RESEARCH METHODS IN INFORMATION SYSTEMS
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14 THE NEED FOR LONGITUDINAL DESIGNS IN THE STUDY OF COMPUTING ENVIRONMENTS[1]

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Abstract

Longitudinal research designs are compatible with the deep structure of process and change characteristic of computing environments. To motivate the need for longitudinal designs the paper focuses upon current practice in IS research and reviews recent post-positivist theories of social action. Implications for IS research and longitudinal research designs are discussed concluding with an assessment of the benefits and costs of longitudinal designs and guidelines for their use in IS research.

Introduction

Longitudinal designs are seldom used in Information Systems research. Common explanations for the avoidance of longitudinal designs are high cost, problems with subject attrition, and concern over delays in the publication of results. Longitudinal designs, however, offer significant advantages over single data collection designs.

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Longitudinal designs permit the exploration of causal relationships without resorting to cross-sectional designs. Most importantly, longitudinal designs permit the exploration of time-dependent phenomenon such as learning, adaptation, and evolution within the research setting. For many research issues confronting the Information Systems field, longitudinal designs offer great opportunity for scientific progress.

This paper calls for a greater use of longitudinal designs in Information Systems research. The objective of this paper is to review the problems facing IS research and illustrate how longitudinal designs can rectify some of these problems. To substantiate this perspective, the paper reviews current practice in IS research at two levels. At the first level, the paper discusses the mismatch between the traditional research designs employed in IS research and the characteristics of IS research settings. It is believed that this mismatch stems from an incomplete view of information systems research settings. Longitudinal designs can assist in reducing this gap because their inherent structure and logic is compatible with many of the research issues facing the Information Systems field.

At the second level, the paper reviews the problems in IS research from the perspective of the philosophy of social science. For the most part, IS research is based on a positivist view of science. Currently the positivist view of science is undergoing a re-evaluation in the social sciences and a new view is emerging: the post-positivist view of social research. As discussed later in the paper, social scientists have critiqued logical positivism as a research philosophy and have developed some alternative perspectives that can improve our research methods. The paper will also illustrate how longitudinal designs may be formulated to incorporate some of the tenets of post-positivist thought.

Research in Information Systems

Many of the current problems in IS research can be traced to two root causes: (1) a mismatch between the research methodologies and the features of IS research settings and (2) the use of a limited and seriously criticized research philosophy that is highly dependent upon positivist research principles. Each of these root problems has affected both the quality of IS research and its ability to make reliable statements about computing phenomena.

Research in information technology and information systems has been characterized by four major themes during the last twenty years:

1. Research to improve the effectiveness of information systems in practice. These types of research projects have utilized either a field test approach or a laboratory experiment.
2. Research to study the problems associated with information systems failures or implementation efforts. These research efforts have depended primarily upon case studies and survey methods.
3. Research to study the impacts and issues associated with the introduction and use of computerized information systems on organizations. This line of research is characterized by case studies and survey research methods.
4. Research on the role and effects of computer systems upon society, its social structures, divisions of labor, class restructuring, and innovation. These studies are interested in the emergence of new social forms and behaviors, and the development of the so-called information society or information age.

Our success in these themes of research have been fragmented. Few of our lines of research have led to new organizational theories, better measures of information, or theories about roles or impacts of computing in organizations. Our empirical studies have resulted in at best mixed findings. IS researchers are left with a number of problems and unresolved issues in their lines of inquiry:

1. Inability to ascertain the impacts of information systems and computer technology on organization structure or patterns of behavior.
2. An inability to make statements about the nature and characteristics of the long-term effects (more than one year) of information systems on a variety of dependent measures.
3. An inability to make statements about the impact of information systems and computer technology on the quality of work life.
4. An inability to accurately reconstruct or observe the antecedent conditions of information systems failure and success.

IS researchers have offered explanations for the lack of convergence in the totality of IS research results. Dickson, Benbasat and King (1980) criticized IS research for its over-dependence on conceptual studies, Keen (1980) criticized IS research for its non-cumulative nature, and Turner (1980) faulted IS research for its lack of methodological rigor. No doubt all explanations have some basis. However, this paper argues that the problem of the convergence can also be explained by the misapplication of research methods to research settings and the reliance upon research methodologies based heavily on the logical positivist philosophy of science. It is further argued that longitudinal designs can remedy some of the problems.

The paper proceeds as follows. The second section of the paper discusses in more detail the limitations of the methodologies employed in IS research. The third section continues this discussion by placing IS research in the context of contemporary social science criticism of the logical positivist research philosophy. The fourth section examines the longitudinal design as a vehicle for overcoming some of the limitations in IS research and incorporating some of the tenets of post-positivist social science. The fifth section concludes the paper by offering suggestions for conducting longitudinal research in IS settings and topics of IS research that would benefit from longitudinal designs.

The Misapplication of Research Methods

Misapplication implies that a tool or method has in some way been applied to a situation in an inappropriate or less than satisfactory manner. From the standpoint of research inquiry, the ability to understand a phenomenon is related both to the overall logic of the research approach and its compatibility with the subject to be studied. In addition, the research method should be capable of successfully achieving the research objectives. Frequently, IS researchers have engaged in studies about the evolution or improvement of IS settings with methods that offer little probability of providing deep understanding of the subject under study. For example, often the studies fail to include time as a central variable and as a result ignore the processes of learning, evolution, and development. Consider studies of organizational structures or user involvement that rely upon single point data collection designs. What possibility have these approaches to capture the relevant underlying processes? Ives and Olson (1984), in an extensive review of the

literature on user involvement, call for the use of longitudinal designs because of the many problems in that line of research.[2]

Misapplication of research methods has occurred at two levels. First, the IS field has been quite narrow in its use of research methods utilizing primarily conceptual studies, case studies, field tests, and experimental studies. Second, misapplication is seen in the broad logic of the research designs (i.e., multi-period vs. single period designs) in terms of their match with the characteristics of the research settings. As a result, the information systems field has not seriously explored the variety of methodologies available to study IS research settings. The following discussion explores the misapplication problem beginning with a review of the types of research methods used in IS research followed by a discussion of the unique characteristics of IS research settings.

