keen and Gersch (1984) have suggested that the more clear the definitions of success and completion in IS application development projects, the smoother the design and implementation effort will run. In this sense, SLA's appear to offer potential for reducing the amount of nonconstructive political activity on IS application development projects and for managing political debate and negotiation more constructively.

A third type of process with potential for facilitating communication between the IS application development and line business functions is involvement of customer representatives in *requirements definition and design "inspections"*. "Inspections" are also known as "reviews" or "walkthroughs" in some organizations. While there are some technical distinctions between these three named techniques, in practice these distinctions are not uniformly drawn. What is a "walkthrough" in one company may be a "review" in another, may be an "inspection" in a third. The term "inspection" will be used here, since this process is well defined by Fagan (1976) and many agree that it holds greater potential for IS application quality improvement than do the, typically, less formal, less focused "review" and "walkthrough".

An "inspection" is a structured meeting focused on the identification of defects in specific IS products (e.g., the documented system requirements or the system design based on these, or, later in the development process, of actual code). The aim is quality control, the early detection and correction of IS application errors and the provision of the correct technical base for the next project step. An explicit aim of an inspection is to verify the traceability of requirements to products (Fagan, 1976). Like JADS, inspections utilize a trained impartial moderator to facilitate the meeting. Also routinely involved as "inspectors" in the inspection process are the specific IS staff member(s) responsible for the product being "inspected" and other skilled IS personnel (sometimes quality assurance specialists). One of the latter plays the role of "reader" during the inspection, guiding the rest of the group through the material being inspected (Fagan, 1976).

In an inspection focused on IS application requirements and design specifications, there is clearly value in involving the IS application customers in the process as "inspectors". According to Keen and Gersch (1984), the major value of this customer involvement is that it encourages the emergence of potentially conflicting goals which, if left unidentified and unresolved, can cause later problems of withdrawal of support or loss of momentum in IS application development efforts. These authors point out that the resolution of ambiguities in defining what the finished system will do and look like is often more a political process than an intellectual one, because different customers may hold conflicting ideas of what they want. Further, Keen and Gersch (1984) contend that the lack of a direct method for ensuring that customers develop clear and complete agreement on specifications for a system often puts the IS application development team in a no win situation, where they are in the middle but lack the power to resolve the tradeoffs and conflicts implicit in different parties' "wish lists".

Research on the effectiveness of inspections focused on the IS application design suggests that these are a more cost effective means of IS application defect detection and removal than is after-the-fact testing (Glass, 1990). Perry (1986) has suggested that techniques utilizing peer review of activities also offer the organization a means of training individuals in quality and quality control concepts. Keen and Gersch (1984) relate a case study wherein IS application customers were provided an opportunity to evaluate and criticize a design specification. They itemize the benefits of the use of this process as follows: acquisition of customer knowledge; transferral of responsibility for the system design from the "technical experts" to the group as a whole; increased customer commitment to the project; and getting the system designers out of "the middle".

Use of customer on the team IS application development project staffing, JAD's, SLA's and application requirements and design inspections with customer involvement can all be viewed as process approaches that organizations may use to improve information handling through closer internal coordination between interdependent work units. Using Van de Ven, Delbecq and Koenig's (1976) terms, these are personal and group, horizontal "coordination mechanisms". According to Daft and Lengel (1984), "media rich" organizational mechanisms like these (utilizing face to face communications) are necessary for the effective processing of information about complex organizational topics and confronting uncertainty and disorder within an organization. These strategies are among the kinds of integrating processes and mechanisms that Galbraith (1973, 1977) discussed which are used by organizations to create lateral relations in order to increase their capacity for internal information processing. Reduction of equivocality in information processing and the gathering of sufficient information for task performance are seen as the primary aims of these types of organizational strategies (Daft and Lengel, 1984).

3. *Problem Significance Summary:* To summarize, this dissertation research aims to accomplish the following:

a. To extend the structural contingency research framework to a new organizational setting - that of the IS application development function.

b. To carefully conceptualize and measure the contingency research variables of structure, uncertainty and effectiveness, specifically in terms of the organizational function of interest.

c. To focus on a work unit level of analysis, minimizing possibilities of inferential errors while optimizing learning about the relationship among contingency variables at the organizational level at which the IS application development function is actually managed.

d. To systematically examine the relative value of current organizational approaches to improvement of IS application function customer-producer alignment in order to provide empirically based guidance in an area of practical management concern.

II. RESEARCH MODEL

A. Level of Analysis

Much of the current work and thought about IS alignment strategy is being conducted at the enterprise level (as was much of the prior research on organizational structure and effectiveness). For example, Henderson and Venkatraman (1990) at MIT's Sloan School of Management Center for Information Systems Research have presented an enterprise level model for research and practice of strategic management of information technology. Their Strategic Alignment Model is defined in terms of four domains of an enterprise's strategic choice:

1. **Business Strategy** - the organization's choice of product-market offerings, distinctive competencies (i.e., attributes of strategy that contribute to competitive advantage), and structural mechanisms to organize the business operations that recognize the continuum between markets and hierarchy;

2. **Information Technology Strategy** - choices of IT systems and capabilities, systemic competencies (i.e., IT attributes that contribute positively to creation of a new business strategy or to support of an existing one), and IT governance (i.e., structural mechanisms such as joint ventures and long-term contracts employed to obtain required IT capabilities and to

exploit IT capabilities and services;

3. **Organizational Infrastructure and Processes** - choices of administrative infrastructure (i.e., organizational structure, roles and reporting relationships), processes (i.e., workflows and information flows for carrying out key activities), and skills (i.e., capabilities to execute the key tasks that support business strategy);

4. **Information Technology Infrastructures and Processes** - choices of IT applications, data and technology configurations (called the "IT infrastructure" in this model), work processes central to the operations of the IT infrastructure, and knowledge and capabilities required to effectively manage the IT infrastructure within the organization.

The model is further conceptualized in terms of two fundamental characteristics of strategic management: strategic fit (i.e., the interrelationships between external and internal domains); and functional integration (i.e., integration between business and functional domains). This model is reproduced in Figure 2.

FIGURE 2
STRATEGIC ALIGNMENT MODEL:
FOUR DOMAINS OF AN ENTERPRISE'S STRATEGIC CHOICE

	BUSINESS	IT
EXTERNAL	**Business Strategy (BS)** Business Scope Distinctive Competencies Business Governance	**IT Strategy (ITS)** Technology Scope Systematic Competencies IT Governance
INTERNAL	**Organizational Infrastructure & Processes (OI&P)** Admin. Infrastructure Processes Skills	**IT Infrastructure & Processes (ITI&P)** IT Infrastructure Processes Skills

STRATEGIC FIT

FUNCTIONAL INTEGRATION

Adapted from Henderson and Venkatraman (1990) p. 7

Henderson and Venkatraman (1990) have defined four areas of cross domain relationships that are of particular relevance and importance for both management and research. Each of these is anchored in one particular domain and involves consideration of three domains in total. These cross domain relationships are defined below and shown in Figure 3.

1. **Strategy Implementation** - a cross-domain perspective that involves the assessment of the implications of implementing the chosen business strategy via appropriate organizational infrastructure and management processes as well as the design and development of the required internal IT infrastructure and process.

2. **Technology Exploitation** - a cross-domain perspective concerned with the exploitation of emerging IT capabilities to impact new products and services (i.e., business scope), influence the key attributes of strategy (distinctive competencies) as well as develop new forms of relationships (i.e., business governance); focus here is on identification of the best set of strategic options for business strategy and the corresponding set of decisions pertaining to organizational infrastructure and processes.

3. **Technology Leverage** - a cross-domain perspective that involves the assessment of the implications of implementing the chosen business strategy through appropriate IT strategy and the articulation of the required

IS functional infrastructure and systemic processes.

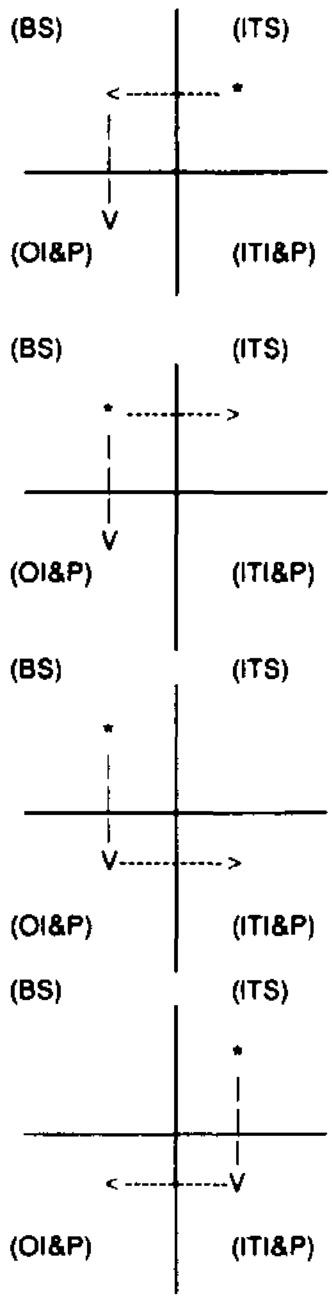
4. **Technology Implementation** - a cross-domain perspective concerned with the strategic fit between the external articulation of IT strategy and the internal implementation of the IT infrastructure and processes with corresponding impact on the overall organizational infrastructure and processes.

The current research focus is on the structure and the coordinating mechanisms employed to link the developer and (internal) customer organizational subunits in specific application development project efforts. Thus, the research falls within what Henderson and Venkatraman (1990) call the strategy implementation cross domain perspective.

As shown in Figure 4, the domain anchor for the proposed research is the given business strategy that results in IS application need conceptualization. The organizational infrastructure/processes dimensions of concern are the IS application development function structure and coordination mechanism use in the organization. Finally, the IT infrastructure/processes outcome dimension of concern is delivery of IS applications and services that meet business needs.

FIGURE 3
FOUR DOMINANT CROSS DOMAIN PERSPECTIVES ON IT PLANNING
Adapted from Henderson and Venkatraman (1990) p. 15

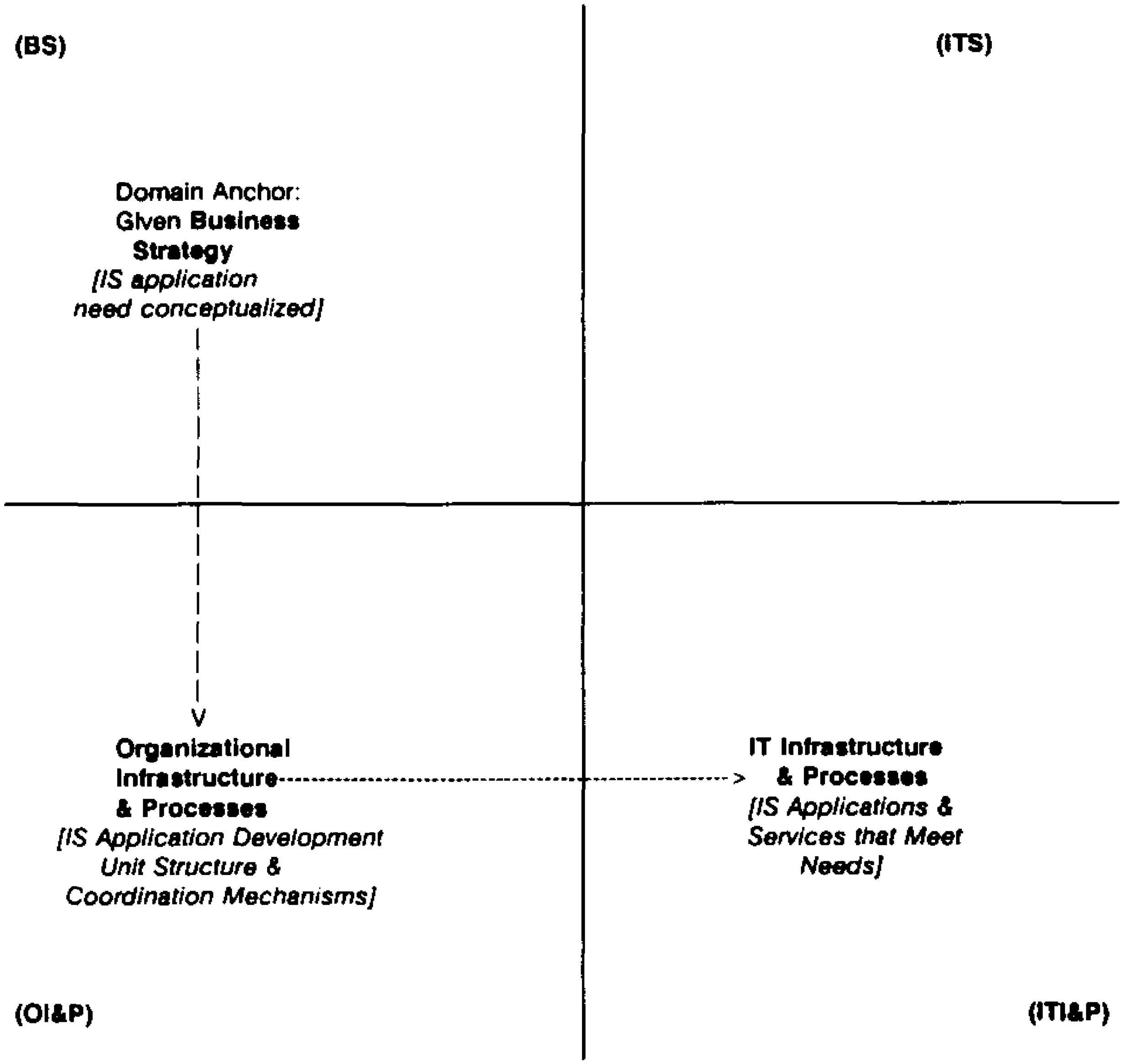
LABEL	CROSS-DOMAIN PERSPECTIVE	COMMON DOMAIN ANCHOR
Technology Exploitation	(see figure)	Technology Strategy
Technology Leverage	(see figure)	Business Strategy
Strategy Implementation	(see figure)	Business Strategy
Technology Implementation	(see figure)	Technology Strategy



* Domain Anchor

FIGURE 4

MODEL OF STRATEGY IMPLEMENTATION CROSS DOMAIN PERSPECTIVE
[as applied in proposed research]



The organizational infrastructure and process components to be operationalized for investigation in this research are further detailed in Figure 5. The specific aspect of the administrative infrastructure component to be studied is the dispersal of the IS application development function. Use of customer on the team, JAD's, SLA's and requirements and design inspections with customer involvement are the variables of concern that fall within the processes component of Henderson & Venkatraman's (1990) model. Focus on the third and final component, skills, is specifically on the organizational capabilities to close the "knowledge/skill gap" in the IS application development life cycle between IS application need conceptualization and IS application requirements and design specification. Figure 6 shows the relationship between the organizational infrastructure/process components of concern and the IS application development process.

B. Open System and Rational System Assumptions

This research model can be seen to represent a combination of open system and rational system assumptions. The problem faced in contingency research is,

FIGURE 5

ORGANIZATIONAL INFRASTRUCTURE & PROCESS COMPONENTS
[as operationalized in proposed research]

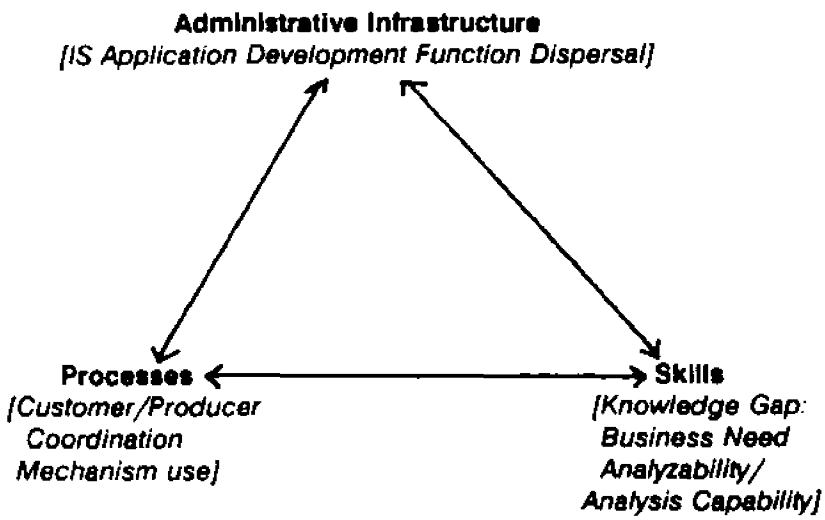
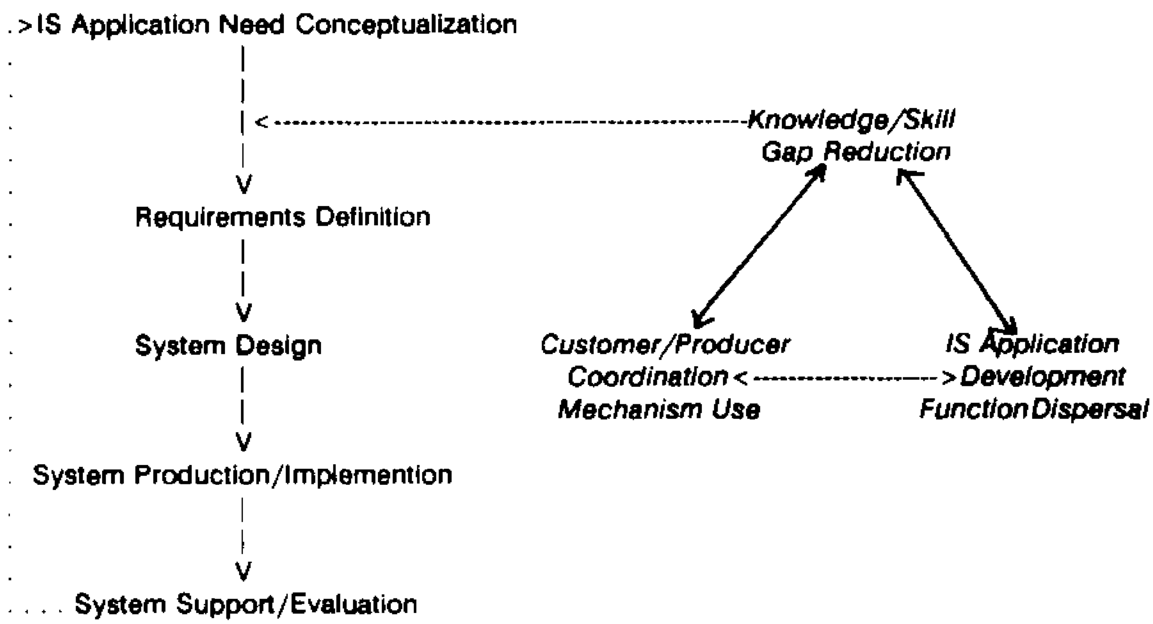


FIGURE 6

COMBINED MODEL
ORGANIZATIONAL INFRASTRUCTURE & PROCESSES RELATIVE TO APPLICATION DEVELOPMENT PROCESS



according to Scott (1981), as follows: Given that an organization is open to the uncertainties of its environment, how can it function as a rational system? The aim of system rationality, in this context, is organization of a series of actions (IS application development project steps, in this case) in such a way as to lead to predetermined goals with maximum effectiveness (i.e., high quality IS product/service delivery).

However, the emphasis in this research is on organizing as opposed to organization, with focus on information flow and processing and, this, according to Scott (1981) is characteristic of an open systems model. The structure of the IS application development unit is not viewed in isolation, but instead is viewed as open to the *impact* of business strategy (the anchor point *in* the model) and to informational aspects of the work unit task environment. Specific attention in the research is paid to level of uncertainty in the task environment (i.e., to IS application requirements definition uncertainty). This is proposed as a key feature of the environment in which the IS application development function operates and one which will impact on the effectiveness of management choices with regard to organizational infrastructure and processes.

C. Contingency Model Specification

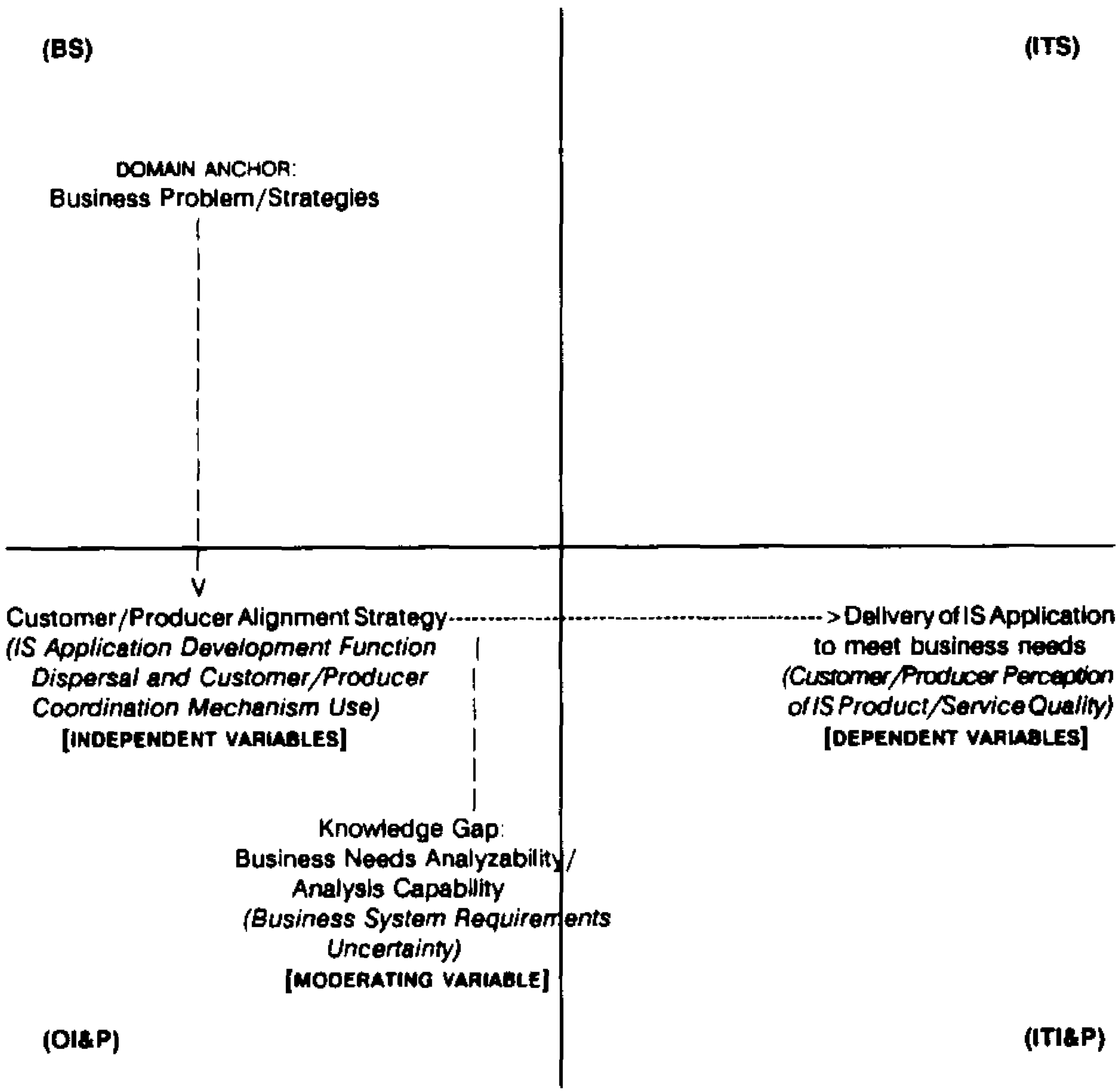
Figure 7 represents the proposed research model. The business strategy and the specific business problem to be addressed through IS application development are "given". The **independent variables** in the model are aspects of the organization's IS customer/producer alignment strategy previously discussed: IS application development function dispersal and IS application customer/producer coordination mechanisms employed in the IS application development process. The **dependent variables** are effectiveness criteria: the quality of IS applications and services delivered to meet the expressed business need - from both the IS customer perspective and the IS producer perspective. **Moderating** the relationship between customer/producer alignment strategy and quality of delivered product and services are characteristics of the knowledge/skills gap faced, termed "business systems requirements uncertainty".

1. ***Independent Variables***: The two aspects of IS application customer/producer "alignment strategy" to be used as independent variables in this research were developed in the discussion at the end of the previous chapter. These are: *dispersal* of the IS application development function; and IS application customer/producer *coordination mechanism* use. No evidence was found in a literature review of previous use of dispersal as an independent variable in studies of structural contingency propositions. Constructs similar to that of "coordination mechanism" use have, however, been employed in this type of research.

Lawrence and Lorsch (1967, 1969), for example, investigated organizational use of "integrative devices". Burns and Stalker's (1961) focus on governance of

FIGURE 7

PROPOSED RESEARCH MODEL



operations and working behavior through "lateral communications" in organizations is also related. In addition, Van de Ven, Delbecq and Koenig's (1976) focus on organizational "modes of coordination" has similarity. The specific measures of IS function dispersal and use of IS customer/producer coordination mechanisms to be used in the current research are described in Chapter IV.

2. ***Dependent Variables***: It has been noted that while the idea of organizational effectiveness lies at very center of all organizational models, including the structural contingency model, researchers have failed to systematically analyze and precisely define this construct (Cameron and Whetten, 1983; Lewin and Minton, 1986). Clearly, organizational effectiveness is a multidimensional construct. However, consensus on its dimensions and their properties is currently lacking. Related to this, Goodman, Atkin and Schoorman (in Cameron and Whetten, 1983) call for a moratorium on studies of overall organizational effectiveness. Instead, they recommend a shift in focus to particular independent-dependent variable linkages based on carefully specified models of single dependent variables. Only after more research using well specified partial indicators has been completed, they say, will the empirical basis exist to form a more generalized model of organizational effectiveness.

The effectiveness criteria selected for operationalization and use herein are: product and service *quality - as perceived by both the internal business customer unit and the unit which produces the IS application*. Quality is not a common performance criterion in contingency research. However, it has been noted that the most common measures of effectiveness in this body of research (e.g., profitability and organizational adaption/survival) are not necessarily the best. Other performance criteria that exist which may be more appropriate in a given research effort include market share, morale, growth, flexibility, efficiency and quality (Tosi and Slocum, 1984). Quality is chosen as the performance criterion for use in the proposed research because its improvement is the major thrust behind organizational experimentation with various IS application development customer/producer "alignment strategies". Meeting the internal business customers' "real needs" and providing improved information quality to support business reengineering efforts that can provide competitive advantage are the current pressures for IS organizational change (Freedman, 1991; Kanter, 1987; Scott Morton, 1991; Von Simson, 1990).

There are many different views of what constitutes "quality". Crosby (1979) has defined quality as "conformance to requirements". Other writers, including Juran (1989) and Deming (1986), have defined quality as "fit for use". Writers have, variously, followed a strategy of looking at product quality characteristics, service quality characteristics, or both product and service quality characteristics. They have also varied in the perspective from which they have examined the meaning of quality - some specifically taking a "customer" view, some taking a more technical "producer" view, and others considering both of these views important. The management practitioner, on the other hand, has often failed to make any of these distinctions.

Garvin (1987) tackled the issue of defining the dimensions of product quality on which American Companies compete. He presents 8 general dimensions of product quality, from the consumer's vantage point:

1. *Performance* - a product's primary operating characteristics;
2. *Features* - a product's "bells and whistles" or supplemental operating characteristics;
3. *Reliability* - the probability of product malfunction or failure;
4. *Conformance* - the degree to which product design and operating characteristics meet established standards;
5. *Durability* - amount of use one gets from a product before it deteriorates;
6. *Serviceability* - speed, courtesy, competency and ease of repair;
7. *Aesthetics* - how a product looks, feels, sounds, tastes and smells;
8. *Perceived quality* - customer judgement of product quality.

Parasuraman, Zeithaml, and Berry (1988) identified 10 service quality attributes and then refined these through their research into 5 dimensions of service quality that could form the basis of a consumer service quality measure (SERVQUAL) for use by retailers and service organizations:

1. *Tangibles* - physical facilities, equipment and appearance of personnel.

2. *Reliability* - ability to perform the promised service dependably and accurately.
3. *Responsiveness* - willingness to help customers and provide prompt service.
4. *Assurance* - knowledge and courtesy of employees and their ability to inspire trust and confidence.
5. *Empathy* - caring, individualized attention the firm provides to customers.

These authors distinguish their conceptualization of the quality construct from that of other writers by its emphasis on perceived, instead of objective, quality. Further, they distinguish between perceived service quality as a global attitude and customer satisfaction as related to a specific transaction. They add, however, that the two constructs are highly related because incidents of satisfaction over time result in perceptions of service quality (Parasuraman, Zeithaml, and Berry, 1988).

The SERVQUAL construct operationalization is based on the idea that service quality, in the view of consumers, stems from a *comparison* of their expectations of what service firms should offer with their perceptions of the actual performance of firms providing the services. The service quality items are, therefore, phrased in terms of the degree and direction of difference between consumers' perceptions and expectations.

There is a notable overlap between the "product" and "service" quality dimensions enumerated in the research discussed above. Garvin's "serviceability" dimension of product quality appears to broadly cover the same concepts as do Parasuraman, et. al.'s (1988) service quality dimensions of "responsiveness", "assurance" and part of "reliability". Further, in Garvin's (1987) discussion of his product dimensions, he cites examples of how these dimensions apply to service organizations' products which lead to observations of additional overlap between "product" and "service" quality dimensions. For example, Garvin says that operating characteristics in service businesses on which "performance" is judged might include things such as promptness of service. This observed overlap suggests that in general models, clear distinctions between "product" and "service" quality may be difficult to make. While the necessity of such distinctions would depend on the specific application to be made of a quality construct model, in many cases such distinctions may serve no useful purpose.

Tosi and Slocum (1984) have criticized contingency research for its lack of consideration of the fact that judgements of effectiveness involve a question of values. They note that an organization cannot usually maximize all of the outcome preferences of its multiple constituencies and that, at any given time, there are likely to be tradeoffs between criteria embedded in competing values held by different constituencies. They conclude that in the selection of effectiveness concepts for assessment, researchers need to consider the tradeoffs with respect to other outcomes that are not selected. Van de Ven and Ferry (1980) suggest that, when selecting performance criteria for assessment, an analyst must determine at the onset whose value judgements and criteria will be operationalized and measured. Similarly, Seashore (in Cameron and Whetten, 1983), suggests the need to take into account different value perspectives, stating that the term effectiveness is evaluative by definition and implies that some coherent set of interests and value preferences is brought to bear. Thus, he concludes that organizational effectiveness should be evaluated from perspectives of different interested parties and that identification and characterization of significant constituencies is needed to clarify research. In the current research, the IS application producer unit (i.e., the information technology application specialists) and the IS application customer unit (i.e., operating personnel in the line business area) are considered important constituencies and the perspectives of each are sought in criterion measurement.

Summarizing many of the points made by others and providing a structure for use toward the goal of building a more generalized model of organizational effectiveness, Cameron & Whetten (1983) provide 7 decision guides for use in each assessment of one or more aspect of organizational effectiveness:

1. From whose perspective is effectiveness being judged?
2. On what domain of activity is the judgement focused?
3. What level of analysis is being used?
4. What is the purpose of judging effectiveness?
5. What time frame is being employed?
6. What type of data are being used for judgement of effectiveness?

7. What is the referent against which effectiveness is judged?

For the current research, answers to these 7 questions are as follows:

1. Both the line business unit's and the IS application development unit's (i.e., the IS application customer and producer) perspectives on software product/service quality are of concern and will be measured. Their combined perception of quality of the results of a particular IS application effort is of interest, as is their independent judgement and potential differences in perception.

2. The domain of activity on which judgements of effectiveness are focused is the I.S. application development work function within organizations.

3. An organizational subunit level of analysis will be used; perception of quality data will be collected from representatives of line business work units receiving IS products and services (i.e., the IS customer) and from representatives of IS application development work units producing these products and services (i.e., the IS producer). The focal point for the collection of quality data from work unit representatives will be outcomes of specific IS application development efforts.

4. As stated earlier, quality has been chosen as the effectiveness measure for use in the proposed research because its improvement is the major thrust behind current organizational experimentation with various IS application development .

function customer/producer "alignment strategies".

5. The time frame to be employed in the assessment of perception of IS application quality is 3 - 12 months after IS application completion and installation. This time frame is chosen to insure sufficient experience with the application development function product and services for valid evaluation of quality characteristics while, at the same time, minimizing memory bias.

6. Separate questionnaires focused on evaluation of IS product and service quality characteristics have been developed for use in collection of quality perception data from each of the two viewpoints (i.e., customer and producer). Each questionnaire includes multiple choice items focused on the characteristics of quality from each perspective. For each IS application development effort included in the study, at least one representative of the customer work unit completed the customer view questionnaire and at least one representative of the producer work unit completed the producer view questionnaire. From these responses, an overall quality rating was derived for the application, based on ratings from both views. The seperate quality ratings of the customer and producer units for IS applications was also used in the research analysis in an examination of potential differential impact of the independent and moderating variables on the independent customer and producer views.

7. In the data analysis performed to test the major hypotheses in this research,

overall IS application quality ratings (based on ratings from both the customer and producer views) obtained from the sample subunits will be compared. Cases of high quality ratings and low quality ratings will be identified based on internal comparison and statistical analysis of sample results.

The items in the quality questionnaires are phrased in terms of the degree to which organizational expectations and standards established for an IS application development effort have been met. The referent that respondents were asked to use in evaluating quality was, again, an internal one: the extent to which a particular system has met the organization's quality expectation with regard to each quality dimension. The questionnaire items' multiple choice options have been anchored based on the literature and the input of an IS industry expert panel with regard to industry quality standards and reasonable response ranges for each quality characteristic.

More detailed discussion of the operationalization of the quality construct in this research is contained in Chapter IV. of this dissertation.

3. ***Moderating Variables***: The "uncertainty" moderating variable in the current research model focuses on the degree to which information needed to accomplish IS application development work is available and analyzable. A theme of incomplete information underlies most definitions of uncertainty (Argote, Turner and Fichman, 1989), but Galbraith (1973, 1977) provides the strongest conceptual

basis for viewing the uncertainty arising in the IS application requirements/design specification task in this particular manner. He conceptualizes uncertainty as the difference between the amount of information required to perform a task and the amount of information already possessed by the organization. Further, he says that the amount of information possessed is largely a function of the organization's prior experience with the service, product, type of client or customer, or the technology used in its operations.

Daft and Macintosh (1981) argue that a distinction should be made between stimulus uncertainty and response uncertainty in organizational research. Stimulus uncertainty, in their view, is largely related to task variety and consists of inability to predict problems or activities in advance. Response uncertainty is the difficulty in analyzing tasks in terms of alternatives, outcomes, costs and benefits. Similarly, Vredenburgh, Schuler and Jackson (1988), in their review of uncertainty, state that the construct must be understood in terms of both predictability of events and analyzability of decision elements such as the amount and nature of information. In the present conceptualization, the focus is on response uncertainty. Stimulus uncertainty is, to a large extent, controlled in the proposed research through its specific focus on the organizational task of IS application development.

In IS application development within an organization, each software product is uniquely designed to meet specific business needs. While some business needs presented may be more routine than others, these vary widely from project to project. An example of a routine operational need might be automation of an existing accounting system or a payroll process. The improvement in efficiency of back office processes like these has been the traditional target of organizational use of information technology.

Examples of less routine, more strategic uses of IS technology have been growing in recent years (Bays, 1985; Freedman, 1991). Ives and Learmonth (1984) described an IS application developed by a taxi firm that tracks and displays the number of empty cabs in various zones, thus allowing drivers to better determine where needs and business opportunities are greatest. Otis Elevator Company developed a customer service response information system application credited with reducing the company's service response time and improving both their elevator service records and ability to market maintenance contracts (Freedman, 1991). Wiseman (1985), in another example, described an IS application developed by a pharmaceutical supplier that provided retail druggists with capability to automatically file insurance claims for customers. This was said to provide both the supplier and the retailer with differentiated service to help them earn customer loyalty. It also provided the supplier with opportunity to develop and market a new product of value to drug manufacturers and others, i.e, marketing reports based on the supplier's analysis of insurance claims data.

The IS application development process, or the "technology" used to convert inputs (i.e., business needs and IT tools) into outputs (i.e., application software), in the terms of Perrow (1970), Woodward (1965) and others, is characterized by varying degrees of uncertainty. The business requirements and design specification tasks, in particular, address a highly variable set of problems across IS application projects in terms of their analyzability. Analysis difficulty is more or less depending upon the size of the "knowledge gap" to be closed and on the skills or capabilities brought to bear on the particular requirements and design problem by both the IS application customer and producer units.

In the most routine business process automation efforts, business needs are well known and stable, leading to greater ease in system requirements and design specification. Here, line business unit staff members have prior experience with the business functions being automated and it is even often the case that the IS application developers also bring at least fundamental understanding of the business need to the system development project. The stability of and experience with the aspect of the business being addressed in the project results in lower levels of response uncertainty. Business requirements analyzability is high in these cases.

In cases of highly innovative applications of IS technology aimed at supporting or helping to shape new business strategy, there is much greater system requirements analysis difficulty faced. Here, business needs are less certain, less well formed at the start of the IS application development project. The initial development of IS applications like these lacks organizational (sometimes even industry) precedent and, thus, represent greater response uncertainty in the IS application development process.

D. Research Model Summary

As discussed, there are two independent variables in the current research model are: IS application development function dispersal and IS application customer/producer coordination mechanism use. Delivered IS product/service quality is the dependent variable, and the measure of this includes both the IS customer and the IS producer perspectives. Additionally, there is a moderating variable posited. The relationship between customer/producer alignment strategy and quality is expected to be moderated by the level of business systems requirements uncertainty faced.

The broad business context for this research model is organizational strategy implementation - specifically the IT organization strategies employed internally to structure and coordinate work activities in order to produce IS applications and services that meet business needs. The orienting view for the research is structural contingency theory, which suggests that there is no one best way to organize under all conditions. The primary research hypothesis is that the quality of IS products and services will be higher or lower, depending upon the level of IS function dispersal and IS customer-producer coordination mechanism use and the level of requirements definition uncertainty faced. Specific research hypotheses .

and their analytical implications are detailed in the following section of this dissertation.

III. RESEARCH HYPOTHESES AND ANALYTIC MODEL

Following Schoonhoven's (1981) suggestions, the conceptual framework for this contingency research have been specified with consideration of its analytical implications for examination of the functional form of interaction between variables and effects of variables on each other.

A. General Propositions: The basic contingency propositions for examination follow:

1. The greater the requirements definition uncertainty faced in an IS application development project, the greater the impact of employment of IS application development function dispersal on customer/producer perceptions of IS product and service quality.

2. The greater the requirements definition uncertainty faced in an IS application development project, the greater the impact of employment of IS application customer/producer coordination mechanisms on customer/producer perceptions of IS product and service quality.

These basic propositions imply a multiplicative form of interaction effect between the uncertainty and each of the alignment strategy variables. The presence of both high uncertainty and high IS function dispersal (or both high uncertainty and high coordination mechanism employment) is expected to have the effect of higher quality results.

The basic propositions stated above do not clearly indicate the research assumptions with regard to the nature of the effect of the independent variables (IS function dispersal and coordination mechanism use) on the dependent variables (IS product/service quality) over the range of systems requirements uncertainty. In order to determine operational and computational procedures appropriate for use, it is necessary to clarify expectations with regard to issues of symmetry and monotonicity of effects in contingency research hypotheses (Schoonhoven, 1981).

In this research, a symmetrical contingency relationship is expected. This follows from contingency theory's broad contention that improving "congruency" between environment variables and organizational variables leads to improved effectiveness. Fit or congruency is the central theme in most contingency studies. The assumption of symmetry in this research implies that as long as there is congruence between the values of the alignment strategy variables and the level of system requirements definition uncertainty, quality results can be expected. That is, both low-low combinations of the independent and moderating variables and high-high combinations of these variables represent congruence and can result in high IS product/service quality. Lower quality is expected to result, however, with low-high or high-low combinations of the independent and moderating variables as these combinations represent "incongruence" in the contingency model.

In the current research, under conditions of low uncertainty, increases in use of the alignment strategies (i.e., dispersal and coordination mechanisms) are expected to negatively impact the quality criterion. This is consistent with the line of reasoning presented by Daft and Lengel (1984) who posit that in cases where an organization uses "rich media" (e.g., face to face communication mechanisms) to resolve unequivocal issues, the organizing process will be inefficient. Face to face discussions to process routine and well understood events are expected to confound rather than clarify. In addition, participants may feel uninvolved because the equivocality that triggers discussion is not present, and this can lead to further impairment of task communication.

A particularly strong effect is expected in cases where there is high requirements definition uncertainty but both low work unit use of IS function dispersal and low work unit use of IS application customer/producer unit coordination mechanisms. It is in cases where neither of these alignment strategies are used despite conditions of high requirements definition uncertainty where the lowest levels of quality performance are expected. To some extent, in cases of high uncertainty, equifinality may operate so that IS dispersal and use of the coordination mechanisms may be substitutable. That is, in these cases, if IS dispersal is used however, with low-high or high-low combinations of the independent and moderating variables as these combinations represent "incongruence" in the contingency model.

In the current research, under conditions of low uncertainty, increases in use of the alignment strategies (i.e., dispersal and coordination mechanisms) are expected to negatively impact the quality criterion. This is consistent with the line of reasoning presented by Daft and Lengel (1984) who posit that in cases where an organization uses "rich media" (e.g., face to face communication mechanisms) to resolve unequivocal issues, the organizing process will be inefficient. Face to face discussions to process routine and well understood events are expected to confound rather than clarify. In addition, participants may feel uninvolved because the equivocality that triggers discussion is not present, and this can lead to further impairment of task communication.

