Combining Qualitative and Quantitative Methods in Information Systems Research: A Case Study

By: Bonnie Kaplan
Department of Quantitative Analysis and Information Systems
University of Cincinnati
Cincinnati, OH 45221-0130

Dennis Duchon
Division of Management and Marketing
College of Business
University of Texas at San Antonio
San Antonio, TX 78285-0634

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Abstract
This article reports how quantitative and qualitative methods were combined in a longitudinal multidisciplinary study of interrelationships between perceptions of work and a computer information system. The article describes the problems and contributions stemming from different research perspectives and methodological approaches. It illustrates four methodological points: (1) the value of combining qualitative and quantitative methods; (2) the need for context-specific measures of job characteristics rather than exclusive reliance on standard context-independent instruments; (3) the importance of process measures when evaluating information systems; and (4) the need to explore the necessary relationships between a computer system and the perceptions of its users, rather than unidirectional assessment of computer system impacts on users or of users characteristics on computer system implementation.

Despite the normative nature of these points, the most important conclusion is the desirability for a variety of approaches to studying information systems. No one approach to information systems research can provide the richness that information systems, as a discipline, needs for further advancement.

Introduction
Information systems had its origins in a variety of reference disciplines with distinct theoretical research perspectives on the important issues to study and the methods to study them (Bariff and Ginzberg, 1982; Dickson, et al., 1982; Mendelson, et al., 1987). This article describes a study that combined some of these distinct perspectives and methods. The article discusses how limitations of one research perspective can be addressed by also using an alternative. This emphasis reflects the lesser familiarity information systems researchers might have with the perspective receiving more in-depth discussion and promotion. A key point to this article is the importance that both perspectives had for this study; no implication of preference in perspectives is intended.

The discussion of perspectives provides background for understanding the process and methods of this research. Following the discussion,
the article describes how this study evolved. The emphasis is on methods rather than on research findings.

**The positivist perspective and quantitative methods**

Despite the differences in reference disciplines and the debate over a paradigm for information systems, American information systems research generally is characterized by a methodology of formulating hypotheses that are tested through controlled experiment or statistical analysis. The assumption underlying this methodological approach is that research designs should be based on the positivist model of controlling (or at least measuring) variables and testing pre-specified hypotheses (Kauber, 1986), although alternative methods might be acceptable until research has reached this more advanced and "scientific" stage. Despite some recent recognition given different research perspectives and methods (e.g., Ives and Olson, 1984; Klein, 1986; Kling, 1980; Lyytinen, 1987; Markus and Robey, 1988; Weick, 1984), even those who argue for introducing doctoral students to such alternative approaches as field study and simulation methods nevertheless advocate research based primarily on the positivist tradition (e.g., Bariff and Ginzberg, 1982; Dickson, et al., 1982).

Exclusive reliance on statistical or experimental testing of hypotheses has been soundly criticized in the social sciences, where some of its major proponents have called its effects "disastrous" (Cook and Campbell, 1979; Manicas and Secord, 1983; Maxwell, et al., 1986). Moreover, the simplification and abstraction needed for good experimental design can remove enough features from the subject of study that only obvious results are possible. As illustrated in the next section, the stripping of context buys "objectivity" and testability at the cost of a deeper understanding of what actually is occurring.²

**The interpretive perspective and quantitative methods**

The need for context-dependent research has been remarked upon by researchers in a variety of disciplines that, like information systems, necessarily incorporate field research methods. Even such strong advocates of quantitative and experimental approaches in behavioral research as Cook and Campbell (1979) state, "Field experimentation should always include qualitative research to describe and illuminate the context and conditions under which research is conducted" (p. 93).

Immersion in context is a hallmark of qualitative research methods and the interpretive perspective on the conduct of research. Interpretive researchers attempt to understand the way others construe, conceptualize, and understand events, concepts, and categories, in part because these are assumed to influence individuals behavior. The researchers examine the social reality and intersubjective meanings held by subjects (Bredo and Feinberg, 1982a) by eliciting and observing what is significant and important to the subjects in situations where the behavior occurs ordinarily. Consequently, qualitative methods are characterized by (1) the detailed observation of, and

² We would like to credit an anonymous reviewer with this point.
involvement of the researcher in, the natural setting in which the study occurs, and (2) the attempt to avoid prior commitment to theoretical constructs or to hypotheses formulated before gathering any data (Yin, 1984).

Qualitative strategies emphasize an interpretive approach that uses data to both pose and resolve research questions. Researchers develop categories and meanings from the data through an iterative process that starts by developing an initial understanding of the perspectives of those being studied. That understanding is then tested and modified through cycles of additional data collection and analysis until coherent interpretation is reached (Bredo and Feinberg, 1982a; Van Maanen, 1983b). Thus, although qualitative methods provide less explanation of variance in statistical terms than quantitative methods, they can yield data from which process theories and richer explanations of how and why processes and outcomes occur can be developed (Marcus and Robey, 1988).