Research Methods in Use

Historically, the IS field has been quite limited in it use of research methods. In addition to the problem of methodological mismatch, IS research is characterized by its methodological particularism. Most problematic is the absence of research designs for the study of change. To understand the present situation, it is important to review the IS literature on IS research.

In an early review of IS research, Van Horn (1973) found that IS research exhibited the following characteristics:

1. paucity of empirical research,
2. limited theories,
3. a reliance on field and case study methods, and
4. a general inability of the case method to provide "enlightenment about the key research issues of MIS" (Van Horn 1973, p. 173).

Van Horn noted that in the first twenty years of MIS research (circa 1953 to 1973) very little empirical research was reported. No comments were made regarding the use or value of longitudinal designs in IS research.

Hamilton, Ives and Davis (1980), Hamilton and Ives (1981), Ives and Hamilton (1982) initiated a series of studies about knowledge utilization in the information systems field. They reviewed IS research as reported in IS doctoral dissertations and published journal articles between 1970 and 1979. Conceptual studies (studies without data) and field studies accounted for 64 percent of the dissertations classified whereas case studies accounted for 13 percent of the dissertations classified. The results of classifying the types of research represented in doctoral dissertations are seen in Table 1.[3]

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[2]Interestingly, they did not find any examples of longitudinal designs, despite the process and time dependent relationships involved in user involvement.

[3]Three hundred and thirty-one dissertations were selected from *Dissertation Abstracts International,* a service that provides copies of doctoral and master's theses from major universities in the United States.

Table 1. Research Methodologies Employed in Doctoral Dissertations in Information Systems, 1973-1979
(Adapted from Hamilton, Ives, and Davis 1980)

Research Methodology	Percent	Rank
Case Study	13	4
Field Test	2	6
Field Study	31	1
Laboratory Study	15	3
Conceptual Study	31	1
Unknown	8	6

Hamilton and Ives (1981) made similar findings in their review of research published in leading information systems journals.[4] Their survey indicated that the most common types of studies were conceptual studies (56%), followed at a distance by three other types of research, case studies (11%), field tests (11%), and field studies (10%). These results are seen in Table 2. In a later study, Ives and Hamilton (1982) itemized 9,911 references in 532 MIS journal articles from 1970 to 1979. Their findings indicated that the most frequently quoted articles were conceptual studies and research frameworks and that the dominant source of information quoted was from journal articles followed by books and conference proceedings. Perhaps most interesting was the finding that the dominant reference disciplines for IS research were computer science, management, and management science. References to journals in accounting and the behavioral sciences were quite small.

Despite the comprehensiveness of these reviews, none of the studies provide any indication of the use of longitudinal designs in IS research. The great majority of IS research has utilized case studies, conceptual studies, field tests, and field studies, all of which are extremely limited in their ability to study change without a longitudinal research frame or cross-sectional design. Case studies can provide insight into the process of evolution and can be useful for theory building. However, case studies are limited by their dependence upon retrospective accounts, selective perception of the observer, and limited sample size. Conceptual studies at this point are best viewed as proto-scientific since the body of empirical research is limited. Field tests and field studies are problematic if they are based upon single sampling points and lack cross-sectional structure.

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[4]A number of well known journals were surveyed. Included in the analysis were *Database, Information and Management, MIS Quarterly, Accounting Review, Journal of Accountancy, ACM Transactions on Database Systems, Communications of the ACM, Computing Surveys, IBM Systems Journal, Academy of Management Journal, Academy of Management Review, Harvard Business Review, Sloan Management Review, Decision Sciences,* and *Management Sciences.*

Table 2. Research Methodologies Employed in Information Systems Research, 1970-1979
(Adapted from Hamilton and Ives 1981)

Research Methodology	Percent	Rank
Case Study	10.6	2
Field Test	10.6	2
Field Study	10.3	4
Laboratory Study	7.9	5
Conceptual Study	55.6	1
Tutorial, Review, Other	7.6	6

An informal review of the published literature in Information Systems reveals that most current studies are single, one shot studies without an explicit cross-sectional design or multiple sampling points. These limited research designs impose severe limitations upon researchers who wish to investigate the multivariate relationships between computing and social action, computing evolution, learning effects, and progressive change in its broadest dimensions.

The Structure of IS Settings

IS research is unique because it focuses upon the development, use, management and evaluation of computing as an activity in and of itself. Computing environments are interesting precisely because of their unique features and implications for individual and collective behavior. Conceptually and theoretically, most IS researchers expect social settings with computers to be qualitatively different as compared to social settings without computers. This is the basic axiom of IS research. Generally, social settings with significant amounts of computing behavior are expected to exhibit high levels of innovation, structure, rationalization and routinization of procedures, higher levels of productivity, high capacities for information processing and dissemination, and a greater ratio of machine/labor investment. Computerized settings are also expected to exhibit different organizational structures, roles, attitudes, beliefs and management strategies.