A particularly strong effect is expected in cases where there is high requirements definition uncertainty but both low work unit use of IS function dispersal and low work unit use of IS application customer/producer unit coordination mechanisms. It is in cases where neither of these alignment strategies are used despite conditions of high requirements definition uncertainty where the lowest levels of quality performance are expected. To some extent, in cases of high uncertainty, equifinality may operate so that IS dispersal and use of the coordination mechanisms may be substitutable. That is, in these cases, if IS dispersal is used but coordination mechanisms are not or vice versa, this may be sufficient to result in moderately positive quality evaluations. IS function dispersal into the line business units should present, at least, the opportunity for closer integration and coordination of the business and IS functions of the organization, potentially leading to more effective information processing about business information systems requirements. Use of the coordination mechanisms, on the other hand, formalizes this information processing. There may be a difference in level of impact of the two alignment strategies used separately, due to the formality of the mechanisms vs. the dispersal, but both are expected to positively impact the criterion measure in this study. The lack of use of any of the alignment strategies in these cases, however, is expected to result in negative quality evaluations.

An assumption of symmetry also implies a nonmonotonic effect of the independent variables on the dependent variables over the range of a moderating variable (Schoonhoven, 1981). Despite this and some research evidence of the existence of curvilinear relationships (see e.g., Woodward, 1965), there has been a tendency to rely on a general linear model and correlational procedures in structural contingency research (Schoonhoven, 1981; Tosi and Slocum, 1984). A nonmonotonic effect would mean that the moderating variable increases the effect of the independent variable on the dependent variable over a portion of its range and decreases it over the remainder. In the current research, it would mean that uncertainty will increase the effect of dispersal and of coordination mechanism use over parts of the uncertainty range, but decrease the effects over the remainder of the range.

Schoonhoven (1981) has suggested that whenever symmetry is assumed in contingency research, a set of nonmonotic hypotheses should be developed. She has also proposed a statistical approach, involving graphing of the partial derivatives from multiple regression equations, that permits identification of the point in the range of uncertainty where a change in the direction of relationship occurs. Her application of this approach to the testing of some of Galbraith's (1973) propositions in an acute-care hospital setting found nonmonotonic effects of information processing structure variables (e.g., destandardization) on organizational effectiveness over the range of uncertainty. Specifically, for example, she found that at a particular value of uncertainty, changes in destandardization had no effect on her dependent variable of surgical effectiveness. That is, under low uncertainty, destandardization decreased effectiveness while under high uncertainty, destandardization increased effectiveness in operating room units. Effectiveness was even further enhanced as destandardization increased in high uncertainty situations. Her analysis enabled her to conclude that destandardization can promote effectiveness (i.e., result in fewer cases of post surgical deaths) in the high end of the uncertainty range but, below a specific point in the uncertainty range, increases in destandardization tend to decrease surgical effectiveness.

In the current research, the impact of IS application customer/producer unit coordination mechanism use on perception of product/service quality are expected to be nonmonotonic over the range of requirements definition uncertainty. Uncertainty is expected to increase the effects of coordination mechanism use on quality at the high and low end of the moderator variable range and decrease the effects over the remainder.

The impact of IS application function dispersal is also expected to be nonmonotonic over the range of uncertainty. In cases of high requirements definition uncertainty, increases in dispersal are expected to positively impact quality and decreases in dispersal are expected to negatively influence quality. However, in cases of lower requirements definition uncertainty, increases or decreases in IS application development function dispersal are expected to have decreased effect on the IS product/service quality criterion.

The reasoning for this is that while the level of dispersal reflects the opportunity for closer organizational alignment of the IS application customer and producer units through a socialization dynamic, different levels of dispersal usage (unlike coordination mechanism use) do not necessarily involve different levels of utilization of formal face to face communication mechanisms. Instead, dispersal reflects the level of integration with and accessibility of IS service to line business. There is no theoretical basis for positing that increased integration and accessibility of this service to the business subunit would have a strong impact on the IS product/service quality criterion when employed under conditions of low requirements definition uncertainty. While other aspects of the general contingency model criterion of organizational effectiveness (e.g., profitability) could feasibly be expected to show significant impact due to the lack of congruence, the quality criterion in this work unit level research is not expected to be significantly impacted.

Recasting the original propositions for investigation, making explicit the assumptions discussed above, yields the following more specific hypotheses:

B. Research Hypotheses

Hypothesis 1: The impact of IS application development function dispersal on customer/producer perception of IS product/service quality is *nonmonotonic* over the range of requirements definition uncertainty.

Hypothesis 1a: When requirements definition uncertainty is high, increases in IS application dispersal will positively influence IS product/service quality.

Hypothesis 1b: When requirements definition uncertainty is high, decreases in IS application development function dispersal will negatively influence IS product/service quality.

Hypothesis 1c: When requirements definition uncertainty is low, increases in IS application development function dispersal will not influence IS product/service quality.

Hypothesis 1d: When requirements definition uncertainty is low, decreases in IS application function dispersal will not influence IS product/service quality.

Hypothesis 2: The impact of IS application customer/producer unit coordination mechanism use on customer/producer perception of product/service quality is nonmonotonic over the range of requirements definition uncertainty.

Hypothesis 2a: When requirements definition uncertainty is high, increases in IS application customer/producer unit coordination mechanism use will positively influence IS product/service quality.

Hypotheses 2b: When requirements definition uncertainty is high, decreases in IS application customer/producer unit coordination mechanism use will negatively influence IS product/service quality

Hypothesis 2c: When requirements definition uncertainty is low, increases in IS application customer/producer unit coordination mechanism use will negatively influence IS product/service quality perceptions.

Hypothesis 2d: When requirements definition uncertainty is low, decreases in IS application customer/producer unit coordination mechanism use will positively influence IS product/service quality.

Hypothesis 3a: When requirements definition uncertainty is high, increases in IS function dispersal and in application customer/producer unit coordination mechanism use will have the greatest positive influence on IS product/service quality.

Hypothesis 3b: When requirements definition uncertainty is high, decreases in IS function dispersal and in application customer/producer unit coordination mechanism use will have the greatest negative influence on IS product/service quality.

Hypothesis 3c: When requirements definition uncertainty is low, decreases in IS application function dispersal and IS customer/producer unit coordination mechanism use, will not influence IS product/service quality.

Hypothesis 3d: when requirements definition uncertainty is low, increases in both IS function dispersal and in IS application customer/producer unit coordination mechanism use will have a moderately negative influence on IS product/service quality.

Hypothesis 3e: When requirements definition uncertainty is high, increases in IS function dispersal or in application customer/producer unit coordination mechanism use, coupled with decreases in the remaining independent variable, will have a moderately positive influence on IS product/service quality.

Hypothesis 3f: When requirements definition uncertainty is low, decreases in IS function dispersal coupled with increases in customer/producer unit coordination mechanism use will have a moderately negative influence on IS product/service quality.

Hypothesis 3g: When requirements definition uncertainty is low, increases in IS function dispersal coupled with decreases in customer/producer unit coordination mechanism use will have a moderately positive influence on IS product/service quality.

It should be noted that no specific hypotheses are being generated here with regard to moderate levels of the independent or moderating variables. The primary reason for this is that little is known about the range of these variables in the population or about the specific functional form of their interaction. Classifying the variables in the hypotheses into low, moderate and high levels would both imply a level of understanding that is not held and force relationships to be analyzed into an artificial pattern. The contingency hypotheses in the current research speak only of increasing and decreasing levels of the independent variables, and of the nature of the effect of these on the dependent variable over the range of the moderating variable. Nonmonotonic effects over the range of the moderating variable are specifically hypothesized to focus statistical analysis on identification of points in the range of uncertainty where changes in the direction of relationships between independent and dependent variables may occur.

Additional hypotheses to be addressed in this research are related to the compound nature of the dependent variable, perception of IS product/service quality. The operationalization of the quality construct in this research includes independent measurement of the view of the IS application line business customer unit and the view of IS application producer unit constituencies, based upon the belief that each constituency offers only a partial view of the criterion. There are both similarities and differences in the two views. There is a major similarity in the focus of both constituencies on meeting the functional and operational business requirements of the line business IS customer unit. Yet, specific differences in the constituency views have been identified which lend themselves to speculation about the possibility of a differential impact of the IS customer/producer alignment variables on the perceptions of quality from each view. These differences in constituency views are presented in detail in Chapter IV, Section E.4 of this dissertation. Among these differences, the following two are of greatest concern here:

1. greater IS producer than IS customer attention to and concern with technical aspects of software product quality;

2. greater IS customer than IS producer attention to and concern with the service aspects of IS quality.

Since IS dispersal is viewed as an integrating mechanism (reducing differentiation of the line business and IS development function units) and coordination mechanism use is viewed as a means of increasing work function information processing capacity, it is reasonable to speculate that the two strategies could have different effects on different constituency views under conditions of uncertainty. Increases in integration and increases in information processing would both be likely to reduce high levels of IS application requirements definition uncertainty and thereby positively influence quality dimensions related to meeting the functional and operational needs of the line business customer as well as positively influencing service quality dimensions. Similarly, in conditions of high requirements definition uncertainty, decreases in integration and/or decreases in information processing would be likely to negatively influence quality dimensions of high concern to IS customers. However, the potential influence of increases and decreases in integration and information processing is less clear when it comes to the technical aspects of software quality that are of concern to the IS producer.

Technical aspects of quality such as "conformity to standards", "portability", "modularity", "interoperability" and "auditability" are the professional concern of the IS application producer unit and are not explicit concerns of the IS application customer unit. Because of this, under conditions of high requirements definition uncertainty, increases in integration between and information processing among the two types of units may be less likely to positively influence the technical aspects of quality. Therefore, the following additional hypotheses are generated:

Hypothesis 4a:. When requirements definition uncertainty is high, increases in IS customer/producer coordination mechanism use will have a more strongly positive influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Hypothesis 4b: When requirements definition uncertainty is high, increases in IS dispersal will have a more strongly positive influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Hypothesis 4c: When requirements definition uncertainty is high, decreases in IS customer/producer coordination mechanism use will have a more strongly negative influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Hypothesis 4d: When requirements definition uncertainty is high, decreases in IS dispersal will have a more strongly negative influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

The influence of increases or decreases in IS function dispersal on IS customer vs. IS producer perceptions of quality might also be expected to be different under conditions of low uncertainty. Here, the theoretical rationale for additional hypotheses is drawn from suggestions in the literature that organizational integration can have a negative impact on the effectiveness of subtask performance if it inappropriately reduces needed worker specialization (Lawrence and Lorsch, 1967; Mintzberg, 1979). In this vein, Konstadt (1991) reports that a movement of IS staff into line business units seems, in some cases, to be leading towards increased pressure from the line business to "get a system out" more quickly and reduced emphasis on "technical elegance" of the product. Freiser (1989) reports a perception that, in order to succeed today, IS managers need to "make customer satisfaction their criteria for success, rather than technical excellence".

Deardon (1987) suggests that potential pitfalls of IS function "decentralization" include technical issues of system incompatibility, problems of non-interoperability among systems, and degradation in data integrity and consistency. Peterson (1989), discusses the increased industry use of IS organization "business alignment" vs. "functional alignment" strategies and suggests that while the former has advantages in terms of its potential for improving the working relationship with the business community, the latter has the important advantage of fostering the level of staff specialization that may be needed to maximize effectiveness in technical IS development activities.

An inherent conflict between organizational differentiation and integration is implied in all of these statements and is reflected in the additional two hypotheses below:

Hypothesis 4e: When requirements definition uncertainty is low, increases in IS dispersal will have a more negative influence on the producer perception of IS product/service quality than it will have on the customer perception of IS product/service quality.

Hypothesis 4f: When requirements definition uncertainty is low, decreases in IS dispersal will have a more positive influence on the producer perception of IS product/service quality than it will have on the customer perception of IS product/service quality.

The only conditions in which no difference is posited in the influence of an independent variables on customer vs. producer perceptions of quality is when in cases of low requirements definition uncertainty, there are decreases or increases in use of coordination mechanism use. Incongruence between the low uncertainty and increased use of coordination mechanisms is expected to have an equally negative influence on both views. Congruence between low uncertainty and decreased use of coordination mechanisms is expected to have an equally positive influence on both views.

Hypothesis 4g: When requirements definition uncertainty is low, increases in IS customer/producer coordination mechanism use will have an equally negative influence on the producer perception of IS product/service quality and the customer perception of IS product/service quality.

Hypothesis 4h: When requirements definition uncertainty is low, decreases in IS customer/producer coordination mechanism use will have an equally positive influence on the producer perception of IS product/service quality and the customer perception of IS product/service quality.

All twenty three of the research hypotheses are summarized in Figure 8 on the following two pages. In the following chapter, the research methodology is fully described.

FIGURE 8
RESEARCH HYPOTHESES

Hypothesis	Independent Variables: Dispersal		Independent Variables: Coord. Mech.	Moderating Variable: Uncertainty	Dependent Variables: Quality Perception
1a	↑			H	+
1b	↓			H	-
1c	↑			L	no impact
1d	↓			L	no impact
2a			↑	H	+
2b			↓	H	-
2c			↑	L	-
2d			↓	L	+
3a	↑	and	↑	H	+ + +
3b	↓	and	↓	H	- - -
3c	↓	and	↓	L	no impact
3d	↑	and	↑	L	-
3e	↑	or	↑	H	+
3f	↓	and	↑	L	-
3g	↑	and	↓	L	+

Note: ↑ = increasing
↓ = decreasing
H = High
L = Low
+ + + = greatest positive effect
- - - = greatest negative effect

FIGURE 8 - continued

Hypothesis	INDEPENDENT VARIABLES Dispersal	Coord. Mech.	MODERATING VARIABLE Uncertainty	DEPENDENT VARIABLES Quality Perception Customer View	Producer View
4a		↑	H	++	
4b	↑		H	++	
4c		↓	H	- -	
4d	↓		H	- -	
4e	↑		L		- -
4f	↓		L		++
4g		↑	L	-	-
4h		↓	L	+	+

Note: ↑ = increasing
↓ = decreasing
H = High
L = Low
++ = more positive influence
- - = more negative influence

IV. RESEARCH METHODOLOGY

This chapter describes the survey research instrument development and testing, the research design, the sampling approach, and the approach taken to the research data collection and analysis.

A. Research Tools

1. *IS Function Dispersal Measurement*

Reference to only one potentially relevant measure for the IS Function Dispersal construct was found in the literature. Lohdahl and Redditt (1989) report that they tested three different measurement scales of IS Dispersal in their research:

1. a Procedures Scale that asked questions about what levels of the organization exert most influence over a variety of procedures, such as "choice of mainframe computers for use within a business unit"

2. an Activities Scale that asked for a report of the organizational level having the greatest influence over 13 specific IS activities, such as "designing databases and data architecture for work groups".

3. an Access to Technology Scale that asked for estimates of what proportions of relevant users have current access to various items of technology, such as, "What proportion of knowledge workers in the company now have

access to some kind of computer or terminal?"

Lohdal and Redditt reported that the measure of dispersal with the highest intercorrelation with other scales and the highest level of reliability (split half reliability coefficient of .91) was their Activities Scale. This scale was also reported to be highly correlated with an independent measure of the percent of IS staff dispersed.

The organizational level distinctions used in the Lohdahl and Redditt research are shown below. The lowest level of dispersal is represented by (1) on the scale, while the highest level of dispersal is represented by (7).

Central IS | 1
Business Unit | 2
Department | 3
Project Team | 4
Info Center | 5
Work Group | 6
Ind'l User | 7

Absent the availability of any additional information about how these scales were validated (i.e., item development approach, samples used, specific correlation data), the specific definitions of organizational levels on their scales, the specific

IS activities listed in their activities scales, and interrater reliability data, it is difficult to evaluate the utility of the Lohdahl and Redditt measure for this research.

What is known, however, is that their research was dissimilar to the current research in that it focused on an enterprise level, but used business unit level responses to categorize enterprises as "high" or "low" dispersal organizations. An enterprise was called a "high dispersal" organization if it had "at least one business unit where the most influence over IS activities was at or below the departmental level (dispersion index = 3)" (Lohdahl and Redditt, 1989).

Their research suggests a strategy of anchoring the IS function dispersal construct to specific work activities. Lohdahl and Redditt (1989) reported finding differences in IS activity dispersal both within and across the 20 enterprises they studied in terms of how much and what was dispersed. They also report some agreement among organizations about which IS activities could be most successfully dispersed. However, their IS dispersal measure, as reported, appears to need refinement in the following ways:

1. The conceptual rationale for including specific IS activities in the measure should be explicitly stated.

2. The organizational level distinctions must be clearly defined and tested to insure they can be used by different raters reliably.

Given the current research focus at the work unit level and the fact that the IS application development function is undergoing rapid changes in many organizations, there are two additional considerations for measure development:

1. A measure of "organizational location" of the IS application development project team is needed to get a fuller picture of the extent of IS function dispersal.

2. Responses must be anchored to a specific time period during which an IS application development project (to be evaluated on the quality dimensions) was active.

A new IS Function Dispersal Measure was developed for use in this research. This is contained in Section IV, Part A of the Measurement Appendix. The 27 IS activities listed in the measure were generated through review of the IS dispersal literature, review of several organization's standard IS application development project life cycle structures, review of the literature on the IS application development process, and discussion with a series of highly experienced information systems technology managers. An attempt was made to include discrete activity statements (in fairly sequential order) that covered the full range of management and technical tasks associated with the IS application development function. The IS dispersal measure was designed to be administered to IS producer organization supervisory managers.

2. *IS Customer/Producer Coordination Mechanism Use Measurement*

a. *Customer on the Team*: Baroudi, Olson and Ives (1986) present a rationale for measuring "user involvement" in IS application development projects by use of questionnaire items reflecting specific system development activity involvement. For example, they utilized the following "user" questionnaire item in their research:

Have you (or your subordinates) developed a cost justification for a new information system?

___No　　___Sometimes　　___Usually　　___Don't know

The advantage of linkage of questions of customer involvement to specific IS application development project tasks is avoidance of responses representing only symbolic involvement. Instead positive responsive to items of this type should better represent true customer involvement in and influence over the system development process.

Baroudi (1990), has suggested that the specific activities detailed in the user involvement questionnaire (Baroudi, Olson and Ives, 1986) are now outdated. A review of the questionnaire items also suggests that they are not comprehensive. A new measure of IS application customer involvement has, therefore, been developed for use in this research. This measure utilizes the same 27 activity statements developed for the IS dispersal construct measure. The rating scale asks for evaluation of whether each activity was primarily the responsibility of the IS customer unit, the IS producer unit, or a joint and equal responsibility of both units. Because of the overlap in structure between the IS dispersal measure and the customer on the team measure, the latter was incorporated in the former for ease of administration to IS producer unit supervisory managers. Rating column 2 of part B of the IS Dispersal measure, shown in Section IV, Part A of the Measurement Appendix, constitutes the Customer on the Team measure.

b. *JAD, SLA and Requirements Definition & Design Inspections*: No model for a measure of this sort was found in the literature so the measure was developed specifically for this research effort. The general issue to be examined for each of these three coordination mechanisms is: For each IS application development effort to be assessed by respondents on the quality criteria, was the coordination mechanism used? Asking first level IS customer unit respondents to provide a simple "yes" or "no" response to each of the mechanisms would be oversimplistic, however. Qualifying information is also needed in order to evaluate to what extent the mechanism was used as it has been defined in the literature.

For example, use of a requirements definition/design inspection without a trained independent meeting facilitator would be expected to lessen the value of these coordination mechanisms (Fagan, 1976). Likewise, SLA's that do not specify procedures by which compliance with agreed upon criteria will be monitored, judged and reported would weaken the expected value of SLA usage (Layman, 1987). Therefore, a measure was developed that itemized and asked about the use of the essential elements (specific practices) of each of the coordination mechanisms utilized. Because of the detailed knowledge required of the actual (i.e., not just planned) practices used during the application development project, the measure was designed for completion by a first level manager representating the IS producer organization. A copy of this is included in Section IV, Part B of the Measurement Appendix.

3. *Requirements Definition Uncertainty Measurement*

Uncertainty measures used in previous contingency research have, to a large extent, focused on broad environmental changes that create instability for an enterprise. For the current research, a measure was needed that was more pertinent to the organizational subunit level and the specific information processing task under study. The measure developed operationalizes "uncertainty" specifically in terms of the degree to which information needed to accomplish IS application development work is available and analyzable.

Six subdimensions of requirements definition uncertainty are utilized in the measure:

1) Extent to which system requirements were preestablished at the start of the IS application development project;
2) Number of customer groups with potentially different requirements of the IS application;

3) Stability of system requirements during the project;

4) Routineness of system requirements;

5) Customer prior experience with the business function(s) being automated;

6) IS application development project team's level of prior knowledge of the business function(s) being automated.

Daft and Lengel's concept of organizational task complexity (1984); Galbraith's concept of uncertainty as an information gap, including prior organizational experience (1973, 1977); Vredenburgh, Schuler and Jackson's (1988) view of uncertainty as both predictability of events and analyzability of decision elements such as the amount and nature of information; and Weick's (1979) concept of equivocality reduction are all foundations of this operationalization.

A supervisory level manager from the line business organization will be asked to report the perceptions of the IS customer unit, while a supervisory level manager from the IS organization will be asked to, independently, report the perceptions of the IS producer unit. This approach is consistent with Vredenburgh, Schuler and Jackson's (1988) view that when uncertainty is treated as a subjective condition, it is important to consider perceptual divergence about the extent and nature of uncertainty. The level of variance among observers will be viewed as "consensual uncertainty", a seventh dimension of requirements definition uncertainty. Both the customer view and the producer view forms of the measures are contained in the Measurement Appendix (Section IV, Parts C and D, respectively).

4. *IS Product/Service Quality Measurement*

The specific characteristics of IS product and/or service quality have been addressed by some researchers. Boehm et. al. (1978) studied and established a conceptual framework for use in analysis of the characteristics of software quality. The characteristics they defined were felt to be important for the general utility of software and are shown below in Figure 9.

There are 3 broad quality factors posited here:

1) Portability - Can the software still be used if the operating environment changes?

2) As-Is Utility - How well (easily, reliably, efficiently) can the software be used as is?

3) Maintainability - How easy is the software to maintain (understand, modify, and retest)?;

These three broad factors represent necessary, but not sufficient (e.g., other needs like security may come into play), conditions for General Utility. The lower-level structure of the characteristics tree provides a set of primitive characteristics (those in **bold**) that are strongly differentiated with respect to each other, and which combine into sets of necessary conditions for the other quality characteristics, called intermediate-level. The primitive characteristics are those that provided

FIGURE 9
Characteristics of Software Quality
(Boehm, et. al., 1978)

GENERAL UTILITY - basic
- Portability
  - **Device Dependence**
  - **Completeness**
- AS-IS UTILITY
  - Reliability
    - **Completeness**
    - **Accuracy**
    - **Consistency**
  - Efficiency
    - **Device Efficiency**
    - **Accessibility**
  - Human Engineering
    - **Accessibility**
    - **Communicativeness**
- MAINTAINABILITY
  - Testability
    - **Accessibility**
    - **Communicativeness**
    - **Structuredness**
    - **Self-Descriptiveness**
  - Understandability
    - **Consistency**
    - **Structuredness**
    - **Self-Descriptiveness**
    - **Conciseness**
    - **Legibility**
  - Modifiability
    - **Structuredness**
    - **Augmentability**

Boehm, et. al. (1978) with their foundation for defining quantitative metrics for use in measuring the relative possession of both the primitive and the higher level characteristics. That is, measures of the primitives, are said to provide a comprehensive view of all quality dimensions in the model.

Boehm, et. al. (1978) provide definitions of each quality characteristic which link them very directly to specific software engineering metrics (e.g., to the structure and flow of physical software programs). Their conceptualization of quality does not address the customer perspective at all. Instead, it is aimed specifically at identifying the internal software characteristics that might be measured to provide software developers with information needed to improve the technical aspects of software quality in order to improve software maintenance cost-effectiveness.

Pearson and Bailey (1977) focused on the related concept of "customer satisfaction" with IS products and services, taking the perspective that the most appropriate viewpoint of effectiveness of IS products and services is that of customer satisfaction. A literature review was conducted to identify all of the factors that were felt to influence satisfaction with computer-based information products and services. This list of factors was then subjected to an empirical test in order to establish its completeness from the customer perspective. Thirty-nine factors resulted, grouped into five categories, as shown in Figure 10.

FIGURE 10
Customer Satisfaction Factors
Pearson and Bailey (1977)

I. Organizational Context
   - Top Management Involvement
   - Organizational Competition with the ADP Unit
   - Priorities Determination
   - Charge Back Method of Payment for Services
   - Organizational Position of the EDP Function

II. EDP (Electronic Data Processing) Center Staff & Policies
   - *Relationship with the EDP Staff
   - *Communication with the EDP Staff
   - Techical Competence of the EDP staff
   - *Attitude of EDP Staff
   - Schedule of Products and Services
   - *Time Required for New Development
   - *Processing of Change Requests
   - Vendor Support

III. Interfaces
   - Response/Turnaround Time
   - Mode of Interface
   - Convenience of Access

IV. Quality of Systems
   - *Accuracy (of output)
   - Timeliness (of output)
   - *Precision (of output)
   - *Reliability (of output)
   - (Information) Currency
   - *Completeness (of output)
   - Flexibility
   - Format of Output
   - Language
   - Volume of Output
   - *Relevancy (to intended function)
   - Error Recovery
   - Security of Data
   - Documentation
   - Integration of Systems

V. User Constructs
   - Expectations (of features)
   - *Understanding of Systems
   - Perceived Utility
   - Confidence in the System
   - *Feeling of Participation
   - Feeling of Control
   - *Degree of Training
   - Job Effects

* indicates characteristics used by Ives, Olson & Baroudi (1983) to form items in their short form

A semantic differential technique was used to construct a "user satisfaction" measure focused on the final set of factors. The measure called for respondents to rate both their attitudes on each factor on a seven interval scale and the degree to which each particular factor was important to them. From their subsequent tests of the measure, Pearson and Bailey (1977) concluded that it had sufficient: reliability (with $r > .90$ for 32 of the 39 factors and at least .72 for each factor); internal consistency (with all but 8 of the 156 correlation coefficients between each pair of scales significant at the .01 level and all but 1 significant at the .05 level); scale discrimination (with 97 of the 156 scales having a response range of more than 3 intervals when mean ratings of a satisfied and dissatisfied users were compared, and all scales having a response range of 1.97 or higher); unidimensionality (factor analysis showed that all but one of their user satisfaction factor scales were defined by a single dimension); and correlated well with an independent global measure of total satisfaction ($r = .79$). Pearson and Bailey (1977) also determined from their testing that the measures' importance scales did not contribute significantly to the utility of the measure since the correlation between scale ratings weighted by importance and the unweighted scale ratings was $r = .9968$. Subsequent research on the measure by Ives, Olson & Baroudi (1983) concluded that a shortened version of the measure, utilizing only 13 factor items, had reasonably good psychometric qualities. The items used in their short survey form are asterisked in the full list above.

The major difference between the Pearson and Bailey (1977) conceptualization of customer satisfaction with IS products/services and the quality conceptualization of Boehm et. al. (1978) and others is not just that it utilizes the customer perspective, but rather that it incorporates issues of organizational context and policy as customer satisfaction considerations. That is, it attempts to address the "how and why" of service and product delivery as well as outcome quality. This resulted in the mixing of climate/cultural variables (e.g., organization competition with the EDP unit; feeling of participation and control), structural variables (e.g., organizational position of the EDP function), and policy variables (e.g., chargeback method of payment), with product and service quality variables (e.g., reliability, accuracy and utility of the software; attitude of and communication with the EDP staff). The utility of this for the current research is therefore questionable. However, the dimensions in their third and fourth categories (interfaces and quality of systems) and some of the dimensions in their second and third categories (EDP staff and policies and user constructs) are more purely dimensions of quality and can be viewed as the authors' concept of quality within their overall view of IS customer satisfaction.

Recent research conducted at The Goodyear Tire & Rubber Company focused on examining differences in IS user vs. IS management perceptions of information systems quality and value (Christensen & Smith, 1991). In this research, fifteen IS quality characteristics and twenty-one IS value characteristics were evaluated in terms of their perceived importance to each constituency. These characteristics are shown in Figure 11.

The distinction drawn between characteristics of IS quality and characteristics of IS value in this research was that "quality applications" conform to specifications, while "valuable applications" take into account the resources and human energy involved in their use. An IS application may, therefore, yield high quality information without yielding high value. For example, an information system might show body temperature accurately to five decimal places (e.g., 104.11652 degrees). While this is highly precise, if a physician who receives the temperature reading only needs a temperature reading in whole numbers (e.g., 104 degrees) in order to treat the patient, then the information, while it has high quality, does not have high value.

The hypotheses tested in the Goodyear study focused on the concept that functional managers use different metrics to judge IS software quality and value than do the managers of IS departments. The research sample consisted of 71% of Goodyear's IS middle management and 50% of user middle management within their headquarters staff, who were asked to rate characteristic importance on a five point rating scale. Significant rating differences were found between users and

FIGURE 11
IS QUALITY & VALUE CHARACTERISTICS
(IN ORDER OF AGGREGATE IMPORTANCE RATINGS AT GOODYEAR)
Christensen & Smith (1991)

IS QUALITY CHARACTERISTICS

1. is accurate
2. output results that can be trusted
3. works as specified
4. is user friendly
5. is relevant to user
6. has fast response time (*)
7. meets all of user's needs
8. has no downtime
9. is delivered on time (#)
10. has user documentation
11. can be changed quickly
12. is delivered on budget
13. has low cost of operation
14. has programmer documentation (**)
15. uses new technology

IS VALUE CHARACTERISTICS

1. reduces errors in a task
2. allows company to meet market demands
3. is accessible to users
4. reduces product lead time
5. reduces product costs
6. allows company to share data internally
7. reduces administrative costs
8. reduces development costs
9. attracts a customer
10. eliminates a manual task (*)
11. allows company to meet government regulations
12. reduced DP maintenance
13. is available on-line (*)
14. blocks a competitor from the market
15. has a positive ROI
16. allows company to share data externally
17. uses graphics (*)
18. is mainframe based (*)
19. attracts a supplier
20. uses color (*)
21. is PC based (*)

(*) = significantly more important to users (**) = significantly more important to IS
(#) = more important to users, but not significantly so

IS managers on two of the quality characteristics and twelve of the value characteristics. Further differences were identified through a primary factor analysis which aggregated the characteristics that each group used to judge application quality and value. The results of the factor analyses for each group (i.e., IS and user), individually, and the aggregate factor analysis for both views are shown in Figures 12 and 13.

Based on the aggregate factor analysis of the quality items, the authors concluded that quality may have two meanings: 1) system performance; and 2) user satisfaction. Further, user satisfaction was seen to contribute to a greater variance on perceived quality of an application than on the measures of performance.

Differences between user and IS management perceptions found through factor analysis of the value items were mostly related to the factor of "environment". Users were seen to view environmental characteristics such as system interactivity, color and graphics as significantly more valuable than did their IS staff. The observed differences in user and IS management perceptions of value led the researchers to speculate that user management may be measuring IS quality against stricter standards than IS measures itself and this may be the source of

FIGURE 12
Factor Analysis Results - Quality
Christensen & Smith (1991)

User	IS	Aggregate
<u>RELIABLE</u>	<u>ACCURACY</u>	<u>RELIABLE</u>
.41 fast response time*	.83 meets user specifications	.74 meets user specifications
.59 meets user specification	.72 is relevant	.81 is accurate
.73 is accurate	.86 is accurate	.73 can trust results
.74 can trust results	.64 can trust results	.45 is relevant
<u>DEPENDABLE</u>	<u>EASE OF USE</u>	<u>RESPONSIVE TO USER NEEDS</u>
.63 meets user needs	.76 is user friendly	.70 is user friendly
.68 can be changed quickly	.51 fast response time*	.51 fast response time*
.66 has no down time	.52 meets user needs	.64 meets user needs
	.69 has no downtime	.62 has no downtime
		.40 can be changed quickly
<u>ECONOMICAL</u>	<u>EASE OF MAINTENANCE</u>	<u>ECONOMICAL</u>
.48 delivered on time	.68 has prgmr. documentation*	.63 delivered on time
.90 delivered on budget	.54 can be changed quickly	.84 delivered on budget
.73 low operating cost	.83 low operating cost	.65 low operating cost
<u>CURRENT</u>	<u>DELIVERY</u>	<u>CURRENT</u>
.60 uses new technology	.91 delivered on time	.61 uses new technology
.80 has user documentation	.80 delivered on budget	.76 has prgmr. document.*
.70 has prgmr. documentation*		.75 has user documentation
<u>BENEFICIAL</u>	<u>CURRENT</u>	
.83 is user friendly	.47 uses new technology	
.56 is relevant	.89 has user documentation	

* denotes significant difference between user and IS views of attribute importance

FIGURE 13
FACTOR ANALYSIS RESULTS - VALUE
Christensen & Smith (1991)

User

COST REDUCTION
.85 reduce product cost
.85 reduce admin. cost
.81 reduce devel. cost
.59 reduce DP maintenance

COMPETITIVE ADVANTAGE
.75 attracts a customer
.81 blocks a competitor
.76 meets market demand
.59 reduce product lead time

ENVIRONMENT
.83 uses graphics*
.87 uses color*
.47 PC*
.56 mainframe*

ONGOING CONCERNS
.72 has positive ROI
.64 attracts a supplier
.39 meets gov't regs
.61 share data externally

EFFICIENCY
.61 share data internally
.81 eliminates manual task*
.70 reduces errors

ACCESSIBILITY
.67 easily accessible
.68 available on line*

IS

COMPETITIVE ADVANTAGE
.52 attracts a supplier
.81 attracts a customer
.76 blocks a competitor
.61 meets market demand
.65 reduce product lead time
.46 reduce errors

ENVIRONMENT
.89 uses graphics*
.91 uses color*
.78 available on line*
.60 PC*

COST REDUCTION
.59 reduce product cost
.83 reduce admin cost
.90 reduce devel cost
.71 reduce DP maintenance

ENHANCE COMMUNICATION
.79 meets gov't regs
.85 share data internally
.56 share data externally

EFFICIENCY
.60 eliminates manual task*
.87 mainframe*

FINANCIAL BENEFIT
.76 has positive ROI
.68 easily accessible

Aggregate

ENVIRONMENT
.85 uses graphics*
.88 uses color*
.69 available on line*
.66 PC*
.57 mainframe*

COST REDUCTION
.81 reduce product cost
.85 reduce admin cost
.83 reduce devel cost
.62 reduce DP maintenance

COMPETITIVE ADVANTAGE
.74 attract a customer
.73 blocks a competitor
.73 meets market demand
.68 reduce product lead time

ONGOING CONCERNS
.69 has positive ROI
.64 meets gov't regs
.55 share data internally
.65 share data externally
.49 attract a supplier

PRODUCTIVITY
.78 eliminates manual task*
.61 reduces errors
.52 easily accessible

* denotes significant difference between user and IS views of attribute importance

much of the animosity of user management towards IS expenditures.

Limitations of the Goodyear study are that: 1) the obtained importance ratings were likely influenced by specific historical problems or limited understanding of business or technical issues by the specific management of Goodyear and, thus, may not be generalizable to the industry at large; and 2) the quality and value characteristics studied were named but not clearly enough defined for use in cross-organizational research. The study results do have value for the current research effort, however, in so far that they clearly suggest that differences operate in how users and IS management view software quality and that measurement of both views is, therefore, warranted.

Research relevant to the operationalization of the dependent variable in the current study was also conducted by Depone and McLean (1992). These researchers reviewed and classified 180 studies, conducted from 1981-1987, in terms of the "IS success" dependent variable employed. Depone and McLean constructed a model of categories of IS success based upon their findings, which links three levels of information success to six distinct aspects of information systems (Figure 14).

While user satisfaction measures were the most commonly employed, the researchers found many different examples of criterion measures for all six of the

FIGURE 14
CATEGORIES OF IS SUCCESS
Depone & McLean (1992)

INFORMATION MEASUREMENT LEVEL	RELATED ASPECTS OF INFORMATION SYSTEMS
1. *Technical Level* - accuracy and efficiency of the system that produces the information.	1. *System Quality* - desired characteristics of the IS that produces the information.
2. *Semantic Level* - the success of the information in conveying the intended meaning.	2. *Information Quality* - desired characteristics of information such as accuracy, meaningfulness, and timeliness.
3. *Effectiveness or Influence Level* - the effect of the information on the receiver; influence; the hierarchy of events that take place at the receiving end of an information system (e.g., receipt, evaluation and application of information - leading to a change in recipient behavior and system performance).	3. *Use* - extent of actual use of the information system. 4. *User Satisfaction* - extent to which the information product satisfies. 5. *Individual Impact* - influence that the information product has on management decisions. 6. *Organizational Impact* - effect of the information product on organizational performance.

components of their model. Among their conclusions were the following:

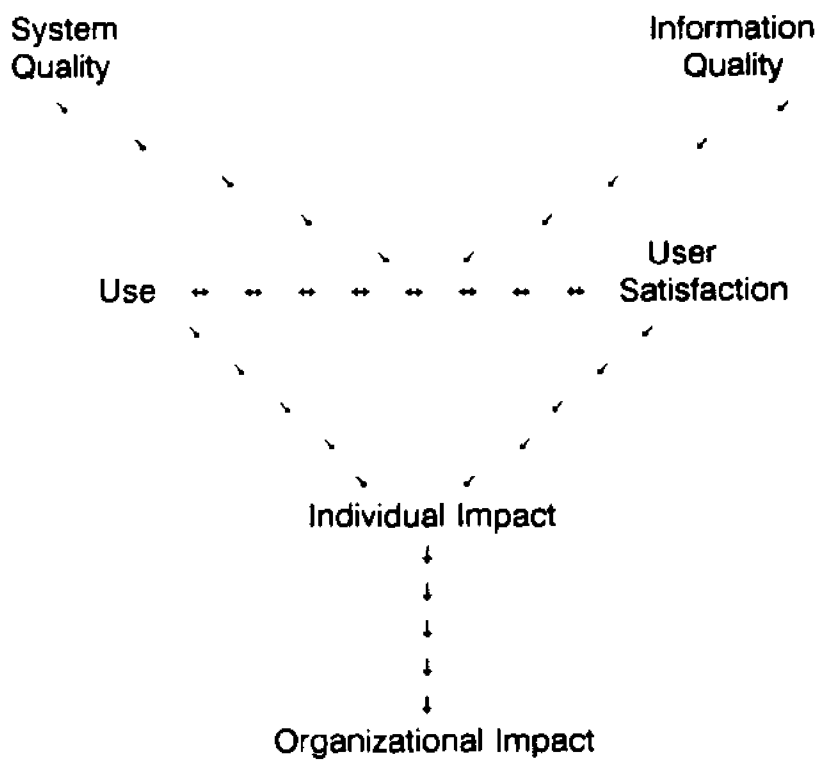
1. There is no consensus on *the* best single measure of IS success. Choice is a function of the objective of the study, the organizational context, the aspect of the information system that is addressed, independent variables under consideration, the research method, and the level of analysis.
2. A significant reduction in the number of different dependent variables is needed before research results can be compared.
3. Not enough IS field research attempts to measure the influence of the IS effort on organizational performance.
4. IS success is clearly a multidimensional construct and should be measured as such.

A richer model of IS success measurement was proposed by the researchers and is shown in Figure 15. In this model, success is treated as a process construct which includes both temporal and causal influences in determining IS success. The six IS success categories are arranged to suggest an interdependent success construct while maintaining the serial, temporal dimension of information flow and impact. *System Quality* and *Information Quality* singularly and jointly affect both *Use* and *User Satisfaction*. The amount of *Use* can affect the degree of *User Satisfaction* and vice versa. *Use* and *User Satisfaction* are viewed as direct antecedents of *Individual Impact*. *Individual Impact*, in turn, should have *Organizational Impact*.

In the current research, the operationalization of the quality construct is based on the findings of the Quality Assurance Institute (QAI) of Orlando, Florida in their studies of the characteristics of software quality (QAI 1989, 1990). The research was unique in that it was the first to begin with an assumption that software customers and software producers might *not* be focusing on the same characteristics when each evaluates the quality of software products and services. It also assumed that the viewpoints of *both* constituencies (*i.e.*, software customers and software producers) *are needed in order to* understand software product and service quality issues.

A model of the "infrastructure for software quality products and services" (replicated in Figure 15) provided a guiding framework for this research. This shows software requirements/needs coming from the customer to the producer/provider, who in turn uses those requirements/needs to create the IS products and services needed by the customer. Measurement is suggested as a two-way feedback process in the model that helps to insure ongoing evaluation of and improvement in the software product/service quality. It should be noted that the "software" focus in this model and throughout the QAI research was confined to IS business applications.

FIGURE 15
PROCESS MODEL OF IS SUCCESS
Depone & McLean (1992)

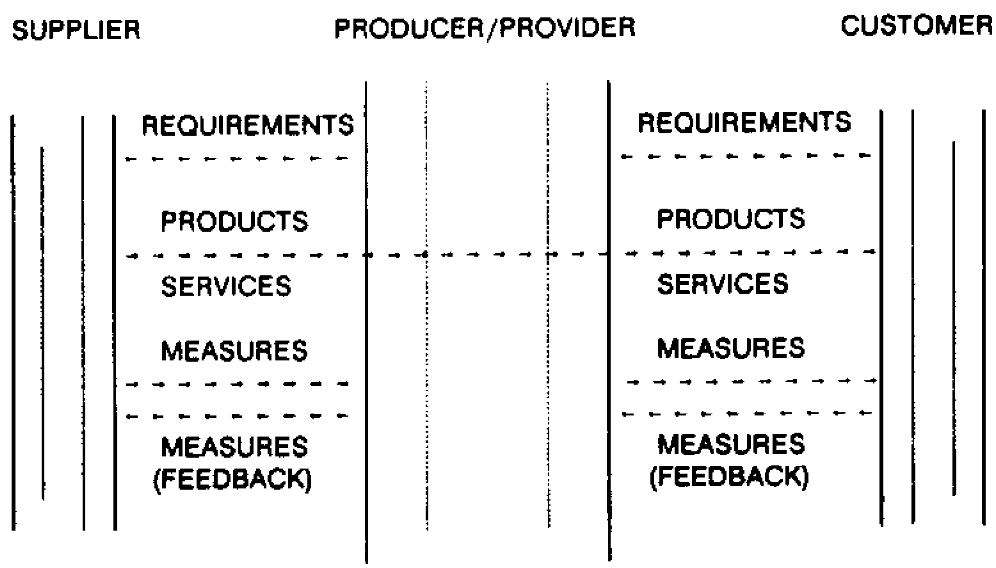


"Customers" in the model are the internal organizational groups who will use IS products and services in their business. "Producers" are the internal organizational groups that acquire, develop, and/or maintain IS applications used by line business. "Providers" are those people responsible for actually delivering the results produced by the IS applications development unit to the business customer. Producers and providers are combined in the model (and referred to in subsequent discussion simply as "producers"). This seems appropriate because while IS producers and providers may be separate organizational entities, their services overlap and are generally indistinguishable to IS customers. The final organizational entity included in QAI's model is the "supplier", an internal or external source of products and services (e.g., operating system and telecommunications hardware and software, and IS application development software tools) needed by the producer to meet the needs of the customer.