Research traditions in information systems

The growing recognition of the value of qualitative methods in social, behavioral, organizational, and evaluation research is manifest in studies and research methodology texts (Argyris, 1985; Bredo and Feinberg, 1982b; Lincoln and Guba, 1985; Miles and Huberman, 1973; Patton, 1978; Van Maanen, 1983c). Van Maanen (1983a), for example, has long advanced and practiced these approaches in organizational research. However, despite the strong ties of information systems with organizational and behavioral research, the use of qualitative research, though practiced and advocated in information systems, has not been as visible in this field as in others. Instead, recently there has been greater reliance on laboratory studies and surveys (Goldstein, et al., 1986).

The dominant approach to information technology studies has been based on a positivistic experimental ideal of research. Using this approach, researchers examine the effects of one or more variables on another. These analyses tend to treat the research objects in one of two ways. Either they portray information technology as the determining factor and users as passive, or they view users or organizations as acting in rational consort to achieve particular outcomes through the use of information technology. In either case, the nature of the information technology and users is considered static in that they are assumed to have an essential character that is treated as unchanging over the course of the study (Bakos, 1987; Lyytinen, 1987).

Markus and Robey (1988) characterize such approaches as "variance theory formulations of logical structure and an imperative conception of causal agency." In variance theories, some elements are identified as antecedents, and these are conceived as necessary and sufficient conditions for the elements identified as outcomes to occur. According to Markus and Robey, much of the thinking about the consequences of information technology in organizations assumes that either technology ("the technological imperative") or human beings ("the organizational imperative") are the antecedents, or agents, of change rather than that change emerges from complex indeterminant interactions between them ("the emergent perspective").

Most studies of computer systems are based on methods that measure quantitative outcomes. These outcomes can be grouped into technical, economic, and effectiveness and performance measures. Such studies treat organizational features, user features, technological features, and information needs as static, independent, and objective rather than as dynamic, interacting constructs, i.e., as concepts with attributes and meanings that may change over time and that may be defined differently according to how individual participants view and experience the relationships between them.

Because such studies are restricted to readily measured static constructs, they neglect aspects of cultural environment, and social interaction and negotiation that could affect not only the outcomes (Lyytinen, 1987), but also the constructs under study. Indeed, most evaluations of computer information systems exhibit these characteritics. Published accounts of computing traditionally focus on selected technical and economic characteristics of the computer system that are assessed according to what Kling and Scacchi (1982) call the "discrete-entity model." Economic, physical, or information processing features are explicitly chosen for study under the assumption that the computer system can be broken down into relatively independent elements of equipment, people, organizational processes, and the like. These elements can then be evaluated independently and additively. Social or political issues often are ignored.
That these assumptions underlie much of the research on information technology is evident in the implementation and impacts literature. The effects of some intervention are studied with respect to implementation success or impacts on, for example, organizational structure, user attitudes, or job satisfaction (Bakos, 1987; Danziger, 1985; Ives and Olson, 1984; Kling, 1980; Markus and Robey, 1988). In these studies, information systems or computers are treated as having “impacts” (Danziger, 1985) rather than as socially constructed concepts with meanings that are affected by the “impacts” and that change from person to person or over time. Few such impact studies are longitudinal — a design promoted in information systems research to track changes over time by collecting data as events occur rather than retrospectively (Franz and Robey, 1984; Vitalari, 1985).

Often such studies do not proceed from an interactionist framework — one that focuses on the interaction between characteristics related to people or subunits affected by the computer system and characteristics related to the system itself (Markus and Robey, 1988). For example, they tend not to explore interrelationships between job-related issues and effectiveness of information technology. Jobs are often considered fixed, even though there are empirical and theoretical reasons to expect that computers change the amount and nature of work performed by system users (Brooks, et al., 1977; Fok, et al., 1987; Kemp and Clegg, 1987; Kling, 1980; Millman and Hartwick, 1987; Zuboff, 1982; 1988). Moreover, job-related issues are interpreted differently by different individuals within an organization, and these differences can affect what constitutes a technology’s “effectiveness” (Kling, 1980; Lyytinen, 1987). Goodhue (1986), for example, advises assessing the “fit” of an information system with a task. However, one person performing the task may have a rather different view of it than another person performing ostensibly the same task, and thus the “fit” will differ for different users. Consequently, different individuals may have different responses to the same system. Interactionist theories would account for this response. Theories that assume that the individual, the job or task, the organization, or the technology is fixed and that one of these determines outcomes would not (Markus and Robey, 1988).

