14 STUDYING ORGANIZATIONAL COMPUTING INFRASTRUCTURES: MULTI-METHOD APPROACHES

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Abstract

This paper provides guidelines for developing multi-method research approaches, provides several examples of their use, and discusses experiences with conducting a multi-method study of one organization's computing infrastructure changes. The focus on organizational computing infrastructures is due to the contemporary belief that these are increasingly critical to organizational success. However, understanding the value of an organization's computing infrastructure is difficult. This is because of their uniqueness, pervasiveness, context-driven nature, temporality, the constant changes in underlying technologies, and the variety of their effects at multiple levels in the organization. These difficulties are especially pronounced in organizations with distributed computing environments because the dispersion of computing accentuates these effects.

Keywords: Organizational informatics, computing infrastructure, multi-method research, ERP, implementation, organizational change, fieldwork

1. Introduction

Computing infrastructures, and the collections of information technologies (IT) that form their fabric, are seen as increasingly critical to organizational success (Goodman and

Sproull 1989; Kling 1992; Yates and Van Maanen 1996). However, the contributions of a computing infrastructure to organizational success are difficult to assess, in part, because of the methodological challenges. This paper addresses two of those challenges. First, what are the methodological issues in researching organizational computing infrastructures? Second, how can we best address these issues?

An organization's computing infrastructure includes the hardware and software, the administrative roles and rules that support that collection, and the informal norms and behaviors that grow up around these IT and the rules governing their use[1] (Barley 1990; Kling 1987; Kling and Iacono 1984; Kling and Scacchi 1982). A computing infrastructure helps to connect the disparate parts of its host organization. This forms the basis of what Kling and Scacchi call the "web of computing." At a more abstract level, a computing infrastructure embodies the organization's information processing capabilities (Galbraith 1974; March and Simon 1958; Yates 1988).

There are at least two reasons why an organization's computing infrastructure is critical to its success. The first is that this infrastructure is increasingly embedded into the conduct of work (Bridges 1994; Sproull and Kiesler 1991; Star and Ruhleder 1996; Wigand, Picot, and Reichwald 1997). For example, help-desk workers require that the phone system, databases, and problem tracking programs are "up" in order for them to perform their work (Pentland 1992). The second reason an organization's computing infrastructure is seen as critical is the growing trend to view IT as levers of organizational strategy (i.e., Henderson and Venkatraman 1991).

There are at least two reasons why it is difficult to understand the roles a computing infrastructure plays in an organization. The first is our limited understanding of the effects of computing infrastructures on work (e.g., Johnson and Rice 1987; Kling 1995; Truex, Baskerville, and Klein 1999). This stems, in turn, from their context-dependent nature, their pervasiveness, and the unpredictable and varied nature of their effects at multiple levels in the organization (i.e., Burkhardt 1994; Manning 1996). The distribution of computing seems to accentuate these effects.

A second reason that makes it difficult to understand the role of a computing infrastructure is the rate at which core IT are changing. Examples include client/server computing, Internet-based technologies, the use of information appliances, and the pervasiveness of personal computing. The constant change in these IT mean that, at any given time, several components of a computing infrastructure may be in flux. Moreover, most computing infrastructures, and especially those that are in the process of distributing, are constructed using products provided by a changing array of hardware and software vendors. The issues with implementing enterprise resource systems (ERPs) are a contemporary example of this trend (Davenport 1998).

This paper continues in four parts. In the first, we address the first question by setting out methodological concerns with studying organizational computing infra-

[1]Viewing an organization's computing infrastructure as comprising technical, administrative, and social aspects broadens the view provided by alternative conceptualizations. For example, the socio-technical (Bostrom and Heinen 1978a, 1978b; Fairhurst, Gren, and Courtright 1995; Holsapple and Luo 1995; Shulman, Penman, and Sless 1990); and soft-systems approach (Checkland and Scholes 1990) also highlight that computing infrastructures are more than the information technologies that form their technical core. However, aggregating both the formal rules and procedures and the norms and behaviors of use limits the interplay of the two non-technology-centered aspects of infrastructure and obscures the roles these forces play in enmeshing computing infrastructures into their host organization (Burkhardt 1994; Kling 1995).

structures. The second presents the first steps to addressing the second question by presenting a discussion of issues regarding multiple method research design. The third presents three examples of multiple method approaches to studying organizational computing infrastructures. In the fourth, a summary comparison of the three case studies is presented and the methodological issues that arise from this comparison are discussed.