In their study of the characteristics of IS application quality characteristics, the QAI researchers focused on obtaining a customer view of quality and a producer view of quality. The supplier view was not considered because of the supplier's characteristic lack of involvement with the end product of the IS application development effort. Further, it was reasoned, that "in the end" it is the producer's responsibility to deliver the quality needed by the customer.

FIGURE 16

Infrastructure for Quality Software Products and Services
(QAI, 1989)



One hundred and twenty four QAI member organizations participated in QAI's research on the characteristics of software product and service quality. A Delphi technique was used by the researchers to identify and rank IS application quality characteristics. In the first round of the research, focus was on the customer view of quality. In the second round of the research, focus was on the producer view of quality.

Step 1 in each round involved having participating organizations identify quality characteristics. For each one identified they were asked to: 1. give the software quality characteristic a name; 2. define the characteristic; 3. indicate how the quality characteristic could be measured; and 4. note how nonconformance to that quality characteristic could be determined.

In Step 2 of each round, results were compiled and consolidated into a refined list of quality characteristics by QAI's research committee. These were then returned to QAI member participants for further evaluation. This evaluation focused on whether these did, in fact, represent the quality characteristics submitted by their organization and on identifying the 5 quality characteristics that they perceived to be the most important of the 20. Participants were also asked to recommend measures that could be used to evaluate each characteristic.

In Step 3 of each round, the research team consolidated the results from step 2 and placed them in a preliminary report. In the customer view study, this was then sent back to participants to confirm whether or not they believed the final results to be reasonable. A 93% agreement rate with the ranked characteristics was obtained. In the producer view study, the QAI researchers themselves performed the final evaluation of results.

Findings were that, in fact, software customers and producers have a number of dissimilar concerns when evaluating software quality. The top 20 characteristics of IS application quality from each view are shown in Figure 17. Key differences in customer and producer views include:

- greater customer differentiation of service quality characteristics (i.e., while producers identified one global "customer satisfaction" characteristic, customers identified "response to problems, overall service quality, attitude and communications" and "adequacy of training" as four distinct quality characteristics);

- greater producer attention to and concern with technical aspects of software product quality (e.g., the characteristics of "conformity to standards", "maintainability", "interoperability", "defect density", auditability", "portability" and "modularity" were identified only by producers);

- greater customer attention to and concern with product cost issues (e.g., the characteristics of "implementation schedules", "cost effectiveness" and "cost estimates" were only identified by customers).

Even in cases where the same quality characteristics were identified by both IS customers and producers, average importance rankings often differed (e.g., customers rated "timeliness of outputs" eighth in importance, while producers rated it only twelfth; customers rated "functional requirements" as the single most important characteristic of quality, while producers rated it seventh in importance).

The model of IS software quality developed by QAI gives equal weight to both the customer and producer perspectives of quality and includes focus on both product and service quality characteristics. It is a more comprehensive conceptualization of quality than those which have been developed by other writers/researchers. It is also the only model found that was developed through research that directly sampled the parties whose perceptions and expectations of quality are of concern and which was constructed on an industry wide basis. Further, it has the advantage of incorporating multiple dimensions of IS effectiveness. In Depone and McLean's (1992) terms, the model concerns itself with three different categories of IS success: 1) system quality; 2) user information quality; and 3) satisfaction. For these reasons, and one other to be addressed, the QAI model of IS application product/service quality provides the basis for operationalization of the dependent variable in this research. The final reason is the currency of this model. Currency

FIGURE 17

CHARACTERISTICS OF SOFTWARE QUALITY
(QAI, 1989 & 1990)

	CUSTOMER'S VIEW	**PRODUCER/PROVIDER'S VIEW**
RANK	*MEASURE NAME*	*MEASURE NAME*
1	Functional Requirements	Customer Satisfaction
2	Accuracy of Output	Accuracy (of results)
3	System Reliability	System Reliability
4	Response to Problems	Completeness
5	On-Line Availability	Availability (of resources)
6	Implementation Schedules	Maintainability
7	Ease of Use	Functional Requirements
8	Timeliness of Outputs	Usability
9	Overall Service Quality	Conformity (to standards)
10	Response Time	Efficiency (of functionality)
11	Attitude & Communications	Documentation
12	System Flexibility	Timeliness
13	Quality of Output	Defect Density
14	Cost Effectiveness	Security
15	Cost Estimates	Modularity
16	Backup/Recovery Procedures	Testability
17	Adequacy of Documentation	Interoperability
18	Distribution of Output	Auditability
19	Adequacy of Training	Portability
20	Data Security	Traceability

in the language used in applied research in IS organizations is important. Respondent understanding of intended communication during the research would be impaired if out-of-date terminology were used in the instrumentation.

For the current research, two different twenty multiple choice item questionnaires were constructed, one representing the customer view of quality, the other representing the producer view of quality. Each of the items represented a quality characteristic identified through the QAI research. A 5 point rating scale was constructed for each item, with 1 representing the lowest rating of quality and 5 representing the highest. Rating scale anchors were based on measurement information collected in the QAI study and advice of an expert panel. The quality surveys were pretested in 12 organizations who evaluated a total of 15 systems from the customer perspective and 17 systems from the producer perspective. Pretest participants were also asked to provide written comments on their perceptions of item and instruction clarity. The pretest process resulted in some modifications of item wording for clarity, and rescaling of 2 items on each survey form to improve score distribution (i.e., to lessen item rating skew or concentration). Pretest results were also evaluated to insure that variance across views within cases was not systematic (i.e., that rating differences were not all skewed in the same direction). The final forms of these surveys are included in Parts E and F of Section IV of the Measurement Appendix.

B. <u>Research Design</u>

A field study research design was planned, using a survey method of data collection, naturally occurring treatment groups, and moderated multiple regression analysis. Neither random assignment of subjects to treatment nor experimental manipulation of the independent variables are possible in this investigation without substantially limiting scope of organizational participation and, potentially, incurring uncontrolled reactive effects in response to the use of different treatments (Cook and Campbell, 1979). The second limitation could effect the internal validity of the study, the first would be likely to negatively impact generalizability of its findings.

The tradeoff in this design, of course, is that this research method cannot be used to *infer* causality. However, results of correlational research utilizing naturally occurring treatment groups within their normal context can provide important information about the form and limits of behavioral relationships. These can then suggest the value of existing explanatory models of the organizational behavior of concern which can be subjected to subsequent empirical verification. As Campbell and Stanley (1963) point out, data from a design like this are *relevant* to causal hypotheses inasmuch as they expose them to the possibility of disconfirmation. That is, if a nonsignificant correlation is obtained between variables posited to be related to one another in a particular manner, the credibility of the hypothesis is lessened. A hypothesis that survives correlational analysis, on the other hand, is one that may then be judged worthy of more rigorous testing.

There is another reason for the choice of use of a nonexperimental design. Given the current lack of consensus on conceptualization and operationalization of the variables of interest in this research, use of an experimental design would appear to be premature (Cook and Campbell, 1979). The purpose of this research is twofold. First, it attempts to carefully define and operationalize contingency theory variables in a manner applicable and useful to real world IS organizations. Second, it attempts to expand exploration of the validity of structural contingency theory models in a specific work setting - that of the internally focused IS application development function.

C. Sample

Participation in this research was requested of the over 1000 member organizations of the Quality Assurance Institute (QAI), a professional organization which focuses on IS quality assurance education and research. QAI's membership is known to have interest in improving the effectiveness of their internal IS application development function. This suggested a higher probability of gaining their agreement to participate in the current research than other sampling approaches might have yielded. Participation of other organizations was also solicited through mailings, presentations at professional meetings and seminars, and through published items in trade periodicals - all targeted at IS management and IS quality assurance professionals. The intent was to approach and obtain the commitment of a large variety of organizations as research participants - both in the private and public sectors and from a broad range of industries.

Research participants were recruited between February and June 1992. Mailings describing the research were sent to all Quality Assurance Institute (QAI) members; brief articles on the research appeared in trade publications (i.e., *CIO*, *Software Development*, and the *Journal of the Quality Assurance Institute*); and a series of oral presentations were made by the researcher at industry conferences and meetings. All participants were promised confidentiality and the right to receive copies of industry research reports in return for their contribution to the study.

As a result of this recruitment effort, a total of 110 organizations expressed interest in research participation. Each of these organizations received a copy of the Research Participant Packet, containing copies of the research questionnaires and instructions for participation. Follow-up telephone calls were then employed to encourage completion and return of the questionnaires and to answer any questions that potential participants might have. Ultimately, 34 work units from a total of 21 organizations submitted data in time for the data analysis. All sets of data were complete with the exception of one that lacked column 1 responses for part B of the IS Dispersal Survey and another that lacked a Software Quality Survey - Customer View.

Since a premise of this research was that the phenomena under study were not specific to any particular type or size of organization, no attempt was made to gather detailed demographic data on the subject work units. Broadly, however, the work unit sample was drawn from U.S. and Canadian organizations with the industry breakdown shown in Table 1. Finance/Investment, Insurance and Banking represented almost 62% of the total organizational sample and about 65% of the work unit sample. Their large representation is consistent with the high level of information intensity and extreme dependence upon information systems in these types of businesses.

The return rate of completed sets of questionnaires was 19% of those organizations that expressed initial interest. During follow-up calls, an attempt was made to learn the reasons why those organizations that chose not to participate had done so. Responses varied. Organizations cited no suitable subject systems, lack of time or staff to coordinate/accomplish required work within time frame, no interest from customers, no interest in this aspect of quality, etc. Even unwillingness to release what was considered strategic information (a Legal Department decision) was cited, in one case. Some of those who initially expressed interest in participation never returned the calls. Others called and said that they regretted their inability to participate, but asked permission to utilize the research questionnaires in their own work. Overall, industry interest in this

TABLE 1
RESEARCH SAMPLE

Industry	Organizations n	Organizations %	Work Units n	Work Units %
Insurance	6	30.00%	9	26.47%
Finance/Investment	4	19.05%	8	23.53%
Banking	3	14.29%	5	14.71%
Petroleum	1	4.67%	4	11.76%
Government	2	9.52%	2	5.88%
Electronics	1	4.67%	2	5.88%
Public Utility	1	4.67%	1	2.94%
Software	1	4.67%	1	2.94%
Chemical	1	4.67%	1	2.94%
Education	1	4.67%	1	2.94%
		Sample N =	34	

research topic was high.

D. Data Collection

The research utilized mail questionnaires that asked organizational members, representing the internal IS application customer or producer work units, to provide historical and perceptual data. Data were obtained from three distinct levels of the IS producer organization and two levels of the IS customer organization as shown in Figure 18. The data collection structure was designed to optimize response validity by aiming the collection of data on each variable at respondents who should be most familiar with each organizational practice and/or phenomenon of concern. It was also designed to minimize the operation of common method variance by utilizing multiple respondents and separate questionnaires for different variables.

As Figure 18 shows, the three levels of each participating organization's management asked to provide data on IS customer (i.e., line business) unit and IS producer (i.e., IS application development) unit views are Senior Executive, Supervisory Management, and First Level Management. At the Senior Executive level, IS Senior Management is asked to provide orienting information for the study, naming one or more specific systems/system versions on which their organization

FIGURE 18

ORGANIZATIONAL TYPE AND LEVEL FOCUS FOR DATA COLLECTION

ORGANIZATIONAL LEVEL OF PARTICIPANT	ORGANIZATIONAL UNIT TYPE	
	PRODUCER	CUSTOMER
SENIOR EXECUTIVE	**IS Senior Management:** - System/system version - Research Coordinator and customer and producer unit participant names	
SUPERVISORY MANAGER	**IS Application Development/ Support Management:** - IS function dispersal - Customer on the team coordination mechanism use - Requirements definition uncertainty	**Customer Management:** - Requirements definition uncertainty
FIRST LEVEL MANAGER	**IS Project Manager/Lead Analyst:** - JAD, SLA and Inspection coordination mechanism use - IS product/service quality perception	**Customer Liaison/Project Representative** - IS product/service quality perception

will focus during data collection and identifying a research coordinator and point of contact for overall organizational participation. They also determined the specific IS customer and IS producer unit representatives at other management levels who would participate in the study (at least four individuals for each system/system version upon which responses will focus), given the following specific guidelines contained in the instruction packet.

- In the line business customer organization:

    * The *Software Quality Survey - Customer View* is to be completed by a first line manager who was directly involved in the system development and implementation, e.g., as a customer liaison/project representative.

    * The *Systems Requirements Information Source Questionnaire - Customer View* is to be completed by a supervisory manager (i.e., typically one level higher than that above) with responsibility for the business function automated by the system of focus.

- In the I.S. organization:

    * The *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire* are to be completed by the I.S. Project Manager or Lead Analyst who was directly

responsible for the system project.

* Two questionnaires are also to be completed by supervisory level I.S. Application Development/Support Management (i.e., typically one level higher than that above): the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View*.

Additional guidance was provided in the participant instructions for respondent selection in cases where: the system of focus was developed for multiple customers who use different aspects of the system; system development and support services are provided by two distinct organizations; and/or organizational structure, staffing and staff level may have changes since system implementation. In all cases, instructions for completing measures specifically directed the individual respondents to *represent their work unit* in preparing their responses.

It should be noted that confidentiality of response was promised and provided to each participating research site by the researcher. However, the way in which completed questionnaire data were collected within each organization was left up to the specific research site. Some used system and respondent names while others developed and used internal codes when providing this information on the questionnaires. It was made clear that the researcher needed only enough identifying information on each questionnaire to insure that data sets were complete and would not use this information for any other purpose. All participating organizations retained the freedom to review and, if they wanted to, retain copies of the individual questionnaires at the organizational collection point. The decision to use this approach was made based on the pilot study experience to be discussed below.

E. Pilot Study

Subsequent to the pretesting of the software quality surveys and prior to the undertaking of this research, a full pilot study of the methodology was conducted. Four business units/subsidiaries of a major insurer agreed to participate in the pilot study and provided full data sets on six systems/system versions that had been completed and installed at least three months ago, but no longer than a year ago.

The major purpose of this pilot study was to gather feedback on workability of the planned research participation process. Pilot organizations were provided with a draft version of the research participant packet, asked to select one or more system efforts on which to focus their data collection, and to oversee the collection and return of data to the researcher. They were also asked to gather and forward comments from participants on perceived needs for researcher improvement of instructions and questionnaires. Additionally, as mentioned above, the pilot was used to explore issues related to maintaining confidentiality of individual participant responses within each participant organization.

Pilot results generally suggested that the planned approach was workable, with little modification, and that organizations perceived research participation to have value for better understanding the IS quality issues they faced. Some additional instructions were added to the participant packet to cover questions raised by pilot participants. The pilot results also identified a need for a general wording changes throughout the research materials to clarify that the systems of focus could either be a new IS application or a new versions of an existing IS application.

The value of an approach that required organizations to collect and return each of the completed questionnaires directly to the researcher in sealed envelopes (thus maintaining total confidentiality of individual responses) was explicitly explored during the pilot study. Two general concerns about use of this approach were identified which resulted in the decision to abandon it. First, because organizations using this approach would not retain copies of their input to the study, the approach eliminated the potential value of participation for benchmarking organizational practices and performance against industry results. This might discourage organizations from participating. Second, the approach increased the likelihood of the researcher's receipt of incomplete data sets, since it did not permit organizational review of research questionnaires prior to submission.

Additionally, this issue was specifically discussed with management of the pilot organizations (as well as with management of a few other organizations that were potential research participants). These people generally expressed the opinion that allowing internal organizational access to individual participant perceptions of IS quality would not impede the honesty of individual assessments. A strong argument was made that IS performance assessment was fairly routine and well accepted throughout the industry and, therefore, neither IS customers nor IS producers should be inhibited by the knowledge that others in the organization would have access to their ratings. The obtained range of quality rating results in both the pretest and the pilot provided some support for this view. As a result, the researcher decided to allow internal organizational access to their own data, while encouraging the selection of a separate "research coordinator" in each participant organization - who would, hopefully, be viewed by participants as an impartial party.

F. Data Analysis

A variety of analytical techniques were employed to screen the research data, examining its psychometric qualities, in particular with regard to statistical assumptions of normality and independence of observations and with regard to research assumptions about the independence of the research variables.

Multiple regression analysis was used to test research models' effects. Both the uncertainty-dispersal interaction term's effect on quality and the uncertainty-coordination mechanism interaction term's effect on quality were tested. Use of multiplicative interaction terms in regression analysis can test for the form of the relationship, as indicated by the beta coefficients in the regression equation (Schoonhoven, 1981; Fry & Slocum, 1984). While regression analysis cannot test for significant differences between correlation coefficients and therefore cannot be applied to test for differential validity, it can be used to test for the interaction of two independent variables in determining a dependent variable (Tosi and Slocum, 1984).

Following Schoonhoven's (1981) suggested approach, interaction terms were analyzed through a process of graphing partial derivatives from the larger regression equation. Each of these graphs express the change in quality given a change in a strategic alignment dimension and provide the opportunity to test for the extent to which the alignment dimensions have a symmetrical and nonmonotonic effect on quality over the range of uncertainty. Through this process, the research results are analyzed to tentatively identify where, in the range of uncertainty, the use of the alignment strategies may be increased to positively impact quality.

The specific steps and results of the statistical analyses conducted are fully described in the next chapter.

V. RESULTS

This chapter describes the approach taken to scoring of the survey measures of IS dispersal, coordination mechanism use, requirements definition uncertainty, and of IS product/service quality. Results of sample data screening for normality, independence of observations, covariance of independent and moderating variables, covariance of dependent variables are also reported. In addition, the statistical methods and results of testing each hypothesis are described, including results of testing alternative regression models. As will be described, tests of the hypothesized models consistently yielded statistically significant results. However, findings ran in the opposite direction from that which was expected.

A. Questionnaire Scoring and Sample Data Screening

1) IS Dispersal Survey - Part A

This survey consisted of a single item and used an ordinal rating scale of one to four. A rating of one on the scale represented "least dispersed" organizational placement of the application development/support function (i.e., IS service organization concentrated at the enterprise level of the organization, serving all businesses and functions in which the larger organization is involved). A rating of four on the scale represented "most dispersed" placement of the application development/support function (i.e., IS service organization located in a divisional subunit of the organization, directly serving a subunit of a specific functional or geographic division of a business unit).

As shown in Table 2, results were quite skewed, with most of the sample work units concentrated organizationally at an enterprise level (23 of 34 work units, or 67.6% of the sample). Four work units operated at the Business Unit level, four others at the Functional/Geographic Division level, and the final three were part of Divisional Subunits.

2) IS Dispersal Survey - Part B

This survey consisted of twenty-seven items (work activities), with two ratings to be obtained on each. **Column 1** of the survey called for the rating of *each activity* on the same ordinal scale as that used in Part A of the survey. The mean activity dispersal rating was calculated to form an alternative measure of dispersal (Dispersal B) for each case in the sample. As shown in Table 2, these Dispersal B scores had a slightly more restricted range than did the Dispersal A scores and a lower standard deviation.

The Pearson Product Moment Correlation obtained between the Dispersal A and Dispersal B measures was .94 (with p = .0001), suggesting a high degree of overlap between the alternative measures. However, the Dispersal A measure is a broader measure of the independent variable than its alternative, Dispersal B, which has focus on the extent to which responsibility for specific work activities has been pushed down into the organization. Therefore, for the purpose of this

TABLE 2
SAMPLE DATA DISTRIBUTION ANALYSIS

Variable	Min/Max	Mean	Median	Mode	Standard Deviation	Shapiro-Wilks W	Shapiro-Wilks *p*
Dispersal A (n=34)	1.00/4.00	1.62	1.00	1.00	1.01	.64	.0001
Dispersal B (n=33)	1.00/3.48	1.62	1.30	1.00	.75	.77	.0001
CMU (0,1,1) (n=34)	0.18/13.85	5.45	4.25	1.11	4.07	.90	.0048
CMU (0,1,0) (n=34)	0.00/12.74	4.21	2.68	0.00	3.93	.87	.0004
CMU (0,0,1) (n=34)	0.00/13.11	5.01	4.07	0.74	4.04	.90	.0065
Uncertainty (n=34)	1.57/3.71	2.77	2.72	2.67	.55	.96	.3948
Total Average Quality (n=33)	2.52/4.70	3.71	3.84	2.92	.58	.96	.2277
Customer Quality (n=33)	1.45/4.75	3.65	3.85	3.94	.84	.94	.0704
Producer Quality (n=34)	2.35/4.76	3.77	3.84	2.90	.54	.96	.2354

research, Dispersal B is felt to be the superior measure since it can better demonstrate *how* dispersal of the IS application development/support function is actually occurring.

The normality of the Dispersal B data distribution was analyzed using the SAS UNIVARIATE PROCEDURE which yields a normal probability plot and measures of central tendency. This procedures also computes a Shapiro-Wilks W statistic which provides a basis for a more formal statistical test of normality. All indicators, in this case, suggest that the Dispersal B data cannot be considered normally distributed. A comparison of the sample mean to the sample median shows a skewed distribution and the normal probability plot confirms that the distribution does, in fact, have a long tail to the right. The calculated Shapiro-Wilks statistics support this interpretation.

The Shapiro-Wilks W statistic with its associated p value provides a measure of skewness that is suitable for use with small sample sizes (i.e., less than 2000 observations). The null hypothesis of normality is rejected for small values of W. The smaller the p value, the less likely that the data are normally distributed (Afifi and Clark, 1990). The W statistic and its associated p value, in this case, also suggest that Dispersal B data are not normally distributed.

Item by item analysis of the Dispersal B results for the current sample shows that some specific IS application development/support work activities are never dispersed, while responsibility for others is more routinely dispersed. Full results of this analysis are contained in **Appendix A, Table A-1**. The 5 most dispersed and 5 least dispersed work activities are shown in Table 3. The least dispersed of the activities require the most technical knowledge or are financial in nature: selecting the software development environment, establishing software development environment standards, maintaining and funding the software production environment, and managing the project budget. The most dispersed activities are those that require the greatest understanding of line business needs for a system: *defining functional requirements, training end users in application system use, designing system interfaces, judging when I.S. product quality is "fit for use", and resolving production system problems.*

Column 2 of the IS Dispersal survey called for the additional evaluation of each of the twenty-seven items (work activities) in terms of *with whom* organizational responsibility rested for their accomplishment. This variable was called "Customer on the Team". Respondents noted that the activity accomplishment was either a responsibility of the IS producer organization (P), the IS customer organization (C), or a joint and equal responsibility of both the IS customer and producer organizations (J).

TABLE 3

Part A. Most Dispersed Activities	Mean Rating	% rating = 1	% rating < 3
26. training customers in application system use	1.94	30.3	81.8
27. performing production system problem resolution related to the application	1.87	30.3	74.2
8. defining the functional requirements to be met in the I.S. application project	1.85	33.3	84.8
17. evaluating the effectiveness of project accomplishment and determining when product quality is sufficient for its release for customer use	1.81	40.4	84.4
10. performing external design of the I.S. application (i.e., designing interfaces with business process, system users/operators, and/or other systems)	1.81	56.3	71.9

Part B. Least Dispersed Activities	Mean Rating	% rating = 1	% rating < 3
20. selecting the software development environment to be used for the project	1.42	78.8	84.8
4. managing a budget for the I.S. application project	1.44	71.9	90.6
22. funding the production environment (i.e., system software and hardware)	1.44	62.5	93.8
23. maintaining the production environment	1.47	71.9	87.5
18. establishing software development environment standards (i.e., the universe of hardware and software tools, languages, etc. that are supported for use	1.48	72.7	84.8

Summary "customer on the team" (COT) responses were scored and analyzed in three different ways, to enable a comparative analysis of the value of the three scoring approaches. In each case, a "P" rating (indicating that the activity lacked substantial customer involvement) was scored as zero. The three methods differed, however, as shown below, in terms of how a "C" response and a "J" response were weighted:

1. Either "C" or "J" ratings on an item were scored as one (indicating some customer involvement in that activity).

2. "C" ratings were scored as one, while "J" ratings were scored as zero.

3. "J" ratings were scored as one, while "C" ratings were scored as zero.

Each of the three summary COT scoring methods had a possible raw score range of 0 to 27. A comparison of the results is shown in part A of Table 4.

The range of results was restricted in all cases. Within this research sample, little use was made of the assignment of responsibility to line business customers for conducting I.S. application development/support project activities. Thus, Method 2 produced the most restricted range of results of all three scoring approaches.

TABLE 4

Comparison of Customer on the Team (COT) Scoring Methods

A. Descriptive Statistics

COT Scoring Method	N	Minimum	Maximum	Mean	Standard Deviation
Method 1 (0,1,1)	34	1.00	16.00	9.00	2.954
Method 2 (0,1,0)	34	0	10.00	2.38	2.558
Method 3 (0,0,1)	34	0	15.00	6.62	2.985

B. Correlation Matrix

	COT (0,1,1)	COT (0,1,0)	COT (0,0,1)
COT (0,1,1)	*R* = 1.00 *p* = 0.0 n = 34		
COT (0,1,0)	*R* = 0.42* *p* = 0.0132 n = 34	*R* = 1.00 *p* = 0.0 n = 34	
COT (0,0,1)	*R* = 0.63** *p* = 0.0001 n = 34	*R* = -0.44** *p* = .0091 n = 34	*R* = 1.00 *p* = 0.0 n = 34

* denotes results at the .05 level of significance

** denotes results at the .01 level of significance

For the current research sample, when activity accomplishment responsibility is assigned to the line business customer, it is most likely to take the form of a joint customer/producer assignment. Table A-2 in Appendix A summarizes the COT findings. Table 5 shows the activities with the highest rate of responsibility assignment (> 50%) to I.S. customers or jointly to I.S. customers and I.S. producers.

It is interesting to note that four of the seven activities found to have been most dispersed (i.e., #'s 8., 17., 26. and 27.) were also among those found to have the highest rate of responsibility assignment to IS customers alone or jointly with the IS producers. In the other three cases shown in Table 5 (#'s 5., 6. and 9.), the project activity was more concentrated at the enterprise and business unit levels of the organization but the IS producers generally shared responsibility for the activities jointly and equally with the IS customers. In this sample, the Customer on the Team coordination mechanism was often employed for activities that were also dispersed, but was also employed for some project activities that were accomplished at the enterprise level of the organization. Accomplishment of one of the most highly dispersed activities (i.e., activity # 10. - external system design), on the other hand, remained primarily the responsibility of the IS producer unit.

The COT rating was conceptualized as one part of a "Coordination Mechanism

TABLE 5

ACTIVITIES WITH THE HIGHEST RATE OF RESPONSIBILITY ASSIGNMENT TO IS CUSTOMERS (solely or jointly, with IS producers)

Work Activity	Responsibility Assignment Rate % C	% J	% P
26. training customers in application system use	50.0	35.3	14.7
17. evaluating the effectiveness of project accomplishment and determining when product quality is sufficient for its release for customer use	8.8	76.5	14.7
5. establishing priorities for what and when information systems work (i.e., enhancement, maintenance and new development) should be accomplished	23.5	61.8	14.7
6. resolving disagreements in information systems application work priorities	14.7	64.7	20.6
8. defining the functional requirements to be met in the I.S. application project	32.4	55.9	11.8
9. establishing service level standards for I.S. application response time availability, recovery and efficiency, etc.	8.8	52.9	38.2
27. performing production system problem resolution related to the application	3.0	51.5	45.5

Use" independent variable in this research (to be combined with, and equally weighted with, the ratings for use of JAD, SLA, and requirements/design inspections from the Coordination Mechanism Use Questionnaire). The combinable form of the COT rating was calculated by dividing the sum COT rating for a case by n = 27 items and then multiplying the result by 5. This resulted in a score for each COT scoring method that was weighted equally to each of the other three subdimensions of coordination mechanism use.

3) IS Customer/Developer Coordination Mechanism Use Questionnaire

This questionnaire had three items (one each for JAD, SLA and Inspection Use), each of which had five categorical (yes/no response) subitems to be scored, which pertained to specific coordination mechanism practices. For the JAD and SLA items, a "no" response to the main item was scored as a zero. A "yes" response to the main item resulted in evaluation of the responses to the five subitems, where any additional "yes" responses were scored as one. For the Inspection item, "no" responses to the main item and to the first subitem were scored as zero. A "yes" response to both the main item and first subitem resulted in evaluation of the responses to subitems B) through F), where each additional "yes" response was scored as one.

Each questionnaire item had a possible scoring range that utilized an ordinal scale of zero to five, with zero representing no use of the defined coordination mechanism practices and five representing full use of the defined mechanism.

Overall, inspections were the most used of these three mechanisms (with 58.8% of sample respondents reporting use on the sample project), followed by JAD's (38.2% use) and then SLA's (20.6% use). Table 6 shows the results of an analysis that identified which of the specific JAD, SLA and Inspection practices were most and least used in the sample projects.

The coordination mechanism use reported in this study suggests that most of the JAD, SLA and Inspection "sound practices" are commonly used (i.e., used by over 60% of sample respondents employing these coordination mechanisms). However, it appears to be common practice *not* to use trained, discussion recorders or scribes during JADs. Only 5 of the 13 (37.5%) JAD users reported that this practice was used. Further, in the case of Inspection use, there was extremely low use reported of trained, impartial moderators (20%) and trained readers (15%).

The JAD, SLA, and Inspection item ratings were added together with the combinable form of the Customer on the Team (COT) rating, to create the "Coordination Mechanism Use" (CMU) score for use in further data analysis. Because of the three alternative methods of calculating COT described above, three alternative Coordination Mechanism Use scores resulted for each case.

TABLE 6
Use of Coordination Mechanism "Sound Practices"

JAD Use
Frequency = 13 of 34 sample projects (38.2%)

% of JADs that Involved:		Use Ranking
61.5% (8 of 13)	A. Use of a trained, impartial JAD facilitator.	4
100.0% (13 of 13)	B. Participation of all key customers and developers.	1
69.2% (9 of 13)	C. Use of a formal JAD session agenda.	3
38.5% (5 of 13)	D. Participation of a trained discussion recorder or scribe.	5
76.9% (10 of 13)	E. Participant training in JAD process and purpose.	2

SLA Use
Frequency = 7 of 34 sample projects (20.6%)

% of SLAs that Involved:		Use Ranking
85.7% (6 of 7)	A. Specified dimensions of information systems and products on which the agreement should focus.	1/2/3/4
85.7% (6 of 7)	B. Specified criteria to be used in judging compliance with the agreement.	1/2/3/4
85.7% (6 of 7)	C. Specified customer organization responsibilities for achieving the agreed upon quality levels.	1/2/3/4
85.7% (6 of 7)	D. Specified developer organization responsibilities for achieving the agreed upon quality levels.	1/2/3/4
71.4% (5 of 7)	E. Specified procedures by which compliance with the SLA would be monitored and reported.	5

Use of Inspections with Key Customer Participation
Frequency = 20 of 34 sample projects (58.8%)

% of Inspections that Involved:		Use Ranking
70.0% (14 of 20)	B. Focus on identification (but not correction) of defects in the specifications.	3
20.0% (4 of 20)	C. Use of a trained, impartial moderator	4
15.0% (3 of 20)	D. Use of a trained "reader" to guide the group through the material being inspected.	5
100.0% (20 of 20)	E. Recording defects found during the inspection and assignment to specific parties for follow-up.	2/1
100.0% (20 of 20)	F. Briefing of all participants on the purpose of the inspection.	2/1

The possible range of each of the Coordination Mechanism Use (CMU) scores was zero to twenty, with each component (i.e., JAD, SLA, Inspection & COT use scores) carrying equal weight. The actual score range for the sample was more restricted. Table 2 shows the minimum and maximum values for each of the alternative scores.

A very rough interpretation of the obtained mean CMU scores is that: on average, only a quarter of the coordination mechanism practices included in this study were actually employed by the sample work units. However, as shown by the modal scores, even less use of these coordination mechanism practices was made by work units in many of the sample cases.

The normality of the coordination mechanism use (CMU) data distribution under each scoring method was analyzed using the SAS UNIVARIATE PROCEDURE. Measures of central tendency, and Shapiro-Wilks statistics are compared in Table 2. Again, based on this analysis, the null hypothesis of normality of data distribution must be rejected.

All three of the CMU scoring methods yielded more normal data distributions than those obtained for dispersal, the other independent variable. The two scoring methods that yielded the most normal distributions were the one that included Customer on the Team (COT) scores with equally weighted "C" and "J" responses (i.e., Method 1), and the method that weighted only "J" responses (i.e., Method 3).

Based upon this analysis, scoring methods 1 and 3 were primarily relied upon in the subsequent investigation of hypothesized relationships.

4) System Requirements Information Source Questionnaire

This questionnaire had six items, each representing a different aspect of requirements definition uncertainty - with both customer and producer ratings obtained on each. A five point ordinal response scale was employed for each item, with one representing the lowest possible uncertainty and five representing the highest possible uncertainty. The possible total score range from the ratings on the six questionnaire items was six to thirty, for each of the two views (i.e., IS customer and IS producer).

The uncertainty variable was also conceptualized as having one additional, equally weighted factor, consensual uncertainty - a measure of customer/producer disagreement on the six questionnaire items. A score for a "consensual uncertainty" item was calculated in two steps:

1. The absolute value of the difference between customer and producer ratings on each questionnaire item was calculated. This yielded a score between zero and twenty four.

2. This score was converted to the same 1-5 scale as the other six uncertainty dimension scores by adding six and dividing by six.

A final average 7 dimension uncertainty score with a possible range of one to five was calculated by:

1. Averaging customer and producer ratings for each of the six questionnaire items;

2. Summing the six average scores and the converted consensual uncertainty score and dividing the result by seven.

As seen in Table 2 actual distribution of the sample data ranged from a low of 1.57 to a high of 3.71 on this variable, with a standard deviation of .55. The normality of the 7 dimension uncertainty data distribution was analyzed using the SAS UNIVARIATE PROCEDURE. The resulting normal probability plot, comparison of measures of central tendency, and the calculated Shapiro-Wilks W statistic all suggest that the uncertainty data may be considered normally distributed.

Uncertainty data were analyzed to determine to what extent each of the six factors included in the measure operated to influence total customer uncertainty and total producer uncertainty. Results of this analysis are shown in Table 7 and reflect substantial differences in the IS customer vs. IS producer view of uncertainty. While items 1 and 3 were those that were rated highest by producers as uncertainty influences, it was items 2 and 6 that were rated highest by customers as uncertainty influences. As noted before, the differences between customer and

TABLE 7

SYSTEM REQUIREMENTS DEFINITION UNCERTAINTY FACTORS

	CUSTOMER		PRODUCER	
	Mean Rating*	Rank**	Mean Rating*	Rank**
1. Extent to which system requirements were pre-established at the start of the project	3.01	4	3.59	1
2. Number of different customer groups that had to be involved in requirements definition for the system	3.18	1	2.50	5
3. Extent to which system requirements were stable during the project	2.93	5	3.26	2
4. Extent to which system requirements were routine in the project	3.12	3	2.97	3
5. Extent to which system customers had prior experience with the business functions being automated	1.94	6	2.35	6
6. Average level of I.S. project team members' knowledge of the business functions being automated	3.13	2	2.91	4

NOTES:

* Rating range is from 1 to 5; 1 = highly certain and 5 = highly uncertain

** Ranked in terms of contribution to total uncertainty producer view of uncertainty were captured formally in a consensual uncertainty score and included as a seventh dimension in the calculation of the average 7 dimension uncertainty score for each project in the sample. The derived average consensual uncertainty score was 1.98 on a scale of 1 to 5, making it the lowest rated uncertainty subfactor influence measured.

5) Software Quality Survey - Customer View

This questionnaire had twenty quality characteristic items, with a five point ordinal rating scale on each. A rating of five represented total satisfaction of quality characteristic expectation, while a rating of one indicated dissatisfaction. Item ratings were averaged to obtain a total customer quality (CQ) rating between one and five for each case in the sample.

In three cases, there were multiple IS customer organization respondents for this measure. This occurred when the system of focus for a work unit in the sample was developed for multiple customer units that use different aspects of the system and might, therefore, potentially have different views of system quality. For these cases, item ratings by all respondents were considered in the calculation of the average total customer quality rating.

The obtained rating range and results of The SAS UNIVARIATE PROCEDURE for the CQ dependent variable are shown in Table 2. Results suggest that the customer quality ratings are fairly normally distributed. Appendix A, Table A-3 contains a summary of all customer ratings of IS quality characteristics.

6) Software Quality Survey - Producer View

This questionnaire had twenty different quality characteristic items, with a five point ordinal scale on each. Again, a rating of five represented total satisfaction of quality characteristic expectation, while a rating of one indicated dissatisfaction. A total producer quality (PQ) rating was derived for this measure in the same manner as that used for customer quality.

Again, in three cases, there were multiple respondents for this measure. This occurred in cases where development and support services for the system of focus were shared by multiple work units - with each having responsibility for different portions of the system.

The obtained rating range and key results of The SAS UNIVARIATE PROCEDURE for the PQ dependent variable are shown in Table 2. Results suggest that the producer quality ratings are close to normally distributed. Appendix A, Table A-4 contains a summary of all producer ratings of IS quality characteristics.

The IS customer and IS producer quality ratings for each observation in the sample were combined and averaged to derive a "total average quality" (TAQ) score for use in the data analysis. This score represents a comprehensive assessment of software quality characteristics, since it includes multiple stakeholder perspectives (i.e., perspectives of both the IS customer and the IS producer) on the issue of quality and ratings of software quality characteristics that are of importance to both IS customers and IS producers.

The obtained rating range and key results of The SAS UNIVARIATE PROCEDURE for the TAQ dependent variable are also shown in Table 2. Again, results suggest that the quality ratings may be considered normally distributed.

Further analysis was conducted to determine the distribution of customer and producer ratings across the 20 software quality characteristics that each assessed. Table 8, Part A shows the 6 lowest quality characteristic ratings for each group, while Table 8, Part B shows the 6 highest quality characteristic ratings for each.

B. Analysis of Independence of Observations

Independence of observations collected from different individuals is an assumption made in the theoretical derivation of the multivariate statistical analysis proposed

TABLE 8
PART A - LOWEST RATED CHARACTERISTICS OF QUALITY

	MEAN RATING
6 Lowest Rated Quality Characteristics - Customer View (Mean CQ Rating =	3.65)
15. **Cost Estimates** - extent to which the system was produced and implemented within projected cost to the customer organization	2.87
6. **Implementation Schedules** - extent to which the system was completed within its projected development and implementation schedule	3.03
1. **Functional Requirements** - extent to which the delivered system functionality matches the business needs of the customer organization	3.13
12. **System Flexibility** - extent of difficulty and timeliness with which desired changes to the system can be implemented	3.14
17. **Adequacy of Documentation** - extent to which system documentation provided to the customer organization is accurate, clear, comprehensive and useful	3.18
14. **Cost Effectiveness** - extent to which any projected increases in customer business or decreased customer operating cost as a result of system implementation have been or are expected to be achieved	3.34
6 Lowest Rated Quality Characteristics - Producer View (Mean PQ Rating =	3.77)
19. **Portability** - degree to which the system design allows easy transfer of its software from one hardware configuration and/or system environment to another	2.50
16. **Testability** - extent to which the software is structured in a manner that facilitates testing of the code	3.02
6. **Maintainability** - extent to which making modifications in this system has been facilitated or made difficult by the system's design and specific implementation	3.27
20. **Traceability (of requirements)** - extent to which the delivered system functionality can be traced back to specific formal requirements and does not include additional features and functionality that were not part of the planned and documented project deliverables	3.31
18. **Auditability** - degree to which the system structure and controls allow error detection and easy tracing of system data from its origination to its final destination	3.58
11. **Documentation** - extent to which documentation is adequate for maintaining operating and utilizing the system	3.65

TABLE 8
PART B - HIGHEST RATED QUALITY CHARACTERISTICS

	MEAN RATING
6 Highest Rated Quality Characteristics - Customer View (Mean CQ Rating = 3.65)	
18. **Distribution of Output** - extent to which physical outputs of this system have been correctly delivered to customers and to which outputs requested by others have not mistakenly been delivered	4.46
5. **On Line Availability** - extent to which customers have had computer access to use this system during their regular business hours to perform needed information processing	4.20
16. **Backup and Recovery Procedures** - extent to which the system's backup and recovery procedures adequately prevent system outages that could interfere with business operations	4.14
20. **Data Security** - extent to which the customer has confidence that the system's data is secure and that unauthorized access to it can be prevented	4.08
13. **Quality of Output** - extent to which the system's physical outputs (e.g., print reports or fiche) have been of usable quality, i.e., properly aligned, clearly printed, etc.	4.03
3. **System Reliability** - extent to which the delivered system runs properly, without failure, so that it provides the expected service and information to customers when they need it	3.82
6 Highest Rated Quality Characteristics - Producer View (Mean PQ Rating = 3.77)	
5. **Availability (of Resource)** - extent to which computer terminals and associated software have actually been available for use during customers' scheduled periods of availability, since system installation	4.49
12. **Timeliness of Output** - extent to which customer output is delivered within the expected time frame	4.40
14. **Security** - extent to which access to software or data by unauthorized persons can be controlled	4.34
3. **Reliability** - extent to which the system has run properly since installation, without failure, providing the expected service and information to customers when needed	4.21
17. **Interoperability (with Other Systems)** - degree to which this system successfully interfaces with other systems	4.06
10. **Efficiency (of Functionality)** - extent to which the delivered system exhibits acceptable response time and performs within its expected processing time	4.05

for this research. While it is often safe to assume independence of observations in cases such as the current research where observations are collected from different people, dependence could exist if a factor or factors exist to affect all of the individuals in a similar manner with respect to the variables being measured. Data collected in the form of a sequence, either in time or in space, can also be dependent (Afifi and Clark, 1990).