Some argue that each type of research method has its appropriate uses (Markus and Robey, 1988; Rockart, 1984; Weick, 1984); different research perspectives focus on different research questions and analytical assumptions (Kling, 1980; Kling and Scacchi, 1982; Lyytinen, 1987; Markus, 1983; Markus and Robey, 1988). However, there is disagreement concerning the value and use of suggested alternative theoretical perspectives and practical approaches, such as critical social theory (Klein, 1986), structuration theory (Barley, 1986), case study (Benbasat, et al., 1987), and socio-technical design (Fok, et al., 1987; Mumford and Henshall, 1979). On the one hand, Mumford (1985) advocates a qualitative approach. She calls for studies of a “total” situation through action-centered, interdisciplinary, participatory research in which research questions and hypotheses evolve as new developments are introduced. Lyytinen (1987) makes a similar appeal for case studies and action research on the grounds that “this research strategy seems to be the only means of obtaining sufficiently rich data” and because the validity of such methods “is better than that of empirical studies.” On the other hand, even some proponents of case study base their position on a research design that fits the quantitative or quasi-experimental approach rather than the qualitative one (Benbasat, et al., 1987; Campbell, 1984; Yin, 1984). Moreover, there has been strong sentiment that information systems researchers need to move beyond case study to more experimental laboratory or field tests (Benbasat, 1984).

Combining Methods

Although not the dominant paradigm, qualitative methods and interpretive perspectives have been used in a variety of ways in information systems research (Barley, 1986; Fok, et al., 1987; Franz and Robey, 1984; Goldstein, et al., 1986; Hirschheim, et al., 1987; Markus, 1983; Mumford and Henshall, 1979; Mumford, et al., 1985). Interpreting information technology in terms of social action and meanings is becoming more popular as evidence grows that information systems development and use is a social as well as technical process that includes problems related to social, organization, and conceptual aspects of the system (Bland, 1978; Hirschheim, et al., 1987; Kling and Scacchi, 1982; Lyytinen, 1987; Markus, 1983). However, many information systems researchers who recognize the value of qualitative methods often portray these methods either as stand-alone or as a means of exploratory research preliminary to the “real” research of generating hypotheses to be tested using experimental or statistical tech-
niques (Benbasat, 1984). Even papers in which qualitative and quantitative methods are combined rarely report the study's methodological rationale or details (Benbasat, et al., 1987). One result is the failure to discuss how qualitative methods can be combined productively with quantitative ones.

There has been a move in other fields toward combining qualitative and quantitative methods to provide a richer, contextual basis for interpreting and validating results (Cook and Reichardt, 1979; Light and Pillemer, 1982; Maxwell, 1986; Meyers, 1981; Van Maanen, et al., 1982; 1983a). These methods need not be viewed as polar opposites (Van Maanen, 1983b). It is possible to integrate qualitative and quantitative methods (Maxwell, et al., 1986). Combining these methods introduces both testability and context into the research. Collecting different kinds of data by different methods from different sources provides a wider range of coverage that may result in a fuller picture of the unit under study than would have been achieved otherwise (Bonoma, 1985). Moreover, using multiple methods increases the robustness of results because findings can be strengthened through triangulation — the cross-validation achieved when different kinds and sources of data converge and are found congruent (Benbasat, et al., 1987; Bonoma, 1985; Jick, 1983; Yin, 1984), or when an explanation is developed to account for all the data when they diverge (Trend, 1979).

This article describes how qualitative and quantitative methods were combined during the first phase of an ongoing multi-method longitudinal study. Detailed research results are reported elsewhere (Kaplan, 1986; 1987; Kaplan and Duchon, 1987a: 1987b; 1987c) and summarized here. This article has a methodological focus. It describes the development and process of the research and omits all but sketches of the data and analysis necessary to understand how the research evolved. Particular attention is given to how both quantitative and qualitative methods were used productively in a collaboration among investigators from different research perspectives.

Research Setting

Organizational and information context

Computers have been used more in clinical laboratories than in many other areas of medical practice (Paplanus, 1985). The clinical laboratory represents a microcosm of automation and information needs from throughout a medical center (Lincoln and Korpman, 1980). The laboratory is responsible for performing tests ordered by physicians to diagnose illness or track the course of therapy and disease. Laboratories meet this responsibility by receiving and processing physicians' test orders, i.e., collecting specimens (such as blood) from patients, performing the designated tests (such as blood sugar measurements or assessments of bacterial sensitivity to antibiotics), and reporting the test results for use by the physician and for inclusion in the patient's medical record. Laboratory technologists, who are specially trained, perform the laboratory tests. They may also report the results and discuss them with those treating the patient.

The principal function of computers in clinical laboratories involves data management. Computers can relieve the clerical burden of data acquisition and transcription while adding new data entry and computer-related tasks. In addition, they improve legibility, organization, and accuracy of laboratory results reports; increase productivity and efficiency; reduce transcription error; and change laboratory organization and turnaround time for test results (Brooks, et al., 1977; Flagle, 1974; Lewis, 1979; Nicol and Smith, 1986). Thus, such computer information systems affect both the process of work as well as the service product of a clinical laboratory.