2. Organizational Computing Infrastructures

As outlined below, understanding an organization's computing infrastructure demands a research approach that can accommodate the unique, pervasive, multi-level/multi-effect, and time-variant nature of these systems.

2.1 Uniqueness

Sproull and Goodman (1989, p. 255) argue that each organization's computing infrastructure (which they call a technical system) is unique since common technical components are woven into an organization's administrative and social fabric. This uniqueness helps to account for some of the variations across organizations using identical IT. Two examples are the variations in the use of Lotus Notes across departments of a large consulting firm (Orlikowski 1993) and the use of the same technology at Zeta Corp. (Orlikowski 1996). Other examples include the variations in use of computer-aided software engineering (CASE) tools among software development teams (Guinan, Cooprider and Sawyer 1997) and in the use of computer-aided design (CAD) (Collins and King 1988; Kelley 1990; Salzman 1989).

2.2 Pervasiveness

By pervasive we mean that the organization's computing infrastructure directly or indirectly affects each member of that organization. With the dispersion of computing (via networks), this reach is more expansive and direct than at any other time in the history of computing. This proliferation of computing increases both the number and distribution of people who support this infrastructure. Indeed the distinction between other workers and technologists (those who exist to serve the computing needs of the organization) is blurring (Wigand, Picot, and Reichwald 1997). For example, Gasser (1986) discusses the way in which new computing technologies were incorporated into work at two firms. Zuboff (1988) described the increasing integration of computing into work as "informating." Salzman (1989) discusses how CAD system use helped to reshape engineering design work by blurring the distinction between technician and engineer. Laudon and Marr (1995) found that increased IT use has helped reshape occupational structures in the U.S. federal government.

2.3 Multi-level/Multi-effect

Because an organization's computing infrastructure is both pervasive and unique, its uses differ based on purpose. For example, lower-level workers interact with IT in their jobs as a matter of course, thus shaping its functions through use (Clement 1994; Kraut, Dumais, and Koch 1987; Manning 1996; Zuboff 1988). Managers plan and act around and with its assistance (Orlikowski 1993). Senior managers actively try to shape and direct its alignment with their strategy (Henderson and Venkatraman 1991).

Variations in IT use across the levels of an organization imply that the effects will also vary. For example, Zuboff describes "panoptic power," where senior managers can exert more control over work even as the workers have more flexibility to make decisions (see also Wilson 1995). Koppell (1994), in his study of a hospital's use of a new integrated computing system, finds that doctors, nurses, and orderlies each used the system in different ways.

2.4 Temporality

Organizations vary over time and the time variance of an organization's computing infrastructure is reflected in every aspect of its design. There are ongoing changes in base IT, steady adaptation of the rules and the roles played by people who shape its use, and constant evolution of social norms surrounding its use. This temporality is a form of organizational homeostasis—the effort to maintain the status quo over time (Lee 1999). Note that this conceptualization of an organization reflects only a dynamic equilibrium and not a statement of success or failure (March and Simon 1958).[2] Over time, the computing infrastructure's form emerges through its uses (Goodman and Sproull 1989; Markus and Robey 1988; Truex, Baskerville, and Klein 1999). Current literature advocates IT as levers to alter an organization's homeostasis (Benjamin and Levinson 1993; Davenport 1998).