Therefore, SAS PLOT procedures were used to check the independence of the research sample observations for each of the hypothesized multiple regression models. This procedure yielded plots of the residuals as well as Durbin-Watson statistics. Durbin-Watson statistics may be used to test whether the serial correlation (i.e., the correlation between successive residuals) is zero when it is assumed that the correlation between successive residuals is restricted to a correlation between immediately adjacent residuals (Berenson, Levine and Goldstein, 1983).

The residual plots showed random scatter of observations as opposed to specific patterns or trends. Additionally, all of the Durbin-Watson *d* statistics (shown in Table 9) were greater than the appropriate upper critical value of *d* at the .01 level of significance, given the number of explanatory variables in each model. That is, all obtained *d* values were close enough to the optimal value of 2.00 to retain the null hypothesis that there is no evidence of autocorrelation and conclude that the

TABLE 9
ANALYSIS OF INDEPENDENCE OF OBSERVATIONS

		Durbin-Watson *d*
Dependent Variable: Total Average Quality		
Model 1 Source:	Dispersal B, Dispersal B*Uncertainty	1.52
Model 2 Source:	Coordination Mechanism Use (0,1,1), CMU (0,1,1)*Uncertainty	1.83
Model 3 Source:	Coordination Mechanism Use (0,0,1), CMU (0,0,1)*Uncertainty	1.81
Model 4 Source:	Dispersal B, Coordination Mechanism Use (0,1,1), Dispersal*Uncertainty, CMU (0,1,1)*Uncertainty	1.66
Model 5 Source:	Dispersal B, Coordination Mechanism Use (0,0,1), Dispersal*Uncertainty, CMU (0,0,1)*Uncertainty	1.62
Dependent Variable: Producer Quality		
Model 1 Source:	Dispersal B, Dispersal B*Uncertainty	1.54
Model 2 Source:	Coordination Mechanism Use (0,1,1), CMU (0,1,1)*Uncertainty	1.78
Model 3 Source:	Coordination Mechanism Use (0,0,1), CMU (0,0,1)*Uncertainty	1.78
Dependent Variable: Customer Quality		
Model 1 Source:	Dispersal B, Dispersal B*Uncertainty	1.69
Model 2 Source:	Coordination Mechanism Use (0,1,1), CMU (0,1,1)*Uncertainty	1.93
Model 3 Source:	Coordination Mechanism Use (0,0,1), CMU (0,0,1)*Uncertainty	1.93

* NOTE: Critical d_u values for these models ranged from 1.35-1.51, at the .01 level of significance. The null hypothesis (i.e., no evidence of autocorrelation) is, therefore, retained for each model (Afifi and Clark, 1990).

statistical assumption of independence of observations is not violated (Afifi and Clark, 1990).

C. Examination of Covariance of Independent and Moderating Variables

Prior to beginning multiple regression analysis to test the research hypotheses, analyses were also conducted to test the assumption of independence between each of the posited independent (and moderating) variables. A Pearson Product Moment correlation analysis was conducted, results of which are shown in a matrix in Table 10. In addition, curvilinear regression models were constructed and evaluated. The inclusion of a squared independent variable term in a simple linear regression model produces data that permits testing of the contribution of a curvilinear effect to a linear one and vice versa (Berenson, Levine and Goldstein, 1983). In the current research, none of the obtained F values for the curvilinear models constructed in this fashion were statistically significant at the .05 level of significance. Inclusion of the squared terms did not result in improved results over those of the linear regression models. F test results are shown compared to those of the simple linear models in Appendix A, Table A-5. The assumption of linearity and use of simple correlation coefficients to represent relationships among the independent and moderating variables are, therefore, appropriate.

TABLE 10
Correlation Matrix - Independent and Moderating Variables

	DispersalB	CMU(0,1,1)	CMU(0,0,1)	Uncertainty
Dispersal B	*R* = 1.00 *p* = 0.0 n = 33			
CMU (0,1,1)	*R* = 0.38 *p* = 0.83 n = 33	*R* = 1.00 *p* = 0.0 n = 34		
CMU (0,0,1)	*R* = 0.39 *p* = 0.83 n = 33	*R* = 0.99** *p* = 0.0001 n = 34	*R* = 1.00 *p* = 0.0 n = 34	
Uncertainty	*R* = -.02 *p* = 0.95 n = 33	*R* = -.16 *p* = 0.35 n = 34	*R* = -.18 *p* = 0.30 n = 34	*R* = 1.00 *p* = 0.0 n = 34

** Denotes result at the .01 level of significance

As Table 10 shows, with the sole exception of the correlation found between the two scoring variations for coordination mechanism use ($R = .99$, $p = .001$), low and non-significant correlations were obtained among the variables. This suggests that the dispersal, coordination mechanism use, and uncertainty measures tapped independent phenomena as intended.

D. <u>Examination of Covariance of Dependent Variables</u>

A simple correlation analysis was also conducted to examine covariance between the dependent variables. The resulting correlation matrix is shown in Table 11.

Results show that, not surprisingly, there are definitely positive and statistically significant relationships among the three dependent variables. However, they also confirm that the two different measures of quality used in this research (i.e., the IS customer viewpoint vs. the IS producer viewpoint) are tapping substantial differences of perception. The square of the obtained correlation coefficient between the two views may be interpreted to mean that only about 17% of the variance in one view can be accounted for by the variance in the other (Welkowitz,

TABLE 11
CORRELATION MATRIX - DEPENDENT VARIABLES

	Total Average Quality	Customer Quality	Producer Quality
Total Average Quality	*R* = 1.00 *p* = 0.0 n = 33		
Customer Quality	*R* = 0.90** *p* = 0.0001 n = 33	*R* = 1.00 *p* = 0.0 n = 33	
Producer Quality	*R* = 0.77** *p* = 0.0001 n = 33	*R* = 0.41* *p* = 0.017 n = 33	*R* = 1.00 *p* = 0.0 n = 34

* denotes results at the .05 level of significance
** denotes results at the .01 level of significance

Ewen and Cohen, 1971).

E. Analysis of Simple Correlations between Independent and Dependent Variables

A correlation analysis was also conducted to examine strength of relationship among individual independent and moderating variables and the dependent variables. The resulting correlation matrix is shown in Table 12.

No significant correlation coefficients were obtained for the Dispersal independent variable and any of the dependent variables. Positive and significant correlation coefficients were obtained between each of the scoring versions of the Coordination Mechanism Use (CMU) independent variable and both the Customer Quality and the Total Average Quality dependent variables. Coordination mechanism use, however, was not found to have a significant relationship with the producer perspective of quality.

A correlation analysis of the components of the CMU independent variable and each of the dependent variables provides additional insight into the possible nature of the influence of this variable on quality perceptions. Table 13 shows the results of this analysis. Significant (at the .05 level) and positive correlations were found between the Total Average Quality dependent variable and the SLA Score, the

TABLE 12
Correlation Matrix - Independent/Moderating and Dependent Variables

Independent and Moderating Variables	Dependent Variables: Total Average Quality	Customer Quality	Producer Quality
Dispersal B	*R* = -.11 *p* = .56 *n* = 32	*R* = -.17 *p* = .36 *n* = 32	*R* = .002 *p* = .99 n = 33
CMU (0,1,1)	*R* = .38* *p* = .03 n = 33	*R* = .36* *p* = .04 n = 33	*R* = .25 *p* = .15 n = 34
CMU (0,0,1)	*R* = .41* *p* = .02 n = 33	*R* = .41* *p* = .02 n = 33	*R* = .25 *p* = .16 n = 34
Uncertainty	*R* = -.54** *p* = .001 n = 33	*R* = -.42** *p* = .01 n = 33	*R* = -.61** *p* = .002 n = 34

* denotes results at the .05 level of significance
** denotes results at the .01 level of significance

Inspection Score, and the COT Method 3 Score. No coordination mechanism use components were significantly correlated with the Producer Quality dependent variable. For the Customer Quality dependent variable, however, significant and positive correlations were found with the following components: SLA Score; Inspection Score; and the COT Method 3 Score. Further, a significant and **negative** correlation was found between the COT Method 2 Score and the Customer Quality dependent variable.

For this sample, JAD use had little or no relationship to the quality outcome of I.S. application development/support projects. However, use of SLA's, Inspections, and of assignment of project activity accomplishment jointly and equally to IS customers and IS producers are each positively related to the quality outcome - from the perspective of the IS customer. Further, a clear distinction between the Customer on the Team (COT) Scoring Methods 1, 2 and 3, in terms of their relationship to quality criteria, is apparent from the analysis.

While joint assignment of project activities to I.S. customers and I.S. producers (as weighted in Scoring Method 3) has a significant, positive relationship to the Customer Quality variable (R = .41, p=.02), assignment of project activity accomplishment to I.S. Customers alone (as weighted in Scoring Method 2) has a significant, negative relationship (R = -.42, p=.02) to the customer's view of

TABLE 13

CORRELATION MATRIX - COORDINATION MECHANISM VARIABLE COMPONENTS AND DEPENDENT VARIABLES

Coordination Mechanism Variable Components	Dependent Variables: Total Average Quality	Customer Quality	Producer Quality
JAD Score	*R* = .08 *p* = .65 *n* = 33	*R* = .13 *p* = .48 *n* = 33	*R* = -.004 *p* = .98 *n* = 34
SLA Score	*R* = .37* *p* = .04 *n* = 33	*R* = .33 *p* = .06 *n* = 33	*R* = .27 *p* = .13 *n* = 34
Inspection Score	*R* = .40* *p* = .02 *n* = 33	*R* = .37* *p* = .03 *n* = 33	*R* = .28 *p* = .11 *n* = 34
COT Method 1 Score	*R* = .12 *p* = .51 *n* = 33	*R* = .06 *p* = .74 *n* = 33	*R* = .17 *p* = .35 *n* = 34
COT Method 2 Score	*R* = -.27 *p* = .12 *n* = 33	*R* = -.42* *p* = .02 *n* = 33	*R* = .05 *p* = .77 *n* = 34
COT Method 3 Score	*R* = .35* *p* = .05 *n* = 33	*R* = .41* *p* = .02 *n* = 33	*R* = .12 *p* = .49 *n* = 34

* denotes results at the .05 level of significance

quality. Together, the effects of assigning activity accomplishment to customers (negative relation to quality) and joint assignment of project activity (positive relation to quality) interact to cancel each other out. This can be seen by the lack of significant correlation between Scoring Method 1 (where customer and joint assignment approaches were equally weighted) to the quality dependent variables.

It appears that I.S. product/service quality, in the eyes of the customer, may actually be hampered by assignment of project task accomplishment to line business staff. On the other hand, joint assignment of task accomplishment to line business staff and I.S. specialist staff seems to operate to generally improve I.S. project quality outcome. Speculatively, we might conclude that I.S. customers too often lack the time and/or the expertise needed to accomplish project activities effectively without assistance of the I.S. staff.

It should be remembered that the Coordination Mechanism Use measure, CMU (0,1,1), utilizes COT Scoring Method 1 as a component, while CMU (0,0,1) uses COT Scoring Method 3 as a component. Thus, results of statistical analyses utilizing the CMU (0,1,1) variable are expected to be somewhat suppressed compared to those using the CMU (0,0,1) variable alternative. This is seen, for example, in the correlation matrix shown in Table 12 where the correlations between CMU (0,1,1) and Total Average Quality or Customer Quality are slightly lower than those for CMU (0,0,1) and these dependent variables.

The strongest correlations were obtained between the hypothesized moderating variable, Requirements Definition Uncertainty, and the three quality dependent variables. As shown in Table 12, uncertainty was found to have a negative and statistically significant correlation to each of the obtained measures of quality, with a stronger relationship found between uncertainty and the producer view of quality than between uncertainty and the customer view of quality. That is, while the strength of the relationship between uncertainty and quality was different for the two different measured perspectives of quality, all views of quality were found to decrease as uncertainty increased.

A correlation analysis of the uncertainty variable components and each of the dependent variables was used to provide additional insight into the nature of the direct influence of this variable on quality perceptions. Table 14 shows the results of this analysis. Four of the components of the uncertainty measure (i.e., stability of system requirements, level of customer experience with the business being automated, level of I.S. project team knowledge of the business being automated, and level of consensual uncertainty) have statistically significant, negative correlations with Total Average Quality. The first three of these also have statistically significant, negative correlations with Producer Quality, while consensual uncertainty does not. Only two dimensions of uncertainty are significantly and negatively correlated with the customer view of quality: level of customer experience with the business being automated, and level of consensual uncertainty.

TABLE 14
CORRELATION MATRIX - UNCERTAINTY COMPONENTS AND DEPENDENT VARIABLES

	Dependent Variables		
Uncertainty Variable Components	**Total Average Quality**	**Customer Quality**	**Producer Quality**
1. Lack of System Requirements Preestablishment	R = -.13 p = .46 n = 33	R = -.10 p = .59 n = 33	R = -.12 p = .51 n = 34
2. # of Customer Groups Needed for Requirements Definition	R = -.32 p = .07 n = 33	R = -.29 p = .10 n = 33	R = -.27 p = .13 n = 34
3. Instability of System Requirements	R = -.44** p = .009 n = 33	R = -.32 p = .07 n = 33	R = -.46** p = .006 n = 34
4. Unroutineness of System Requirements	R = -.09 p = .63 n = 33	R = .007 p = .97 n = 33	R = -.19 p = .29 n = 34
5. Customer Lack of Prior Experience with Business being Automated	R = -.43** p = .01 n = 33	R = -.37* p = .03 n = 33	R = -.35* p = .04 n = 34
6. I.S. Project Team Lack of Knowledge of Business being Automated	R = -.42** p = .01 n = 33	R = -.21 p = .24 n = 33	R = -.56** p = .0006 n = 34
7. Consensual Uncertainty	R = -.50** p = .003 n = 33	R = -.63** p = .0001 n = 33	R = -.12 p = .51 n = 34

* denotes results at the .05 level of significance
** denotes results at the .01 level of significance

The existence of the strong simple correlations between Uncertainty and the dependent variables raises questions about whether Uncertainty should be considered an independent variable instead of, or in addition to, a moderating variable in the research model. This possibility was examined through comparison of the results of polynomial regression analyses of models that included uncertainty as an independent variable with the results of moderated regression analyses and will be discussed in the next section of this chapter.

F. Hypotheses Testing

Multiple regression analyses of results were performed using the SAS GENERAL LINEAR MODELS PROCEDURE. This procedure yields F values that can be submitted to tests of statistical significance for both the entire model and for the individual independent variable and interaction term inputs to the model. Type I and Type III Sum of Squares (SS) data are presented. Type I SS reflects the sequential, incremental contribution of each input to the model, i.e., the sum of squares accounted for by a variable, given only the previous variables entered in the model. Type III SS, on the other hand, reflects the partial contribution of each input to the model, i.e., the sum of squares accounted for by a variable, given that all other variables are already in the model. Type III tests are appropriate for hypotheses that are invariant to the ordering of effects in the model (SAS Institute, Inc., 1991), as is the case in the current research.

The SAS GENERAL LINEAR MODELS PROCEDURE also yields regression parameter estimates which are useful in examining the form of the relationships among independent and moderating variables and the dependent variable. These parameter estimates take the form of positive or negative coefficients which, when plugged into the regression equation along with values for each independent and moderating variable, can be used to estimate the effect on the dependent variable. In the current research, parameter estimates were examined to determine the size and direction of independent and moderating variables' effects on IS product/service quality outcome.

Finally, analysis of the form of relationships between independent and dependent variables over the range of the moderating variable was conducted by graphing partial derivatives from each regression equation. Each of these graphs express the change in quality given a change in a strategic alignment dimension (i.e., dispersal or coordination mechanism use) and provide the opportunity to test for the extent to which the alignment dimension has the hypothesized nonmonotonic effect on quality over the range of uncertainty.

Figure 19 shows the 6 forms that these graphs may take. In each graph, the vertical axis represents the range of the moderating variable (uncertainty, in this research). The plotted line in the body of the graph shows change in the dependent variable (quality, here), given change in the independent variable (an alignment mechanism, in this research). The horizontal axis of each graph represents the point of inflection of the partial relation dY/dX along the range of uncertainty - that is, the point at which the independent variable has no effect on the dependent variable. Above this point, plotted effects are positive while below it, plotted effects are negative.

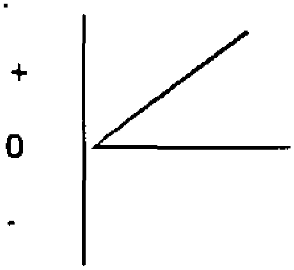
When an effect is constant over all values of the moderating variable, the plotted line will not cross the graph's horizontal axis (e.g., as in graphs 1 - 4 of Figure 19). When, on the other hand, the plotted line does cross the horizontal axis, this is an indication of a nonmonotic effect - a case where the moderating variable increases the effect of the independent variable on the dependent variable over a portion of the range, but decreases it over the remainder.

In this study, the posited relationship of the independent variables to the dependent variables is nonmonotonic across the range of the uncertainty moderating variable. The two types of nonmonotonic relationships that are possible are shown in graphs 5 and 6 of Figure 19. If the independent variable is positively related to the dependent variable over the high end of the moderating

Figure 19
Possible Forms of Graphs of Partial Derivatives of Regression Functions
Change in Quality Given Change in Alignment Variables

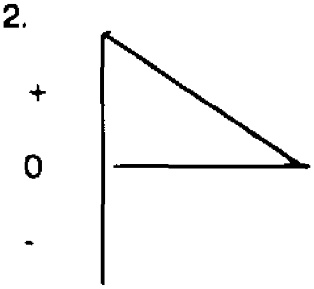
Monotonic Patterns

1.



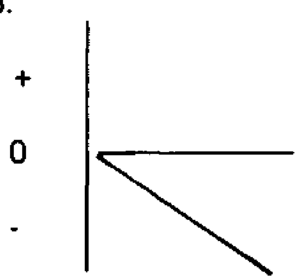
Here b_1 = + and b_3 = +

2.



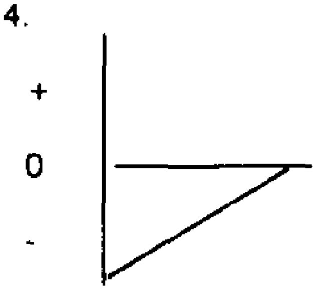
Here b_1 = + and b_3 = -

3.



Here b_1 = - and b_3 = -

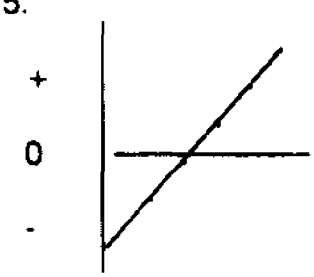
4.



Here b_1 = - and b_3 = +

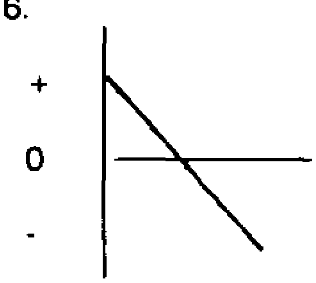
Nonmonotic Patterns

5.



Here b_1 = - and b_3 = +

6.



Here b_1 = + and b_3 = -

variable range but negatively related to the dependent variable over the low end of the range, the graph of partial derivatives would take the pattern shown in graph 5 of Figure 19. If, however, the independent variable is negatively related to the dependent variable over the high end of the moderating variable range but positively related to the dependent variable over the low end of the range, the graph of partial derivatives would take the pattern shown in graph 6 of Figure 19.

Given this background, the results of testing each of the four sets of research hypotheses will now be considered.

1) Hypotheses Set 1

This set of hypotheses focused on the relationship between the *Dispersal B* independent variable and the *Total Average Quality* dependent variable, over the range of the *Uncertainty* moderating variable. Generally, a symmetrical contingency relationship was expected wherein congruence between the level of use of dispersal and the level of requirements definition uncertainty faced would be related to achievement of higher levels of perceptions of IS product/service quality. This relationship was also expected to be nonmonotonic across the range of the moderating variable. Specifically, it was expected that dispersal would be found to have a greater effect on the dependent variable over part of the range of uncertainty, while having little effect over the remainder.

The hypotheses in Set 1 included:

Hypothesis 1: The impact of IS application development function dispersal on customer/producer perception of IS product/service quality is nonmonotonic over the range of requirements definition uncertainty.

Hypothesis 1a: When requirements definition uncertainty is high, increases in IS application dispersal will positively influence IS product/service quality.

Hypothesis 1b: When requirements definition uncertainty is high, decreases in IS application development function dispersal will negatively influence IS product/service quality.

Hypothesis 1c: When requirements definition uncertainty is low, increases in IS application development function dispersal will not influence IS product/service quality.

Hypothesis 1d: When requirements definition uncertainty is low, decreases in IS application function dispersal will not influence IS product/service quality.

Table 15, Part 1 shows the results of the moderated multiple regression analysis used to test hypotheses set 1. A statistically significant F value (at the .05 level of significance) and an R-Square value of .224 were attained for the regression model that included the independent variable Dispersal B, the Dispersal B*Uncertainty interaction term, and the dependent variable Total Average Quality. Type III SS

TABLE 15
REGRESSION ANALYSIS RESULTS
Dependent Variable = Total Average Quality

PART 1 - Hypotheses Set 1: n=32

VARIABLES IN MODEL	*TYPE III SS*	*F VALUE*	*R-SQUARE*
Dispersal B	F= 5.41*	F=4.19*	R-Sq=.2240
Dispersal B*Uncertainty	F= 7.95**	Pr>F=.0253	
Dispersal B	F= .60	F=6.59**	R-Sq=.3125
Uncertainty	F=12.71**	Pr>F=.0044	
Dispersal B	F= .58	F=4.44**	R-Sq=.3222
Uncertainty	F= 4.06*	Pr>F=.0113	
Dispersal B*Uncertainty	F= .40		

PART 2 - Hypotheses Set 2: n=33

VARIABLES IN MODEL	*TYPE III SS*	*F VALUE*	*R-SQUARE*
CMU (0,1,1)	F= 8.94**	F=5.75**	R-Sq=.2772
CMU (0,1,1)*Uncertainty	F= 5.62*	Pr>F=.0077	
CMU (0,1,1)	F= 4.04*	F=9.13**	R-Sq=.3783
Uncertainty	F=11.41**	Pr>F=.0008	
CMU (0,1,1)	F= .08	F=5.89**	R-Sq=.3785
Uncertainty	F= 4.73*	Pr>F=.0029	
CMU (0,1,1)*Uncertainty	F= .01		
CMU (0,0,1)	F= 8.53**	F=6.11**	R-Sq=.2894
CMU (0,0,1)*Uncertainty	F= 5.07*	Pr>F=.0059	
CMU (0,0,1)	F= 4.93*	F=9.76**	R-Sq=.3942
Uncertainty	F=11.13**	Pr>F=.0005	
CMU (0,0,1)	F= .07	F=6.30**	R-Sq=.3946
Uncertainty	F= 5.04*	Pr>F=.0020	
CMU (0,0,1)*Uncertainty	F= .02		

* F value significant at .05 level
** F value significant at .01 level

TABLE 15 - PART 3
Regression Analysis Results
Dependent Variable = Total Average Quality

Hypotheses Set 3: n=32

Variables in Model	*Type III SS*	*F Value*	*R-Square*
Dispersal B	F= .54	F=3.41*	R-Sq=.3360
CMU (0,1,1)	F= 1.67	Pr>F=.0220	
Dispersal B*Uncertainty	F= 1.12		
CMU (0,1,1)*Uncertainty	F= .82		
Dispersal B	F= .85	F=6.53**	R-Sq=.4116
CMU (0,1,1)	F= 4.72*	Pr>F=.0017	
Uncertainty	F=11.82**		
Dispersal B	F= 1.44	F=4.03**	R-Sq=.4364
CMU (0,1,1)	F= 15	Pr>F=.0077	
Uncertainty	F= 4.63**		
Dispersal B*Uncertainty	F= 1.13		
CMU (0,1,1)*Uncertainty	F= 0.00		
Dispersal B	F= .69	F=3.66*	R-Sq=.3518
CMU (0,0,1)	F=1.51	Pr>F=.0165	
Dispersal B*Uncertainty	F=1.34		
CMU (0,0,1)*Uncertainty	F= .65		
Dispersal B	F= .89	F=6.97**	R-Sq=.4275
CMU (0,0,1)	F=5.63*	Pr>F=.0012	
Uncertainty	F=11.55**		
Dispersal B	F= 1.39	F=4.27**	R-Sq=.4507
CMU (0,0,1)	F= .15	Pr>F=.0058	
Uncertainty	F= 4.68*		
Dispersal B*Uncertainty	F= 1.08		
CMU (0,0,1)*Uncertainty	F= .01		

* F value significant at .05 level
** F value significant at .01 level

TABLE 15 - PART 4
Regression Analysis Results
Dependent Variable = Customer Quality

Hypotheses Set 4: n=32

Variables in Model	*Type III SS*	*F Value*	*R-Square*
Dispersal B	F= 2.26	F=2.61	R-Sq=.1525
Dispersal B*Uncertainty	F= 4.27*	Pr>F=.0908	
Dispersal B	F= 1.16	F=4.06*	R-Sq=.2188
Uncertainty	F= 7.09**	Pr>F=.0279	
Dispersal B	F= .74	F=2.81	R-Sq=.2317
Uncertainty	F= 2.89	Pr>F=.0574	
Dispersal B*Uncertainty	F= .47		

Hypotheses Set 4: n=33

Variables in Model	*Type III SS*	*F Value*	*R-Square*
CMU (0,1,1)	F= 4.27*	F=3.51*	R-Sq=.1897
CMU (0,1,1)*Uncertainty	F= 2.17	Pr>F=.0426	
CMU (0,1,1)	F= 3.56	F=5.48**	R-Sq=.2675
Uncertainty	F= 5.58*	Pr>F=.0094	
CMU (0,1,1)	F= .01	F=3.62*	R-Sq=.2725
Uncertainty	F= 3.30	Pr>F=.0247	
CMU (0,1,1)*Uncertainty	F= .20		
CMU (0,0,1)	F= 3.96*	F=4.15*	R-Sq=.2167
CMU (0,0,1)*Uncertainty	F= 1.72	Pr>F=.0257	
CMU (0,0,1)	F= 4.96*	F=6.33**	R-Sq=.2968
Uncertainty	F= 5.34*	Pr>F=.0051	
CMU (0,0,1)	F= .02	F=4.23**	R-Sq=.3043
Uncertainty	F= 3.65	Pr>F=.0135	
CMU (0,0,1)*Uncertainty	F= .31		

* F value significant at .05 level
** F value significant at .01 level

TABLE 15 - PART 4 continued
Regression Analysis Results
Dependent Variable = Producer Quality

Hypotheses Set 4: n=33

Variables in Model	*Type III SS*	*F Value*	*R-Square*
Dispersal B	F= 6.15*	F=3.64*	R-Sq=.1952
Dispersal B*Uncertainty	F= 7.28**	Pr>F=.0385	
Dispersal B	F= .00	F=5.09**	R-Sq=.2534
Uncertainty	F=10.18**	Pr>F=.0125	
Dispersal B	F= .08	F=3.32*	R-Sq=.2554
Uncertainty	F= 2.34	Pr>F=.0337	
Dispersal B*Uncertainty	F= .08		

Hypotheses Set 4: n=34

CMU (0,1,1)	F= 8.77**	F=4.67*	R-Sq=.2314
CMU (0,1,1)*Uncertainty	F= 6.77**	Pr>F=.0169	
CMU (0,1,1)	F= 1.19	F=6.16**	R-Sq=.2845
Uncertainty	F= 9.58**	Pr>F=.0056	
CMU (0,1,1)	F= .43	F=4.08*	R-Sq=.2896
Uncertainty	F= 2.46	Pr>F=.0153	
CMU (0,1,1)*Uncertainty	F= .21		
CMU (0,0,1)	F= 8.63**	F=4.61*	R-Sq=.2293
CMU (0,0,1)*Uncertainty	F= 6.75**	Pr>F=.0177	
CMU (0,0,1)	F= 1.00	F=6.04**	R-Sq=.2804
Uncertainty	F= 9.43**	Pr>F=.0061	
CMU (0,0,1)	F= .51	F=4.03*	R-Sq=.2873
Uncertainty	F= 2.44	Pr>F=.0160	
CMU (0,0,1)*Uncertainty	F= .29		

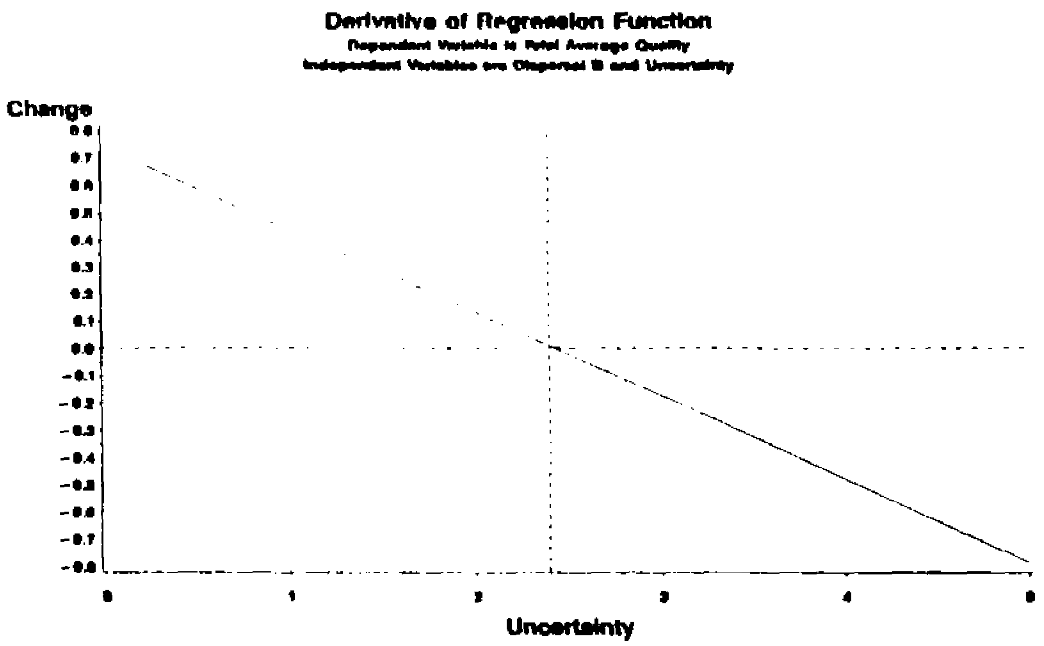
* F value significant at .05 level
** F value significant at .01 level

data indicate that the Dispersal B input did contribute significantly towards reduction of error in the model, but that the interaction term had even greater impact.

The nonmonotocity of the relationship was tested by graphing the partial derivatives from the multiple regression. Figure 20A is the plot of the partial derivatives for hypothesis 1. This plot shows that, as hypothesized, a nonmonotonic relationship does exist. However, contrary to expectation, it is over the low end of the range of uncertainty that the independent variable Dispersal B appears to have its greatest impact on the dependent variable Total Average Quality. Specifically, for the current sample, only when requirements definition uncertainty is 2.43 or lower on the five point scale, is increased use of IS dispersal related to higher quality outcomes. Under conditions of higher uncertainty (i.e., above 2.43), increased use of dispersal is actually negatively related to the quality perception dependent variable.

A review of the parameter estimates obtained for this moderated multiple regression model (shown in Table 16 Part 1) confirm this interpretation. Since the parameter estimate for the interaction term is a negative value (-.30), while that for

FIGURE 20A



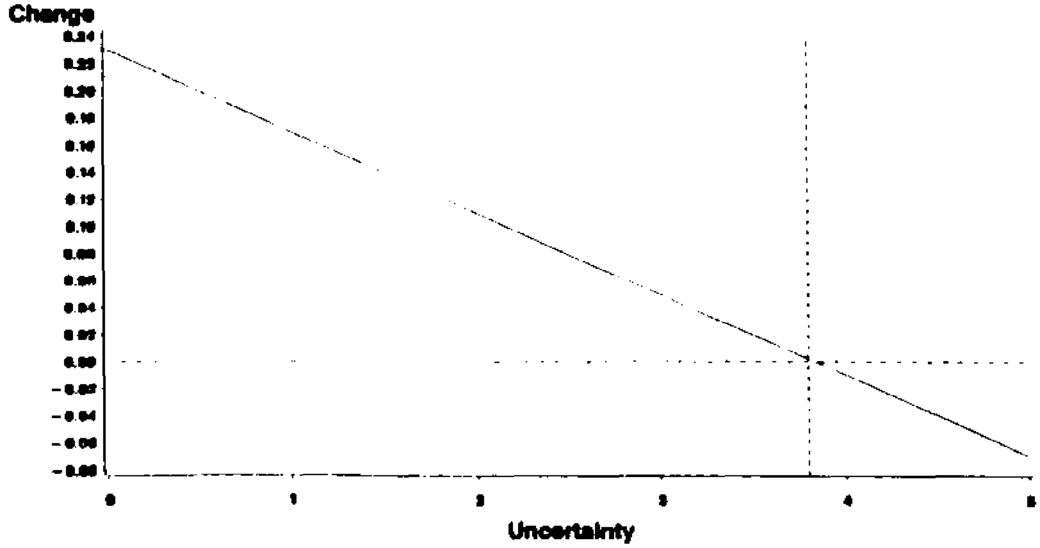
Change in Total Average Quality given change in Dispersal B equals zero when Uncertainty = 2.4

FIGURE 20B

Derivative of Regression Function

Dependent Variable is Total Average Quality

Independent Variables are CMU (0,1,1) and Uncertainty



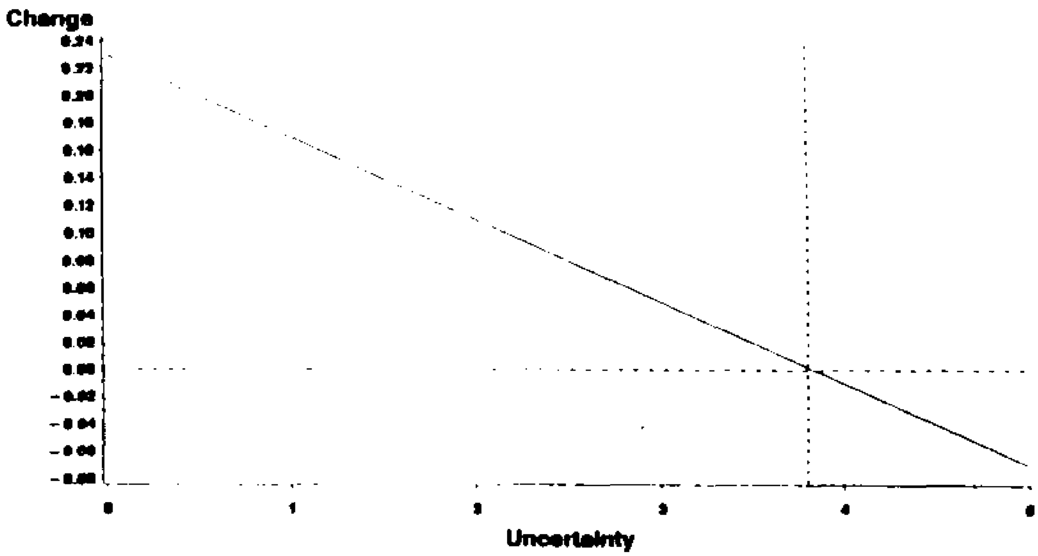
Change in Total Average Quality given change in CMU (0,1,1) equals zero when Uncertainty = 3.8

FIGURE 20C

Derivative of Regression Function

Dependent Variable is Total Average Quality

Independent Variables are CMU (0,0,1) and Uncertainty



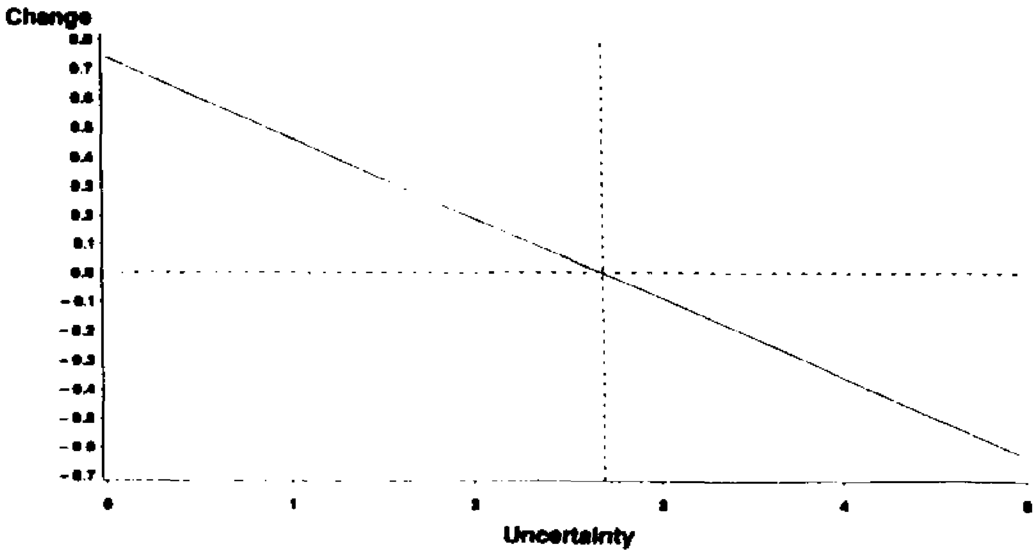
Change in Total Average Quality given change in CMU (0,0,1) equals zero when Uncertainty = 3.8

FIGURE 20D

Derivative of Regression Function

Dependent Variable is Producer Quality

Independent Variables are Dispersal B and Uncertainty



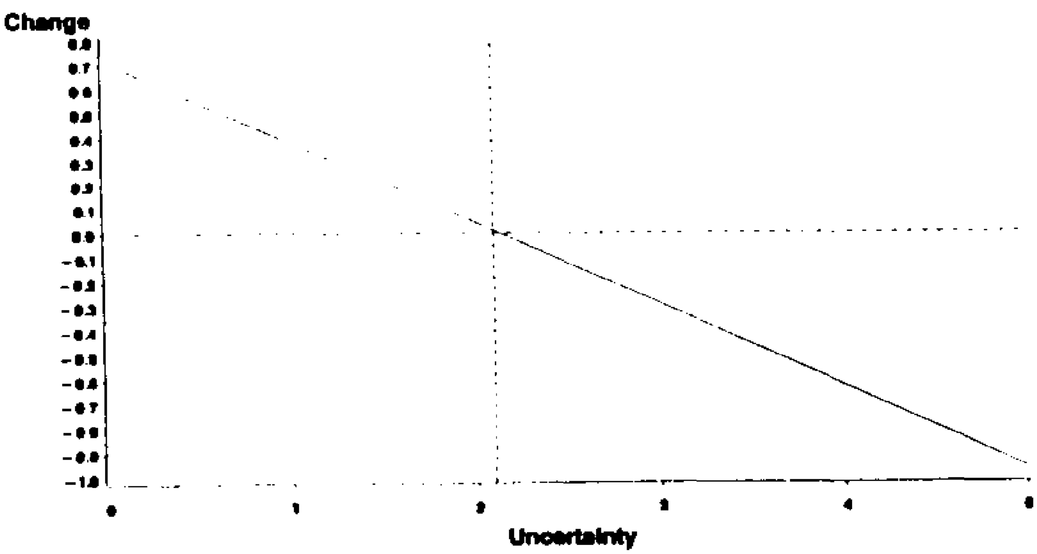
Change in Producer Quality given change in Dispersal B equals zero when Uncertainty = 2.7

FIGURE 20E

Derivative of Regression Function

Dependent Variable is Customer Quality

Independent Variables are Dispersal B and Uncertainty



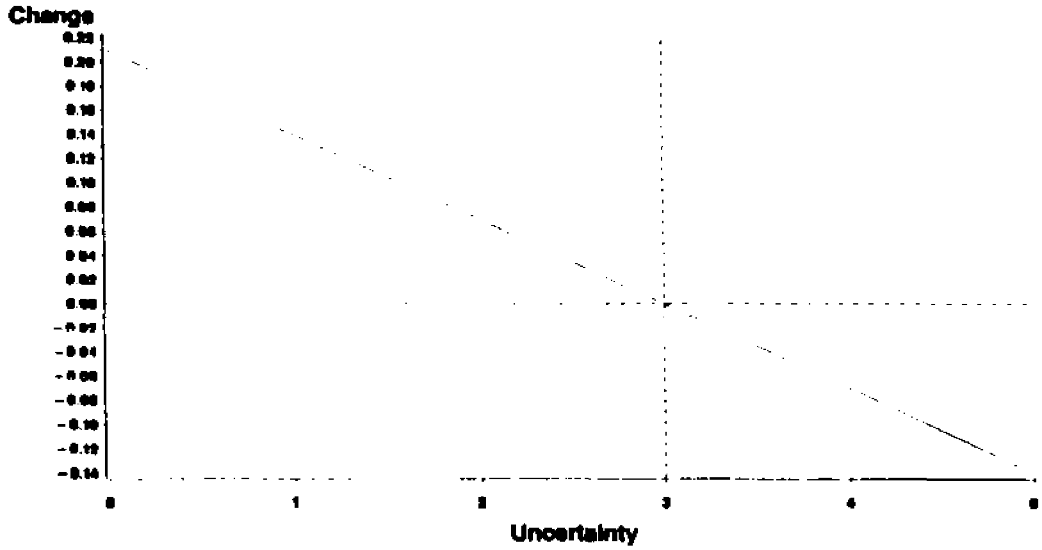
Change in Customer Quality given change in Dispersal B equals zero when Uncertainty = 2.1