The research site

Research was conducted within the Department of Pathology and Laboratory Medicine at a 650-bed midwestern urban metropolitan university medical center. A widely used and well-respected commercial laboratory computer information system was installed in April 1985 for use by all nine laboratories within the Division of Laboratory Medicine. These nine laboratories were responsible for laboratory work to support the care of patients admitted to the hospital and those treated in clinics and in the emergency unit. The laboratories also performed specialty tests for other institutions.

This research site was selected because a new computer information system was replacing a manual operation in a context representative of the entire institution's information systems needs. Another advantage was that multiple organizational units would use the same computer

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system. Consequently, a comparison between units would be possible under conditions where system variables would be reasonably constant. Thus, the study could include both macro and micro units of analysis: individuals, workers and managers, individual laboratories as a whole, the department in which the laboratories were situated, and the organization as a whole. Mixing levels of analysis made it possible to explore the interplay among units at each level and across levels (Markus and Robey, 1988).

The site became available because of the first author's prior contact with the director of laboratory medicine. The director arranged for entry into the laboratories and meetings and gave his support throughout the study's duration. He was available to the research team as needed.

Research team

The project was undertaken by four faculty members in the College of Business Administration at the University of Cincinnati. The researcher from the information systems (IS) area, Bonnie Kaplan, conceived the project, conducted the fieldwork, and provided knowledge of the research setting. She envisioned the purpose of the study as researching what happens when a computer information system is installed into a new setting.

The other three researchers were from the organizational behavior area. Two of them left the study at an early stage; Dennis Duchon remained. Their primary interest was in testing pre-existing theory in a new setting using questionnaires as the means of gathering quantitative data for statistical analysis. They viewed qualitative methods as a means for deriving quantitative measures, rather than as rich sources of research data useful for grounding theory and interpretation. Consequently, they approached the study differently from Kaplan in three ways: (1) they decided to research the impact of the computer information system on work in the laboratories; (2) they began the study intending to test theory through statistical analysis of quantitative survey data; and (3) they did not consider interviewing and observation as a means of data collection.

Methods

Research question

Each member of the original research team formulated different research questions. The three organizational behavior members viewed the new computer system as an opportunity to test existing theory concerning job characteristics and job satisfaction in a new setting. Although each of their research questions differed, these three wished to investigate how job characteristics varied in the clinical laboratories. Consequently, the study focused on laboratory technologists. The research questions for these three researchers were to investigate (1) the effects of the computer information system on job characteristics, (2) how departmental technology affected computer acceptance, (3) how leader-subordinate relationships affected computer acceptance, and (4) how job characteristics varied among laboratories and changed over time.

Working in the interpretive tradition, Kaplan expected to shuttle among questions, hypotheses, and data throughout the study. Because of the other team members' primary interest in the laboratory work, she also adopted this focus. Her research question was to identify and account for both similarities and differences among laboratory technologists and among laboratories in their responses to the computer information system.

Research design

Each research question reflected differences between a quantitative hypothesis-testing approach (where the effects of an intervention on dependent variables are statistically assessed) and a qualitative approach (where categories and theories are developed inductively from the data, generalizations are built from the ground up, and various interpretive schemes are tried and hypotheses are created and reformulated during the course of the study) (Glaser and Strauss, 1967; Van Maanen, 1983b). These differences resulted in a longitudinal multi-method case study that incorporated each team member's interest and skills. Because this initial case design included both qualitative and quantitative methods, both positivist and interpretive perspectives were incorporated in order to best link method to research question.}

3 Case study, an investigation using multiple sources of evidence to study a contemporary phenomenon within its real-life context (Bonomo, 1985; Yin, 1984), has been advanced for information systems research in order to understand the nature and complexity of the processes taking place (Benbasat, et al., 1987). Although they are often distinguished from quantita-
The initial design was developed after considerable discussion and, as is common in qualitative research, was left open for modification and extension as necessary during the course of the study (Glaser and Strauss, 1967). Because research access to the site was not secured until shortly before the new system was installed, no pre-installation survey measures were taken. Consequently, as is often true in case studies, there could be no comparison of measures after installation (Cook and Campbell, 1979, p. 96).

The first step in the design was to interview laboratory directors and selected hospital administrators prior to system installation. The second step was to observe in each laboratory after installation. The remaining steps were to administer questionnaires at several periods after the computer system was installed.

The first wave of questionnaire data gathering occurred when a new routine had been established after the computer system was installed. The second wave was planned for approximately one year later, when the initial changes caused by the computer system became part of normal procedure. Future waves would be at intervals depending on initial results. Initially, regular participant observation at laboratory management meetings and staff meetings was not included in the design. This component was added when the meetings were instituted.

**Data collection**

Qualitative methods included open-ended interviewing, observation, participant observation, and analysis of responses to open-ended items on a survey questionnaire. Quantitative methods were employed to collect and analyze data from survey questionnaires. All participants were assured of confidentiality.