In some cases, these differences are designed and researchers are interested in producing normative guidelines to assist in creating a desired state within the computing environment as compared to the previous non-computing environment. In other cases, the researcher is interested in understanding the nature of computing environments together with the relationships among key variables. The fundamental problem in conducting IS research and generating valid results is that these settings are not static and a single snapshot of the situation is seldom capable of embracing the complexity. Moreover, computing environments, in whatever form, are inextricably entwined with the social system. This manifold complexity within computing environments has led some

researchers to characterize IS settings as the "Web of Computing" (Kling and Scacchi 1982) and to refer to computer technology as a "computing package" rather than a monolithic technological tool (Danzinger et al. 1982). Thus, in order to conduct research about computing, the researcher must take great care to carefully characterize the research setting and use the appropriate methodology. Conducting analyses of computing requires that the setting drive the method, not vice-versa.

Because computing systems are part of the social system, IS research settings are often in flux. Computer settings are characterized by changing behaviors, structures and technology. In addition, the rates of change for the variables may be quite different. In fact, much of the research in the information systems field has been concerned with the effects of computer technology on organizations and individuals and its ability to effect change. (Leavitt and Whisler 1958; Hoos 1960; Burlingame 1961; Delehanty 1967; Mumford and Banks 1967; Meyers 1967; Whisler 1970; Dickson and Simmons 1970; Hunt and Newell 1971; Ginzberg 1975; Alter 1980; Bostrom and Heinen 1977; King and Kraemer 1981; Kling 1980; Kraemer 1982; Keen 1981; Vitalari, Venkatesh, and Gronhaug 1983). Many would agree that the relationship between computer technology and social change is fundamental to most research issues confronting the IS researcher today.

For example, organization structure may change in terms of years, whereas patterns of system use may change in weeks or months. It is also reasonable to expect that over a period of time usage patterns and individual behavior may fluctuate according a wide variety of exogenous variables. Many times equilibrium positions in the structure, behavior, and processes of computerized settings are transient and temporary and in other cases are stable for months and years. At the outset of a study, the IS researcher can only assume that computing has the potential to affect the setting. A priori, many hypotheses are possible, including the null hypotheses that the technology will have no observable effect. In other cases, the impact of the technology may be a function of significant priors and antecedent conditions. Kling (1980), in an extensive review of the computing literature, concludes that the social setting is a far stronger determinant of computer impacts than the technology. Still, in other cases, the setting may be looking for a reason to change and computing becomes a vehicle for that change process.

In most cases, the IS researcher is interested in the ways existing or new information technology affect certain dependent variables such as worker productivity, decision making, attitudes, beliefs, or innovation. In evaluation studies, the researcher's objective may be to determine if a new computerized work setting is superior to the old configuration. In normative studies, the researcher may attempt to compare settings to analyze the effect of a new set of management strategies or decision procedures and derive new guidelines. In descriptive studies, the researcher may be interested in how the setting evolves and its relative changes. Each of the research objectives—evaluative, normative, and descriptive—are related. Central to these concerns is an implicit understanding of process and change. Process and change are perceptual constructs for time dependent linkages and alterations that occur randomly or in a progression. Within computing settings, changes occur in the technology, the organizational structure, the task setting, the motivations and attitudes of personnel, and the goals and focus of management.

Thus, to study computing in IS settings, the researcher must consider the following features in their structure:

1. IS settings are characterized by the presence of computer technology in a variety of forms; however, the technology is not monolithic but part of the social system. In some situations, the computer technology will reinforce the existing behavior and structure of the social system; in other cases, it will alter and reform the social system.
2. IS research settings are characterized by different rates of change. Research issues concerned with the effectiveness of the technology, the effectiveness of a development or implementation process, the impact on social action, or the evaluation of the setting all depend upon the measurement of changes in the setting. In short, change is central to understanding IS settings.
3. Information systems themselves become a type of social organization. Information systems direct different types of social action in the form of procedures, work behaviors, and directed communication links. Because information systems are a form of social organization, they too evolve through processes of adaptation to remain relevant to the users.
4. Research methods that are unable to grasp the above features of IS settings are unlikely to yield fruitful results.

In short, in order to understand computing environments, we must understand the interplay between computer technology and the social organization and how that relationship changes over time. No matter how ubiquitous computing becomes, social life from now on will be a function of this interplay between technology and human behavior. No doubt this relationship will change and evolve over time. Social settings today and in the future will be different from their past precisely because computing is a fact of social life. In the most abstract sense, IS researchers are studying a new type of relationship between semi-autonomous machines and human behavior. It is the job of the IS researcher to stand back and reflect upon those features that make computing environments unique. These unique features in turn call for research designs that are able to capture the correct information to understand the observed phenomena. Progress in our descriptive understanding of IS settings and our ability to make normative pronouncements depend on this type of understanding.

Limitations in Current Research Philosophy

An examination of the research philosophy operative in IS studies provides a second explanation for the problems in IS research. Not only have the methodologies employed in IS research been limited but the philosophy of research has been limited as well. The issues of research philosophy and research methods are closely related. A limited research philosophy is most likely to lead to a limited set of research methods and away from a concept of methodological pluralism. To date, the driving research philosophy in Information Systems, even among the critics of IS research, is based on a rather strict interpretation of the logical positivist philosophy of science.[5] Logical positivism (or

[5]A few exceptions exist; see, for example, Kling (1980) and Klein (in this volume). It is also important to note that the Information Systems field is not alone in its dependence upon the logical

simply positivism) refers to a philosophical perspective that has guided most "scientific" research during the last 100 years. The basic tenets of the positivist scientific philosophy are: (1) researchers can obtain objective, value-free facts about social reality which are independent of the researcher; (2) the hypothetical deductive method provides for a unified approach to scientific inquiry; (3) the search for causal relationships is the pre-eminent concern of science; and (4) empiricism and measurement are essential for scientific discovery.