FIGURE 20F

Derivative of Regression Function

Dependent Variable is Producer Quality

Independent Variables are CMU (0,1,1) and Uncertainty



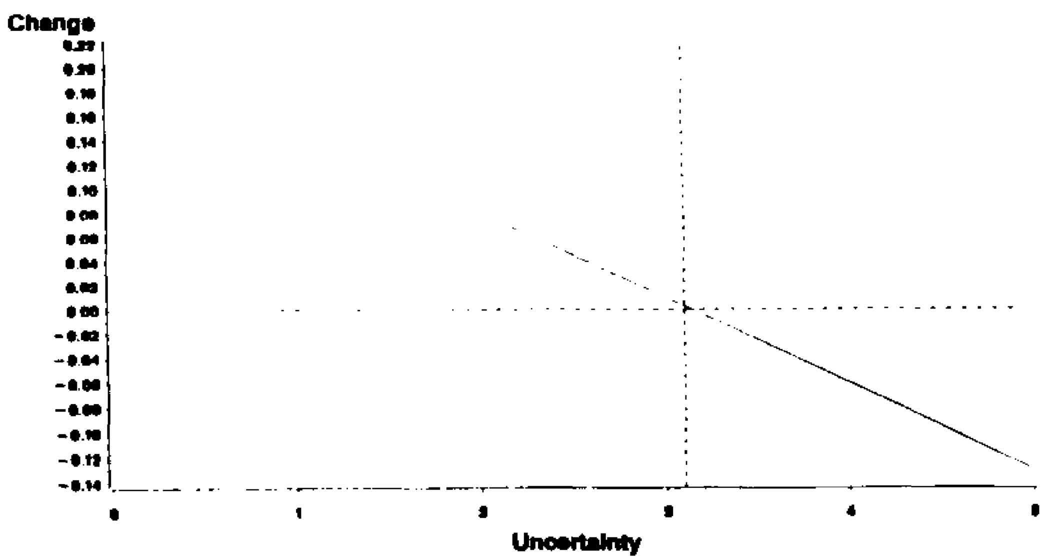
Change in Producer Quality given change in CMU (0,1,1) equals zero when Uncertainty = 3.0

FIGURE 20G

Derivative of Regression Function

Dependent Variable is Producer Quality

Independent Variables are CMU (0,0,1) and Uncertainty



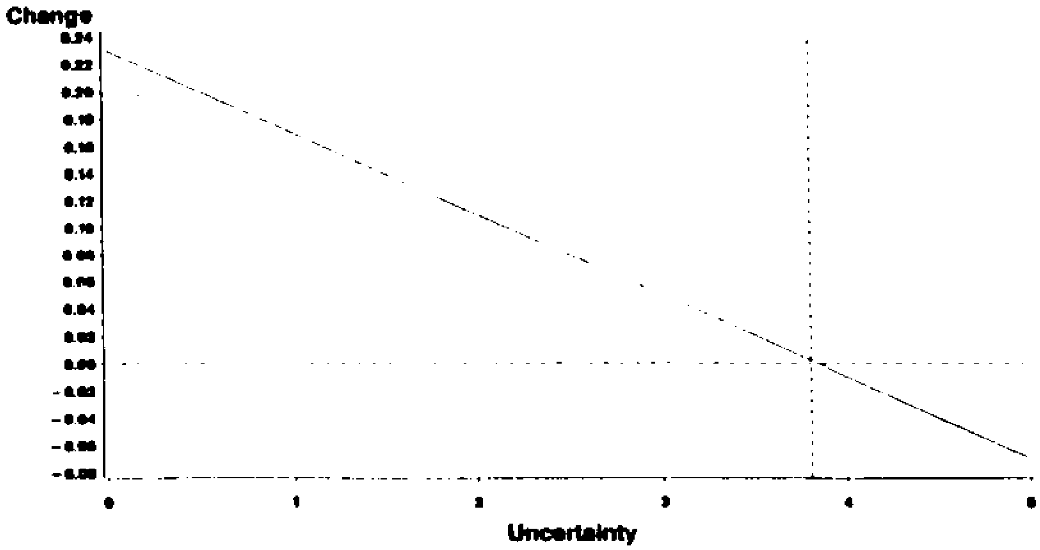
Change in Producer Quality given change in CMU (0,0,1) equals zero when Uncertainty = 3.1

FIGURE 20H

Derivative of Regression Function

Dependent Variable is Customer Quality

Independent Variables are CMU (0,1,1) and Uncertainty



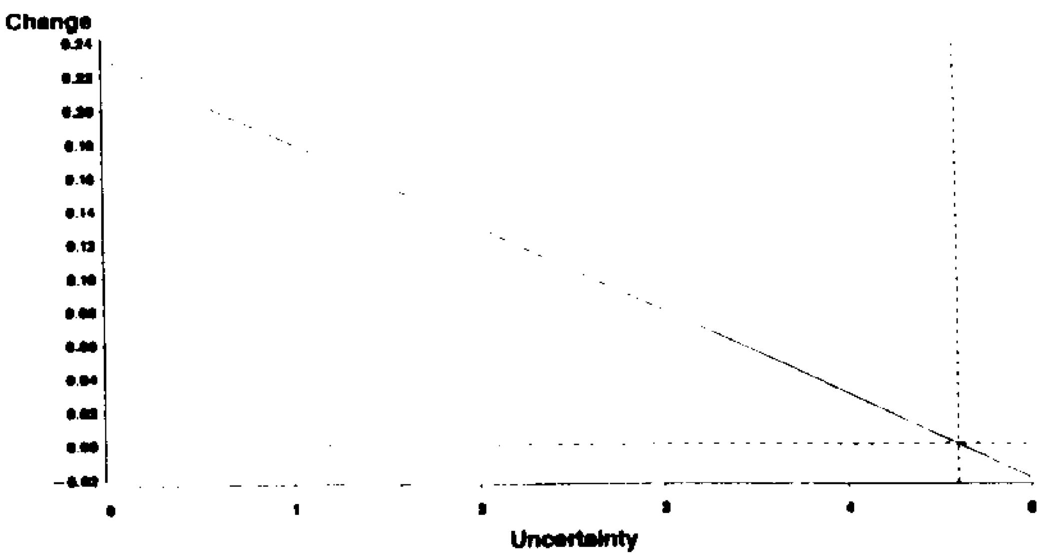
Change in Customer Quality given change in CMU (0,1,1) equals zero when Uncertainty = 3.8

FIGURE 20I

Derivative of Regression Function

Dependent Variable is Customer Quality

Independent Variables are CMU (0,0,1) and Uncertainty



Change in Customer Quality given change in CMU (0,0,1) equals zero when Uncertainty = 4.6

the dispersal B variable is a positive value (.74), higher levels of requirements definition uncertainty are seen to tend to result in negative perceptions of the quality outcome. For example, if Dispersal B is higher than the sample average (e.g., 3.00), while Uncertainty is above the 2.43 value (e.g., 3.00), the negative impact on Total Average Quality would be estimated as follows:

$$(.74)\ (3.00) + (-.30)\ (3.00)\ (3.00) = -.48$$

On the other hand, if Dispersal B is higher than the sample average (e.g., 3.00), while Uncertainty is below the 2.43 level (e.g., 2.00), the impact on Total Average Quality would be positive as shown below:

$$(.74)\ (3.00) + (-.30)\ (3.00)\ (2.00) = .42$$

Conclusion - Test of Hypothesized Model: With the exception of the general confirmation of the expectation of nonmonotonicity and the suggestion of the operation of uncertainty as a moderating variable, no support was found for this set of hypotheses. Conclusions must be tentative due to the nonnormality of the sample distribution of the dispersal data and the possibility that Uncertainty is better treated as a main effect than as a moderator (discussion of this possibility follows). However, the test of the hypothesized model suggests that IS application development activity dispersal into line business units, as it is practiced by the

TABLE 16
REGRESSION ANALYSIS PARAMETER ESTIMATES
Dependent Variable = Total Average Quality

PART 1

HYPOTHESES	*PARAMETER*	*ESTIMATE*	*T FOR H0: PARAMETER = 0*	*PR>T*	*STD ERROR OF EST.*
Set 1 (n=32)	Intercept	3.8828	16.96	.0001	.2290
	Dispersal B	0.7400	2.32	.0273	.3183
	Dispersal B * Uncertainty	-0.3054	-2.82	.0086	.1083
	Intercept	5.4724	10.86	.0001	.5037
	Dispersal B	-0.0927	-0.77	.4454	.1199
	Uncertainty	-0.5807	-3.56	.0013	.1629

PART 2

HYPOTHESES	*PARAMETER*	*ESTIMATE*	*T FOR H0: PARAMETER = 0*	*PR>T*	*STD ERROR OF EST.*
Set 2 (n=33)	Intercept	3.4412	23.27	.0001	.1479
	CMU (0,1,1)	0.2193	2.99	.0055	.0733
	CMU (0,1,1) * Uncertainty	-0.0622	-2.37	.0244	.0262
	Intercept	4.9278	10.60	.0001	.4650
	CMU (0,1,1)	0.0416	2.01	.0536	.0207
	Uncertainty	-0.5173	-3.38	.0020	.1531
	Intercept	3.4256	24.57	.0001	.1394
	CMU (0,0,1)	0.2252	2.92	.0066	.0771
	CMU (0,0,1) * Uncertainty	-0.0618	-2.25	.0319	.0275
	Intercept	4.8942	10.66	.0001	.4591
	CMU (0,0,1)	0.0459	2.22	.0341	.0207
	Uncertainty	-0.5061	-3.34	.0023	.1517

TABLE 16 - PART 3

Dependent Variable = Total Average Quality

Hypotheses	*Parameter*	*Estimate*	*T for H0: Parameter = 0*	*Pr>T*	*Sd Error of Est.*
Set 3	Intercept	3.6476	14.55	.0001	.2507
(n=32)	Dispersal B	0.3286	0.74	.4674	.4458
	CMU (0,1,1)	0.1429	1.29	.2073	.1106
	Dispersal B				
	* Uncertainty	-0.1632	-1.06	.2983	.1539
	CMU (0,1,1)	-0.0349			
	* Uncertainty	-0.90	.3784	.0386	
	Intercept	5.1027	10.13	.0001	.5039
	Dispersal B	-0.1044	-0.92	.3635	.1130
	CMU (0,1,1)	0.0464	2.17	.0385	.0214
	Uncertainty	-0.5328	-3.44	.0019	.1550
	Intercept	3.6367	14.95	.0001	.2432
	Dispersal B	0.3564	0.83	.4150	.4305
	CMU (0,0,1)	0.1395	1.23	.2295	.1135
	Dispersal B				
	* Uncertainty	-0.1726	-1.16	.2571	.1491
	CMU (0,0,1)				
	* Uncertainty	-0.0317	-0.03	.4280	.0394
	Intercept	5.0739	10.21	.0001	.4970
	Dispersal B	-0.1054	-0.95	.3522	.1115
	CMU (0,0,1)	0.05	2.37	.0248	.0212
	Uncertainty	-0.5212	-3.40	.0020	.1534

TABLE 16 - PART 4

Dependent Variable = Customer Quality

Hypotheses	*Parameter*	*Estimate*	*T for H0: Parameter = 0*	*Pr>T*	*Std Error of Est.*
Set 4	Intercept	3.9876	11.57	.0001	.3448
(n=32)	Dispersal B	0.7205	1.50	.1435	.4793
	Dispersal B * Uncertainty	-0.3369	-2.07	.0479	.1631
	Intercept	3.2664	14.48	.0001	.2256
(n=33)	CMU (0,1,1)	0.2312	2.07	.0476	.1119
	CMU (0,1,1) * Uncertainty	-0.0589	-1.47	.1516	.0400
	Intercept	3.2316	15.31	.0001	.2110
(n=33)	CMU (0,0,1)	0.2321	1.99	.0559	.1167
	CMU (0,0,1) * Uncertainty	-0.0545	-1.31	.1995	.0415

Dependent Variable = Producer Quality

Hypotheses	*Parameter*	*Estimate*	*T for H0: Parameter = 0*	*Pr>T*	*Std Error of Est.*
Set 4	Intercept	3.8041	17.85	.0001	.2131
(n=33)	Dispersal B	0.7436	2.48	.0190	.2998
	Dispersal B * Uncertainty	-0.2749	-2.70	.0113	.1019
	Intercept	3.6078	25.50	.0001	.1415
(n=34)	CMU (0,1,1)	0.2069	2.96	.0058	.0669
	CMU (0,1,1) * Uncertainty	-0.0652	-2.60	.0141	.0251
	Intercept	3.6105	26.80	.0001	.1347
(n=34)	CMU (0,0,1)	0.2180	2.94	.0062	.0742
	CMU (0,0,1) * Uncertainty	-0.0688	-2.60	.0142	.0265

current sample, has a relatively minor relationship to achievement of positive IS product/quality outcome. Further, this relationship is in the opposite direction, over the range of requirements definition uncertainty, than that which was hypothesized.

Results suggest a *nonsymmetrical* contingency relationship among the variables in this case, as opposed to the symmetric one most often assumed in structural contingency research. While increasing IS application dispersal *may* have a positive influence on IS product/service quality and decreasing IS application dispersal *may* have a negative influence on the total average quality outcome, the moderating influence of level of requirements definition uncertainty does not operate as posited in hypotheses set 1. Instead, tentatively:

- When requirements definition uncertainty is high, increases in IS dispersal will *negatively* influence IS product/service quality perceptions.

- When requirements definition uncertainty is high, decreases in IS dispersal will *positively* influence IS product/service quality perceptions.

- Under conditions of low requirements definition uncertainty, increases in IS dispersal *will* influence IS product/service quality perceptions - in a positive direction.

- Under conditions of low requirements definition uncertainty, decreases in IS dispersal *will* influence IS product/service quality perceptions - in a negative direction.

<u>Investigation of Alternative Regression Models</u>: Since, as mentioned earlier, the correlational analysis revealed that Uncertainty had a strong negative and independent relationship (R=-0.54, p=.001) to the Total Average Quality dependent variable, an alternative polynomial regression model was also tested that used Uncertainty as an independent, rather than moderating variable. The results are shown in Table 15, Part 1.

A statistically significant F value (F=6.59, Pr>F=.0044) was obtained for this unmoderated regression model. The obtained R-Square value was .3125, as opposed to the R-Square of .2240 obtained for the moderated model. However, for the unmoderated model, the Type III SS data indicate that *only* the uncertainty term is contributing significantly to reduction of error in the model.

Given that R-Square for the simple correlation between Uncertainty and Total Average Quality was already .2915, the use of the Dispersal variable in the unmoderated polynomial regression model adds little value in terms of explaining variance in the quality criterion. Since, statistically, SST is a constant in these alternate models, R-Square will always increase when additional variables are added to the regression model (Berensen, Levine and Goldstein, 1983). Thus, slightly higher R-Square values obtained from including additional variables are not sufficient to allow conclusion that these models are superior. Further, the unmoderated polynomial regression model has little explanatory value.

A third model, which included uncertainty as *both* a main effect and as a moderator, was then tested. Results are also shown in Table 15, Part 1. Statistically significant results (F=4.44, Pr>F=.0113) were obtained using the three explanatory variables in the regression model but, again, only the uncertainty main effect attained a statistically significant Type III SS value. Further, while the R-Square value for this model was the highest of the three tested (R-Sq=.3223), it is only slightly higher than that which was obtained for the unmoderated two variable model just discussed. Again, the conclusion that must be drawn is that this model has no clear superiority.

Results of this investigation of Uncertainty as a main effect instead of a moderating effect are not fully conclusive. All models tested had statistically significant F values. The hypothesized model attained the lowest R-Square, but was the only model in which all explanatory variables had a statistically significant contribution to reduction of variance. On the basis of R-Square value analysis and the "rule of parsimony", the simple regression model that included only uncertainty as the only predictor appears superior to the other regression models. Data analysis results clearly show that variance in the Total Average Quality criterion for this sample is more a function of the level of requirements definition uncertainty faced than it is a function of the degree to which IS activities have been dispersed. Accepting the simple regression model would suggest that dispersal is not an effective alignment mechanism, that it has little or no relationship to the IS quality outcome under any circumstances. This may be the case.

Alternatively, the reality may be that the sample size here is too small to detect the effects of the IS Dispersal and the Uncertainty*IS Dispersal interaction terms in a test of the three explanatory variable regression model that also includes the Uncertainty main effect. The violation of the assumption of normality in the dispersal data distribution may also contribute to the inconclusive findings. With additional data, it is possible that this polynomial regression model would have had stronger results.

2) Hypotheses Set 2

Hypotheses Set 2 focused on the relationship between the *Coordination Mechanism Use* independent variable and the *Total Average Quality* dependent variable, over the range of the *Uncertainty* moderating variable. As in Hypotheses Set 1, symmetrical contingency relationships were expected wherein congruence between the level of use of coordination mechanisms and the level of requirements definition uncertainty faced would be related to achievement of higher levels of IS product/service quality. Again, this relationship was posited to be nonmonotonic across the range of the moderating variable uncertainty. It was expected that uncertainty would be found to increase the effect of the independent variable on the dependent variable over a portion of the range of uncertainty, while decreasing it over the remainder.

Specifically, Hypotheses Set 2 included:

Hypothesis 2: The impact of IS application customer/producer unit coordination mechanism use on customer/producer perception of product/service quality is nonmonotonic over the range of requirements definition uncertainty.

Hypothesis 2a: When requirements definition uncertainty is high, increases in IS application customer/producer unit coordination mechanism use will positively influence perceptions of IS product/service quality.

Hypotheses 2b: When requirements definition uncertainty is high, decreases in IS application customer/producer unit coordination mechanism use will negatively influence perceptions of IS product/service quality.

Hypothesis 2c: When requirements definition uncertainty is low, increases in IS application customer/producer unit coordination mechanism use will negatively influence perceptions of IS product/service quality.

Hypothesis 2d: When requirements definition uncertainty is low, decreases in IS application customer/producer unit coordination mechanism use will positively influence perceptions of IS product/service quality.

Statistical analysis of results was performed using the SAS GENERAL LINEAR MODELS PROCEDURE. Table 15, Part 2 shows the results of the moderated multiple regression analysis used to test hypotheses set 2. Significant F values were obtained for moderated regression models using both CMU scoring methods 1 and 3 and the Total Average Quality dependent variable. An R-Square value of .2772 was obtained for the model using CMU (0,1,1), while an R-Square value of .2894 was obtained for the model using CMU (0,0,1). For both scoring methods, Type III SS data show that the independent variable input to the model is significant at the .01 level, while the interaction term inputs to the model are significant at the .05 level. That is, both the Coordination Mechanism Use independent variable and the Uncertainty moderating variable inputs contribute significantly to the reduction of error in these models.

The nonmonotonicity of the relationship was tested by graphing the partial derivatives from the multiple regression. The plots of the partial derivatives for hypothesis 2 are shown in Figures 19B and 19C (19B for CMU scoring method 1, 19C for CMU scoring method 2). These plots show that, as hypothesized, a nonmonotonic relationship does exist. However, similarly to the effect seen with Dispersal B, it is over the low end of the range of uncertainty that the independent variable Coordination Mechanism Use appears to have its greatest impact on the dependent variable Total Average Quality. Specifically, for the current sample, for both CMU scoring methods, it is when requirements definition uncertainty is below 3.80 on the five point scale, that increased use of coordination mechanisms is most strongly related to higher Total Average Quality outcomes. Above this value of uncertainty, increased use of coordination mechanisms has a negative relationship to the Total Average Quality outcome.

Again, a review of the parameter estimates obtained for the moderated multiple regression models (shown in Table 16, Part 2) confirm this interpretation. The parameter estimates for Coordination Mechanism Use scoring methods 1 and 3 are very close in value. The interaction term parameter estimate is a negative value (-.06), while that for the coordination mechanism use variable is a positive value (.22). Thus, higher levels of requirements definition uncertainty are seen to tend to result in a negative impact on the quality outcome. For example, if CMU (0,1,1) is higher than the sample average (e.g., 10.00), while Uncertainty is above the 3.8 value (e.g., 4.00), the negative impact on Total Average Quality would be estimated as follows:

$$(.22)\ (10.00) + (-.06)\ (10.00)\ (4.00) = -.20$$

On the other hand, if CMU (0,1,1) is higher than the sample average (e.g., 10.00), but Uncertainty is below the 3.8 level (e.g., 3.00), the impact would be positive as shown below:

$(.22) (10.00) + (-.06) (10.00) (3.00) = .40$

Conclusion - Test of Hypothesized Model: This test confirms the general expectation of nonmonotonicity and lends some support to the contention that uncertainty moderates the relationship between coordination mechanism use and the quality outcome. Conclusions must be tentative due to the possibility that Uncertainty is better treated as a main effect than as a moderator (discussion of this possibility follows). However, the test of the hypothesized model suggests that coordination mechanism use, has a significant, but opposite relationship to achievement of IS product/service quality outcome over the range of requirements definition uncertainty than that which was hypothesized.

Results show that the Coordination Mechanism Use variable has greater strength than the Dispersal B variable as an explanatory variable. Otherwise, findings are quite similar to those resulting from the test of Hypotheses Set 1. While increasing IS application customer/producer unit coordination mechanism use *may* have a positive influence on IS product/service quality and decreasing coordination mechanism use *may* have a negative influence on the total average quality outcome, the moderating influence of level of requirements definition uncertainty does not operate as posited in Hypotheses Set 2. Instead:

- When requirements definition uncertainty is high, increases in IS application customer/producer unit coordination mechanism use will *negatively* influence perceptions of IS product/service quality.

- When requirements definition uncertainty is high, decreases in IS application customer/producer unit coordination mechanism use will *positively* influence perceptions of IS product/service quality.

- Under conditions of low requirements definition uncertainty, increases in IS application customer/producer unit coordination mechanism use will *positively* influence perceptions of IS product/service quality.

- Under conditions of low requirements definition uncertainty, decreases in IS application customer/producer unit coordination mechanism use will *negatively* influence perceptions of IS product/service quality.

Again, this is a nonsymmetric contingency relationship, as opposed to the symmetric one assumed.

<u>Investigation of Alternative Regression Models</u>: Two alternative polynomial regression models were also tested. The first of these used uncertainty as an independent variable instead of a moderating variable. The second included both an uncertainty main effect and a CMU*Uncertainty interaction term. Results of

these tests are shown in Table 15, Part 2 for both CMU scoring methods 1 and 3.

The F tests for the unmoderated regression models were statistically significant. Obtained R-Square values for these alternative models were substantially higher than those for the hypothesized model (R-Sq = .3783 for CMU scoring method 1 as opposed to .2772 for the moderated model; and R-Sq = .3942 for CMU scoring method 3, as opposed to .2894 for the moderated model). In addition, the Type III SS data indicate, in each of these cases, that both the coordination mechanism use and the uncertainty terms are contributing significantly to reduction of error in the models. Thus, there *is* adequate support, for the conclusion to be drawn that the alignment variable tested, coordination mechanism use, is related to the achievement of IS product/service quality.

The models constructed to test for both uncertainty and coordination mechanism use main effects and uncertainty*CMU interaction effects, were also significant but R-Square values were not improved significantly from inclusion of the interaction term. Further, Type III SS data show that only the uncertainty main effect contributed significantly to reduction of error in these models.

The potential explanatory value of the model that contains uncertainty as both a moderating and independent variable, along with the coordination mechanism use independent variable, is more compelling than that of the alternative unmoderated model. It incorporates the finding from the test of the simple regression model that: As uncertainty increases, perceived IS total average quality decreases. It also incorporates the findings from the test of the hypothesized moderated polynomial regression model, adding that: 1) Under conditions of high uncertainty, increased use of coordination mechanisms has an additional negative influence on the IS quality outcome; but that 2) when requirements definition uncertainty is low, increased coordination mechanism use can positively influence IS project outcome quality. Further research, with larger sample sizes, is needed to test this possibility.

3) Hypotheses Set 3

This set of hypotheses focused on the combined impact of use of IS function dispersal and IS application customer/producer unit coordination mechanism use under different conditions of uncertainty. Combined and increasing use of these alignment mechanisms were expected, under conditions of high uncertainty, to have the greatest positive influence on perceptions of IS product/service quality. Combined and decreasing use of the alignment mechanisms, under these same high uncertainty conditions, was expected to have the greatest negative influence on IS product/service quality.

Other hypotheses in this set addressed the quality effects of increased and decreased use of both alignment mechanisms under conditions of low uncertainty, positing no or moderately negative influence on the quality criterion. Another hypothesis posited that, under conditions of high uncertainty, increased use of one alignment mechanism and decreased use of the other would have a moderately positive influence on the total average quality. Finally, two hypotheses addressed the influence of decreased use of one alignment mechanism coupled with increased use of the other, under conditions of low uncertainty.

Statistical analysis of results was performed using the SAS GENERAL LINEAR MODELS PROCEDURE. As Table 15, Part 3 shows, statistically significant F values were obtained (at the .05 level) for the moderated multiple regression models containing both independent variables and both uncertainty terms. R-Square values were .3360 and .3518, respectively, for the versions of these models using CMU scoring method 1 and CMU scoring method 3. Type III SS data indicate that *none* of the independent or moderating variables contribute significantly to reduction of error in these models.

Regardless of the coordination mechanism scoring method used, the calculated parameter estimates for the models were similar. In both models, the estimates for the independent variables were positive (Dispersal B = .3286 or .3564; CMU = .1429 or .1395) while the estimates for the interaction terms were negative (Dispersal B*Uncertainty = -.1632 or -.1726; CMU*Uncertainty = -.0349 or -.0317).

This pattern, not surprisingly, is the same as that seen in the single independent variable and moderating term models previously discussed. Again, the general effect suggested is that under conditions of high uncertainty, increased use of alignment mechanisms has a negative (not positive) influence on the total average quality outcome; and, under conditions of low uncertainty, increased used of alignment mechanisms has a positive (not negative) influence on quality outcome.

The obtained parameter estimates for this model can be used to tentatively suggest the size and direction of effects on IS perceived product/service quality, given different levels of independent and moderating variables. The estimates for the regression model using the CMU (0,1,1) variable are used in the following section to evaluate each of the Set 3 Hypotheses, but results must be viewed as highly tentative given the statistical evidence. In the examination of the parameter estimates for each hypothesis in this set, high, average and low values of each independent variable were set relative to its sample mean and standard deviation. High and low levels of uncertainty were set relative to the results of the obtained point of inflection in the graphing of the partial derivatives from each regression equation. The specific variable values used with parameter estimates to examine direction and size of effects for this set of hypotheses are shown in Table 17.

Hypothesis 3a. When requirements definition uncertainty is high, increases in IS function dispersal and in application customer/producer unit coordination mechanism use will have the greatest positive effect on IS product/service quality.

TABLE 17
VARIABLE VALUES USED WITH PARAMETER ESTIMATES TO EXAMINE DIRECTION AND SIZE OF EFFECTS FOR HYPOTHESES SET 3

VARIABLES	VALUE LEVELS	
INTERACTION TERMS		
	High	**Low**
Uncertainty with:		
Dispersal B[1]	3	2
CMU (0,1,1)[2]	4	3
both independent variables[3]	4	2

INDEPENDENT VARIABLES			
	High	**Average**	**Low**
Dispersal B[4]	3	1.5	1
CMU (0,1,1)[5]	10	5	1

1 values set relative to *d*TAQ/*d*DispersalB = 0 at Uncertainty 2.43, so that low uncertainty < 2.40 and high uncertainty > 2.40.

2 values set relative to *d*TAQ/*d*CMU(0,1,1) = 0 at Uncertainty 3.80, so that low uncertainty < 3.80 and high uncertainty > 3.80.

3 values set relative to inflection point of *d*TAQ/*d*DispersalB and inflection point of *d*TAQ/*d*CMU(0,1,1) so that low uncertainty < 2.40 and high uncertainty > 3.80.

4 values set relative to mean = 1.62, standard deviation = .75

5 values set relative to mean = 5.45, standard deviation = .4.07

The test conditions used below hold the uncertainty level stable at a high level, while varying levels of the independent variables from average to high. Test condition 3a.2 represents the situation under which the greatest positive effect on TAQ was predicted.

Test Condition 3a.1:	High Uncertainty (4), High Dispersal (3), Average CMU (5)
Results:	Effect on TAQ is .33(3) + .14(5) + (-.16)(3)(4) + (-.03)(5)(4) = -.83
Test Condition 3a.2:	High Uncertainty (4), High Dispersal (3), High CMU (10)
Results:	Effect on TAQ is .33(3) + .14(10) + (-.16)(3)(4) + (-.03)(10)(4) = -.73
Test Condition 3a.3:	High Uncertainty (4), Average Dispersal (1.5), High CMU (10)
Results:	Effect on TAQ is .33(1.5) + .14(10) + (-.16)(4)(1.5) + (-.03)(10)(4) = -.265

Interpretation: Hypothesis 3a. was not supported. Under conditions of high uncertainty, increased use of dispersal and coordination mechanisms (test condition 3a.2) has a strong *negative* effect on total average quality perceptions. Comparison to other test conditions shows that this is neither the strongest, nor the weakest negative effect found.

Hypothesis 3b. When requirements definition uncertainty is high, decreases in IS function dispersal and in application customer/producer unit coordination mechanism use will have the greatest negative effect on perceptions of IS product/service quality.

Test Condition 3b.1: High Uncertainty (4), Low Dispersal (1), Low CMU (1)

Results: Effect on TAQ is .33(1) + .14(1) + (-.16)(1)(4) + (-.03)(1)(4) = -.29

Interpretation: Results were in the expected direction but Hypothesis 3b. was not supported. Under conditions of high uncertainty, decreased use of dispersal and coordination mechanisms is seen to have a moderately negative effect on TAQ. However, this effect is less strong than the negative effects found when examining conditions of high uncertainty and high use of Dispersal B.

Hypothesis 3c. When requirements definition uncertainty is low, decreases in IS function dispersal and in application customer/producer unit coordination mechanism use will not influence IS product/service quality.

The test conditions used below hold the uncertainty level stable at a low level, while varying levels of the independent variables. Test condition 3c.1 represents the situation where no effect is hypothesized.

Test Condition 3c.1: Low Uncertainty (2), Low Dispersal (1), Low CMU (1)

Results: Effect on TAQ is .33(1) + .14(1) + (-.16)(1)(2) + (-.03)(1)(2) = .09

Test Condition 3c.2: Low Uncertainty (2), Average Dispersal (1.5), Low CMU (1)

Results: Effect on TAQ is .33(1.5) + .14(1) + (-.16)(1.5)(2) + (-.03)(1)(2) = .095

Test Condition 3c.3: Low Uncertainty (2), High Dispersal (3), Low CMU (1)

Results: Effect on TAQ is .33(3) + .14(1) + (-.16)(3)(2) + (-.03)(1)(2) = .11

Test Condition 3c.4: Low Uncertainty (2), Low Dispersal (1), Average CMU (5)

Results: Effect on TAQ is .33(1) + .14(5) + (-.16)(1)(2) + (-.03)(5)(2) = .41

Interpretation: Hypothesis 3c. is tentatively supported. The results of test condition 3c.1 suggest that, under conditions of low uncertainty, decreased use of dispersal and coordination mechanisms has a minimal impact on total average quality. When uncertainty is low, TAQ tends to be positive. However, the TAQ increase estimated for condition 3c.1 is smaller than those resulting from assumptions of higher levels of one or both of the independent variables. It is also noted that under the same low uncertainty and low CMU conditions, increasing dispersal to an average level has only a minimal impact.

Hypothesis 3d. When requirements definition uncertainty is low, increases in both IS function dispersal and in application customer/producer unit coordination mechanism use will have a moderately negative influence on IS product/service quality.

The test conditions used below hold the uncertainty level stable at a low level and vary the independent variables. Test condition 3d.1 represents the situation where a moderately negative effect on TAQ is hypothesized.

Test Condition 3d.1:	**Low Uncertainty (2), High Dispersal (3), High CMU (10)**
Results:	**Effect on TAQ is .33(3) + .14(10) + (-.16)(3)(2) + (-.03)(10)(2) = .83**

Test Condition 3d.2:	**Low Uncertainty (2), Average Dispersal (1.5), High CMU (10)**
Results:	*Effect on TAQ - .33(1.5) + .14(10) + (-.16)(1.5)(2) + (-.03)(10)(2) = .815*

Interpretation: Hypothesis 3d is not supported. Results suggest that under conditions of low uncertainty, increased use of coordination mechanisms and dispersal has a strongly *positive* influence on total average quality. Further, under the same uncertainty and coordination mechanism use conditions, dispersal use need only be at average levels to achieve approximately the same level of improvement in TAQ.

Hypothesis 3e. When requirements definition uncertainty is high, increases in IS function dispersal or in application customer/producer unit coordination mechanism use, coupled with decreases in the remaining independent variable, will have a moderately positive influence on IS product/service quality.

The test conditions below hold uncertainty stable at a high level and test the effect of holding each alignment variable at a high level while the other is at a low level.

Test Condition 3e.1:	**High Uncertainty (4), Low Dispersal (1), High CMU (10)**
Results:	**Effect on TAQ is .33(1) + .14(10) + (-.16)(4)(1) + (-.03)(10)(4) = -.11**

Test Condition 3e.2: High Uncertainty (4), High Dispersal (3), Low CMU (1)

Results: Effect on TAQ is .33(3) + .14(1) + (-.16)(3)(4) + (-.03)(1)(4) = -.91

Interpretation: Hypothesis 3e. was not confirmed. Under conditions of high uncertainty, increased use of dispersal coupled with low use of coordination mechanisms appears to have the highest negative impact on total average quality. Under these same conditions, decreased use of dispersal coupled with increased use of coordination mechanisms has only a small negative effect on TAQ. Findings are in the opposite direction from that posited. Results of the tests of these conditions suggest that increased use of dispersal when requirements definition uncertainty is high has a more negative influence on TAQ than does increased use of CMU.

Hypothesis 3f. When requirements definition uncertainty is low, decreases in IS function dispersal coupled with increases in customer/producer unit coordination mechanism use will have a moderately negative influence on IS product/service quality.

Test Condition 3f.1: Low Uncertainty (2), Low Dispersal (1), High CMU (10)

Results: Effect on TAQ is .33(1) + .14(10) + (-.16)(1)(2) + (-.03)(10)(2) = .81

Interpretation: Hypothesis 3f. is not supported. Results suggest that under conditions of low uncertainty, decreases in IS dispersal coupled with increased coordination mechanism use have a strongly positive influence on total average quality. In fact, results are quite similar to those found in testing hypothesis 3d and are, again, in the opposite direction from those posited. The positive influence on TAQ can be attributed primarily to the strength of the effects of coordination mechanism use. As shown here and in the hypothesis 3d. test conditions, under conditions of low uncertainty with increased use of coordination mechanisms, large increases in TAQ result regardless of the level of IS dispersal.

Hypothesis 3g. When requirements definition uncertainty is low, increases in IS function dispersal coupled with decreases in customer/producer unit coordination mechanism use will have a moderately positive influence on IS product/service quality.

In the following test conditions, uncertainty is held stable at a low level, dispersal is held stable at a high level and CMU is varied from low to average. Test condition 3g.1 is the one hypothesized to result in a moderately positive increase in TAQ.

Test Condition 3g.1:	Low Uncertainty (2), High Dispersal (3), Low CMU (1)
Results:	Effect on TAQ is .33(3) + .14(1) + (-.16)(3)(2) + (-.03)(1)(2) = .11
Test Condition 3g.2:	Low Uncertainty (2), High Dispersal (3), Average CMU (5)
Results:	Effect on TAQ is .33(3) + .14(5) + (-.16)(3)(2) + (-.03)(5)(2) = .43

Interpretation: Partial support was found for Hypothesis 3g. Under conditions of low uncertainty with low use of coordination mechanisms, increased use of dispersal has a small positive influence on TAQ. While results are in the expected direction, they are not as strong as posited. As shown by the results for test condition 3g.2, when uncertainty is low and there is high use of IS dispersal, coordination mechanism use must be at least at an average level of CMU before a "moderate" positive influence on total average quality is seen.

Conclusion - Test of hypothesized model: Analysis of Hypotheses Set 3 began with the finding that, although the hypothesized regression model attained a statistically significant F value, none of the individual inputs to the model contributed significantly to the reduction of error in the model. The weakness of the regression results is consistent with similar weaknesses found in all regression models tested in this research that included more than two explanatory terms. Sample size may be insufficient for adequate tests of these models.

The parameter estimates for the hypothesized regression model were used to explore each of the seven hypotheses in this set. No support was found for Hypotheses 3a., 3b., 3d. 3e. and 3f. Data analysis results for Hypotheses 3a., 3b. and 3e. (which all related to effects under conditions of high uncertainty) ran in the opposite direction from that posited as did results for Hypotheses 3d. and 3f. (which related to effects under conditions of low uncertainty). Tentative support was found for Hypothesis 3c. and partial support found for Hypothesis 3g.

The following conclusions are suggested:

- Under conditions of high uncertainty, combined and increasing use of the alignment mechanisms has a strongly *negative* influence on IS product/service quality.

- Under high uncertainty conditions, combined and decreasing use of IS dispersal and coordination mechanisms has only a *moderately negative* influence on the quality criterion.

- Under conditions of low uncertainty, combined and increasing use of both alignment mechanisms has a strongly *positive* influence on total average quality.

- Under low uncertainty conditions, combined and decreasing use of both IS dispersal and coordination mechanism use has *minimal influence* on the quality criterion.

- Under conditions of high uncertainty, increased use of dispersal coupled with decreased use of coordination mechanisms has the *highest negative* impact on total average quality. Increased use of coordination mechanisms coupled with decreased use of dispersal under these conditions, on the other hand, has only a small negative effect on TAQ.

- Under conditions of low uncertainty, increased use of coordination mechanisms has the *highest positive* effect on TAQ, regardless of the level of IS dispersal. Increased use of dispersal coupled with decreased coordination mechanism use, on the other hand, results in only low to moderate positive influence on the quality criterion.

Investigation of Alternative Regression Models: Two other forms of regression models were tested as alternatives to the hypothesized model. The first included both the Dispersal B and a CMU independent variable term and used Uncertainty only as a main effect. The second included all four of the terms included in the hypothesized model, but also added Uncertainty as an independent variable. As shown in Table 15, Part 3, the resulting models were an improvement over the hypothesized model. F values attained greater significance and R-Square values increased substantially.

The models containing only the three independent variables yielded the highest R-Square values discussed thus far (.4116 for the model using CMU scoring method 1, .4275 for the model using CMU scoring method 3). Type III SS values were significant for both the CMU term and the uncertainty term.

The models containing all five explanatory terms yielded a very modest increase in R-Square over the unmoderated model, given than they included two additional variables. R-Square equaled .4362 for the model containing CMU (0,1,1) and

.4507 for the model containing CMU (0,1,1). Statistically significant Type III SS values were obtained only for the uncertainty term in each model.

The strongest alternative model for Hypotheses Set 3 is the unmoderated one, including both alignment variables and an uncertainty main effect. Results of using the parameter estimates for this model to test hypothesized conditions and effects are shown in Table 18.

All calculated effects on the total average quality criterion using the parameter estimates from the alternative unmoderated model are negative, ranging from -.66 to -2.37. Comparison of the test condition results for this model to the results yielded from the hypothesized model, however, show movement in the same direction. As in the hypothesized model results, the strongest negative influence results from test condition 3e.2. The weakest negative influence, on the other hand, results from test condition 3f.1, which is the condition that gave the highest positive influence in the testing of the hypothesized model. Similar operational differences between the influence of Dispersal B and the influence of Coordination Mechanism Use are seen in both models, with increased use of the former tending to negatively influence the quality criterion, while use of the latter tends to positively influence it.

TABLE 18
EXAMINATION OF HYPOTHESES SET 3
USING PARAMETER ESTIMATES FROM ALTERNATIVE UNMODERATED MODEL

Test Condition 3a.1:	High Uncertainty (4), High Dispersal (3), Average CMU (5)
Results:	Effect on TAQ is -.10(3) + .05(5) + (-.53)(4) = -2.17
Test Condition 3a.2:	High Uncertainty (4), High Dispersal (3), High CMU (10)
Results:	Effect on TAQ is -.10(3) + .05(10) + (-.53)(4) = -1.92
Test Condition 3a.3:	High Uncertainty (4), Average Dispersal (1.5), High CMU (10)
Results:	Effect on TAQ is -.10(1.5) + .05(10) + (-.53)(4) = -1.77
Test Condition 3b.1:	High Uncertainty (4), Low Dispersal (1), Low CMU (1)
Results:	Effect on TAQ is -.10(1) + .05(1) + (-.53)(4) = -2.17
Test Condition 3c.1:	Low Uncertainty (2), Low Dispersal (1), Low CMU (1)
Results:	Effect on TAQ is -.10(1) + .05(1) + (-.53)(2) = -1.11
Test Condition 3c.2:	Low Uncertainty (2), Average Dispersal (1.5), Low CMU (1)
Results:	Effect on TAQ is -.10(1.5)+.05(1) + (-.53)(2) = -1.16
Test Condition 3c.3:	Low Uncertainty (2), High Dispersal (3), Low CMU (1)
Results:	Effect on TAQ is -.10(3)+ .05(1) + (-.53)(2) + (-.03)(2) = -1.31
Test Condition 3c.4:	Low Uncertainty (2), Low Dispersal (1), Average CMU (5)
Results:	Effect on TAQ is -.10(1) + .05(5) + (-.53)(2) = -1.11
Test Condition 3d.1:	Low Uncertainty (2), High Dispersal (3), High CMU (10)
Results:	Effect on TAQ is -.10(3) + .05(10) + (-.53)(2) = -.86
Test Condition 3d.2:	Low Uncertainty (2), Average Dispersal (1.5), High CMU (10)
Results:	Effect on TAQ is -.10(1.5) + .05(10) + (-.53)(2) = -.71
Test Condition 3e.1:	High Uncertainty (4), Low Dispersal (1), High CMU (10)
Results:	Effect on TAQ is -.10(1) + .05(10) + (-.53)(4) = -1.72
Test Condition 3e.2:	High Uncertainty (4), High Dispersal (3), Low CMU (1)
Results:	Effect on TAQ is -.10(3) + .05(1) + (-.53)(4) = -2.37
Test Condition 3f.1:	Low Uncertainty (2), Low Dispersal (1), High CMU (10)
Results:	Effect on TAQ is -.10(1) + .05(10) + (-.53)(2) = -.66
Test Condition 3g.1:	Low Uncertainty (2), High Dispersal (3), Low CMU (1)
Results:	Effect on TAQ is -.10(3) + .05(1) + (-.53)(2) = -1.31
Test Condition 3g.2:	Low Uncertainty (2), High Dispersal (3), Average CMU (5)
Results:	Effect on TAQ is -.10(3) + .05(5) + (-.53)(2) = -1.11

Acceptance of this alternative model instead of the hypothesized model would imply that alignment mechanisms (at least, as applied by the work units in this sample) can *never* positively offset the negative influence of uncertainty on the quality criterion sufficiently enough to increase the quality outcome. The conclusion that would be drawn is that increased uncertainty negatively influences the IS product/service quality outcome, use of IS dispersal adds a little to this negative effect, and coordination mechanism use has a slightly positive effect that can only improve the quality outcome slightly. Given the results of the test of Hypotheses Sets 1, 2 and 4 (to be discussed next), this conclusion seems unwarranted. While uncertainty appears to definitely operate as a main effect, there is also sufficient evidence to suggest that it has a moderating effect as well. Additional research with larger sample size is needed to confirm this.