Although both qualitative and quantitative approaches were used, it quickly became apparent that they were viewed differently by research team members. Each team member conducted interviews and observations, but only the qualitatively-oriented member kept systematic field notes to be used for data analysis. Other team members viewed interviews and observations as providing "background" rather than "data." Consequently, Kaplan's field notes from each of these activities were used for analysis.

**Interviews and Observations**

The director of the laboratories, the chairman of the department, and the administrator of the hospital were interviewed early in the study. Teams of two or three researchers also interviewed the individual laboratory directors and some chief supervisory personnel during the week prior to computer system installation. Kaplan was present at all but two of these interviews. The purpose of the interviews was three-fold: (1) to determine what interviewees expected the potential effects of the computer system to be on patient care, laboratory operations, and hospital operations; (2) to inquire about possible measures and focus of the study; and (3) to generate questionnaire items for a survey of laboratory technologists.

During the month prior to administering the survey, individual researchers were present in the laboratories to observe and talk with laboratory staff while they worked. These observations were intended to influence questionnaire item development.

Starting three months after the computer information system was installed, Kaplan was urged by one of the laboratory directors to attend weekly meetings where directors and head supervisors discussed laboratory management problems. These meetings were instituted as a result of system installation and they became a regular feature of laboratory management even after system problems ceased to be discussed. Kaplan attended these meetings regularly throughout the study as an observer and occasional participant, and was a participant observer at other departmental meetings.

**Survey Questionnaire**

A survey instrument was developed for laboratory technologists, the primary direct users of the computer information system. It was composed of three parts. The first part consisted of measures adapted from the standard instruments that addressed job characteristics (Hackman and Oldham, 1976), role conflict and ambiguity (House and Rizzo, 1972), departmental technol-
ogy (Withey, et al., 1983), and leader-member relationships (Dansereau, et al., 1975).

The second part of the questionnaire used Likert-scale measures of expectations, concerns, and perceived changes that may be related to the use of the computer system. These measures were developed by analyzing the interviews and observations to derive categories for questions that focused on the primary expectations expressed by interviewees, attendees at meetings, and the laboratory technologists who were observed. Additional questions concerning expectations were adapted from Kjerulff, et al. (1982).

The survey instrument concluded with four open-ended questions that assessed changes caused by the computer system and elicited suggestions for improved system use. These questions were also derived from the observations and interviews. They were intended to serve two purposes. The first was to ensure that important issues were addressed even if they had been included in scaled-response questions. The second was to elicit information about impacts for which measures were difficult to develop.

All questionnaire items were pretested on a sample of laboratory personnel selected by head supervisors. After revision, the questionnaire was administered to all 248 members of the laboratory staff seven months after computer system installation. The staff knew about the study because of the prior laboratory observations and announcements at meetings. Each survey was accompanied by an explanatory letter. A research team member also explained the study during weekly staff meetings when the questionnaires were distributed. In some laboratories, this meeting was devoted to answering the questionnaire. In others, staff members were allowed to complete the survey during work hours provided that it not interfere with their job functions.

A modified version of the questionnaire was distributed to all laboratory technologists for the second wave of data collection beginning nearly a year after the first. No further surveys were conducted.

Sample

Just before the system was installed, 11 interviews were conducted with 20 interviewees representing all the laboratories. These interviewees included laboratory directors at all levels, head supervisors, and an administrator of one unit of the hospital.

All 248 members of the laboratory staff were surveyed starting seven months after system implementation. Data from all 119 completed (48%) questionnaires were analyzed. Only seven of the respondents had been interviewed. Most respondents were technologists who had college degrees, worked first shift, and had not worked previously in a laboratory with a computer information system. As is typical of laboratory technologists, almost all were women.

Analysis and Results

Data are presented from interviews immediately prior to installation and from the first wave of survey questionnaires seven months later. The quantitative data were analyzed using a standard statistical software package. Interview notes and responses to open-ended questions on the questionnaire were analyzed by the constant comparative method (Glazer and Strauss, 1967). Using this method, categories reflecting computer system issues important to laboratory directors and technologists were derived systematically.

Open-ended questions

Kaplan first analyzed open-ended questions on the questionnaire. Three themes predominated in the answers: (1) changes in technologists' work load, (2) improvements in results reporting, and (3) the need for physicians and nurses to use computer system terminals rather than telephones for results inquiry. Technologists expressed a general sense that their clerical duties and paperwork had increased and productivity had suffered. However, they credited the computer system with making laboratory test results available more quickly. They said that results reports were also more complete, more accurate, easier to read, and provided a picture of “the whole patient.” Even though phone calls interrupted laboratory work, they felt that doctors and nurses expected to get test results by calling the laboratories rather than by using the computer system. In addition, respondents sensed they were being blamed by others in the medical center for problems caused by the computer system.