2.5 Methodologic Ramifications

This set of forces suggests that the most useful research methods for understanding computing infrastructures should span levels of analysis and explicitly address the ways in which computing infrastructures are entwined within their host organization. Not surprisingly, research into computing infrastructures has generally employed multiple methods of data collection (e.g., Adler 1995; Barley 1986; Burkhardt 1994; Gasser 1986; Kelley 1990; Kling and Scacchi 1982; Koppel 1994; Ruhleder 1995; Salzman 1989). /These authors represent a range of disciplines and conceptual perspectives. Each

[2]Concepts such as organizational homeostasis and dynamic equilibrium reflect the ongoing debate between structuralism and functionalism. In this paper, the focus is not on the debate. Rather, it serves as a background and the author's position regarding this debate is implied by the use of the homeostasis/dynamic equilibrium.

provides a rich set of descriptions regarding the roles and issues with various aspects and elements of the computing infrastructures in the organizations that they study. However, discussions of how the authors developed and used their multiple methods is not as extensive. While this is understandable, as these papers report empirical findings and do not specifically focus on methods, it leaves the researcher interested in studying organizational computing infrastructures and/or conducting multi-method research with little explicit guidance.[3]

3. Defining Multi-method Research

A multi-method approach to social science research involves the use of several data collection techniques in an organized manner to provide multiple data sets regarding the same phenomena. This is typically done by drawing on a set of data collection methods that accommodate each other's limitations (Gallivan 1997; Jick 1979). Since both the conceptual bases and data collection techniques help to shape the phenomena of interest, there are many ways to conduct multi-method research (Brewer and Hunter 1989). This paper focuses on "multi-method fieldwork": blending fieldwork with surveys.

Fieldwork includes participant observation, interviewing, and the collection of archival records—characteristics of both intensive and prolonged involvement with the social units being studied. Surveys involve data collection instruments (often self-administered) to collect responses to *a priori* formalized questions on predetermined topics from a valid sample of members of identified social categories. Surveys are a mainstay of the quasi-experimental field research tradition on which most IS research is based; survey-based studies comprise more than 49% of research done on the use of IT in organizations (Orlikowski and Baroudi 1991). Explicit multi-method studies represent about 3% of the same research base (Gallivan 1997).

A multi-method fieldwork approach uses surveys in a manner that differs from traditional quasi-experimental field research. In the latter, survey data are extracted from the field and quantified. Non-survey data are used to support or enrich findings from survey data. A multi-method approach sees the two forms of data collection as intertwined. That is, each data collection method must both stand on its own and also be combinable (typically called triangulation) (Brewer and Hunter 1989; Gallivan 1997; Jick 1979; Kaplan and Duchon 1988).

There are few common conventions to describe the process of triangulating data (Howe and Eisenhardt 1990; Jick 1979; Williams 1986). (One exception is the multi-trait/multi-method matrix described by Campbell and Stanley 1966.) This often limits the

[3]Fieldwork is one of the many qualitative or intensive methods being used to study information technologies in organizations (e.g., Avison and Myers 1995; Kling 1980; Lee 1989; Lee and Markus 1995; Markus 1983; Markus and Robey 1988; Walsham 1995), although this approach is not without criticism (e.g., Sandstrom and Sandstrom 1995). There are also special issues of leading journals (e.g., *Administrative Science Quarterly* in 1979 and *Organization Science* in 1990) describing approaches to fieldwork methods for organizational research in general. Edited volumes by Mumford et al. (1984), Nissen, Klein, and Hirschheim (1991), and Lee, Liebenau, and DeGross (1997) provide additional direction for researchers conducting fieldwork on the use of IT in organizations. Electronic sources are also avaialble (i.e., http://comu2.auckland.nc.nz/~isworld/quality.htm).

value of this type of research to the broader community because describing the methods used in triangulating is both space-consuming and important for establishing credibility (Lincoln 1995; Sieber 1973; Sutton and Staw 1995). The need to write extensively about methods typically comes at the cost of reduced space devoted to discussing findings.