3) Hypotheses Set 4

This set of hypotheses focused on the differential impact of use of the alignment mechanisms under different conditions of uncertainty on the customer view of quality versus the producer view of quality. It was expected that under conditions of high uncertainty, increases in use of alignment mechanisms would have a more strongly positive impact on customer perception of quality than on producer perception of quality. Further, under this same high uncertainty condition, it was expected that decreased use of alignment mechanisms would have a more strongly negative influence on customer perception than producer perception of quality.

Statistical analysis of results was again performed using the SAS GENERAL LINEAR MODELS PROCEDURE. As Part 4 of Table 15 shows, all but one of the hypothesized regression models yielded statistically significant F values at the .05 level of significance. For the producer quality dependent variable, all hypothesized models yielded significant F values with significant Type III SS values for all both independent variable and moderating variable inputs. For the customer quality dependent variable, on the other hand, the regression results were more mixed. Each of the hypothesized models that included a coordination mechanism use (CMU) independent variable attained significance, but the Type III SS data for them indicate that only the CMU term, and not the uncertainty interaction term, contributed significantly to reduction of error in customer quality. The F value for the model including Dispersal B and the uncertainty interaction term, with the customer quality dependent variable, was not statistically significant. Type III SS data for this model show that only the uncertainty interaction term (and not the dispersal variable) contributed significantly to reduction of error in the customer quality criterion.

Use of the parameter estimates from the hypothesized models (shown in Part 4 of Table 16) to approximate effects can be used tentatively, as they were in the previous section of this analysis, to explore each of the hypotheses in this set. Again, graphs of the partial derivatives from each regression equation (shown in

Figures 20D.-20I.) show a nonmonotonic effect and can be used to identify the point on the uncertainty scale at which there is a change in the direction of an alignment strategy's impact. This information along with the calculated means and standard deviations of the independent variables are used to set the variable values for the test conditions to be examined in the following section of this research report. Low, Average and High levels of the IS dispersal and coordination mechanism use variables are set in accord with Table 17 values. Uncertainty levels for the interaction terms that can be used to compare effects on the producer quality (PQ) criterion to the customer quality criterion (CQ) were established as shown in Table 19.

Hypothesis 4a. When requirements definition uncertainty is high, increases in IS customer/producer coordination mechanism use will have a more strongly positive influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Test Condition 4a.1:	High Uncertainty (4.5), High CMU(0,1,1,) (10)
Results:	Effect on CQ is .23(10) + -.06(10)(4.5) = -.40
	Effect on PQ is .21(10) + -.065(10)(4.5) = -.825

TABLE 19
INTERACTION TERM VALUES USED WITH PARAMETER ESTIMATES TO EXAMINE DIRECTION AND SIZE OF EFFECTS FOR HYPOTHESES SET 4

Customer Quality Criterion

	High	Low
Uncertainty with:		
Dispersal B[1]	3	1.5
CMU (0,1,1)[2]	4.5	3
CMU (0,0,1)[3]	5	4

[1] values set relative to *d*CQ/*d*DispersalB = 0 at Uncertainty 2.10, so that low uncertainty < 2.10 and high uncertainty > 2.10.

[2] values set relative to *d*CQ/*d*CMU(0,1,1) = 0 at Uncertainty 3.80, so that low uncertainty < 3.80 and high uncertainty > 3.80.

[3] values set relative to *d*CQ/*d*CMU(0,0,1) = 0 at Uncertainty 4.60, so that low uncertainty < 4.60 and high uncertainty > 4.60.

Producer Quality Criterion

	High	Low
Uncertainty with:		
Dispersal B[4]	3	2
CMU (0,1,1)[5]	3.5	2.5
CMU (0,0,1)[6]	4	2.5

[4] values set relative to *d*PQ/*d*DispersalB = 0 at Uncertainty 2.70, so that low uncertainty < 2.70 and high uncertainty > 2.70.

[5] values set relative to *d*PQ/*d*CMU(0,1,1) = 0 at Uncertainty 3.00, so that low uncertainty < 3.00 and high uncertainty > 3.00.

[6] values set relative to *d*PQ/*d*CMU(0,0,1) = 0 at Uncertainty 3.10, so that low uncertainty < 3.10 and high uncertainty > 3.10.

For Comparison of PQ and CQ Effects

	High	Low
Uncertainty with:		
Dispersal B	3	1.5
CMU (0,1,1)	4.5	2.5
CMU (0,0,1)	5	2.5

Test Condition 4a.2: **High Uncertainty (5), High CMU(0,0,1) (10)**

Results: **Effect on CQ is .23(10) + -.05(10)(5) = -.20**

Effect on PQ is .22(10) + -.07(10)(5) = -1.30

Interpretation: Little support was found for Hypothesis 4a. The overall effects of high coordination mechanism use under conditions of high uncertainty are negative, not positive, for both PQ and CQ. Results suggest that this negative impact is greater for PQ than for CQ.

Hypothesis 4b. When requirements definition uncertainty is high, increases in IS dispersal will have a more strongly positive influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Test Condition 4b.1: High Uncertainty (3), High Dispersal B (3)

Results: Effect on CQ is .72(3) + -.33(3)(3) = -.81

Effect on PQ is .74(3) + -.27(3)(3) = -.18

Interpretation: Hypothesis 4b. is not supported. Results are the opposite of those posited. They suggest that under conditions of high uncertainty, increases in IS dispersal have a more strongly negative influence on the customer perception of quality than on the producer perspective of quality.

Hypothesis 4c. When requirements definition uncertainty is high, decreases in IS customer/producer coordination mechanism use will have a more strongly negative influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Test Condition 4c.1:	High Uncertainty (4.5), Low CMU(0,1,1,) (1)
Results:	Effect on CQ is .23(1) + -.06(1)(4.5) = -.06
	Effect on PQ is .21(1) + -.065(1)(4.5) = -.0825

Test Condition 4c.2:	High Uncertainty (5), Low CMU(0,0,1) (1)
Results:	Effect on CQ is .23(1) + -.05(1)(5) = -.02
	Effect on PQ is .22(1) + -.07(1)(5) = -.15

Interpretation: Hypothesis 4c. is not supported. While a negative effect resulted from these tests, the effects are quite small and, opposite from what was posited, are slightly more negative for the producer view than for the customer view of quality. Results suggest that the gap between the level of negative influence on the two views is small in both cases tested, but widens when the CMU (0,0,1) scoring mechanism is used.

Hypothesis 4d. When requirements definition uncertainty is high, decreases in IS dispersal will have a more strongly negative influence on the customer perception of IS product/service quality than it will have on the producer perception of IS product/service quality.

Test Condition 4d.1: High Uncertainty (3), Low Dispersal B (1)

Results: Effect on CQ is .72(1) + -.33(1)(3) = -.27

Effect on PQ is .74(1) + -.27(1)(3) = -.07

Interpretation: Hypothesis 4d. is tentatively supported. Test results suggest that low use of dispersal under conditions of high uncertainty will have a more negative effect on CQ than PQ.

Hypothesis 4e. When requirements definition uncertainty is low, increases in IS dispersal will have a more negative influence on the producer perception of IS product/service quality than it will have on the customer perception of IS product/service quality.

Test Condition 4e.1: Low Uncertainty (1.5), High Dispersal B (3)

Results: Effect on CQ is .72(3) + -.33(3)(1.5) = .675

Effect on PQ is .74(3) + -.27(3)(1.5) = 1.005

Interpretation: Hypothesis 4e. is not supported. The opposite effects of those posited were found. High dispersal use under conditions of low uncertainty has a positive (not negative) influence on both views of quality, with its greater positive influence on the producer perspective of quality.

Hypothesis 4f. When requirements definition uncertainty is low, decreases in IS dispersal will have a more positive influence on the producer perception of IS product/service quality than it will have on the customer perception of IS product/service quality.

Test Condition 4f.1:	Low Uncertainty (1.5), Low Dispersal B (1)
Results:	Effect on CQ is .72(1) + -.33(1)(1.5) = -.225
	Effect on PQ is .74(1) + -.27(1)(1.5) = -.335

Interpretation: Hypothesis 4f. is not supported. The opposite effects of those posited were found. Low dispersal use under conditions of low uncertainty has a negative (not positive) influence on both views of quality, with its greater negative influence on the producer perspective of quality.

Hypothesis 4g. When requirements definition uncertainty is low, increases in IS customer/producer coordination mechanism use will have an equally negative influence on the producer perception of IS product/service quality and the customer perception of IS product/service quality.

Test Condition 4g.1:	Low Uncertainty (2.5), High CMU(0,1,1,) (10)
Results:	Effect on CQ is .23(10) + -.06(10)(2.5) = .80
	Effect on PQ is .21(10) + -.065(10)(2.5) = .475

Test Condition 4g.2: Low Uncertainty (2.5), High CMU(0,0,1) (10)

Results: Effect on CQ is .23(10) + -.05(10)(2.5) = 1.05

Effect on PQ is .22(10) + -.07(10)(2.5) = .45

Interpretation: Hypothesis 4g. is not supported. The opposite effects of those posited were found. High coordination mechanism use under conditions of low uncertainty has a positive (not negative) influence on both views of quality, with its greater positive influence on the customer perspective of quality.

Hypothesis 4h. When requirements definition uncertainty is low, decreases in IS customer/producer coordination mechanism use will have an equally positive influence on the producer perception of IS product/service quality and the customer perception of IS product/service quality.

Test Condition 4h.1: Low Uncertainty (2.5), Low CMU(0,1,1,) (1)

Results: Effect on CQ is .23(1) + -.06(1)(2.5) = .08

Effect on PQ is .21(1) + -.065(1)(2.5) = .0475

Test Condition 4h.2: Low Uncertainty (2.5), Low CMU(0,0,1) (1)

Results: Effect on CQ is .23(1) + -.05(1)(2.5) = .105

Effect on PQ is .22(1) + -.07(1)(2.5) = .045

Interpretation: Hypothesis 4h. is not supported. Results suggest that decreased use of coordination mechanisms under conditions of low uncertainty has a very small positive influence on both views of quality. This influence is slightly higher for the customer view than for the producer view.

A difference is observed here in terms of how much coordination mechanism or IS dispersal use influence the two different views of quality. Use of dispersal seems to have very little impact on the customer view of quality, while coordination mechanism use does have significant influence. Consistent with previous results, the effects are basically the opposite of those posited.

Conclusion - Test of hypothesized models: In Hypotheses Set 4, the first evidence of a differential impact of use of alignment mechanisms on the customer vs. the producer view of quality was seen in the F values that resulted from testing of the hypothesized regression models. While all regression models for the producer quality criterion (PQ) yielded statistically significant F values, only those models that used the CMU independent variable for the customer quality criterion (CQ) attained significance. That is, the data suggest that the Dispersal B variable has a more significant influence on the PQ criteria than on the CQ criteria. Consistent with previous results, however, for both views of quality, the influence of dispersal is not as great as that of coordination mechanism use.

The parameter estimates for the hypothesized regression models were used to explore each of the eight hypotheses in this set. Hypotheses 4a., 4b., 4c., 4e., 4f., 4g. and 4h. were not supported. Data analysis results for Hypotheses 4a., 4b. and

4c. (which both related to effects under conditions of high uncertainty) ran in the opposite direction from that posited as did results for Hypotheses 4e., 4f. and 4g. (which related to effects under conditions of low uncertainty). Results for Hypothesis 4h., where an equally positive influence on CQ and PQ from decreased use of coordination mechanisms under conditions of low uncertainty was posited, suggested a small positive influence that is slightly higher for the customer view than for the producer view.

Hypothesis 4d. received tentative support, with test results suggesting that low use of dispersal under conditions of high uncertainty might have a more negative influence on CQ than PQ. However, this is qualified by the results of the test of Hypothesis 4e. which suggest that high use of dispersal under conditions of low uncertainty has a more positive influence on PQ than CQ.

The following conclusions are suggested:

- Under conditions of high uncertainty, increased use of coordination mechanisms will have a stronger negative influence on PQ than CQ; while decreased use of coordination mechanisms will have very little effect on either view, but still a tendency to more negatively impact PQ.

- Under conditions of low uncertainty, increased use of coordination mechanisms will have a stronger positive influence on CQ than PQ; while decreased use of coordination mechanisms will have little influence on either view, but still a tendency to more positively impact CQ.

- Under conditions of high uncertainty, increased use of dispersal will have a stronger negative influence on CQ than on PQ; while decreased use of dispersal will have little impact on the producer's view of quality, but still a small negative influence on CQ.

- Under conditions of low uncertainty, increased use of dispersal will have a stronger positive influence on PQ than CQ; while decreased use of dispersal will have a more negative influence on PQ than CQ.

<u>Investigation of Alternative Regression Models</u>: The R-Square values for this set of hypotheses are the lowest seen in this research. For the hypothesized models that attained significance, the R-Squares ranged from a low of about .19 to a high of about .23. Two alternative forms of regression models were tested and compared to the hypothesized models. Results are shown in Part 4 of Table 15 for both the Producer Quality dependent variable and the Customer Quality dependent variable.

The first type included an alignment variable and used uncertainty only as a main effect. The second type included the alignment variable and used uncertainty both as an independent variable and an interaction term. For the PQ criterion, significant F values and improved R-Squares were obtained for all of the alternative models. However, while the Type III SS values for variables in the hypothesized PQ models were statistically significant, none were significant in the three explanatory parameter models, and only the uncertainty independent variable contributed significantly to reduction of variance in the unmoderated model. Thus, similarly to the circumstances seen in tests of Hypotheses Set 1 and 2, the alternative PQ models have no clear superiority.

Tests of the alternative CQ models using the Dispersal B independent variable also resulted in higher R-Square values, but only the unmoderated alternative model attained a statistically significant F value ($F=4.06$, $Pr>F=.0279$). For this model, the only significant Type III SS value was for the uncertainty main effect. While the unmoderated model appears superior to the hypothesized model, in this case, neither model holds much explanatory value. Results simply show once more that Dispersal, as practiced by the work units in this sample, has a fairly minimal influence on IS product/service quality outcome - and suggest that this is especially so from the perspective of the IS customer.

Significant F values and improved R-Squares were obtained for all of the alternative CQ models using the Coordination Mechanism Use independent variable. The test of the alternative models that included uncertainty as both an independent and a moderating variable resulted in no statistically significant Type III SS values for any of the regression model parameters. The test of the unmoderated alternative model using the CMU (0,0,1) scoring method resulted in statistically significant Type III SS values for both independent variables, while only the uncertainty main effect was found to significantly contribute to reduction of error in the test of this model using the CMU (0,1,1) scoring method. This finding is consistent with the earlier correlational finding that joint assignment of accomplishment of IS activities to IS customers and IS producers has a positive relationship to CQ, while assignment of accomplishment of these activities to customers alone is negatively correlated to CQ.

From this analysis, it can be concluded that the alternative unmoderated models using CMU (0,0,1) are superior to those using CMU (0,1,1) when examining effect on Customer Quality. The test of this unmoderated model clearly attained the best statistical results for the CQ criterion. However, again, this may be a result of the sample size. It is possible that, with a larger sample, the alternative model that used CMU (0,0,1) and included uncertainty as both an independent and a moderating variable would attain better results. Additional research is needed to examine this.

VI. Interpretation of Results and Conclusions

A. Discussion

1. *IS Requirements Definition Uncertainty*: Uncertainty was by far the most powerful predictor of IS quality results examined in this research. Research results tentatively support the operation of uncertainty as a moderator between each of the IS customer/producer alignment mechanisms (i.e., IS Dispersal and Coordination Mechanism Use) and the Total Average Quality (TAQ) and Producer Quality (PQ) criteria. In addition, uncertainty was also found to operate as a fairly strong independent variable for all of the quality criteria (i.e., for TAQ, PQ, and Customer Quality, as well). In general, as uncertainty increases, quality perceptions are expected to decrease.

The nature of this independent, negative relationship between IS requirements definition uncertainty and the IS product/service quality outcome is strong enough to suggest the following:

- Unless requirements definition uncertainty can be reduced before and/or during an IS application development/support project, the quality outcome of the IS project is likely to be impaired.

The nature of the uncertainty interaction effect between IS alignment mechanisms and IS product/service quality outcome suggests the further caution:

* IS dispersal and IS customer/producer coordination mechanism use (at least, as they are practiced by this research sample) cannot reduce requirements definition uncertainty. Rather, *under conditions of high uncertainty*, use of these mechanisms appears to exacerbate the situation, resulting in an increased negative influence on perceptions of IS product/service quality.

This is contrary to what the organizational structure literature suggests. The alignment mechanisms studied in this research are the very type that other researchers (Burns and Stalker, 1961; Van de Ven, Delbecq and Koenig, 1976; Tushman and Nadler, 1978, Tushman, 1979; Gresov, 1989) have suggested are most appropriate for reducing task uncertainty. Mechanisms like these are said to create the capacity to process more information and allow work units to engage in more intensive modes of coordination - both requirements for work unit effectiveness under conditions of high uncertainty (Gresov, 1989).

2. *IS Dispersal*: In this research sample, little use was made of IS Dispersal as an IS customer/producer alignment strategy. Most of the IS activities remained concentrated at the enterprise level of the sample organizations, while some

specific IS activities were found to be more routinely dispersed below this organizational level. The more frequently dispersed activities were those that required the greatest understanding of the line business. The more concentrated activities were those that required a high level of technical skill in IS and those that involved financial management of IS work.

Tests of hypothesized regression models involving the relationship of use of IS dispersal to IS product/service quality outcome over a range of requirements uncertainty were not fully conclusive. The Dispersal B variable and DispersalB*Uncertainty interaction terms, both contributed significantly to the reduction of error in the Total Average Quality (TAQ) and the Producer Quality (PQ) criterions. However, when alternative models that used Uncertainty as a main effect were constructed, the impact of Dispersal B on these criteria was reduced. Tests of Hypotheses Set 4 provided evidence that IS Dispersal has little influence on the Customer Quality (CQ) criterion.

The basic form of the relationships between Dispersal B and the IS quality outcomes that is suggested by the research is quite different than that originally posited, and somewhat more complicated. It appears that:

* When requirements definition uncertainty is high, increases in IS dispersal will negatively influence TAQ, and decreases in IS dispersal will positively influence IS product/service quality. Further, under conditions of high uncertainty, increased use of dispersal will have a stronger negative influence on CQ than on PQ.

* Under conditions of low requirements definition uncertainty, increases in IS dispersal will positively influence TAQ, and decreases in IS dispersal will negatively influence TAQ. Further, under conditions of low uncertainty, increased use of dispersal will have a stronger positive influence on PQ than CQ; while decreased use of dispersal will have a more negative influence on PQ than CQ.

Recent IS industry literature has suggested that many enterprises have failed to find clear advantage from the dispersal of their IS application and development units that occurred in the late 1980's (Maglitta and Mehler, 1992; Margolis, 1992). Given the complex nature of the benefits and pitfalls of IS dispersal suggested by this research, this is not surprising. It appears that appropriate use of IS dispersal (i.e., under situations of low uncertainty) can most positively influence the IS Producer's view of quality, while inappropriate use can work to the detriment of either the Customer's perspective of quality or the Producer's view of quality, depending upon the specific conditions. Increased use of dispersal under conditions of high uncertainty has its most negative influence on CQ, while decreased use of dispersal under conditions of low uncertainty has its most negative influence on PQ. Whether or not a specific organization finds benefit in IS dispersal is likely to be both a matter of the situation in which dispersal is used and a matter of *who* (i.e., IS customers or IS producers) is judging the success of the results.

Some organizations are reported to be moving now towards concentration of IS activities. Others report that they are rethinking exactly which activities are most effectively dispersed vs. concentrated. In those cases where organizations are moving to reunite formerly dispersed IS development groups or activities, one stated aim has been the reestablishment of necessary control in order to reduce duplicated efforts, promote standards, and achieve greater efficiencies (Maglitta and Mehler, 1992). Inefficiencies introduced in these areas, as a result of use of IS dispersal under conditions of high uncertainty, might be part of the cause for the greater negative impact on the IS Customer view of quality. This inefficiency would affect software cost and timeliness - issues of greater concern to IS customers than IS producers.

It has also been suggested that, in some cases, the partial dispersal of IS staff and activities into an enterprise's line business units accomplished during the 1980's has now been found to be counterproductive for a different reason. According to Margolis (1992), in the case of N.Y. Life, this kind of organizational change had the unintentional result of increasing the differentiation of the IS functions that remained concentrated, instead of fostering the increased integration of IS with line business activities which was intended. The situation described here is one likely to negatively influence characteristics of software quality of concern to both IS producers and IS customers, but the link to the current research findings is not clear cut. It may be that the increased differentiation is, in fact, a result of use of dispersal under conditions of high uncertainty. Research results suggest that this would have a negative impact on all views of quality, but especially on those of the customer.

3. *IS Customer/Producer Coordination Mechanism Use*: Tests of hypothesized regression models involving the relationship of use of IS coordination mechanism use to IS product/service quality outcome over a range of requirements uncertainty were not fully conclusive. The Coordination Mechanism Use (CMU) variable and CMU*Uncertainty interaction terms, both contributed significantly to the reduction of error in the TAQ, PQ, and CQ criterions. However, when alternative models that used Uncertainty as a main effect were constructed, the impact of CMU on these criteria was reduced.

Again, the basic form of the relationships between Dispersal B and the IS quality outcomes that is suggested by the research is quite different than that originally posited, and somewhat more complicated. It appears that:

- When requirements definition uncertainty is high, increased use of IS customer/producer coordination mechanisms will negatively influence the quality criteria, while decreases in coordination mechanism use will positively influence them. Further, under conditions of high uncertainty, increased use of coordination mechanisms will have a stronger negative influence on PQ than CQ.

- Under conditions of low requirements definition uncertainty, increases in coordination mechanism use will positively influence IS product/service quality from all views, while decreases in coordination mechanism use will tend to negatively influence the quality criteria. Further, under conditions of low uncertainty, increased use of coordination mechanisms will have a stronger positive influence on CQ than PQ.

Generally, the IS customer view of quality seems more favorably influenced by use of IS coordination mechanisms than does that of the IS producers (which could simply relate to their feeling of greater involvement in the project and "ownership" of results). However, quality from both views is negatively influenced by use of coordination mechanisms under conditions of high uncertainty. To some extent, mechanisms like JAD's, SLA's and requirements definition inspections seem to actually heighten the problems faced when the uncertainty level is too high. This is likely to lead to frustration on all fronts. Witness this assessment of things gone wrong in a new accounting system development and implementation project, as reported by Kordich (1992):

> "In this instance, communication seemed to play the largest part in making the conversion a difficult one. (Name omitted) has been involved in the numerous discussions during the past year with the crucial areas - the accounting unit responsible for the conversion and the MIS testers and programmers responsible for implementing the revised system. According to (this person), *the most frustrating thing was that while numerous meetings were held, actual coordination among users was practically non-existent. Decisions reached were often revised after the fact and not communicated to all those involved*. This caused much of unproductive "we said"/"you said" discussions. While it appears the project will be implemented on time (there really was no choice), the final product will not be as comprehensive nor error free as everyone had originally planned."

This anecdote suggests two additional influences on the effectiveness of coordination mechanism use for improving the IS product/service quality outcome: 1) the extent to which the coordination mechanisms applied are soundly implemented; and 2) the extent to which political influences operate outside of and without the involvement of key project participants from the IS producer and/or IS customer units. That is, the problem reported by Kordich (1992) illustrates that bringing together IS customers and IS producers in "meetings" focused on the IS project is insufficient if the meeting techniques are not effective or if the decisions and agreements reached in these venues are disregarded due to more powerful outside influences.

4. *Characteristics of Software Quality - IS Producer and IS Customer Views*: The measure of IS product/service quality used in this research incorporated the two independent perspectives on quality - those of the IS producer unit staff and those of the IS customer unit staff. This approach was adopted based upon observation and previous research that suggested that the two parties have different perceptions of IS quality, in part, because they tend to focus on different quality characteristics.

Research results confirmed that the two views of quality are substantially different. The Pearson Product Moment correlation between the IS producer and the IS customer quality ratings was only .41 (p = .017), implying that only 17% of the variance in one view may be accounted for by the other. Further, the lowest and highest rated quality characteristics from each view overlapped very little. IS customers and IS producers agreed that data security and on line availability were generally *not* problems. They also agreed that system documentation *was* generally a quality problem. Otherwise, there was no overlap in the quality characteristics that they rated the lowest. Customers reported the greatest quality problems in the IS cost estimates, implementation schedules, functional requirements, system flexibility and cost effectiveness. Producers reported the greatest quality problems in the IS portability, testability, maintainability, traceability (of requirements), and auditability.

The differences in perspective on quality were also apparent in the results of the tests of the hypothesized models in Hypotheses Set 4. Findings suggest that the appropriate organizational use of alignment mechanisms is dependent upon what particular aspects of quality need to be most improved. Similarly, the inappropriate use of alignment mechanisms seems to have a differential impact on the customer vs. the producer view of quality.

Despite this and the obvious value of obtaining IS quality perceptions from multiple views, it may well be that the quality issues from each perspective are more related than can be observed in this research. This would be the case if the issues raised by the IS producers could be shown to be ones that *lead to* most of the quality problems raised by the IS producers. Future research is needed to examine this possibility.

B. <u>Limitations of the Research</u>

The greatest limitation of this research, in terms of statistical analysis, was the relatively small work unit sample used (N=34). While the sample was large enough to allow evaluation of regression models with two explanatory variables, models with more parameters could not be conclusively evaluated. Thus, while there is a suggestion in the research results that requirements definition uncertainty operates both as a moderator and an independent variable, tests of regression models including both an uncertainty main effect and an uncertainty interaction term were inconclusive. In most of these cases, the models attained significant F values and improved R-Squares. However, the uncertainty main effect was the only input which could conclusively be said to have contributed to reduction of error in the quality dependent variable in these regression models.

The same effect was seen in the tests of Hypotheses Set 3 which focused on the combined impact of use of IS Dispersal and Coordination Mechanism Use. Without more data to yield more conclusive tests, results like those that suggest that the negative influence on quality from the inappropriate use of both IS Dispersal and Coordination Mechanisms (i.e., under conditions of high uncertainty) relates more to the impact of use of IS Dispersal than it does to Coordination Mechanism Use are merely speculation.

A further limitation, statistically, was constituted by the skewed distributions of the Dispersal B and the Coordination Mechanism Use data. Assumption of normality in regression analysis is necessary for the purpose of inference. The Dispersal B data is particularly problematic in this sense, but the Shapiro-Wilks tests of normality for both independent variable data sets resulted in rejection of the null hypothesis of normality of data distribution.

Other limitations of this study are related to potential explanatory variables that were not included in the research models. These include: 1) the performance levels of the IS project staff; and 2) requirements definition techniques other than those addressed. With regard to performance levels, it has been suggested that this may the *primary* explanatory variable for accomplishment of an IS project on time and within budget (Jones, 1981). This variable was uncontrolled in the current research.

Other requirements definition techniques that might have been in use on the sample projects and thereby been an uncontrolled influence on IS quality outcomes could include an information engineering approach (e.g., CASE usage), which highly structures the definition of the system problem to be addressed in context of the larger business system; a system prototyping approach, which takes a more evolutionary approach to requirements definition through the building and successive refinement of a series of models of the target information system; or some other less widely used technique. As an example of the latter, Anthes (1993) describes an approach called Managed Evolutionary Development (MED) in use in some Federal agencies. This approach assumes that, you need not, and indeed cannot, resolve all uncertainties and eliminate all risks at the front end of IS projects. Rather, by explicitly recognizing and documenting the unknowns, the methodology is said to make it possible to proceed safely with the project, while the uncertainties get resolved in a carefully managed way.

C. Implications for Contingency "Theory"

The results of the current research clearly suggest that structural contingency theory is inadequate to provide operational guidance to managers in how to organize the IS function to optimize IS product and service quality. As Schoonhoven (1981) has suggested, most existing contingency arguments are not specific enough about the form and direction of expected contingency relationships, to be of real value. By making explicit the assumptions of multiplicative, symmetric and nonmonotonic effects in the current research, structural contingency relationships have been examined in much greater detail than in earlier research. However, results suggest that, in this case, the assumption of symmetry in the relationship between the structure and uncertainty variables does not hold.

The three most major differences between the nature of the specific research model used here and previous research applications of contingency theory are:

> The current research focused on the work unit level of analysis. Prior research has been conducted almost entirely at the enterprise level of analysis, so that any work unit differences within the enterprise would have been obscured.

In the current research, perception of quality was used as the effectiveness variable. No prior contingency research was found in which this effectiveness variable was used.

> Unlike this research, prior research has not considered the possibility of different effects of structural variables on different "stakeholder" views of organizational effectiveness. Prior research has not as fully considered that judgements of effectiveness involve questions of values.

A powerful reason for the contrary findings in the current contingency research is suggested by these differences. Quite simply, the results of this research are not directly comparable to prior contingency research. Rather than contradicting contingency theory propositions, the research results should be viewed as clarifying and elaborating upon it. The basic premises of contingency theory remain uncontested. These are:

- The effectiveness of a given structural form is "contingent" upon the nature of the tasks performed and the specific demands of the work environment.

- No universally ideal organization form exists.

- Accurate and intelligent diagnosis of task requirements within an organization is a prerequisite to effective organization design and management.

- An organization, to be viable, must possess a structure that corresponds in its level of complexity with the level of complexity of its environment.

- The nature of the task environment determines, or at least places constraints on, the choices of organizational designs that will be effective.

Similar to Schoonhoven's (1981) conclusion from her contingency research:

> "...traditional versions of contingency theory like Galbraith's (1973) underrepresent the complexity of relations between technological uncertainty, structure and organizational effectiveness." "Our results are consistent with a more enlightened version of the contingency-orienting strategy in general. The relations that we have found" ...... "support an approach to organizational design that begins with the statement that 'It all depends...'"

D. Implications for IS Management

A specific objective of this research was systematic examination of the value of common organizational approaches to improvement of IS application function customer-producer alignment in order to develop empirically based guidance for IS managers.

Based upon the research results, the following IS Management prescriptions are offered:

* When technical issues (PQ) prevail, drive down uncertainty as much as possible and use IS Dispersal

  Under high uncertainty, use of IS dispersal seems has less negative impact on PQ than does use of CMU

* When service & functionality issues (CQ) prevail, drive down uncertainty as much as possible and use coordination mechanisms

  Under high uncertainty, increasing CMU has less negative impact on CQ than does use of IS Dispersal.

A large issue remains. How can management reduce requirements definition uncertainty? The IS alignment mechanisms studied have been seen to be ineffective in accomplishing this. Yet, unless requirements definition uncertainty is reduced in some manner, the quality outcome of an IS product is clearly likely to be impaired.

The components of the IS requirements definition uncertainty variable (see Table 14) suggest the following possible approaches to uncertainty reduction.

- Staff projects with personnel who have greater *knowledge of the business process being automated.* If in-house experience is not available, consider sending staff out to learn about other companies' experiences relevant to impending IS projects.

- Introduce system design and development methods that might better deal with *requirements instability* (e.g., information engineering, prototyping, or Managed Evolutionary Development).

- Management should slow down and discuss the project circumstances that result in uncertainty. Since *consensual uncertainty* was seen to have such a negative influence on perceptions of quality in this research, simply gaining better agreement on the sources of uncertainty faced has potential to effectively reduce the amount of uncertainty faced.

E. Suggestions for Future Research

To better understand the current findings and their relation to other research applications of contingency theory, greater consideration probably needs to be given in this type of research to the specific nature of the work and of the workers performing it. More specifically, a better understanding of the cognitive complexity of the work of focus and the personality dynamics involved in necessary worker task collaboration are called for in future contingency research.

information systems application development/support work requires significant information gathering, processing and integration. This, in fact, is the fundamental nature of the requirements definition task upon which the uncertainty variable in this research focused. Remembering that the operational definition of uncertainty used here was "the degree to which information needed is available and analyzable", level of uncertainty should reasonably have a very direct effect on the work outcome effectiveness in this setting. This may not have been the case in task settings for previous contingency research. A "high" level of IS requirements definition uncertainty may have much greater independent effects on the quality dependent variable that does a "high" level of uncertainty surrounding the accomplishment of organizational tasks with lower cognitive complexity. The point is that "high" and "low" uncertainty are probably relative to the specific task setting and this should be a consideration in future tests of contingency propositions.

In this research, there was specific focus on structural mechanisms employed to better align one work unit's efforts with that of another. Since this is the case, gaining an understanding of any significant personality differences between people working in IS producer and IS customer units may be important to the understanding of the results. Research on predominant personality types of people drawn to different careers suggests that, in fact, information systems occupations are populated with many people who have distinctly different personalities than those found in the general population. For example, Myers and McCaulley (1989) report findings that relate personality type as measured by the

Myers Briggs Temperament Inventory (MBTI) to different occupational choices. The predominant MBTI type among systems analysts and computer scientists tends to be both introverted and analytical. This type is said to be precise in thought and language, impressed only by logic and competence, fairly oblivious to emotional responses of others and insensitive to the complexities of interpersonal relations, and to prefer work that can be done independently (Keirsey and Bates, 1984).

"Introverted analysts" represent only about 3% of the general population (Keirsey and Bates, 1984). This suggests that conflicts among IS producers and IS customers could arise simply due to the different "world views" of those within the work units that must collaborate in order for IS application development/support work to be successful. The relationship between personality differences of the members of the different work units and their ability to work effectively together within different organizational structures to accomplish different types of tasks, under different conditions of uncertainty, offers interesting avenues for future contingency research.

These research findings have also raised a number of additional research questions worthy of examination. Some of the most compelling of these are:

- What causal relationships might exist between IS product/service quality problems perceived by the IS producer and the quality problems perceived by the IS customer?

- What aspects of use or disuse of coordination mechanism "sound practices" really make a difference? Is, for example, a JAD or an inspection that uses a trained, impartial facilitator really superior to one that does not, in terms of its influence on the quality outcome?

- Why does assignment of accomplishment of IS activities to IS customers *alone vs. jointly* to IS customers and IS producers more negatively influence the customer perspective of quality?

- Overall, is use of IS dispersal still growing? Or is use of IS Dispersal shrinking due to the type of problems reported in the recent literature? If organizations are "reconcentrating" their IS activities, on what basis are they deciding to do so?

- What are the underlying dynamics of "consensual uncertainty"? Why don't the managers of the IS customer unit and the IS producer unit agree more about some seemingly objective aspects of the IS projects they have undertaken?

And, last, but not least:

- What techniques can organizations use to successfully reduce requirements definition uncertainty at the start of and during their IS application development/support projects?

APPENDIX A

SUMMARY STATISTICS

TABLE A-1
DISPERSAL RATINGS - ACTIVITIES RANKED BY MEAN RATINGS

ACTIVITIES	Mean Rating	N	% rating 1	2	3	4
26. training customers in application system use	1.939	33	30.3	51.5	12.1	16
27. performing production system problem resolution related to the application	1.870	31	48.4	25.8	16.1	79
8. defining the functional requirements to be met in the I.S. application project	1.848	33	33.3	51.5	12.1	03
17. evaluating effectiveness of project accomplishment & determining when product quality is sufficient for its release for customer use	1.812	32	40.6	43.8	9.4	36
10. performing external design of the I.S. application (i.e., designing interfaces with business process, system users/operators, and/or other systems)	1.812	32	56.3	15.6	18.8	49
15. directing the day to day work of staff engaged in I.S. development, maintenance, enhancement and support	1.718	32	59.4	18.8	12.5	49
5. establishing priorities for what and when information systems application work (i.e., enhancement, maintenance and new development) should be accomplished	1.696	33	42.4	45.5	12.1	00
14. performing internal design (i.e., program and module structure and physical data base structure) of the I.S. application	1.696	33	66.7	6.1	18.2	19
6. resolving disagreements in information systems application work priorities	1.656	32	46.9	43.8	6.3	13
12. monitoring adherence to data administration standards	1.656	32	62.5	18.8	9.4	49
16. formally evaluating the performance of staff engaged in I.S. development, maintenance, enhancement and support	1.636	33	63.6	15.2	15.2	16
25. installing application software into the production environment	1.636	33	63.6	18.2	9.1	19
24. performing production coordination	1.625	32	56.3	31.3	6.3	36

TABLE A-1 continued..

ACTIVITIES	Mean Rating	N	% rating 1	2	3	4
11. establishing data administration standards	1.625	32	59.4	25.0	9.4	36
3. establishing a budget to accomplish the I.S. application project	1.593	32	53.1	37.5	6.3	13
13. making data structure (i.e., technical architecture) decisions on the IS application project	1.562	32	75.0	3.1	12.5	49
7. establishing the processes to be used to accomplish a system project (e.g., the requirements definition and system design processes in the project life cycle)	1.545	33	66.7	18.2	9.1	16
19. maintaining the software development environment	1.545	33	69.7	12.1	12.1	16
9. establishing service level standards for I.S. application response time, availability, recovery and efficiency, etc.	1.531	32	62.5	28.1	3.1	36
1. determining staffing level required for the I.S. application project	1.515	33	69.7	12.1	15.2	03
2. assigning staff to the I.S. application project	1.515	33	72.7	9.1	12.1	16
21. choosing the particular hardware/system software environment in which the production system should be installed	1.500	32	75.0	6.3	12.5	36
18. establishing software development environment standards (i.e., the universe of hardware and software tools, languages, etc. that are supported for use)	1.484	33	72.7	12.1	9.1	16
23. maintaining the production environment (i.e., system software and hardware)	1.468	32	71.9	15.6	6.3	36
22. funding the production environment (i.e., system software and hardware)	1.437	32	62.5	31.3	6.3	00
4. managing a budget for the I.S. application project	1.437	32	71.9	18.8	3.1	36
20. selecting the software development environment to be used for the project	1.424	33	78.8	6.1	9.1	16

TABLE A-2
Customer on the Team Measure - Summary Results by Activity

Work Activity	N	Responsibility Assignment Rate % C	% J	% P
1. determining staffing level required for the I.S. application project	34	0.0	11.8	88.2
2. assigning staff to the I.S. applic. project	34	0.0	0.0	100.0
3. establishing a budget to accomplish the I.S. application project	33	12.1	36.4	51.5
4. managing a budget for the I.S. application project	34	8.8	23.5	67.6
5. establishing priorities for what and when information systems work (i.e., enhancement, maintenance and new development) should be accomplished	34	23.5	61.8	14.7
6. resolving disagreements in information systems application work priorities	34	14.7	64.7	20.6
7. establishing the processes to be used to accomplish a system project (e.g., requirements definition & system design processes in the project life cycle)	34	0.0	35.3	64.7
8. defining the functional requirements to be met in the I.S. application project	34	32.4	55.9	11.8
9. establishing service level standards for I.S. application response time availability, recovery and efficiency, etc.	34	8.8	52.9	38.2
10. performing external design of the I.S. application (i.e., designing interfaces with business process, system users/operators, and/or other systems)	34	5.9	41.2	52.9
11. establishing data administration standards	33	9.1	9.1	81.8
12. monitoring adherence to data administration standards	32	12.5	9.4	78.1
13. making data structure (i.e., technical architecture) decisions on the IS application project	33	0.0	9.1	90.9

TABLE A-2 continued..