When responses were grouped by laboratory, marked differences were evident among some
of the laboratories. Laboratories differed in their assessment of changes in their workload, number of telephone calls, improvement in reporting, and attitudes expressed toward the computer system.

**Scaled-response questions**

Responses to the questionnaire items pertaining to job characteristics and to the scaled-response items assessing computer expectations and concerns were analyzed next by two researchers who intentionally remained unaware of the findings on open-ended questions. Having already analyzed the responses to open-ended questions, Kaplan assisted them in an initial Q-sort of computer system questionnaire items and later interpretation of a factor analysis of these items. A fourth researcher had left the study team. Another of the original team members left the study during data analysis, leaving Duchon and Kaplan to interpret the results of Duchon’s statistical analysis.

A factor analysis of job items provided evidence of construct validity for the measures. Four factors were extracted: skill variety, task identity, autonomy, and feedback. These factors comprise a four-factor model of the core job dimensions (Birnbaum, et al., 1986; Ferris and Gilmore, 1985), and are also used to assess job complexity (Stone, 1974). Overall, no job characteristic differences due to environmental or individual factors were found. Respondents reported the same levels of job characteristics regardless of age, gender, job experience, etc.

Five computer system variables were extracted: external communications, service outcomes, personal intentions, personal hassles, and increased blame. Reliability for these five factors ranged between .53 and .87. Data on these variables indicated that respondents generally were positive about the computer system. They reported that the system had improved relations and aided communication between staff in the laboratories and the rest of the medical center (external communications), and that results reporting and service was better (service outcomes).

Respondents were very positive about their own continued use of the computer system (personal intentions). They did not think that irritants of their jobs, such as the number of phone calls and the amount of work (personal hassles), had increased, or that laboratory staff was blamed more and cooperated with less by physicians and nurses (increased blame). There were no statistically significant correlations between job characteristic measures and computer system measures.

At this point, nothing reportable had been found in the quantitative data. This was surprising because computer system variables were similar to themes identified in responses to the open-ended questions, where some laboratories differed markedly in their responses. Consequently, Kaplan continued to seek explanations for the differences among laboratories that were evident in the qualitative data.

**Interviews**

Next, Kaplan again analyzed the interviews with laboratory directors, this time to determine expectations of the directors prior to system implementation. She thought that perhaps different expectations among directors could have contributed to different responses within the laboratories. Different expectations were not found. The analysis indicated that prior to implementation, directors generally agreed that there would be more work for laboratory technologists, but that technologists’ jobs would not be changed by the computer system.

This assessment was made with full knowledge that technologists would have to enter test results and some test orders, and that their paperwork and billing duties were expected to decrease. Interviewees also expected that test results would be available more quickly. They thought that reports would have fewer transcription errors, would be more legible, and would provide useful cumulative information and patient profiles. They expected these improvements to reduce the number of unnecessary laboratory tests and stat (i.e., emergency) and duplicate test orders, and anticipated that the number of telephone inquiries concerning results would decrease.

**Developing an Interpretative Theoretical Model**

The five computer system variables that were developed from the questionnaire items reflected themes very similar to those found in the qualitative data from interviews and responses to
open-ended questionnaires: changes in workload and changes in results reporting. This congruence of themes from independent sources of data strengthened confidence in their validity.

The analysis of qualitative data from the questionnaires suggested important differences among laboratories, even in the absence of statistical verification, because the differences were so striking. Knowledge obtained from observations in the laboratories and at meetings, as well as from comments made to her by individual laboratory technologists and directors, strengthened Kaplan's conviction that these differences were important. It remained to determine the nature of the differences and to explain the lack of reportable statistical results.

An impression gained from the qualitative data suggested an interpretation. Kaplan had noticed that laboratory technologists seemed to emphasize either the increased work or the improved results reporting in their answers to the open-ended questions. The repetition of these themes in all the data sources reinforced their importance. This repetition suggested that there were two groups of respondents corresponding to these two themes. The finding that directors did not expect technologists' jobs to change raised the question of what constituted a technologist's job. It seemed that directors and technologists might have different conceptions of the technologist's job and that these differences were reflected in their assessment of the computer system. Individual laboratory technologists might also differ in their views of their jobs, just as they differed in what they emphasized about the computer system in their comments on the questionnaires.

These insights led to a model depicting two groups of laboratory technologists. According to this model, one group saw their jobs in terms of producing results reports, the other in terms of the laboratory bench work necessary to produce those results reports. As shown in Figure 1, the group who saw its jobs in terms of bench work was oriented toward the process of producing laboratory results, whereas the group who viewed its work in terms of reporting results was oriented toward the outcomes of laboratory work; the members of this group saw themselves as providing a service.