However, the exclusive dependence upon the positivist model of research has led to problems in social science research and is undergoing significant debate. The problems encountered by the IS researcher in developing a cumulative tradition of verifiable knowledge is not unique. In fact, it parallels significant problems encountered by kindred researchers in the behavioral sciences. The purpose of the following discussion is to place contemporary IS research philosophy in the context of contemporary post-positivist criticisms in the philosophy of science. The discussion will review the major tenets of the post-positivist research philosophy and discuss its implications for IS research and it relationships to longitudinal designs.

Tenets of the Post-positivist Research Philosphy

The post-positivist debate refers to a body of philosophical works and social science criticism that re-examines the role of the positivist approach in social science research.[6] The behavioral sciences are undergoing a rethinking process about paradigms and research methods. For example, in psychology, researchers are reexamining the validity and value of the laboratory experiment as a primary means of inquiry (Prohansky 1981). In sociology, researchers are questioning the logical-positivist perspective and the dependence upon empirical measures for inquiry into social systems (Brittan 1973; Menzies 1982; Schwartz and Jacobs 1979; Gergen 1982; Giddens 1982; Morgan 1983; Habermas 1984). Similar debates have appeared in management disciplines (Bush and Hunt 1982).

The tenets of the post-positivist research philosophy are of interest because much of IS research is guided by the positivist tradition of behavioral research. The positivist assumptions influence the choice of IS research designs, research methods, and research measures. It is argued that to advance the art of research in IS, the major tenets of the

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positivist philosophy of research. In fact, post-positivism represents the suggested type of research for many social science disciplines. However, most of the social science disciplines (e.g., sociology, psychology, marketing, and organization behavior) are debating the merits of a strict dependence upon the positivist view of scientific research. Although the debate is far from complete, it is generally recognized that the positivist concept of science has been less than satisfactory for social science inquiry.

[6]A number of diverse groups and schools of thought form the post-positivist movement. Some of the most prominent thinking comes from the Frankfurt School, including Hurkheimer, Fromm, and Habermas. In the United States, post-positivist thinking can be seen in the symbolic interactionist school—Goffman, Blumer, and, more recently, Gergen, within social psychology, and March, Simon, and Mitroff, in Management. To some extent, post-positivist thinking is seen earlier in the works of Veblen, Levi-Strauss, and Jung.

post-positivists must be understood and incorporated into our lines of research. Furthermore, as we shall later see, longitudinal designs can incorporate some of the post-positivist tenets and yet retain some of the advantages of the positivist tradition.

For the purposes of this paper, we will cover five major tenets of the post- positivist movement. This list is not exhaustive but it is relevant to our discussion of longitudinal designs and their application in IS research. The five tenets are:

1. The instability of social systems and human behavior.
2. The limits of the stimulus-response paradigm.
2. Problems with trans-historical generalizations.
4. Problems with the concept of observer neutrality.
5. The limits of research method.

The Instability of Social Systems and Human Behavior

For the post-positivist social theorist, a fundamental feature of social reality is its instability. Social systems change and respond in an almost endless variety of ways. The instability hypothesis is based on the observation that humans and and thus social organizations respond to stimuli and adapt their behavior. Thus, social settings are qualitatively different than the patterned response of the natural systems studied by the physical scientist. Few responses within a social system can be predicted with absolute certainty and those which can be predicted can only be predicted under a very tight range of conditions. Moreover, the response can be ideosyncratic. The instability premise distinguishes social systems from the structure and patterned characteristics of natural systems (Gergen 1982).

Any stability found in a social setting is based upon a combination of social inertia and social contracts rather than a natural stability that is trans-historically or trans-culturally invariant (Brittan 1973; Fiske 1981; Gergen 1982). The post-positivists argue that the instability premise is a major reason for the inability of positivist research approaches to produce strong research findings in the social sciences (see Harvey 1981; Morgan 1983).

The Limits of the Stimulus-Response Paradigm

Post-positivists also criticize the stimulus-response paradigm of laboratory experimentation. Due to the instability of social systems and human volition, studies informed by the stimulus response paradigm can be grossly simplistic and in many cases misleading (Gergen 1982; Prohansky 1981). It is argued that this paradigm views the human as an automaton that must respond to a particular stimulus in a finite number of ways. However, even the most casual observer of human behavior knows this to be false. Rather than automatons, humans learn and are capable of a great deal of indeterminancy in their actions. The social scientist cannot assume patterned, rigid, routinized behavior or a finite set of human reactions. As a result, the social scientist faces an instability in their real social laboratories that is not part of the stimulus response laboratories or of the controlled laboratories in which natural scientists operate.

Problems with Trans-historical Generalizations

A trans-historical generalization is a claim that a theory or empirical finding applies across history and across cultures. Post-positivists argue that it is very difficult to discover principles about social life that are valid regardless of the epoch in which they are found. Gergen notes that

> to the extent that the individual is capable of transforming the meaning of stimulus conditions in an indeterminate number of ways, existing regularities must be considered historically contingent-dependent on the prevailing meaning systems or conceptual systems of the times.