Work Activity	N	Responsibility Assignment Rate % C	% J	% P
14. performing internal design (i.e., program & module structure and physical data base structure) of the I.S. application	34	0.0	2.9	97.1
15. directing the day to day work of staff engaged in I.S. development, maintenance, enhancement & support	34	2.9	8.8	88.2
16. formally evaluating the performance of staff engaged in I.S. development, maintenance, enhancement & support	34	0.0	2.9	97.1
17. evaluating the effectiveness of project accomplishment and determining when product quality is sufficient for its release for customer use	34	8.8	76.5	14.7
18. establishing software development environment standards (i.e., the universe of hardware and software tools, languages, etc. supported for use)	34	0.0	2.9	97.1
19. maintaining the software development environment	34	0.0	0.0	100.0
20. selecting the software development environment to be used for the project	34	0.0	11.8	88.7
21. choosing the particular hardware/system software environment in which the production system should be installed	34	2.9	17.6	79.4
22. funding the production environment (i.e., system software and hardware)	33	33.3	9.1	57.6
23. maintaining the production environment (i.e., system software and hardware)	33	3.0	6.1	90.9
24. performing production coordination	32	6.3	28.1	65.6
25. installing application software into the production environment	34	2.9	2.9	94.1
26. training customers in application system use	34	50.0	35.3	14.7
27. performing production system problem resolution related to the application	33	3.0	51.5	45.5

TABLE A-3
IS CUSTOMER VIEW OF QUALITY - SUMMARY RESULTS

Quality Characteristics	Mean Rating	N	Standard Deviation	Min/Max	Rank (Hi=1)
1. Functional Requirements	3.134	32	1.328	1.00/5.00	18
2. Accuracy of Output	3.639	33	1.017	1.00/5.00	10/11
3. System Reliability	3.821	33	1.051	1.00/5.00	6
4. Response to Problems	3.464	33	1.318	1.00/5.00	14
5. On Line Availability	4.197	29	.806	1.00/5.00	2
6. Implement. Schedules	3.030	33	1.403	1.00/5.00	19
7. Ease of Use	3.639	33	1.106	1.00/5.00	10/11
8. Timeliness of Output	3.804	25	1.279	1.00/5.00	7
9. Overall Service Quality	3.509	33	1.068	1.00/5.00	13
10. Response Time	3.718	33	1.399	1.00/5.00	9
11. Attitude & Communic.	3.803	33	1.352	1.00/5.00	8
12. System Flexibility	3.136	33	1.040	1.00/5.00	16
13. Quality of Output	4.027	29	1.018	1.00/5.00	5
14. Cost Effectiveness	3.341	22	1.340	1.00/5.00	15
15. Cost Estimates	2.868	19	1.665	1.00/5.00	20
16. Backup and Recovery Procedures	4.138	29	.990	2.00/5.00	3
17. Adequacy of Documen.	3.179	28	1.467	1.00/5.00	17
18. Distribution of Output	4.464	28	.744	2.00/5.00	1
19. Adequacy of Training	3.510	29	1.433	1.00/5.00	12
20. Data Security	4.076	33	1.133	1.00/5.00	4

TABLE A-4
IS PRODUCER VIEW OF QUALITY - SUMMARY RESULTS

Quality Characteristics	Mean Rating	N	Standard Deviation	Min/Max	Rank (Hi=1)
1. Customer Satisfaction	3.804	34	1.089	1.00/5.00	10
2. Accuracy (of Results)	4.044	34	.656	3.00/5.00	7
3. Reliability	4.212	33	.587	3.00/5.00	4
4. Completeness (of Implemented Requirements)	3.980	34	.716	2.00/5.00	8
5. Availability (of Resource	4.486	34	.609	3.00/5.00	1
6. Maintainability	3.265	34	1.310	1.00/5.00	18
7. Funct'l Requirements	3.696	34	.956	2.00/5.00	14
8. Usability	3.712	33	.718	2.00/5.00	13
9. Conformity (to Stndrds)	3.870	32	1.105	1.00/5.00	9
10. Efficiency (Functional)	4.048	31	.888	1.00/5.00	6
11. Documentation	3.652	33	.852	2.00/5.00	15
12. Timeliness of Output	4.402	29	.580	3.00/5.00	2
13. Defect Density	3.758	33	.561	2.00/5.00	12
14. Security	4.343	34	.955	2.00/5.00	3
15. Modularity	3.760	34	1.147	1.00/5.00	11
16. Testability	3.020	34	1.077	1.00/5.00	19
17. Interoperability (with Other Systems)	4.059	31	.736	2.00/5.00	5
18. Auditability	3.583	34	.945	2.00/5.00	16
19. Portability	2.500	34	1.243	1.00/5.00	20
20. Traceability (of Requirements)	3.314	34	1.468	1.00/5.00	17

TABLE A-5

Test Results: Non-linearity of Relationships Among Independent and Moderating Variables

Variables in Curvilinear Models		Comparative Results	
Dependent	Independent	Curvilinear Model	Linear Model*
Dispersal B	CMU (0,1,1) CMU (0,1,1)*CMU (0,1,1)	F = 0.04 Pr>F=.9651	F = 0.04 Pr>F=.8343
Dispersal B	CMU (0,0,1) CMU (0,0,1)*CMU (0,0,1)	F = 0.06 Pr>F=.9458	F = 0.05 Pr>F=.8288
Dispersal B	Uncertainty Uncertainty*Uncertainty	F = 0.69 Pr>F=.5082	F = 0.01 Pr>F=.9194
CMU (0,1,1)	Uncertainty Uncertainty*Uncertainty	F = 1.05 Pr>F=.3605	F = 1.02 Pr>F=.3203
CMU (0,1,1)	Dispersal B Dispersal B*Dispersal B	F = 0.54 Pr>F=.5859	F = 0.04 Pr>F=.8345
CMU (0,0,1)	Uncertainty Uncertainty*Uncertainty	F = 1.12 Pr>F=.3389	F = 1.25 Pr>F=.2717
CMU (0,0,1)	Dispersal B Dispersal B*Dispersal B	F = 0.61 Pr>F=.5489	F = 0.05 Pr>F=.8288
Uncertainty	CMU (0,1,1) CMU (0,1,1)*CMU (0,1,1)	F = 0.87 Pr>F=.4270	F = 1.02 Pr>F=.3203
Uncertainty	CMU (0,0,1) CMU (0,0,1)*CMU (0,0,1)	F = 1.35 Pr>F=.2752	F = 1.25 Pr>F=.2717
Uncertainty	Dispersal B Dispersal B*Dispersal B	F = 0.07 Pr>F=.9343	F = 0.01 Pr>F=.9194

* Linear Models included *only* the independent variable term, and *not* the squared term.

MEASUREMENT APPENDIX

ORGANIZING FOR I.S. QUALITY

This appendix consists of the Research Participant Packet which was provided to each organization that expressed interest in being part of the research sample.

Dear Research Participant:

Thank you for your interest in the ***Organizing for I.S. Quality*** research effort. The attached packet contains complete instructions for your organization's participation and one full set of questionnaires.

One difficulty of conducting mail questionnaire research is that the researcher is not on site and cannot personally monitor progress and make sure that all instructions are understood and all questionnaires completed and returned. For this reason, it is important that a specific research coordinator be appointed in your organization. The coordinator's role will be to distribute the questionnaires, collect and return them when they are completed, and to serve as the central contact point in your organization for questions regarding the research. Your coordinator should feel free to contact me with any questions that arise during the research project.

Participation in this research involves four steps. These are described below:

1. **Planning** - done by Senior I.S. Management.

In the planning step:

a) the business system projects upon which the research participants in the organization will be asked to focus must be chosen;
b) a research coordinator should be named;
c) the names of the appropriate persons in the I.S. and customer units who will need to complete each questionnaire must be obtained.

Guidelines for selecting system projects for research focus and for identifying the appropriate respondents for each questionnaire are provided in the instruction packet. In addition, a "research participation record sheet" is enclosed for use in documenting the decisions made in this step. When completed, this record sheet should be given to the research coordinator for follow-up action.

2. **Questionnaire Distribution** - done by research coordinator

In this step, the research coordinator will duplicate, package and distribute the blank questionnaires for completion by organizational participants according to the plans made in step 1 and the instructions in the research participant packet.

3. **Questionnaire Completion** - done by management staff in the I.S. and the line business customer units

In this step, for each system project selected for focus, the following six questionnaires must be completed:

* *I.S. Dispersal Survey*
* *System Requirements Information Source Questionnaire - Customer View*
* *System Requirements Information Source Questionnaire - Producer View*
* *I.S. Customer/Developer Coordination Mechanism Use Questionnaire*
* *Software Quality Survey - Customer View*
* *Software Quality Survey - Producer View*

Each questionnaire is brief, requiring little time to complete. Participants should be able to complete and return them to the research coordinator **within 5 - 10 working days**.

4. Data Collection and Return - done by research coordinator

In the final step, completed sets of questionnaires should be collected, packaged and mailed to the researcher, along with a copy of the "research participation record sheet". **The target deadline for submission of data for this research is June 26, 1992.**

All organizations that participate in this research will receive a written report of research findings. Data analysis will focus on gaining an increased understanding of:

* *the relationship between customer and producer views of I.S. quality and the value of measuring both views;*

* *the potential quality improvement value of use of various coordination mechanisms and of organizational dispersal of the I.S. application development function;*

* *the issue of whether the impact of using these strategies is the same for I.S. customer quality perception as it is for I.S. producer quality perception;*

* *identification of the conditions under which use of one or more of the strategies has the greatest potential payoff in terms of I.S. product/service quality.*

Your participation is greatly appreciated. Please feel free to call with any questions.

Yours truly,

Marianne Bays, CQA

ORGANIZING FOR I.S. QUALITY

RESEARCH PARTICIPANT PACKET

Researcher: Marianne Bays, CQA
549 Grove Street
U. Montclair, NJ 07043

(201) 783-9233

Organizing for I.S. Quality
RESEARCH PARTICIPANT PACKET
TABLE OF CONTENTS

A. Identification of I.S. Application Systems/Projects for Research Focus:
The first step in research participation is to name the particular systems (one or more) that will provide the focus for organizational completion of the surveys. **Appropriate systems are I.S. business applications that were developed in-house and moved into production at least 3 months ago, but no longer than 12 months ago**. These may be the results of new development projects or the results of significant maintenance or enhancement projects. They must be distinct systems or system versions, identifiable as 3 - 12 months old to both the customers and the developers.

In the case of particularly large systems efforts that were broken into subprojects focused on delivery of different business functionality, the system subproject may be the appropriate level of focus for this research. This is particularly true if separate requirements definition were conducted by the different subproject teams and/or different line business customers and I.S. professionals were involved in the definition of functional requirements for and implementation of the subsystems.

The decision on what business application(s) should be included in the research should be made at a senior management/executive level in the I.S. organization and documented on the "Research Participation Record Sheet". The request for research participation by staff in the system customer and developer organizations (see section B. below) can then be initiated by the research coordinator (see section C. below) on behalf of the senior management.

B. Naming of Research Participants:
For each system named, a minimum of 2 research participants will be needed from each the line business customer and the I.S. professional organization that produced the system. In total, 4 individuals are typically needed to complete questionnaires as follows:

- In the line business customer organization:

  * The *Software Quality Survey - Customer View* is to be completed by a first line manager who was directly involved in the system development and implementation, e.g., as a customer liaison/project representative.

  * The *Systems Requirements Information Source Questionnaire - Customer View* is to be completed by a supervisory manager (i.e., typically one level higher than that above) with responsibility for the business function automated by the system of focus.

- In the I.S. organization:

  * The *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire* are to be completed by the I.S. Project Manager or Lead Analyst who was directly responsible for the system project.

  * Two questionnaires are also to be completed by supervisory level I.S. Application Development/Support Management (i.e., typically one level higher than that above): the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View*

Note: In some cases it may be appropriate to include other respondents in addition to those described above. For example, if a system was developed for multiple customers who use different aspects of the system and would, therefore, have different views of system quality - it would be appropriate to ask first level management from each of the customer organizations to complete the *Software Quality Survey - Customer View*. Also, in cases where system development and system support services are provided by two distinct organizations - it would be appropriate to have first level managers from each of these organizations collaborate on the completion of the *Software Quality Survey - Producer View*.

In some cases, organizational structure, staffing and staff level may have changed since system implementation. To the extent possible, the people who were in each of the 4 roles defined above <u>during the project and at the time that the system first went into production</u> should be asked to participate in the survey form completion. If this is not possible, current incumbents may be asked to participate in their stead - as long as their experience with the project and/or system is sufficient to allow them to provide the requested information. Collaboration between current and past incumbents in completing the surveys is also an acceptable alternative.

C. <u>Research Coordination</u>:

Senior I.S. management should name a specific research coordinator to organize distribution and collection of the research questionnaires and to serve as a central point of contact on any questions that arise. The coordinator's job is to:

- prepare and distribute blank questionnaires to each participant identified by senior management in the planning step of the research;

- track completion and return of participant questionnaires, insuring timely response;
- mail completed sets of questionnaires and a copy of the "research participation record sheet" to the researcher for inclusion in data analysis.

D. Instructions for Preparation of Questionnaires for Distribution:

1. Duplicate the blank questionnaires so that you have a full set of each for each system/system version selected for focus. Keep one extra copy of the full set of questionnaires for reference and in case extra copies are needed at a later date.

2. Each questionnaire has a header area that needs to be completed by the coordinator prior to sending it out for participant completion.

   a) The name of the system/system version selected for focus and its date of implementation must be filled in on all questionnaires before they are distributed.*

   b) The name of the respondent's organization must be filled in on all questionnaires before they are distributed.*

   c) Codes *or* actual names may be used to complete the header field for name of respondent before questionnaire distribution. This field is primarily for internal use in tracking response returns; the researcher does not need and will not use actual organizational members' names.

*NOTE: System and organization names provided are only for internal use in assembling data sets. All research participants will be provided full confidentiality.

3. A cover letter should accompany each questionnaire distributed for completion. This should briefly announce the research project and request participation; provide the research coordinator's name, address and telephone number; and establish the return due date (5 - 10 work days from receipt). A model cover letter is contained in Section III of this packet.

E. Researcher Name Address & Phone Number:

Questions and completed questionnaire sets should be directed to:

Marianne Bays
549 Grove Street
Upper Montclair, NJ 07043

(201) 783-9233

II. Research Participant Record Sheet

Instructions This is a record keeping sheet for use in documenting: the organization's appointed research coordinator; the system(s)/system version(s) chosen to be included in the research; names of the I.S. customer and producer organizations to be asked to participate in questionnaire completion; and the names of or codes for each I.S. customer and I.S. producer organization staff member who is asked to participate in the research. The record sheet is also intended to be used by the research coordinator to track questionnaire distribution and return dates.

♦ **Participating Organization Name:** ____________________

♦ **Research Coordinator's Name:** ____________________
♦ **Research Coordinator's Phone #:** ____________________

System/System Version # 1 Record

System/System Version Name: ____________________

System/System Version Implementation Date: __/__/__

I.S. Customer Organization Name: ____________________

I.S. Producer Organization Name: ____________________

Customer Organization Participant Names or Codes:

* Customer Liaison(s)/Project Representative(s) asked to complete the *Software Quality Survey - Customer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__
____________________	__/__/__	__/__/__

* Customer Supervisory Management asked to complete the *Systems Requirements Information Source Questionnaire - Customer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__

Producer Organization Participant Names or Codes:

* I.S. Project Manager(s)/Lead Analyst(s) asked to complete both the *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire:*

	Date Out	Date In
____________________	__/__/__	__/__/__
____________________	__/__/__	__/__/__

* I.S. Application Development/Support Supervisory Management asked to complete both the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__

System/System Version # 2 Record

System/System Version Name: ______________________________

System/System Version Implementation Date: __/__/__

I.S. Customer Organization Name: ______________________________

I.S. Producer Organization Name: ______________________________

Customer Organization Participant Names or Codes:

* Customer Liaison(s)/Project Representative(s) asked to complete the *Software Quality Survey - Customer View:*

	Date Out	Date In
______________________________	__/__/__	__/__/__
______________________________	__/__/__	__/__/__

* Customer Supervisory Management asked to complete the *Systems Requirements Information Source Questionnaire - Customer View:*

	Date Out	Date In
______________________________	__/__/__	__/__/__

Producer Organization Participant Names or Codes:

* I.S. Project Manager(s)/Lead Analyst(s) asked to complete both the *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire:*

	Date Out	Date In
______________________________	__/__/__	__/__/__
______________________________	__/__/__	__/__/__

* I.S. Application Development/Support Supervisory Management asked to complete both the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View:*

	Date Out	Date In
______________________________	__/__/__	__/__/__

System/System Version # 3 Record

System/System Version Name: ______________________________

System/System Version Implementation Date: __/__/__

I.S. Customer Organization Name: ______________________________

I.S. Producer Organization Name: ______________________________

Customer Organization Participant Names or Codes:

* Customer Liaison(s)/Project Representative(s) asked to complete the *Software Quality Survey - Customer View:*

	Date Out	Date In
______________________________	__/__/__	__/__/__
______________________________	__/__/__	__/__/__

* Customer Supervisory Management asked to complete the *Systems Requirements Information Source Questionnaire - Customer View.*

	Date Out	Date In
______________________________	__/__/__	__/__/__

Producer Organization Participant Names or Codes:

* I.S. Project Manager(s)/Lead Analyst(s) asked to complete both the *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire:*

	Date Out	Date In
______________________________	__/__/__	__/__/__
______________________________	__/__/__	__/__/__

* I.S. Application Development/Support Supervisory Management asked to complete both the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View:*

	Date Out	Date In
______________________________	__/__/__	__/__/__

System/System Version # 4 Record

System/System Version Name: ____________________

System/System Version Implementation Date: __/__/__

I.S. Customer Organization Name: ____________________

I.S. Producer Organization Name: ____________________

Customer Organization Participant Names or Codes:

* Customer Liaison(s)/Project Representative(s) asked to complete the *Software Quality Survey - Customer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__
____________________	__/__/__	__/__/__

* Customer Supervisory Management asked to complete the *Systems Requirements Information Source Questionnaire - Customer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__

Producer Organization Participant Names or Codes:

* I.S. Project Manager(s)/Lead Analyst(s) asked to complete both the *Software Quality Survey - Producer View* and the *I.S. Customer/Producer Coordination Mechanism Use Questionnaire:*

	Date Out	Date In
____________________	__/__/__	__/__/__
____________________	__/__/__	__/__/__

* I.S. Application Development/Support Supervisory Management asked to complete both the *I.S. Dispersal Survey* and the *Systems Requirements Information Source Questionnaire - Producer View:*

	Date Out	Date In
____________________	__/__/__	__/__/__

** If more than 4 systems have been chosen for focus, this form should be duplicated and used for #'s 5, 6, etc.**

ORGANIZING FOR I.S. QUALITY - RESEARCH PARTICIPANT PACKET
SECTION III. SAMPLE QUESTIONNAIRE COVER LETTER

To: *(research participant's name)*

From: *(senior I.S. manager's name)*

Subject: ***Organizing for I.S. Quality*** Research Project Participation

Date: *(questionnaire distribution date)*

(Organization name) has recently agreed to participate in a Ph.D. dissertation research project that is being undertaken in conjunction with the Quality Assurance Institute by a doctoral student at City University of New York. This research examines information systems product and service quality and various organizational strategies that might be effectively used to improve this.

As part of our participation in this project, we are requesting your completion and return of the attached questionnaire(s). Your focus in answering these questions should be the specific system/system version named in the questionnaire header. Representatives of both the I.S. customer and producer organizations are being asked to provide information for this research.

Please read and complete the attached questionnaire(s) carefully within the next couple of work days. If you have any questions, please contact: *(name of research coordinator)* at *(phone number of research coordinator)*.

Your completed questionnaire(s) should be returned no later than *(10 work days after questionnaire distribution date)* to:

(research coordinator name)
(research coordinator address)

Thank you.

A. I.S. DISPERSAL SURVEY - GENERAL INSTRUCTIONS

There are two parts of the I.S. dispersal survey, both to be completed by supervisory level management in the I.S. application development/support organization. The specific supervisory level manager who completes this form should be an individual with a good understanding of the organizational structure that existed at the time of the I.S. application project of concern and familiarity with the dynamics of who was responsible for what project activities.

Part A of the survey asks which level of the organizational enterprise had overall responsibility for the system project.

Part B of the survey lists specific project activities and asks: 1) at what level of the enterprise responsibility for each is concentrated; and 2) who (the business customer, the system producer or both) has the primary responsibility for each.

The attached sample hierarchical organizational structures should be used to further define the dispersal rating scale point values.

I.S. DISPERSAL SURVEY - PART A

__/__/__
Today's Date

____
System or System Version Name

____
Company and Unit Name

____
Implementation Date

RATING INSTRUCTIONS: Please use the scale below to indicate which level of the organizational enterprise had overall responsibility for the system project named above? *Refer to the attached sample hierarchical organization structures for further definition of the scale point values.*

WHERE WAS THE I.S. PROJECT TEAM THAT CONDUCTED THIS SYSTEM PROJECT LOCATED ORGANIZATIONALLY DURING THE DURATION OF THE PROJECT? ***Please circle the best single response:***

Level 1 **Level 2** **Level 3** **Level 4**

DISPERSAL RATING SCALE

Level 1 - Enterprise:
- Staff were part of an organization concentrated at the enterprise level (i.e., they were/are part of an organization that provides its I.S. support to all of the businesses and functions in which the total enterprise is involved and which reports to senior management of the enterprise)

Level 2 - Business Unit:
- Staff were part of an organization concentrated at the business unit level (i.e., they were/are part of an organization that provides its I.S. support to a major department or to a subsidiary of the enterprise and which reports to senior management of the business unit)

Level 3 - Functional/Geographic Division:
- Staff were part of an organization located in a functional or geographic division of the business unit (i.e., they were/are part of an organization that provides its I.S. support to a specific functional or geographic division of a major department or subsidiary of the enterprise and which reports to senior management of the division)

Level 4 - Divisional Subunit:
- Staff were part of an organization located in a Divisional Subunit - a subunit of a functional or geographic division of the business unit (i.e., they were/are part of an organization that provides its I.S. support to a subunit of a specific functional or geographic division of a major department or subsidiary of the enterprise and which reports to senior management of the divisional subunit)

I.S. DISPERSAL SURVEY - PART B

__/__/__
Today's date

____
System or System Version Name

____
Producer Organization Name

____
Implementation Date

RATING INSTRUCTIONS: Twenty-seven different I.S. activities are listed below. This survey asks you to evaluate where and by whom in the organization these activities were performed in the specific system effort named above.

In **Column 1**, indicate the *organizational level at which each of the activities was performed* on the project, using the Dispersal Rating Scale defined in Part A of this survey. For example, if the greatest responsibility for determining the staffing level required for the I.S. application project rested with staff at the enterprise level, you should enter a "1" next to activity # 1. If, on the other hand, this is the responsibility of a work group concentrated at the business unit level, this activity should be rated "2".

In **Column 2**, circle the appropriate letter to indicate whether the activity listed was the:

P = primary responsibility of the I.S. producer organization
C = primary responsibility of the I.S. customer organization
J = jointly and equally shared responsibility of both the I.S. customer and producer organizations

Col. 1	Col. 2	ACTIVITIES
___	P C J	1. determining staffing level required for the I.S. application project
___	P C J	2. assigning staff to the I.S. application project
___	P C J	3. establishing a budget to accomplish the I.S. application project
___	P C J	4. managing a budget for the I.S. application project
___	P C J	5. establishing priorities for what and when information systems application work (i.e., enhancement, maintenance and new development) should be accomplished
___	P C J	6. resolving disagreements in information systems application work priorities
___	P C J	7. establishing the processes to be used to accomplish a system project (e.g., the requirements definition and system design processes in the project life cycle)
___	P C J	8. defining the functional requirements to be met in the I.S. application project

Col. 1	Col. 2	ACTIVITIES
___	P C J	9. establishing service level standards for I.S. application response time, availability, recovery and efficiency, etc.
___	P C J	10. performing external design of the I.S. application (i.e., designing interfaces with business process, system users/operators, and/or other systems)
___	P C J	11. establishing data administration standards
___	P C J	12. monitoring adherence to data administration standards
___	P C J	13. making data structure (i.e., technical architecture) decisions on the I.S. application project
___	P C J	14. performing internal design (i.e., program & module structure and physical data base structure) of the I.S. application
___	P C J	15. directing the day to day work of staff engaged in I.S. development, maintenance, enhancement and support
___	P C J	16. formally evaluating the performance of staff engaged in I.S. development, maintenance, enhancement and support
___	P C J	17. evaluating the effectiveness of project accomplishment and determining when product quality is sufficient for its release for customer use
___	P C J	18. establishing software development environment standards (i.e., the universe of hardware and software tools, languages, etc. that are supported for use)
___	P C J	19. maintaining the software development environment
___	P C J	20. selecting the software development environment to be used for the project
___	P C J	21. choosing the particular hardware/system software environment in which the production system should be installed
___	P C J	22. funding the production environment (i.e., system software and hardware)
___	P C J	23. maintaining the production environment (i.e., system software and hardware)
___	P C J	24. performing production coordination
___	P C J	25. installing application software into the production environment
___	P C J	26. training customers in application system use
___	P C J	27. performing production system problem resolution related to the application

SAMPLE HIERARCHICAL ORGANIZATION STRUCTURE EXAMPLES

Major Insurance Company Example

Level 1: Enterprise - entire company; all lines of business and administrative functions

Level 2: Business Unit

e.g., Individual insurance products company
Group insurance products business unit
Investment products subsidiary
Human Resources department
European operations group
Comptrollers department

Level 3: Functional or geographic subdivisions of business units

e.g., Accounting Department of the investment products subsidiary
Latin American Operations of the individual insurance products company
Personnel Administration Division of the enterprise human resources department
Marketing Division of the group insurance products business unit

Level 4: Subunits of functional or geographic subdivisions of business units

e.g., Market research unit of the Marketing Division of the group insurance products business unit
Eastern region of the Personnel Administration Division of enterprise Human Resources Dept.
Product development unit of Latin American Operations Group of the individual insurance products company

University Example

Level 1: Enterprise - entire university

Level 2: Business Unit

e.g., Admissions Office
Bursars Office
School of Social and Behavioral Science
School of Mathematics and Physical Sciences
School of Education

Level 3: Functional or geographic subdivisions of business units

e.g., Psychology Department of the School of Social and Behavioral Sciences
Computer Science Department of the School of Mathematics and Physical Sciences
Continuing Education Program Division of the Admissions Office

Level 4: Subunits of functional or geographic subdivisions of business units

e.g., Satellite campus admissions program of the Graduate Student Program Division of the Admissions office
Industrial and Organizational Psychology Degree Program in the Psychology Department of the School of Social and Behavioral Sciences

Manufacturing Conglomerate Example

Level 1: Enterprise - entire conglomerate

Level 2: Business Unit

e.g., Power Generation Business
Major Appliance Business Group

Level 3: Functional or geographic subdivisions of business units

e.g., Nuclear Energy Products Division
Latin American Business
Eastern Region
Market Research

Level 4: Subunits of functional or geographic subdivisions of business units

e.g., Production Control, Eastern Region, Major Appliances
Manufacturing, Household Appliances
Marketing Unit, Household Appliances

Multiple Facility Medical Center Example

Level 1: Enterprise - entire medical center

Level 2: Business Unit

e.g., Hospital A
Hospital B
Nursing Administration - medical center wide

Level 3: Functional or geographic subdivisions of business units

e.g., Nursing School, Hospital A
Department of Neurology, Hospital B
Accounting Department, Hospital A

Level 4: Subunits of functional or geographic subdivisions of business units

e.g., Administrative Office, Department of Neurology

U.S. Courts Example

Level 1: Enterprise - entire Federal judiciary

Level 2: Business Unit

e.g., 1st Judicial Circuit
9th Judicial Circuit
Administrative Office (AO)

Level 3: Functional or geographic subdivisions of business units

e.g., Court Administration Division of the AO
Court of Appeals, 4th Circuit
Southern District Court, 2nd Circuit

Level 4: Subunits of functional or geographic subdivisions of business units

e.g., Clerk's Office, Southern District Court, 2nd Circuit
Circuit Executive's Office, Court of Appeals, 3rd Circuit
Staff Attorney's Office, Court of Appeals, 9th Circuit

B. I.S. CUSTOMER/DEVELOPER COORDINATION MECHANISM USE QUESTIONNAIRE - GENERAL INSTRUCTIONS

This questionnaire is to be completed by the first level I.S. project manager or lead analyst on the project. Its aim is to learn about the project team's use of specific processes (e.g., Joint Application Design Sessions, Service Level Agreements, and Requirements and Design Inspections during this system project. The specific first level manager who completes this questionnaire should be thoroughly familiar with the techniques that were used in the project of concern.

__/__/__
Today's Date

____
System or System Version Name

____
Company and Unit Name

____
Implementation Date

I.S. CUSTOMER/DEVELOPER COORDINATION MECHANISM USE QUESTIONNAIRE

The purpose of this questionnaire is to learn about the project team's use of different types of processes during the systems project named above. Please complete each of the three sections below, checking the appropriate response (yes or no).

1. JAD Use

Was a Joint Application Design (JAD) or similar type session (e.g., "Facilitated Application Specification Technique") used to help develop the requirements and design specifications for this project? Yes __ No __

If a JAD was held:

A) Was a trained, impartial JAD facilitator/leader used? **Yes** __ **No** __

B) Did all key customers and developers participate in the JAD? **Yes** __ **No** __

C) Was there a formal agenda for the JAD session? **Yes** __ **No** __

D) Did a trained discussion recorder or scribe participate in the JAD? **Yes** __ **No** __

E) Were all customer and developer participants trained (briefed) in the process and its purpose prior to beginning the JAD? **Yes** __ **No** __

2. Service Level Agreement (SLA) Use

Was a Service Level Agreement (SLA) developed and agreed to by both customers and developers in this project? Yes __ No __

If an SLA was developed for this system project:

A) Did it specify the dimensions of information products and services on which the service level agreement should focus? **Yes** __ **No** __

B) Were the criteria to be used in judging compliance with the service level agreement specified? **Yes** __ **No** __

C) Did it cover the responsibilities of the customer organization in achieving the agreed upon quality levels? **Yes** __ **No** __

D) Did it include the responsibilities of the developer organization in achieving the agreed upon quality levels? **Yes** __ **No** __

E) Were the procedures by which compliance with the SLA would be monitored and reported specified? **Yes** __ **No** __

3. Requirements and Design Specifications Inspection Use

Was an inspection that focused specifically on the I.S. application requirements and design specifications conducted in this project? __ Yes __ No

***If a requirements and design inspection was conducted*:**

A) Did key system customers participate as inspectors? **Yes** __ **No** __

B) Did the inspection focus on identification (but not correction) of defects in the specifications during the session? **Yes** __ **No** __

C) Was the inspection led by a trained, impartial moderator? **Yes** __ **No** __

D) Did the inspection use a trained "reader" who guided the rest of the group through the material being inspected? **Yes** __ **No** __

E) Were all defects found during the inspection recorded and assigned to specific parties for follow up? **Yes** __ **No** __

F) Were all customer and developer participants briefed on the purpose of the inspection prior to its start? **Yes** __ **No** __

C. SYSTEM REQUIREMENTS INFORMATION SOURCE QUESTIONNAIRE - CUSTOMER VIEW

- GENERAL INSTRUCTIONS

This questionnaire is to be completed by a supervisory level business customer manager. Its aim is to learn about the sources of information that were available to the project team during the requirements definition phase of the project. The specific supervisory level manager who completes this form should be an individual who is thoroughly familiar with the business aims that drove the systems project and the state of understanding of the system requirements at the start of the project.

__/__/__ Today's Date

__________ System or System Version Name

__________ Company and Unit Name

__________ Implementation Date

SYSTEM REQUIREMENTS INFORMATION SOURCE QUESTIONNAIRE - CUSTOMER VIEW

The objective of this rating process is to learn about the sources of information available to the project team during the requirements definition phase of this project.

Rate the system project named above on each of the three rating scales shown below by circling the number of the rating that best describes the circumstances in this project.

1. To what extent were system requirements preestablished at the start of the project?

Completely preestablished system requirements would be, for example, those for a project that were entirely set by law, regulation or some outside authority and which fully defined, from the moment of conceptualization, the necessary output of the project.

Partially preestablished system requirements would be those, for example, for an application system project aimed both at meeting requirements established by law, regulation or an outside authority and at meeting some other, less well-defined, customer needs. In cases like this, some requirements are pre-set, others need to be developed during the project itself through interaction with the customer.

System requirements that were not at all preestablished would be those, for example, for an application system project that began with only broad concepts of customer need, and for which specific customer needs must be defined through interaction with the customer as the project progresses.

System requirements were (circle the best response):

1	2	3	4	5
Completely Preestablished		Partially Preestablished		Not at all Preestablished

2. How many different customer groups needed to be involved in order to define system requirements? That is, how many separate line business functions with potentially different system needs are the organizational customers for this system?

The number of separate customer groups that had to be involved in requirements definition for this system were (circle the best response):

1	2	3	4	5
One	Two	Three or Four	Five or Six	Seven or More

3. To what extent were system requirements stable during this project?

Very stable system requirements are those for a project that were well defined from the start and not subject to change after project conceptualization. For example, this would be the case when a project aim is to rewrite a standard business transaction processing system using new technology, but with no new business functionality needed. This would typically only be the case where the system's intended use is to support an established and stable business.

Moderately stable system requirements are those for a project that may not have been fully understood at the start, but which lend themselves to fairly standard *requirements definition techniques*, aim at supporting an established business function, and can be fairly well "set" in the early phases of the project, because they relate to stable customer business processes.

Very unstable system requirements would be, for example, those for a project that has as its aim providing automated support to a customer business function that experiences substantial change during the life of the project.

System requirements were (circle the best response):

1	2	3	4	5
Very Stable		Moderately Stable		Very Unstable

4. To what extent were system requirements routine in this project?

Very routine system requirements would be, for example, those for a project aimed at automating a very traditional and straightforward customer business function (*e.g., a basic transaction processing or recordkeeping system*) with simple logic paths.

System requirements that are moderately routine would be, for example, those for a project aimed at automating a fairly simple business function in a novel way or for a project aimed at automating a business function of average logical complexity.

Highly non-routine system requirements are those with little or no organizational precedent and/or with highly complex logic paths and which are, therefore, difficult for the customer to visualize and articulate.

System requirements were (circle the best response):

1	2	3	4	5
Very Routine		Moderately Routine		Highly Non-routine

5. To what extent did the system customers have prior experience with the business functions being automated in this project?

An example of high customer experience would be a case where customers had much prior practice performing the business function (in either automated or manual fashion) and the system's intended use is well known.

Moderate experience might be a case where the customer was familiar with some of the business functions, but had little practical knowledge of other functions being automated.

Low experience would be a case where the business function(s) being automated were completely new to the organization or to the customer representatives on the project and the system's intended use is, therefore, not well known.

Customers had (circle the best response):

1	2	3	4	5
High Experience		Moderate Experience		Low Experience

6. What was the average level of knowledge of the business functions being automated that the I.S. project team members brought to the start of this project?

If all of the key I.S. team members worked on previous versions of the system or had prior experience and training on quite similar business systems applications, they may be said to have brought a high level of knowledge to the project.

Where the I.S. team members were, on average, knowledgeable only about half of the business functions being automated in the project they may be said to have brought a moderate level of knowledge to the project. This might also be the case where some key team members were highly knowledgeable about the business functionality, while others had no prior experience or training that was relevant to the project.

Team members may be said to have brought a very low level of knowledge of the business functions being automated to the project if the business functions were completely new to the organization, or if the team, otherwise, had no prior experience or training relevant to the project.

On average, the I.S. team members were (circle the best response):

1	2	3	4	5
High Level of Knowledge		Moderate Level of Knowledge		Very Low Level of Knowledge

D. SYSTEM REQUIREMENTS INFORMATION SOURCE QUESTIONNAIRE - PRODUCER VIEW

- GENERAL INSTRUCTIONS

This questionnaire is also to be independently completed by a supervisory level I.S. manager. Its aim is to learn about the sources of information that were available to the project team during the requirements definition phase of the project. The specific supervisory level manager who completes this form should be an individual who is thoroughly familiar with the business aims that drove the systems project and the state of understanding of the system requirements at the start of the project.

__/__/__
Today's Date

____
System or System Version Name

____
Company and Unit Name

____
Implementation Date

SYSTEM REQUIREMENTS INFORMATION SOURCE QUESTIONNAIRE - PRODUCER VIEW

The objective of this rating process is to learn about the sources of information available to the project team during the requirements definition phase of this project.

Rate the system project named above on each of the three rating scales shown below by circling the number of the rating that best describes the circumstances in this project.

1. To what extent were system requirements preestablished at the start of the project?

Completely preestablished system requirements would be, for example, those for a project that were entirely set by law, regulation or some outside authority and which fully defined, from the moment of conceptualization, the necessary output of the project.

Partially preestablished system requirements would be those, for example, for an application system project aimed both at meeting requirements established by law, regulation or an outside authority and at meeting some other, less well-defined, customer needs. In cases like this, some requirements are pre-set, others need to be developed during the project itself through interaction with the customer.

System requirements that were not at all preestablished would be those, for example, for an application system project that began with only broad concepts of customer need, and for which specific customer needs must be defined through interaction with the customer as the project progresses.

System requirements were (circle the best response):

1	2	3	4	5
Completely Preestablished		Partially Preestablished		Not at all Preestablished

2. How many different customer groups needed to be involved in order to define system requirements? That is, how many separate line business functions with potentially different system needs are the organizational customers for this system?

The number of separate customer groups that had to be involved in requirements definition for this system were (circle the best response):

1	2	3	4	5
One	Two	Three or Four	Five or Six	Seven or More

3. To what extent were system requirements stable during this project?

Very stable system requirements are those for a project that were well defined from the start and not subject to change after project conceptualization. For example, this would be the case when a project aim is to rewrite a standard business transaction processing system using new technology, but with no new business functionality needed. This would typically only be the case where the system's intended use is to support an established and stable business.

Moderately stable system requirements are those for a project that may not have been fully understood at the start, but which lend themselves to fairly standard requirements definition techniques, aim at supporting an established business function, and can be fairly well "set" in the early phases of the project, because they relate to stable customer business processes.

Very unstable system requirements would be, for example, those for a project that has as its aim providing automated support to a customer business function that experiences substantial change during the life of the project.

System requirements were (circle the best response):

1	2	3	4	5
Very Stable		Moderately Stable		Very Unstable

4. To what extent were system requirements routine in this project?

Very routine system requirements would be, for example, those for a project aimed at automating a very traditional and straightforward customer business function (e.g., a basic transaction processing or recordkeeping system) with simple logic paths.

System requirements that are moderately routine would be, for example, those for a project aimed at automating a fairly simple business function in a novel way or for a project aimed at automating a business function of average logical complexity.

Highly non-routine system requirements are those with little or no organizational precedent and/or with highly complex logic paths and which are, therefore, difficult for the customer to visualize and articulate.

System requirements were (circle the best response):

1	2	3	4	5
Very Routine		Moderately Routine		Highly Non-routine

5. To what extent did the system customers have prior experience with the business functions being automated in this project?

An example of high customer experience would be a case where customers had much prior practice performing the business function (in either automated or manual fashion) and the system's intended use is well known.

Moderate experience might be a case where the customer was familiar with some of the business functions, but had little practical knowledge of other functions being automated.

Low experience would be a case where the business function(s) being automated were completely new to the organization or to the customer representatives on the project and the system's intended use is, therefore, not well known.

Customers had (circle the best response):

1	2	3	4	5
High Experience		Moderate Experience		Low Experience

6. What was the average level of knowledge of the business functions being automated that the I.S. project team members brought to the start of this project?

If all of the key I.S. team members worked on previous versions of the system or had prior experience and training on quite similar business systems applications, they may be said to have brought a high level of knowledge to the project.

Where the I.S. team members were, on average, knowledgeable only about half of the business functions being automated in the project they may be said to have brought a moderate level of knowledge to the project. This might also be the case where some key team members were highly knowledgeable about the business functionality, while others had no prior experience or training that was relevant to the project.

Team members may be said to have brought a very low level of knowledge of the business functions being automated to the project if the business functions were completely new to the organization, or if the team, otherwise, had no prior experience or training relevant to the project.

On average, the I.S. team members were (circle the best response):

1	2	3	4	5
High Level of Knowledge		Moderate Level of Knowledge		Very Low Level of Knowledge

E. SOFTWARE QUALITY SURVEY - CUSTOMER VIEW - GENERAL INSTRUCTIONS

This questionnaire is to be completed by a first level business customer manager who is very familiar with the system product and services delivered. Its aim is to learn about the customer organization's perception of product and service quality with regard to the specific system/system version of concern.

__/__/__
Today's date

____
System or System Version Name

____
Implementation Date

____
Customer Organization Name

SOFTWARE QUALITY SURVEY - CUSTOMER VIEW

The aim of this survey is to learn about your perceptions, as an information systems customer, of different aspects of software quality with regard to the information systems application named above. Twenty dimensions of software quality have been identified and are described below. For each of the dimensions, rate the extent to which this system/system version has satisfactorily met your organization's quality expectation. Try to keep the different dimensions of quality separate in your evaluation. Your responses will be confidential.

FOR EACH ITEM BELOW, CIRCLE THE RATING THAT BEST DESCRIBES YOUR PERCEPTION OF THE QUALITY OF THIS SYSTEM/SYSTEM VERSION ON THE STATED DIMENSION

1. **FUNCTIONAL REQUIREMENTS** - extent to which the delivered system functionality matches the business needs of the customer organization that were communicated to the development team; or the extent to which the system/system version performs the business processing that is needed by the customers

1 = Many needed business features were not provided or have been incompletely implemented; many changes to current system functionality are needed to meet customer needs.

2 = Several needed business features were incompletely implemented and need to be modified to fully meet customer needs.

3 = The most commonly needed business functionality has been provided; however, there are a few cases where modifications need to be made to system functions in order to fully meet business needs.

4 = Minor changes in system functionality are needed in order to meet customer needs.

5 = All needed business functionality was completely provided; i.e., the system, when operating properly, does what the customers need it to do.

2. ACCURACY OF OUTPUT - extent to which the delivered system/system version's output is as free from error as needed; extent to which the level of accuracy of any reports, fiche, files or other outputs meets customer needs and expectations.

-

1 = There have been unacceptable errors in the most important outputs of the system; these outputs are not usable.

2 = One or more important system outputs have contained errors that made them unreliable or otherwise seriously limited their usefulness.

3 = While the most important system outputs have been accurate, other outputs from the system have not been entirely usable due to the errors contained in them.

4 = While all outputs are usable, some contain minor inaccuracies.

5 = All outputs are error free.

3. SYSTEM RELIABILITY - extent to which the delivered system/system version runs properly, without failure, so that it provides the expected service and information to customers when they need it

1 = The system fails so frequently and totally that the customer organization cannot depend upon it and must rely instead on alternate methods of obtaining needed service and information.

2 = At least one major part of the system (e.g., a particular reporting or data processing run) has a high failure rate necessitating use of alternate methods, but other parts of the system are reliable.

3 = The system is generally reliable, but is prone to occasional failures that slow down business.

4 = Very few system failures have occurred that have interfered with business in the customer organization.

5 = The system is highly reliable, providing expected service and information to customers when needed.

4. **RESPONSE TO PROBLEMS** - extent to which customer support has been provided in a timely fashion, i.e., so that elapsed time between customer report of a problem and support organization attention and response does not unnecessarily delay operations

1 = Support organization response to most system problem reports has been unacceptably slow, resulting in unnecessary and unacceptable delays to customer operations.

2 = Initial support organization response to most system problem reports is quick, but many problems have not been fully addressed in a timely fashion.

3 = Responses to major system problem reports are generally timely, but responses to minor problem reports can be overly slow.

4 = Most major and minor system problem reports have been responded to in a timely fashion by the support organization.

5 = All system problem reports have received timely support organization attention and response.

5. **ON LINE AVAILABILITY** - extent to which customers have had computer access to use this system/system version during their regular business hours to perform needed information processing

1 = Needed information processing has had to be done during "off hours" 15% or more of the time because of problems in obtaining computer access to this system during regular business hours.

2 = Information processing has had to be done during "off hours" 10% to 14% of the time because of problems in obtaining computer access to the system during regular work hours.

3 = Information processing has had to be done during "off hours" 5% to 9% of the time because of problems in obtaining computer access to the system during regular work hours.

4 = Only a very few occasions (less than 5%) have arisen in which customers did not have needed computer access to this system during their regular business hours.

5 = Customers always (100% of the time) have access to this system during their regular business hours.

NA = Not Applicable; system does not have an on line component.