The ways in which the computer affected the production work in the laboratories were assessed in those questionnaire items comprising personal hassles and increased blame, e.g., effects on paper work and telephone calls. Thus, the group who saw its jobs in terms of the bench work (i.e., the process of producing laboratory tests results) would have responded to the computer system according to how it had affected what was assessed in these items. The product-oriented group of respondents who saw its jobs in terms of the service provided (i.e., the product, rather than the process, of laboratory work) would have assessed the computer system in

![Figure 1. A Model Depicting Different Orientations to Work and the Computer in Clinical Laboratories]

<table>
<thead>
<tr>
<th>View of Job</th>
<th>Process</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responses to Computer System</td>
<td>Bench Work</td>
<td>Results, Service</td>
</tr>
<tr>
<td>Computer System Variables</td>
<td>Increased</td>
<td>Improved Results</td>
</tr>
<tr>
<td></td>
<td>Work Load</td>
<td>Reporting</td>
</tr>
<tr>
<td></td>
<td>Hassles</td>
<td>Communications</td>
</tr>
<tr>
<td></td>
<td>Blame</td>
<td>Service</td>
</tr>
</tbody>
</table>

Orientation = (Communications + Service) - (Hassles + Blame)
terms reflected in its responses to external communications and service outcomes items, e.g., improved results reporting.

This interpretation indicated a reason why job characteristics measures did not depict differences among laboratories and why there was no correlation between job characteristics and computer system variables. The kinds of differences in job orientation depicted in the model would not have been measured by job characteristic measures.

After this model was proposed, two new variables were created to measure whether technologists' responses differed according to the computer system's impact on process versus product aspects of their jobs. As shown in Figure 1, one variable combined scores on external communication and service outcomes, and the other combined scores on personal hassles and increased blame. The variable personal intentions was omitted because there was no theoretical basis for including it; personal intentions did not assess the interaction between specific aspects of the computer system and the job. Moreover, this variable was not a good discriminator between laboratories or individuals because individual respondents' scores were all high.

There was a significant negative correlation between these two new variables, thus indicating that respondents tended to have high scores on one variable and low scores on the other, i.e. they were either product- or process-oriented. An orientation score for each respondent was then computed by subtracting the sum of that person's scores on personal hassles and increased blame from his or her scores on external communication and service outcomes.

When the orientation score was regressed on laboratories, statistically significant differences in orientation were found across laboratories. Thus, some laboratories, like some technologists, were process-oriented while others were product-oriented. Moreover, respondents from the laboratories rating the strongest process orientation expressed the most hostility on the open-ended questions from the survey, whereas respondents from laboratories with the strongest product orientation expressed strong satisfaction with the computer system.

Thus, our results suggested that the interpretation was correct. Discussion with the laboratory director about the intermediate and final results and about the research papers produced from the study supported the interpretation.

**Discussion**

This study illustrates the difficulties as well as the strengths that occurred when research perspectives from different disciplines were combined. Although both authors agree that this collaboration enriched the study as well as their own understanding of research, it was rife with frustrations. Neither author initially realized the extent to which differing values, assumptions, and vocabularies would interfere with the project. Continued interaction was necessary to recognize that there were differences even in understanding the same words. Persistent effort was needed to identify and resolve these differences. A key incident in the study stemmed from these differences. Because the incident is illustrative of the difficulties as well as the enrichment caused by the different perspectives of research team members, we recount it here.

After the initial statistical analysis of data from the scaled response questions, Duchon thought that there were no statistical results worth reporting. Kaplan thought he meant that there were no statistically significant differences among laboratories in their reaction to the computer system. However, she did not agree with these results because they did not fit with her observations and analysis. Duchon remained convinced that there were no results worth pursuing. Consequently, Kaplan began to analyze the remaining data from the interviews. This analysis strengthened her convictions that the qualitative data did indicate patterns worth investigating and that Duchon had to be convinced of this. That determination led to the development of the interpretive theoretical model.

The turning point in the study, and in the authors' collaboration, happened when Duchon reanalyzed the quantitative data as suggested by Kaplan. This new analysis supported her interpretation. When the initial analysis was repeated, there were statistically significant differences among laboratories for the computer system variables. We were not able to determine the reason for the apparent lack of reportable differences during the first statistical analysis. Because of continued difficulties in communication, misunderstandings, in retrospect, were not surprising.

Some of the difficulties we experienced have been described so that others who participate
on similar research teams may shorten the learning period and reduce the communication problems. It should be clear from this account that, as is common in research that includes qualitative approaches, the process is messy. Impressions, interpretations, propositions, and hypotheses were developed over the course of the study, a process that hardly fits the positivist ideal of objective collection of neutral or purely descriptive "facts" (Van Maanen, 1983b). This messiness should not dismay those who experience it.

Despite the methodological and communications problems, the collaboration was productive and friendly. Our tenacity in holding to our initial independent analyses of the different data — though a problem at the time — and the increased respect each of us developed for the other's approach, in fact, were positive aspects of our research. As has happened in other projects (Trend, 1979), a strong determination to accommodate each approach and to reconcile apparently conflicting data resulted in an interpretation that synthesized the evidence. We cannot state too strongly that the advantages of our collaboration outweighed the difficulties.