He goes on to point out that

> In effect, from this perspective the scientist's capacity to locate predictable patterns of interaction depends importantly on the extent to which the population is both homogeneous and stable in its conceptual constructions.

Much of this perspective has emerged from the work of the symbolic interactionists (Blumer 1969; Goffman, 1959, 1974) who have focused upon the meaning and interpretation inherent within social action. Others, in the critical theory school (Habermas 1984; Held 1980) have also pointed out the problems in making trans-historical claims for validity due to the intersubjectivity of the observer and the cultural bias latent in any truth claim.

Problems with the Concept of Observer Neutrality

Positivism argues that if the researcher uses a systematic method of inquiry, a research design with proper controls, and valid measures, the results of the research may be viewed as neutral objective facts. However, research in the sociology of knowledge, social psychology and epistemology have questioned this viewpoint. The post-positivists maintain that any human observer will always be subject to bias as a result of previous experience, limitations in knowledge, values, beliefs and attitudes. From this perspective, "facts are not facts" but really a series of perspectives on reality according to a particular observer.[7]

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[7]The extreme interpretation of this line of reasoning is that researchers should discard any attempts to achieve systematic approaches to social research and simply study systems "in vitro" and work toward change according to a value system. This is sometimes the extreme position taken by some proponents of action research. Some of the Marxist and Neo-marxist philosophers are actually hostile to any notion of empirical or positivist methods. Nevertheless, it is important to distinguish between the problems of subjectivity and validity. Subjectivity in the most problematic case refers to the researcher subjecting all interpretation of the results to their world view. Validity, or the veridicality of truth claims, is important in all research. Validity refers to the degree to which the

In other words, the post-positivist would view the researcher as a special type of story teller whose accounts of social reality are valid within a given frame. These accounts of social reality are deemed reliable only to the extent that they apply to certain types of contexts under certain documented conditions. Menzies (1982) argues that the objective of social research is to develop middle range theories based on a realist philosophy in which causal tendency statements (i.e., "A leads to B as long as everything else can be ignored," Menzies 1982, p. 124) are made in contrast to direct causal statements:

> Middle-range theory seeks to establish scientific laws about the impact of particular social factors on particular activities and avoids making comprehensive statements about society. It puts forward limited causal claims about specific social processes. (Menzies 1982, p. 123)

Thus a body of knowledge grows to the extent that these findings are corroborated by independent observers over time. Non-repeatable findings are viewed as interesting aspects of individual behavior in their own right, reflecting social action in its many forms.

The Limits of Research Method

A fifth aspect of the post-positivist debate focuses upon the role of research method (Feyerbend 1975). Can a method, a static procedural form, capture the reality of social action? If social reality is dynamic and uncertain, doesn't method by definition restrict the ability of the researcher to understand? Researchers learn, they receive feedback from the research setting. The learning process may alter their understanding of the setting. From this perspective, an adherence to method is not a guarantee of validity nor is it sufficient as a form of inquiry.

Implicit in the discussion of the limits of research method is the call for methods that permit learning and feedback and ultimately alterations of the method during the research process. In one sense, the researcher will always live with the limitation of method. This is the ultimate research limitation because the method along with the theoretical frame and research objectives circumscribe the inquiry process. However, the post-positivists want researchers to be aware of these limitation in choosing research designs. Single studies offer little hope in overcoming these limitations. Replications offer some promise; however, not all the features of the setting are repeatable since they are not under the control of the researcher. At present, longitudinal designs seem to offer the most promising option to deal with the limits of method.

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results of the study are reliable and consistent within a particular world view. For example, a political interpretation of a social setting focuses upon particular features and questions, the validity of which follow certain rules of reasoning within political science.

Implications for IS Research

The implications of the post-positivist debate for IS research fall into several categories. First, the debate taken in its totality argues for a plurality of research approaches and methodologies. Different methods have relative advantages in different research contexts. Due to the complexity of social settings, multiple methods may be required to furnish a reliable picture.

Second, since social action is action, change and movement underlies much of "that which is studied." As a consequence, research methodologies must be capable of capturing this movement and action and view its evolution. This leads us to a rejection of one shot studies and argues for multiple sampling frames.

Third, the post-positivist debate encourages the IS researcher to be aware of some of the strong value systems that have developed in the computing milieu. These values influence the researcher as well as the subject. For example, as Kling (1980) has pointed out, most studies of computing rely heavily upon a rationalist and structural functionalist perspective of individual and social behavior which often leads to certain conclusions and excludes others.[8] It is not the rationalist perspective that is at fault but rather the failure to realize the bias in the perspective employed and the alternative explanations and modes of inquiry available.

Fourth, the debate encourages IS researchers to include additional documentation about the context of the phenomena studied. It is important for the researcher to collect both qualitative and quantitative data that accurately describes the setting. Due to the instability of social systems, the researcher can not realistically hope for generalizable results, even with random, probability samples in a single study. At most the results will be pertinent to a particular population segment, social setting, or computing arrangement.