6. **IMPLEMENTATION SCHEDULES** - extent to which this system/system version was completed within its projected development and implementation schedule

1 = System implementation was very late; the project schedule was overrun by at least 75% (e.g., as in a case where the elapsed time estimate on the project was 12 months and it actually took 21 months or more to accomplish).

2 = System implementation was delayed due to schedule overrun by at least 45% but less than 75%.

3 = System implementation was delayed some due to schedule overrun greater than 20%, but less than 45%.

4 = Only a minor delay in system implementation was experienced; schedule overrun was 20% or less.

5 = The development organization was able to implement this system within the scheduled time frame.

7. **EASE OF USE** - degree of customer difficulty in learning the system/system version and utilizing it efficiently; extent to which the system design itself provides customers with ease of use features

1 = This system is extremely difficult to learn and to use efficiently; features that could have improved ease of use (e.g., automatic cursor movement, report and/or input screen layout, and other human performance factors) were not included.

2 = Basic system functionality is easy to learn, but operators have trouble using many system features efficiently because of design flaws.

3 = Most functions of the system are easy to learn and use efficiently; some, however, are clumsy and should have been designed better, with greater human performance factor consideration.

4 = The system is generally very easy to learn and to use; very few features of the system are considered difficult to use.

5 = The system design has facilitated customer learning about the system and how to use it efficiently; system ease of use is fully satisfactory.

8. **TIMELINESS OF OUTPUT** - extent to which customers' total scheduled monthly output from this system/system version has been received on time (i.e., at the time of day, on the day of the week or month needed)

1 = 15% or higher of scheduled output has not been received on time.

2 = 10% to 14% of scheduled output has been received late.

3 = 5% to 9% of scheduled output has been received late.

4 = Some, but less than 5%, of all scheduled output has been received late

5 = All scheduled outputs have been received on time.

NA = Not applicable; system has no scheduled output.

9. **OVERALL SERVICE QUALITY** - extent to which the organization(s) that support your information system (e.g., computer operations, information systems development and support, information center, etc.) provide service of a satisfactory quality

1 = Service quality is generally unsatisfactory from all support groups (i.e., answers usually cannot be relied upon; staff is often uncooperative, unavailable and/or lacks the necessary level of knowledge of customer business and systems needs).

2 = Service quality is deficient in one or two major areas (as above) or services of one or two support groups are fully unsatisfactory

3 = Service quality is generally of an acceptable level, but there are some weak points that need correction.

4 = Service quality ranges from acceptable to excellent.

5 = Service quality is routinely excellent.

10. RESPONSE TIME - extent to which the average elapsed time between a customer pressing a function key and receiving the first presentation of computer response is both consistent across functions and meets customer needs

1 = System response time is erratic and too slow, on the average.

2 = System response time is erratic but, on the average, is of acceptable speed.

3 = System response time is inconsistent across functions; it is adequate in most system uses, but overly long when utilizing some particular system functions.

4 = System response time is consistent across functions, but somewhat slow.

5 = System response time is fast and consistently meets customer needs.

11. ATTITUDE AND COMMUNICATIONS - extent to which the staff of the system support organization is willing to be of assistance and effectively communicates useful information on system changes, opportunities, and problems

1 = The support organization staff often seems unwilling to help with problems and often fails to communicate needed information on system changes, opportunities and problems.

2 = Support organization staff members generally try to be helpful when we call them. However, they often fail to communicate useful information about system changes, opportunities and problems.

3 = Support organization staff generally communicate well with us, providing us with useful information and offering helpful assistance. However, there have been instances in the past year where poor communication on the part of support organization staff has resulted in system problems that could have been avoided.

4 = Most support organization staff communicate effectively with us, provide us with useful information and offer helpful assistance. However, there have been several instances where the attitude of specific support organization staff members has been poor and this has caused bad relations with customer staff.

5 = Support organization staff is always willing to be of assistance and always communicates needed information on system changes, opportunities and problems.

12. SYSTEM FLEXIBILITY - extent of difficulty and timeliness with which desired changes to the system can be implemented; degree to which the system/system verson design itself has incorporated features that allow future business needs of the customer organization to be accommodated

1 = Need to accommodate system changes to support future business needs was not considered in the design of this system. The system is so inflexible that implementation of even minor changes is unacceptably difficult and time consuming and, in some cases, is fully impossible.

2 = Need to accommodate system changes to support future business needs was not considered in this system's design. While changes can be made, anything other than minor changes will be very difficult and time consuming.

3 = Some flexibility was built into this system to accommodate need for change (e.g., it provides flexible query capability); but other aspects of the system where need for change is anticipated are less flexible and cannot be changed without significant difficulty and/or cost.

4 = Potential need for future system change was considered in the system design and, as a result, most, but not all, needed changes are readily achievable.

5 = The system design incorporates features to allow future customer business needs to be easily accommodated (e.g., customer control data is kept in tables that can be easily updated, flexible query capability exists to accommodate all changing information needs, etc.).

13. QUALITY OF OUTPUT - extent to which the system/system version's physical outputs (e.g., print reports or fiche) have been of usable quality, i.e., properly aligned, clearly printed, etc.

1 = Many of the system's physical outputs (e.g., 25% or more) have not been of usable visual quality.

2 = At least 10% but less than 25% of systems outputs have not been of usable visual quality.

3 = Output quality is somewhat uneven; while usually acceptable, in some cases we have needed to rerun reports in order to obtain acceptable visual quality.

4 = Output quality is usually high; print and alignment problems that occur are rare.

5 = All of the system's physical outputs are consistently of high visual quality.

NA = This system has no physical outputs (e.g., print reports or fiche).

14. COST EFFECTIVENESS - extent to which any projected increases in customer business or decreased customer operating cost as a result of implementation of this system/system version have been or are expected to be achieved; extent to which the return on investment of time and money in this system's development, implementation and support meets expectations.

1 = Actual system cost exceeded projected system value and, additionally, the expected benefits of system implementation have not or will not be realized.

2 = While actual system cost was lower than projected system value, the expected benefits of system implementation have not or will not be realized.

3 = Some expected benefits of system implementation have been or will be realized. However, these benefits are, at most, only likely to recover system development costs.

4 = Most, but not all, aspects of expected system value were or will be realized. Benefits should exceed expenditures. However, the total return on investment for the system will be slightly lower than projected.

5 = All expected benefits of system implementation have or will be realized; system cost-benefit is fully satisfactory.

NA = No increases in customer business or decreases in customer operating cost were projected.

15. COST ESTIMATES - extent to which this system/system version was produced and implemented within projected cost to the customer organization

1 = System development (or modificaiton) and implementation costs overran those projected by at least 50% (e.g., as in a case where the project cost estimate was $ 100,000 but it actually cost $ 150,000 or more to accomplish).

2 = Project costs overran projections by 35% to 49%.

3 = Project costs overran projections by 20% to 34%.

4 = Project costs overran those projected by less than 20%.

5 = The development organization was able to develop and implement this system/system version within the estimated cost.

UK = Unknown

16. BACKUP AND RECOVERY PROCEDURES - extent to which this systems' backup and recovery procedures adequately prevent system outages that could interfere with business operations

1 = Existing system backup and recovery procedures are unsatisfactory. Recovery from system outages is extremely time consuming and business operations are seriously impacted (i.e., outages have resulted in severe time and money loss).

2 = The system's backup and recovery procedures do not adequately prevent system outages nor do they minimize time needed to recover from these. While no serious monetary loss has resulted from outages, a substantial amount of negative public exposure has been a consequence.

3 = Problems with system backup and recovery procedures have been experienced which have resulted in time loss and minor delays of business operations.

4 = System backup and recovery procedures are not fully capable of preventing system outages, but do minimize interference with business operations.

5 = Existing system backup and recovery procedures effectively prevent system outages that could interfere with business operations.

17. ADEQUACY OF DOCUMENTATION - extent to which system documentation provided to the customer organization is accurate, clear, comprehensive and useful; extent to which customer documentation can be relied upon in mastering system functionality and use

1 = System use documentation does not exist or is of such poor quality that it is almost fully unusable.

2 = The system use documentation that does exist is accurate, clear and useful, but over half of the system features are undocumented.

3 = System use documentation exists but is either not comprehensive, is inaccurate in parts, is not clearly written, or in some other way is not fully usable 25 - 50% of the time.

4 = System use documentation is comprehensive and accurate, but poorly written in some areas or somewhat poorly organized so that it is not always easy to understand and use.

5 = System use documentation is accurate, clear, complete and useful.

18. DISTRIBUTION OF OUTPUT - extent to which physical outputs of this system/system version have been correctly delivered to customers and to which outputs requested by others have not mistakenly been delivered to you

1 = Over 25% of outputs we receive have been mistakenly delivered to us or misdirected elsewhere before reaching us.

2 = 15% to 25% of the outputs we receive have been mistakenly delivered to us or misdirected elsewhere before reaching us.

3 = 5% to 14% of the outputs we receive have been mistakenly delivered to us or misdirected elsewhere before reaching us.

4 = Some, but less than 5%, of the outputs we receive have been mistakenly delivered to us or misdirected elsewhere before reaching us.

5 = We receive 100% of the physical outputs we expect to receive and hardly ever receive outputs for others mistakenly directed to us.

NA = Not applicable; system has no physical outputs.

19. ADEQUACY OF TRAINING - extent to which training provided in use of this system/system version was comprehensive, timely and effective; extent to which customers' skill levels were satisfactorily developed through this training

1 = No training was provided, despite our need for it; or the quality of training provided was so poor that it was unsuccessful in developing required customer skill levels.

2 = Training was provided but was either so late or so poorly developed and delivered that beginning operators needed to heavily rely on other sources of information in order to understand the use of this system.

3 = Timely training was provided in use of this system and provided basic mastery of the simplest and most common functions of the system. However, training was not as comprehensive or effective as needed to develop operator skill levels fully in more complex system functions.

4 = Timely and comprehensive training was provided in all necessary aspects of use of the system and satisfactorily prepared most employees to use the system effectively. However, the training was better suited to one audience than another (e.g., data entry clerks vs. management level operators) or was otherwise less than fully successful at meeting some subset of customer needs.

5 = The level and type of training provided fully met customer needs; all system use training provided was comprehensive and of fully satisfactory quality to successfully develop needed customer skill levels.

20. DATA SECURITY - extent to which you have confidence that this system/system version's data is secure and that unauthorized access to it can be prevented

1 = Unauthorized access to this system and its data cannot be prevented without extensive system redesign.

2 = Unauthorized access to this system and its data cannot be prevented without substantial extra effort on the part of the customers.

3 = Data security was considered in the design of this system. However, some minor security weaknesses have been identified and until they are corrected we cannot have full confidence that all data is secure and unauthorized system access can be prevented.

4 = While unauthorized access to this system cannot be completely prevented, it is fairly well controlled and not a current concern.

5 = The design of this system gives us full confidence that our data is secure and that unauthorized system access can be prevented.

F. SOFTWARE QUALITY SURVEY - PRODUCER VIEW - GENERAL INSTRUCTIONS

This questionnaire is to be completed by a first level I.S. manager who is/was responsible for delivering/supporting the system of concern. Its aim is to learn about the I.S. producer organization's own perception of the I.S. application product and service quality.

__/__/__
Today's date

System or System Version Name

Implementation Date

Producer Organization Name

SOFTWARE QUALITY SURVEY - PRODUCER VIEW

The aim of this survey is to learn about your perceptions, as an information systems producer, of different aspects of software quality with regard to the information systems application named above. Twenty dimensions of software quality have been identified and are described below. For each of the dimensions, rate the degree to which this system/system version has attained the level of quality desired by your organization. Try to keep each of the different dimensions of quality separate in your evaluation. Your responses will be confidential.

FOR EACH ITEM BELOW, CIRCLE THE RATING THAT BEST DESCRIBES YOUR PERCEPTION OF THE QUALITY OF THIS SYSTEM/SYSTEM VERSION ON THE STATED DIMENSION

1. **CUSTOMER SATISFACTION** - extent to which the expectations and business needs of the customer organization have been met by the information systems development and support services delivered by your organization.

1 = Many customer complaints have been received since system installation with regard to both application functionality and our support services. Customers report that they are highly dissatisfied with both the information system product and with the support services that we have provided on this system.

2 = Several customer complaints have been received since system installation with regard to both application functionality and our support services. Customers have reported specific instances of disappointment with both the information system product and with the support services that we have provided on this system.

3 = Customer expectations have been met with regard to either delivered application functionality or our support services, but not both. This is demonstrated through customer complaints in one area, but not the other.

4 = Our customers have expressed basic satisfaction with both the delivered application functionality and our support services; complaints in either area have been minimal, though not nonexistent.

5 = Customers have expressed high satisfaction since system installation with both application functionality and our support services.

2. **ACCURACY (OF RESULTS)** - Extent to which physical system outputs of the system/system version used by the customers (e.g., print reports, fiche, etc.) have been error free since implementation

1 = Users report that there are unacceptable errors in the most important outputs of the system; these outputs are not usable.

2 = One or more important system outputs contain errors that make them unreliable or otherwise seriously limit their usefulness to customers.

3 = While the most important system outputs are accurate, users report that other outputs from the system are not entirely usable due to the errors contained in them.

4 = While customers consider all outputs usable, some are reported to contain minor inaccuracies.

5 = All outputs are error free.

3. **RELIABILITY** - extent to which the system/system version, has run properly since installation, without failure, providing the expected service and information to customers when needed

1 = The system fails so frequently and totally that the customer organization cannot depend upon it and must rely instead on alternate methods of obtaining needed service and information.

2 = At least one major part of the system (e.g., a particular reporting or data processing run) has a high failure rate necessitating customer use of alternate methods, but other parts of the system are reliable.

3 = Continuity of system operation is fair under normal conditions; however, system failures under abnormal conditions (e.g., in cases of power interruptions, hardware failures, etc.) have been difficult to recover from and have interrupted customer business.

4 = Some, but very few and very contained, system failures have occurred, under normal or abnormal conditions.

5 = The system is highly reliable, surviving even unforeseeable circumstances without failure; expected service and information is being provided to customers when needed.

4. COMPLETENESS (OF IMPLEMENTED REQUIREMENTS) - extent to which customer requirements were implemented in the delivered software

1 = Many documented business requirements (35% or more) were not provided or have been incompletely implemented.

2 = 20% - 34% of customer requirements were not provided or have been incompletely implemented.

3 = The most commonly needed/critical business functionality has been provided; however, between 11% and 19% of the customer requested business functionality was not implemented.

4 = 90% - 99% of the business functions expected and agreed upon by the customers have been implemented.

5 = 100% of the business functions expected and agreed upon by the customers have been implemented.

5. AVAILABILITY (OF RESOURCE) - extent to which computer terminals and associated software have actually been available for use during customers' scheduled periods of availability, since system/system version installation

1 = This system is available for customer use less than 85% of its scheduled (promised) availability.

2 = This system is available for customer use only 85% - 89% of its scheduled (promised) availability.

3 = This system is available for customer use 90% - 94% of its scheduled (promised) availability.

4 = This system is available for customer use 95% - 99% of its scheduled (promised) availability.

5 = This system is available for customer use 100% of its scheduled (promised) availability.

6. **MAINTAINABILITY** - extent to which making modifications in this system has been facilitated or made difficult by the design and specific implementation of this system/system version

1 = This system is among the most difficult and time consuming to maintain and/or enhance; e.g., considering its size, the average cost per "change request" and/or average hours spent in maintenance and enhancement are much higher than average due to system structure, documentation quality, technology used, etc.

2 = The average costs and time requirements for modifying this system are somewhat greater than those for most other systems of the same size.

3 = Compared to other systems of this size, this system requires an average amount of time and cost to maintain and/or enhance.

4 = This system is somewhat less difficult, time consuming and costly to maintain and/or enhance than most other systems of the same size.

5 = This system is among the least difficult, time consuming and costly to maintain and/or enhance; i.e., considering its size, the average cost per "change request" and/or average hours spent in maintenance and enhancement are much lower than average.

7. **FUNCTIONAL REQUIREMENTS** - extent to which the delivered system functionality matches the business needs of the customer organization that were communicated to the development team; or the extent to which the system/system version correctly performs the business processing that is needed by the customers

1 = Many needed business features were not correctly implemented; many changes to current system functionality are needed to meet fundamental customer requirements.

2 = Several needed business features were incorrectly implemented and need to be modified to meet customer requirements.

3 = The most commonly needed/critical business functionality has been correctly implemented; however, customers have reported a few cases where modifications need to be made to system functions in order to meet their specified business needs.

4 = Minor changes in system functionality are needed in order to fully meet customer needs; most functions were correctly implemented.

5 = All needed business functionality has been completely provided and no problem reports have been received on delivered functionality; i.e., the system does what the customers need it to do.

8. USABILITY - extent to which the system/system version is being employed by customers without need for extra technical assistance

1 = Customers have reported extreme difficulty in operating and learning to use the features of this system efficiently; the rate of customer errors and demand for customer assistance on this system is exceptionally high, compared to other systems.

2 = Customers require extensive training and assistance in documentation interpretation in order to learn to operate and use the more complicated features of this system efficiently; a somewhat higher than average customer error rate has been experienced.

3 = Customers report that while most features of the system are easy to learn and use efficiently, some are difficult to understand; several calls for assistance in use of these particular features have been received.

4 = The system is generally very easy to use; very few usage problem reports or questions about how to use system features have been received from the customers since implementation.

5 = This system is so easy to use that only minimal customer training has been needed and no usage problem reports at all have been received.

NA = Not applicable; customers do not directly interface with or operate this system.

9. CONFORMITY (TO STANDARDS) - extent to which the delivered system/system version conforms to the organization's software design, implementation and documentation standards

1 = A great deal of time and effort has been (or still needs to be) devoted to rework of this system due to its initial nonconformance with software standards; the percentage of nonconformance rework to total rework effort requirements is unusually high for this system.

2 = A higher than average number of system defects have been found in this system related to nonconformance with software design, implementation and documentation standards.

3 = The number of nonconformance defects found in this software have required an average amount of rework, when compared to other systems.

4 = The system, with only a few minor exceptions (requiring minimal rework effort), conforms with the organization's software design, implementation and documentation standards.

5 = The system fully complies with established organizational standards for design, implementation and documentation of software; any deviations from standards were formally reviewed and approved.

NA = No specific software standards have been established.

10. EFFICIENCY (OF FUNCTIONALITY) - extent to which the delivered system/system version exhibits acceptable response time and performs within its expected processing time

1 = System response time has been, on average, erratic and slower than that required by the customer; in addition, 15% of the time or more, the system cannot perform within its designated processing window.

2 = System response time is erratic but, on the average, is of acceptable speed; in addition, system processing time exceeds that expected 5% - 10% of the time.

3 = System response time is inconsistent across functions; it is adequate in most system uses, but overly long when utilizing some particular system functions; in addition, system processing time exceeds the designated processing window 5% - 10% of the time.

4 = System response time is consistent, but somewhat slow; system processing is accomplished within the designated processing window more than 95% of the time.

5 = System response time is fast and consistently meets customer needs; in addition, 100% of system processing is accomplished within the designated processing window.

11. DOCUMENTATION - extent to which documentation is adequate for maintaining, operating and utilizing the system

1 = Documentation for this system does not exist or is of such poor quality that it is almost fully unusable for system maintenance, operation and end use.

2 = Documentation that does exist for this system is accurate, clear and useful, but over half of the needed documentation does not exist, is inaccurate, or is so poorly organized or written that it is difficult to use over 50% of the time.

3 = Documentation exists for this system but is either not comprehensive, is inaccurate in parts, is not clearly written, or in some other way is not fully usable 25 - 50% of the time.

4 = Documentation for this system is, for the most part, comprehensive and accurate. However a few pieces of it are not well written or are somewhat poorly organized.

5 = All documentation exists and is accurate, clear, complete and fully useful for maintaining, operating and utilizing the system

12. TIMELINESS OF OUTPUT - extent to which customer output is delivered within the expected time frame

1 = 15% or more of scheduled output is delivered to customers late.

2 = 10% to 14% of scheduled output is delivered to customers late.

3 = 5% to 9% of scheduled output is delivered to customers late.

4 = Less than 5% of all scheduled output is delivered to customers late.

5 = All scheduled outputs are delivered to customers on time.

NA = Not applicable; system has no scheduled output.

13. DEFECT DENSITY - defect rates in production software

1 = Considering the system size and complexity, the number of defects found needing correction after this system/system version went into production has been extremely high.

2 = The number of production defects found in this system/system version is higher than average, considering the software size and complexity.

3 = The production defect rate of this system/system version has been average, considering the software size and complexity.

4 = Considering the system size and complexity, the number of defects found after this system/system version went into production has been lower than average.

5 = A zero defect level in production has been attained in this system/system version implementation effort.

14. SECURITY - extent to which access to software or data by unauthorized persons can be controlled

1 = Unauthorized access to this system and its data cannot be prevented.

2 = Unauthorized access to this system and its data cannot be prevented without substantial extra effort on the part of the customers or system redesign.

3 = Data security was considered in the design of this system/system version. However, some minor security weaknesses have been identified and until they are corrected we cannot have full confidence that all data is secure and unauthorized system access can be prevented.

4 = While unauthorized access to this system cannot be completely prevented, it is fairly well controlled and not a current concern.

5 = The design of this system/system version gives us full confidence that its data are secure and that unauthorized system access can be prevented.

15. MODULARITY - extent to which the system/system version is composed of independent modules, programs, subsystems, and other components

1 = Most modules, programs, and/or subsystems of this system are highly interdependent; 55% or more of system modification efforts resulting from problem reports involve making changes to interrelated, multiple components of the system.

2 = Many modules, programs, and/or subsystems of this system are interdependent; 40% - 54% of system modification efforts resulting from problem reports involve making changes to interrelated, multiple components of the system.

3 = The modules, programs, and/or subsystems of this system that are expected to need change most frequently are mostly independent; only 25% - 39% of system modification efforts involve making changes to interrelated, multiple components of the system.

4 = Many of this system's modules, programs, and/or subsystems are independent; 10% - 24% of system modification efforts involve making changes to interrelated, multiple components of the system.

5 = This system is composed primarily of independent modules, programs and subsystems; over 90% of modification efforts for this system involve making changes to discrete, independent components of the system.

16. TESTABILITY - extent to which the software is structured in a manner that facilitates testing of the code

1 = This system is highly complex, with complicated calculation routines, many condition codes, and/or a high number of independent logic flow paths; compared to other systems of similar size, testing is very time consuming and difficult.

2 = This system has higher logical complexity than average; compared to other systems of similar size, testing is more time consuming and difficult.

3 = This system is of average logical complexity; compared to other systems of similar size, testing its logic requires a normal amount of effort and time.

4 = This system has lower logical complexity than average; compared to other systems of similar size, testing requires less than normal levels of effort and time.

5 = This system has a low level of logical complexity, with very few independent flow paths and simple processing routines; compared to other systems of similar size, testing is quick and easy.

17. INTEROPERABILITY (WITH OTHER SYSTEMS) - degree to which this system/system version successfully interfaces with other systems

1 = This system/system version, as originally implemented, was unable to successfully exchange data with more than one of the other systems with which interface was planned; many interface problem reports have been received and many reruns due to interface problems have been needed since installation.

2 = The most important interfaces for data exchange were successfully implemented in this system effort; however, the system/system version, as originally implemented, was unable to successfully exchange data with at least one other system with which interface was planned.

3 = Several interface problems were encountered during system testing and were corrected prior to installation; however, reliability problems in exchanging data still exist in at least one case where a system interface was planned.

4 = Only minor reliability problems have been encountered with interfaces since this system/system version's installation.

5 = This system/system version, from the time of its initial implementation, has been fully successful in accomplishing data exchange with all of the other systems with which interfaces were planned and developed.

18. AUDITABILITY - degree to which the system structure and controls (e.g., run-to-run controls, record counts, financial controls, etc.) allow error detection and easy tracing of system data from its origination to its final destination

1 = In this system, out-of-balance situations, situations where output data does not correspond with input data, or where transaction processing is otherwise in error are very difficult to identify and troubleshoot, or are sometimes even impossible to trace to their origin.

2 = In this system, out-of-balance situations, situations where output data does not correspond to input data, or where transaction processing is otherwise in error are fairly easy to identify; however, tracing these types of errors to their origin so that they can be corrected is very difficult and time consuming.

3 = In this system, identification and tracing of out-of-balance situations, situations where output data does not correspond with input data, or where transaction processing is otherwise in error is of average difficulty.

4 = The implemented system structure and controls make both identification and tracing of out-of-balance situations, situations where output data does not correspond with input data, or where transaction processing is otherwise in error somewhat easier than that for the average system.

5 = Implemented system structure and controls are superior in terms of allowing easy identification and tracing of out-of-balance situations, situations where output data does not correspond with input data, or where transaction processing is otherwise in error.

19. PORTABILITY - degree to which the system/system version design allows easy transfer of its software from one hardware configuration and/or system environment to another

1 = This system was strictly designed and implemented to run in one particular hardware/system software environment; the software could not run in a different environment without modification of virtually every module, which would be prohibitively expensive.

2 = Extensive effort and expense would be required to modify the software to run in a different hardware/system software environment than the one it was originally developed for; not all, but still the majority of modules would need to be modified.

3 = The system design considered the organization's most likely target hardware/system software environments; accomplishing the modifications needed for this software to run in another environment than that in which it was originally installed would involve only average cost and effort.

4 = This system was designed for and implemented in two different existing hardware/system software environments; less than average effort and cost would be required to perform the modifications needed to transfer the software to yet another environment.

5 = A explicit system design objective in this project involved developing highly portable software; because of this, only minimal effort and expense, requiring changes to very few modules, would be required to transfer the software to a different environment than that in which it currently runs.

20. TRACEABILITY (OF REQUIREMENTS) - extent to which the delivered system functionality can be traced back to specific formal requirements and does not include additional features and functionality that were not part of the planned and documented project deliverables

1 = At least one program was delivered as part of this system that provides functions that cannot be traced back to any formal requirements; the code that cannot be "tied back" to a documented requirement constituted more than 20% of the total development effort time and/or cost.

2 = Most delivered system functionality can be linked back to formal requirements; however, delivered functionality that constituted 10% - 20% of the total development effort and/or cost was never formally requested nor approved.

3 = Some functions/features were added to this system that were not formally requested; however, these constituted only 5% - 9% of the total development effort time and/or cost.

4 = Additional features or functionality added to this system that cannot be directly "tied back" to formal requirements constituted less than 5% of the total development effort time and/or cost.

5 = All delivered system functionality and features can be traced back to specific, documented requirements.

BIBLIOGRAPHY

Afifi, A.A. & Virginia Clark (1990). *Computer-Aided Multivariate Analysis*. New York: Van Nostrand Reinhold Company.

Anthes, G.H. (1992). User role gains CIO backing. *Computerworld*, February 24, p. 63.

Anthes, G.H. (1993). Welcome to the Unknown Zone. *Computerworld*, February 8, pp. 55-57.

Argote, L. (1982). Input uncertainty and organizational coordination in hospital emergency units, *Administrative Science Quarterly*, Vol. 27, pp. 420-434.

Argote, Linda, Marlene E. Turner & Mark Fichman (1989). To centralize or not to centralize: The effects of uncertainty and threat on group structure and performance, *Organizational Behavior & Human Decision Processes*, Vol. 43, No. 1

Baroudi, J. (1990). Personal correspondence to M. Bays. Information Systems Department, New York University

Baroudi, J., M. Olson and B. Ives (1986). An empirical study of the impact of user involvement on system usage and information satisfaction, *Communications of the ACM*, March Vol. 29, No. 3, pp. 232-238.

Bays, M. (1985). Strategic Information Systems Planning: Process and Contextual Factors. Unpublished Paper, Ph.D. Program in Business, Baruch College

Berenson, M.L., Levine, D.M. and M. Goldstein (1983). *Intermediate Statistical Methods and Applications: A Computer Package Approach* Englewood Cliff, NJ: Prentice-Hall, Inc.

Boehm, Barry W., J.R. Brown, H. Kaspar, M. Lipow, G.J. MacLeod and M.J. Merritt (1978). *Characteristics of Software Quality*. New York: Elsevier North-Holland Publishing Company, Inc.

Brown, D. (1988). Joint application design: The Royal Bank story. *Proceedings from the Third International Conference on Improving Software Quality and Productivity*. Toronto: Quality Assurance Institute, pp. 123-147.

Burns, Thomas and Gerald Stalker (1961). *The Management of Innovation*. London: Tavistock.

Cabrera, J. (1991). A process for implementing service level agreements. *Proceedings of the Ninth International Conference on Measuring Information Quality, Productivity, and Customer Satisfaction*, March 20-22, Orlando, FL: Quality Assurance Institute, pp. 2-174 - 2-201.

Cameron, K.S. and D.A. Whetten, Eds. (1983). *Organizational effectiveness: a comparison of multiple models*. New York: Academic Press.

Campbell, D.T. and J.C. Stanley (1963). *Experimental and Quasi-Experimental Designs for Research*. Boston: Houghton Mifflin Company.

Carlyle, R.E. (1989). Careers in crisis. *Datamation*, August 15, pp. 12-16.

Champy, J. and M. Hammer (1989). Help wanted: Heroes and visionaries preferred. *Computerworld*, March 20, pp. 69, 72-78.

Chandler, A. (1962). *Strategy and Structure*. Garden City, NY: Doubleday.

Christensen, L.A. and R.D. Smith (1991). Information systems quality and value: A comparison of user versus IS perceptions. *Journal of Information Technology*, Volume II, Number 3, pp. 17-24.

Cook, T.D. and D.T. Campbell (1979). *Quasi-Experimentation: Design & Analysis Issues for Field Settings*. Boston: Houghton Mifflin Company.

Crawford, A. (1988). Requirements analysis methods - Defining business requirements. *Proceedings from the Third International Conference on Improving Software Quality and Productivity*. Toronto: Quality Assurance Institute, pp. 101-114.

Crosby, P.B. (1979). *Quality is Free*. New York: McGraw-Hill, Inc.

Daft, R.L. and R.H. Lengel (1984) Information richness: A new approach to manager information processing and organization design, in *Research in Organizational Behavior*, Vol. 6, B. Staw and L.L. Cummins (eds.), Greenwich, CN: JAI Press.

Daft, R.L. and N.B. McIntosh (1981). Alternative exploration into the amount and equivocality of information processing in organizational work units. *Administrative Science Quarterly*, Vol. 26, pp. 207-224.

Davis, Dwight (1989). Special Report: Industry-by-Industry Spending Survey, *Datamation*, November 15, pp. 42-44.

Davis, Gordon B. and Margrethe H. Olson (1985). *Management Information Systems: Conceptual Foundations, Structure and Development*. New York: McGraw-Hill.

Deardon, J. (1987). The Withering Away of the IS Organization. *Sloan Management Review*, Vol. 28, No. 4., pp. 87-91.

DeLone, W.H. and E.R. McLean (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, Vol. 3, No. 1, pp. 60-95.

Deming, W. Edwards (1986). *Out of the crisis*. Cambridge, MA: Massachussetts Institute of Technology, Center for Advanced Engineering Study.

Fagan, M.E. (1976). Design and code inspections to reduce errors in program development. *IBM Systems Journal*, Vol. 15, Number 3.

Freedman, D. (1991). The myth of strategic I.S. *CIO*, Vol. 4, No. 10, pp. 42-48.

Freiser T. (1989). IS can't joint the business till it learns the high wire. *Computerworld*, October 2, p. 67.

Fry, L. & J. Slocum (1984). Technology, structure, and workgroup effectiveness: A test of a contingency model. *Academy of Management Journal*, Vol. 27, pp. 221-246.

Galbraith, J. (1973). *Designing complex organizations*. Reading, MA: Addison-Wesley, Inc.

Galbraith, J. (1977). *Organizational Design*. Reading, MA: Addison-Wesley, Inc.

Garvin, D.A. (1987). Competing on the eight dimensions of quality, *Harvard Business Review*, Nov.-Dec. pp. 101-109.

Glass, R.L. (1990). Which is better - reviews or testing? *System Development*, Vol. 10, No. 7., p. 7.

Godfrey, L.E. (1986). Joint Application Design: A Timesaver. *Resource*, March/April, pp. 24-28.

Gresov, C. (1989). Exploring fit and misfit with multiple contingencies. *Administrative Science Quarterly*, Vol. 34, pp. 431-453.

Head, R.V. (1984). *Planning Techniques for Systems Management*. Wellesley Hills, Mass.: QED Information Sciences, Inc.

Henderson, John (1990). Plugging into strategic partnerships: The critical IS connection". *Sloan Management Review*, Spring, Vol 31, No. 3, pp. 7-18.

Henderson, John & N. Venkatraman (1990). Strategic alignment: A model for organizational transformation via information technology, CISR WP No. 217 (Sloan Working Paper No. 3223-90, November (MIT Sloan School of Management)

Ives, B., and G.P. Learmonth (1984). The informations system as a competitive weapon. *Communications of the ACM*, Volume 27, No. 12, December, pp. 1193-1201.

Ives B., and M. Olson (1984). User involvement and MIS success: A review of research. *Management Science*, Vol. 30, No. 5, May, pp. 586-603

Jones, Capers (1981). *Programming Productivity: Issues for the Eighties*. New York: IEEE Computer Society Press.

Juran, Joseph M. (1989). *Juran on Leadership for Quality*. New York: The Free Press.

Kangas, M. (1987). Open to discussion. *Office Management & Automation*, July, pp. 1-3.

Kanter, R.M. (1987). "Infotech" and corporate strategy. *Management Review*, October, pp. 21-22.

Keen, P.G. (1991). Wa$te not, want not. *Computerworld*, February 25, pp. 77-79.

Keen P.G. and E.M. Gersch (1984). The politics of software systems design, in Brill, A.E. (ed) *Techniques of EDP Project Management*. New York: Yourdon, Inc., pp. 264-271.

Keirsey, D. and M. Bates (1984). *Please Understand Me*. Del Mar, CA: Prometheseus Nemesis Book Company.

Kerlinger, F.N. (1973). *Foundations of Behavioral Research*. New York: Holt, Rinehart and Winston, Inc.

Kerr, J.D. (1989). Systems design: Users in the hot seat. *Computerworld*, February 27, pp. 87-96.

Kirkley, J. (1988). The restructuring of MIS: Business strategies take hold. *Computerworld*, March 21, pp. 79-93.

Konstadt, P. (1991). A partner is born. *CIO Magazine*, February, pp. 51-59.

Kordich, E. (1992). *Successful Implementation of Information Technology in the Insurance Industry*. Unpublished termpaper. West Long Branch, NJ: Monmouth College School of Business, p.14.

Kramer, S. (1990). How business managers greet arrivals. Executive Report: When IS moves into departments. *Computerworld*, December 10, p. 94

Kroon, Lee (1989). The cost clause in the new IS mandate. *Computerworld*, October 9, p. SR/12.

La Belle, A. and H.E. Nyce (1987). Whither the IT Organization? *Sloan Management Review*, Vol. 28, No. 4., pp. 75-85.

Lawrence, P.R. and J.W. Lorsch (1967). High-performing organizations in three environments. In *Organization Theory*, D.S. Pugh (ed.). Middlesex, England: Penguin Books, 1985, pp. 87-105.

Lawrence, P.R. and J.W. Lorsch (1969). *Organization and Environment*. Homewood, IL: Richard D. Irwin.

Layman, B. (1989). QAI guide to service-level agreements. *Preconference seminar materials - Seventh International Conference on Measuring Data Procesing Quality and Productivity*, March 14, Orlando, FL: Quality Assurance Institute.

Lewin, A.Y. & J.W. Minton (1986). Determining organizational effectiveness: Another look and an agenda for research. *Management Science*, Vol. 32, pp. 514-38.

Lohdahl, T.M. and K.L. Redditt (1989). Aiming IS at business targets. *Datamation*, February 15.

MacKinnon, M.D. (April 1989). *Downloading of Certain Application Development Functions. Memorandum for all ISOF Employees*. Prudential Insurance Company of America: Roseland, NJ

Maglitta, J. and Mark Mehler (1992). The new centralization. *Computerworld*, April 27, pp. 85-88.

Margolis, Neil (1992). N.Y. Life moves back to the future. *Computerworld*, February 24, pp. 89-90.

McFarlan, F.W., and J.L. McKenney (1983). *Corporate Information Systems Management: The Issues Facing Senior Executives*. Homewood, IL: Richard D. Irwin, Inc.

Mintzberg, H. (1979). *The Structuring of Organizations*. Englewood Cliffs, NJ: Prentice-Hall Inc.

Myers, I.B. and M.H. McCaulley (1989). *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*. Palo Alto, CA: Consulting Psychologists Press.

Parasuraman, A., V.A. Zeithaml, & L.L. Berry (1988). SERVQUAL; A Multiple-item scale for measuring consumer perceptions of service quality, *Journal of Retailing*, Vol. 64, No 1, pp. 12-37.

Parsons, G.L. (1983). Information technology: A new competitive weapon. *Sloan Management Review*, Vol.25, pp. 3-14.

Pearson, S.W. and J.E. Bailey (1977). Measurement of Computer User Satisfaction. Reprint of paper originally published by the American Institute of Industrial Engineers, pp. 49-58

Perrow, Charles (1970). *Organizational Analysis: A Sociological Approach*. Belmont, CA: Wadsworth.

Perry, W. (1986). *Effective Methods for Data Processing Quality Assurance*. Orlando, FL: Quality Assurance Institute.

Peterson, R.O. (1989). The best of both worlds. *Computerworld*, May 22, pp. 87-93.

Pfeffer, J. (1982). *Organizations and Organization Theory*. Marshfield, MA: Pitman.

Poo, C.D. (1991). Shaping the development process. *System Development*, Vol. 11, No. 1, pp. 5-7.

Porter, Michael E. (1980) *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: The Free Press.

QAI (1989). *Quality Assurance Institute Research Report #1: Measurement of the Customer's View of Information Systems Quality Characteristics*. Orlando, FL: Quality Assurance Institute.

QAI (1990). *Quality Assurance Institute Research Report #3: Measurement of the Producer's View of Information Systems Quality Characteristics*. Orlando, FL: Quality Assurance Institute.

Redditt, K.L. and T.M. Lohdahl (1988) Leaving the IS mothership. *CIO Magazine*, October, pp. 54-60.

Redditt, K.L. and T.M. Lohdahl (1989). What should a CFO know about dispersed computing? *Financial Executive*, July/August.

Rockart, J.F. and M.S. Scott-Morton (1984). Implications of changes in information technology for corporate strategy. *Interfaces*, Vol. 14, No. 1, Jan-Feb., pp. 84-95.

Rush, G.R. (1986). A proven way to better specifications - FAST. Unpublished Paper, Bloomfield Hills, Michigan: MG Rush Systems, Inc.

Santosus, M. (1991). CIO Software Productivity Survey, *CIO*, March, p. 24+

SAS Institute Inc. (1991). *SAS User's Guide: Statistics, Version 6 Edition*. Cary, NC.

Schoonhoven, C.B. (1981). Problems with contingency theory: Testing assumptions hidden within the language of contingency theory. *Administrative Science Quarterly*, Vol. 26, pp. 349-377.

Scott, W. Richard (1981). *Organizations: Rational; Natural, and Open Systems*. Englewood Cliffs, NJ: Prentice-Hall

Scott-Morton, Michael (ed.) (1991) *Corporations in the 1990's*. London: Oxford University Press.

Sill, N. (1983). Review techniques for QA in the systems development life cycle. Unpublished paper presented at the DPMA National Symposium on EDP Quality Assurance: Chicago.

Smith, R.G. (1988). Joint Application Design. *Proceedings from the Third International Conference on Improving Software Quality and Productivity*. Toronto: Quality Assurance Institute, pp. 148-151.

Sullivan-Trainor, M.L.(1988). Not just another end-user liaison. *Computerworld*, March 29, pp. 95-97

Sullivan-Trainor, M.L. (1989a). Building competitive advantage by extending information systems. Special Report: IS in the 1990's, *Computerworld*, October 9, p.SR19.

Sullivan-Trainor, M.L. (1989b). Changing the fixtures in the house that IS built. *Computerworld*, July 24, pp. 51-60.

Thompson, James D. (1967). *Organizations in Action*. New York: McGraw-Hill.

Tosi, H.L. Jr. & J.W. Slocum, Jr. (1984). Contingency theory: some suggested directions, *Journal of Management*, Vol. 10, pp. 9-26.

Tushman, M.L. (1979). Work characteristics and subunit communication structure: A contingency analysis, *Administrative Science Quarterly*, Vol. 24, pp. 82-98.

Tushman, M.L. and D.A. Nadler (1978) Information processing as an integrating concept in organization design, *Academy of Management Review*, Vol. 3, pp. 613-624.

Van de Ven, A.H., A.L. Delbecq and R. Koenig, Jr. (1976). Determinants of coordination modes within organizations, *American Sociological Review*, Vol. 41, pp. 322-338.

Van de Ven, A.H. and R. Drazin (1985) The concept of fit in contingency theory. In L. Cummings and B. Staw (eds.), *Research in Organizational Behavior* (Vol. 7). Greenwich, CT: JAI Press.

Van de Ven, A.H. and D.L. Ferry (1980) *Measuring and Assessing Organizations*. New York: Wiley Interscience

Von Simson, Ernest (1990). The "centrally decentralized" IS organization, *Harvard Business Review*, July-August, pp. 158 -162.

Vredenburgh, D., Schuler, R. and Jackson S. (1988). Conceptualizing Uncertainty in the Organizational Sciences: Linking Levels of Organizational Analysis. Unpublished working paper presented at Doctoral Seminar, Baruch College, NY.

Weick, K.E. (1979). *The Social Psychology of Organizing*. Reading, MA: Addison-Wesley.

Welkowitz, J., Ewen R. B., and J. Cohen (1971). *Introductory Statistics for the Behavioral Sciences*. New York: Academic Press, Inc.

Wiseman, C. (1985). Strategic vision. *Computerworld*. volume XIX, No. 20, May20, pp.ID/1-ID/16.

Wood, J. and D. Silver (1989). *Joint Application Design*. New York: Wiley.

Woodward, R. (1965). *Industrial Organization: Theory and Practice*. London: Oxford University Press.

Yourdon, E. (1982). *Managing the System Development Life Cycle*. New York: Yourdon Press.