Conclusions

This article describes how qualitative and quantitative approaches were combined in a case study of a new information system. It illustrates four methodological points: (1) the value of combining qualitative and quantitative methods; (2) the need for context-specific measures of job characteristics; (3) the importance of process measures when evaluating information systems; and (4) the need to explore the necessary relationships between a computer system and the perceptions of its users.

Combining qualitative and quantitative methods proved especially valuable. First, the apparent inconsistency of results between the initial quantitative analysis and the qualitative data required exploration. The initial statistical analysis revealed only that certain well-recognized job characteristic measures were not capturing the differences in the sample and that the correlations between job characteristics and computer system variables were not significant. However, systematically different responses to the computer system were present in the qualitative data. Further analysis to resolve the discrepancy led to the use of new measures developed from the quantitative questionnaire data that captured job-related responses to the computer system and that supported conclusions drawn from the qualitative data.

Thus, triangulation of data from different sources can alert researchers to potential analytical errors and omissions. Mixing methods can also lead to new insights and modes of analysis that are unlikely to occur if one method is used alone. In the absence of qualitative data, the study would have concluded that there were no reportable statistically significant findings. However, on the strength of the qualitative data, a theoretical interpretative model was developed to drive further statistical analysis. The inclusion of qualitative data resulted in the generation of grounded theory.

The results also suggest the value of investigating specifically how a computer system affects users' jobs. In this study, as in others, no correlation was found between standard job characteristic measures and variables measuring responses to the computer system. Nevertheless, these responses were related to differences in job orientation. Studies that independently assess characteristics and attitudes ignore the specific impacts of a computer system on work. Standard job characteristic measures do not necessarily assess job-specific factors or capture the different job orientations held by workers with "the same job." Instead of sole reliance on these measures, instruments need to include context-specific measures of how a computer system supports work, as conceptualized by the worker. In this study, measures assessing these aspects were derived from knowledge of the setting gained by field experience, again suggesting the value of combining qualitative and quantitative methods.

The study further suggests the need to move beyond outcome evaluations to investigating how a computer system affects processes. By extending research to examine specific efforts of individual computer information systems in particular contexts, our general understanding of what affects the acceptance and use of computer information systems can be improved.

Lastly, there is a growing amount of literature that assesses the impacts of computer information systems. This study was intended, by part of the research team, as an assessment of the impacts of a computer information system on work. However, impact studies consider only one
side of the important interaction between computer information system users and the computer information system: the effects of the system on users, the organization, or society. Research designs could just as well consider the impacts of users, the organization, or society on the computer information system. Sorting out the direction of causality is a difficult, if not meaningless, task that is made all the more difficult by the multitudes of confounding factors common to any field setting. It also may be impossible to do because the design does not account for changes due to the interrelationships between the “dependent” and “independent” variables.

For example, in this study, the job orientation of the users could have mediated their response to the computer information system. Alternatively, the system itself could have caused the differences in job orientation. Rather than formulate the analysis in either of these ways, it seemed more fruitful to take an interactionist approach and consider the interrelationships between users’ job orientations and their responses to the system. “Impacts” implies unidirectional causality, whereas, as has been found in other studies, investigations of interactions can be more productive and meaningful.

Despite the normative nature of the methodological points, the most important conclusion is the need for a variety of approaches to the study of information systems. For the same reasons that combining methods can be valuable in a particular study, a variety of approaches and perspectives can be valuable in the discipline as a whole. No one method can provide the richness that information systems, as a discipline, needs for further advance.

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References


Mumford, E. and Henshall, D. A Participative Approach to Computer Systems Design: A Case


About the Authors

Bonnie Kaplan is an assistant professor of information systems at the University of Cincinnati’s College of Business Administration. She is also an adjunct assistant professor of clinical pathology and laboratory medicine. Dr. Kaplan received her Ph.D. in history from the University of Chicago. She has had extensive practical experience in information systems development at major academic medical centers. Dr. Kaplan’s research interests include behavioral and policy issues in information systems, implementation of technological innovations, information systems in medicine and health care, and history and sociology of computing. Her publications have appeared in Journal of Medical Systems, International Journal of Technology Assessment in Health Care, Journal of Health and Human Resources Administration, Journal of Clinical Engineering, and volumes on human-computer interaction and on medical computing.

Dennis Duchon is an assistant professor of organizational behavior in the College of Business at the University of Texas at San Antonio. Before joining the faculty there, he was an assistant professor of organizational behavior at the University of Cincinnati. He received a Ph.D. in organizational behavior from the University of Houston. He has worked as a manager both in the United States and abroad. Dr. Duchon’s research interests include behavioral decision making and the implementation of new technologies. He has published in the Journal of Applied Psychology, IEEE Transactions in Engineering Management, and Decision Sciences.