As a result, the documentation of the context must go beyond the standard demographics such as industry type, revenue level, and number of employees. Other, more qualitative information should be provided such as a description of the managerial climate and culture, competitive pressure and stress, internal conflicts, and level of cooperation with the researcher. For example, Robey' s (1977) reformulation and reinterpretation of studies on the relationship between computing and organizational structure is an excellent example of the use of contextual information to integrate and propose alternative lines of explanation. Through a careful re-examination of the

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[8]Strong values and beliefs are also evident in the computing literature. Consider the following values: (1) The concept of integration of organizational functions and computing equipment as a preferred design solution; (2) systems thinking, including reductionism, and functionalism as means of analysis and social reconstruction; (3) the goal of person-computer symbiosis and interaction as a preferred design objective; (4) the organization as a form of patterned data flows; (5) the rationalization of social systems as a means of achieving productivity and social welfare; and (6) computing as an independent variable in social action. For other accounts on beliefs and values in the IS field, see Mowshowitz (1976) for a general discussion; Davis (1983), Dickson (1980), and Vitalari (1978) for an account of the evolution of the IS discipline; Kling (1980) for a discussion of frames for analyses of computing environments; Hedberg and Mumford (1975), Bostrom and Heinen (1977), Mumford (1978), and Dagwell and Weber (1983) on the values of systems designers.

organizations' environments (i.e., degrees of homogeneity-heterogeneity and stability-instability, environmental factors in goal setting and goal attainment, Robey 1977, p. 967), Robey suggests that computing as a sole independent variable in structural change is suspect. The point is that richer contextual information will allow others to later use the research findings in constructive ways not anticipated by the original researcher and develop new insights.[9]

Fifth, the debate encourages IS researchers to discuss the limitations of the methodology employed and offer other alternative explanations for the results of the study from their first hand perspective. For example, it is interesting to note that few studies contain post-hoc comments upon the appropriateness of the research methodology employed in the study. In many cases, the choice of the methodology is unexplained. Moreover, field studies, surveys, controlled experiments, and longitudinal designs are in the minority. It is difficult to characterize the IS field as oriented to methodological pluralism at the current time.[10]

Longitudinal Research Designs

Marvin Olsen (1968) makes an observation about social organizations that has often been overlooked by information systems researchers. According to Olsen, social organizations are properly understood as social processes. In reality, social organizations are in a constant process of movement and operation.[11] Structure is only apparent at a point in time wherein the observer "freezes the action" and explicitly documents the structure and static patterns in the social organization. According to Olsen,

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[9]It is important to point out that most research studies in the information systems field are quite sterile in terms of the types of background information provided about the social setting. This criticism applies to both case study and field study research. The context is simply not reported. The field could easily solve this problem by supplying both quantitative and qualitative information about the social context. For several exceptions to this critique, see Kling and Scacchi (1982), Mumford and Banks (1967), and Pettigrew (1973).

[10]It is also interesting to note that, to date, the information systems field has not made a synthetic advance in thinking about the world that contributes to other fields of endeavor. The opposite is more apparent. Information Systems researchers borrow from other fields and adapt pre-existing research approaches to study in this field. To achieve a level of research and inquiry that will create new basic knowledge that has the efficacy to inspire other non-IS researchers, researchers in IS must identify the unique thematic concerns in IS and then develop new paradigms and research approaches to study these unique and evolving concerns. It is highly likely that, in the area of computers and organizations, such revolutionary issues may be found to spur new contributions to knowledge. In this sense, computing may be viewed as a new phenomena that is occurring in social settings and may act as a catalyst to provide new insights and interpretations about classical issues in the study of human behavior.

[11]See Whitehead (1929), *Process and Reality*, for a further discussion on the relationship between process and structure.

> These two fundamental ideas of process and organization unite in the realization that *social organization is a dynamic process*. As a result of this process, social life becomes ordered and meaningful for its participants, although never static. That is, *social organization is the process of bringing order and meaning into human social life*. (Olsen, 1968, p. 2)

Since structure emerges from process, it can be argued that only two ways exist to study changes in social organization. First, one can sample the results of the process at several points in time and thus with the proper controls make statements about the changes in structure. Second, one can reconstruct the process and evolution of the structure from historical accounts or retrospective reports. Most IS research that has attempted to study change has relied on the latter despite the well known limitations of case studies and retrospective reports by individual observers. In some cases, IS researchers have relied upon single, one time data collection methods despite the serious limitations of the one-shot survey design (Campbell and Stanley 1963). Other attempts to study change have relied upon the laboratory experiment to study change. But Dickson, Senn and Chervany (1977) note the limitations of this approach and its application to the study of real computing environments. Thus, it has been very difficult for IS researchers to observe changes brought about by computing or to convincingly argue that a particular type of information technology produces the desired positive or negative change in the organization.

IS research designs must include notions about the rates of change in information systems and the capability of those systems to change in response to contextual variables. The abstract concepts of flexibility and adaptation that are often discussed in the IS literature are conditioned by the context and characteristics of the social setting. To examine such concepts requires research designs that fully incorporate the reality of time-dependent change. This paper suggest that longitudinal designs can improve IS research.

A longitudinal research design is a design in which behavior is measured at a number of points in time during a finite period of time (Goldstein 1979; Schlusinger, Mednick and Knop 1981; Kessler and Greenberg 1981).[12] Longitudinal designs vary according to:

1. The number of measurement points or waves of data collection.
2. The overall period of the study.
3. The methods of data collection and measurement.

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[12]A longitudinal design is to be distinguished from a cross-sectional design. A cross-sectional design, according to Kessler and Greenberg (1981), is a study in which "change effects are inferred from variations between units at a single point in time." In the study of change processes, cross-sectional designs can be seriously flawed because they can lead to alternative (and sometimes erroneous) interpretations depending upon the types of time-dependent processes that were assumed to lead to the differences in the units observed. It is, of course, possible to collect retrospective data in a cross-sectional design and infer the process of change that lead to the differences. It is also possible to carefully stratify a sample on some time variable (age, length of ownership) and other demographics and assume minimal intra-sample covariance and infer time dependent effects.

4. The sampling design (panel, cohort, sample with replacement, sample without replacement) and stratification of sample.
5. Units of analysis.
6. The amount of redundancy and flexibility imbedded in the design.

A longitudinal research design has many benefits. Perhaps the most important benefit of a longitudinal design is its ability to track change and make causal statements of various types. Longitudinal designs allows the researcher to track change. The design permits the researcher to monitor the responses of a system to a stimulus and how that response changes over time. Because social settings have a vast repertoire of responses that are both learned and envisioned, an understanding of a particular social system is dependent upon the monitoring of these accommodative, adaptive and negotiated responses.

A longitudinal design allows for this sort of tracking and, if properly designed, allows for the collection of both quantitative and qualitative data. A longitudinal approach allows the researcher to track the changes in a particular set of variables and behaviors, and these changes can be simultaneously observed from several perspectives and units of analysis in a single study.

Second, researchers can employ longitudinal designs to combine exploratory data gathering objectives with targeted data gathering approaches. In a multiple wave study, a certain percentage of the data gathering efforts can be reserved for serendipitous findings and exploration. This ability to change a portion of the data collection process allows the researcher to incorporate their learning process into the research. The longitudinal design is also robust. Mistaken hypotheses or poor measures can be modified and changed in subsequent waves.

Third, since social settings have inertia, change is not likely to be observed in minutes, hours, days, or even weeks. Action and reaction sequences are more like to be observed over longer periods of time, such as months, and perhaps years. A multiple wave study with both quantitative and qualitative data collection approaches can point to features that have changed and uncover some of the dynamics that lead to the changes. The key issue is to select the appropriate interval between data collection efforts for a given unit of analysis and set of research objectives.

Fourth, a longitudinal design provides the opportunity to collect data that can shed light on potential causal linkages in the subject of study. Even though the causality may not be proven, the ability to understand how conditions change over time and evolve provides important information for future studies.

Fifth, and most importantly, the longitudinal design offers some particularly appealing advantages because most of the major information systems issues implicitly depend upon an understanding of change processes. Table 3 provides examples of contemporary information systems research activity and indicates how these areas could benefit from a longitudinal design. A longitudinal design is particularly suited to investigate the locus of concerns in Decision Support Systems, user involvement, social impacts, and management of computing. For each of the research streams identified in Table 3, a longitudinal design offers the potential to explore fundamental questions. Longitudinal design can provide additional insight into fundamental information systems research issues.

Table 3. Potential Benefits of Longitudinal Designs in Contemporary IS Research Streams

Research Streams	Traditional Research Designs	Longitudinal Issues
Decision Support Systems	Case Study Field Study and Test Laboratory Experiment Conceptual Study	Long-term and Short-term Learning Effects Useful Life of System Problem Reformulation and Perspective Change Effectiveness of New DSS Technique
Interface Design	Case Study Laboratory Experiment Field Study and Test Conceptual Study	Learning (Time) Patterns of Learning Interface Evolution
End-User Computing	Survey Case Study	Evolution of End-User Designs Instability of Commercial Software Cycle of End-User Problems Learning Effectiveness of Managerial Controls
Decision Making and Cognitive Styles	Survey Laboratory Experiment Case Study	Stability of Cognitive Styles Processes Underlying Cognitive Styles Computing Interaction Effects with Cognition Evolution of World Views
Evolution of Organizational Computing	Surveys (cross-sectional) Case Study Conceptual Study	Stages of Computing Co-adaptation of Systems and Organizations Demand vs. Supply Driven Evolution Long-term Effects of Slack and Control Effectiveness of Computing Arrangements
Social Impact of Computing	Case Study Survey Conceptual Study Macro-Statistical	Accommodation Patterns Conditions for Computer-Induced Change Evolution of Impacts Changes in Organization Structure Changes in Attitudes, Beliefs and Values
Systems Analysis and Design	Case Study Conceptual Study Quasi-Experiment Field Test	Development of Analyst Skills Training of Systems Analysts Development and Validation of Selection Methods Development and Validation of Techniques
Implementation	Case Study Surveys Conceptual Study	Prevention and Remedy of Implementation Problems Processes Underlying Implementation Efforts Processes of Planned Social Change

While longitudinal designs offer much promise for IS research, few appear in the IS literature. One question implicitly raised in this discussion is: If longitudinal designs are so good, why aren't more researchers using them? A number of problems are associated with longitudinal designs that often discourage their use. The following problems have been raised:[13]

1. **Cost.** Longitudinal designs are expensive and require multi-year funding that research foundation are often reluctant to provide, especially for social research.
2. **Effort.** Longitudinal designs require a great deal of extended effort. Design of the studies is crucial, data collection is time consuming, and the studies require well developed instruments.
3. **Obsolescence.** It is possible that concepts and measures that were thought to be relevant at the outset become irrelevant or trivial with the passage of time. This can be a significant problem with long term studies.
4. **Participation and Attrition.** Longitudinal designs require a great deal of effort and cooperation from the subjects, and the participating organizations and a sustained level of effort. These requirements can lead to attrition and dwindling sample size.
5. **Publication of Results.** Because by definition longitudinal designs depend on the passage of time, the publication of research results must many times wait. As a result, researchers may be penalized by the reward and compensation systems within which they work.
6. **The Bias and Influence Introduced by Repeated Measures.** Longitudinal studies may repeatedly measure and elicit the same category of responses from subjects and in so doing reinforce or influence the phenomena under study.
7. **Longitudinal Designs Require Sophisticated Analysis Methods.** Longitudinal designs may require sophisticated data analysis methods such as structural-equation modeling, log linear analysis, or continuous-time stochastic models.

It is true that each of the above problems can be serious and deter researchers from longitudinal research. However, in many cases longitudinal studies can be designed in such a way as to avoid most of the above problems.

For example, obsolescence in a longitudinal design can be addressed by formulating the inquiry around classic issues of an enduring nature. Attrition can be countered by establishing a positive rapport with the subjects, over-sampling, and cross-sectional designs within the larger longitudinal design. The relatively long wait time for publication can be reduced by exploiting cross-sectional issues in the early waves of the study and publishing early results. Bias introduced by repeated measures can be tested with control groups. And relatively simple analyses of longitudinal data can be performed such as regression using dichotomous variables, path analysis or chi-square analysis. Thus many of the problems can be successfully dealt with and the value of longitudinal designs call for their serious consideration in IS research. In the next section, guidelines are proposed for developing longitudinal designs for IS research.

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[13]See Janson (1981) for additional discussion.

Developing Longitudinal Designs for IS Research

A final question remains: How do IS researchers incorporate the criticisms and perspectives of the post-positivist social thinkers into IS research? It is believed that properly formulated longitudinal designs address some of the issues raised by the critical theorists and the post-positivists.

Five guidelines are proposed in response to the criticisms of the post-positivists and the limitations in IS research discussed earlier. The guidelines are:

1. **Use Longitudinal Designs.** Longitudinal designs are particularly appropriate in the study of instability and change. Computing environments exhibit such characteristics.
2. **Describe the Computing Environment.** Augment longitudinal designs with case studies and unobtrusive measures that focus on contextual factors, history, values, and beliefs. Both quantitative and qualitative data should be used to describe the context in which computing occurs. Such description should include demographics, history, values, beliefs, and goals.
3. **Collect Quantitative Data.** Use if possible accepted instruments, collect perceptual measures on values, attitudes, beliefs, and "hard" measures on time use, cost, level of investment, etc.
4. **Include Open-ended Questions.** Open-ended questions should be included in the longitudinal design and anecdotal data should be reported in the results. It is recommended that open-ended questions be used to provide alternate measures on quantitative items.
5. **Focus on Process Issues.** The research design should be formulated at a sufficiently abstract level to permit a program of inquiry into the processes underlying the behavior observed. Facilitation of a process can be accomplished by a focus upon activities, learning, attitude changes, value changes, choice patterns, and interaction patterns among the actors.

The five guidelines provide a starting point and a challenge to the IS researcher. First, a longitudinal design that includes open-ended questions and measures to assess attitudes and values permits the researcher to observe and analyze the way in which values change over time and examine the type of learning that occurs within the setting. It is plausible to argue that a longitudinal design is one of the only ways to combine the rigor associated with traditional empirical inquiry while simultaneously studying the development of values and attitudes and their impact upon other variables. Critical theorists and other social thinkers have called for designs that explicitly incorporate the historical and value characteristics of the social setting studied. It is possible, in a longitudinal design, to examine how history and values influence and bias behavior.

Second, a longitudinal design implicitly considers the instability of social systems. A longitudinal design can be used to track the changes in selected variables over time. This information and the understanding of these change processes can be used to formulate a mathematical model of change in that setting and assist in developing theory.

Third, longitudinal designs can assist in understanding causality. Causal arguments require more than simple co-appearance of two or more events. The longitudinal designs permit the researcher to observe the appearance of events over time. Because more of the process of evolution is observed, the researcher is in a better position to make causal arguments.

Fourth, the longitudinal design is one of the only research methods available, other than case studies and retrospective reconstructions, for observing the process of human volition and choice in a social context. However, such activity very seldom becomes evident in a short time frame. Moreover, antecedent conditions and learning are frequently very important factors in the way a particular individual will behave. A longitudinal design has a rich structure in which to capture such behavior.

Summary

The value of longitudinal designs in IS research has been overlooked by IS researchers. Because many issues in the study of computing environments and social settings have, at their base, the reality of process and change, the longitudinal design holds promise. This paper has attempted to raise issues about current IS research for the purposes of discussion and to suggest longitudinal designs as one potential solution.

Since the longitudinal design is not a panacea, it should be combined with other methods, such as case studies, open-ended questions, multiple measures, and background contextual information. While it is acknowledged that longitudinal designs are expensive, time consuming, and have unique problems (attrition, commitment), they have too often been superficially rejected for these reasons. Given that many of the IS research issues are closely connected with the concepts of time and change, IS researchers should seriously explore the use of longitudinal designs in their research. Moreover, with the advent of computers themselves and the increasing pervasiveness of telecommunications in our society, it is likely that the data collection problems with longitudinal designs will continue to decrease. For example, at the University of California at Irvine, Project NOAH, our national longitudinal study of computing in home, has used computer-aided telephone interviewing (CATI) to increase response rates, reduce attrition and reduce the time for data collection and the elapsed time to data analysis.

The IS field has reason to be optimistic. Longitudinal designs provide the opportunity for the IS researcher to explore cause-effect linkages, process patterns, accommodation processes, and the co-evolution of computing systems and social settings. It is believed that the use of longitudinal designs in a program of IS inquiry will provide insight into many of the perplexing issues in IS research.

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