Both fieldwork and the more common survey-based approaches have strong ideological bases. A multi-method approach that combines surveys with fieldwork seeks to integrate these perspectives. The result is a new method, not just an aggregation of styles (Brewer and Hunter 1989, p. 17). For example, Kaplan and Duchon, (1988), Trauth and O'Connor (1991), and Wynekoop, (1992) collected data on various IT uses in organizations using both observation/ interviews and surveys. In this way, the studies draw on the strengths of the combination of data collection methods (Gallivan 1997; Jick 1979).

4. Conducting Multi-method Research

Zuboff (1988, p. 423) began the discussion of her methodology by writing: "behind every method is a belief." The belief expressed here is that multi-method fieldwork is well-suited to research on organizational computing infrastructures. This belief stems from the fact that the multi-method approach is typically longitudinal and builds on interpreting data collected from observations, interviews, archival records, and surveys. Analysis draws on different combinations of data sets that provide different perspectives on the same phenomena. In a multi-method fieldwork approach, new events demand re-analysis over time. This implies that an understanding of the data develops from a constant reinterpretation of existing data/observations in the new light of unfolding events (Jackson 1987; Van Maanen 1988).

Multi-method research is guided by a number of factors such as validity and generalizability. These factors are well documented in other work and not discussed here (see Brinberg and McGrath 1984; Creswell 1994; Danzin 1970). There are additional factors specific to multi-method research: the role of theory, method independence, insulation, data interdependence, analytic integration, and data comparability versus contrast (Brewer and Hunter 1989). These are defined in Table 1 and discussed below.

4.1 The Role of Theory

Central to most research is the development and/or testing of theory (Blalock 1971; Popper 1968). Contributions toward theory can be seen along a continuum from development to testing (Bagozzi 1979; Blalock 1971; Glaser and Strauss 1967; Hoyle 1995; Sutton and Staw 1995; Yin 1989). However, theory development and testing are often not done well in organizational research, a subset of which is research on organizational computing infrastructures (Merton 1967; Sutton and Staw 1995; Weick 1995). For example, Grunow (1995) reported on the methodological and theoretic approaches to 303 papers concerning organizational research. He found that 78% of these papers did not align theory to their research questions and 82% of the papers could not contribute meaningful results to theory development. As Sutton and Staw (1995, p. 371) state: "references, data, variables, diagrams and hypotheses are not theory."

Table 1. Six Issues with Multi-method Data Collection (from Brewer and Hunter 1989)

Role of theory	Used to guide the study and establish relationships between multiple data sets
Independence	The effect of one data collection method on another
Insulation	Exposing subjects to effects of multiple waves of data collection
Interdependence	Providing for intentional links between data
Integration	Combined analysis of multiple data sets
Comparability v. Contrast	Analysis highlights differences caused by different type of data and can lead to incongruities in analysis

Even if Sutton and Staw are correct and Grunow's analysis is accurate, some form of theoretical rationale still forms the basis of the analysis and discussion sections of most scholarly papers on IT use in organizations. For instance, papers reporting theory development provide extensive rationales. Typically, this rationale is based on several sources of evidence (see Eisenhardt 1989). For example, Zuboff approaches her fieldwork using a grounded theory approach across her series of cases (see Glaser and Strauss 1967). In his fieldwork, Barley (1986) draws on structuration and compares findings from two sites over time. Markus (1983) uses three theoretic perspectives to reflect on the data drawn from a case study of one implementation, arguing that one perspective best fits the data. Orlikowski (1993), however, uses *a priori* theory as a basis for her work.

One benefit, and the primary differentiator, of multi-method research is multiple data sets. This suggests that theory is both the source of guidance and a means for uniting the various data collection approaches. While some authors protest against using formal theory (see Van Maanen 1995a; 1995b), theory serves as a stabilizing force for multi-method-based research. A theory-based approach helps sort through the blur of reality, providing a way to characterize observation and interpretation (Weizenbaum 1976). Vaughan (1992) calls this "theory elaboration" and Weick (1995, p. 385) calls it "theorizing." Hence, using theory does not preclude description, nor does it demand prescription.

4.2 Dependence and Insulation: Collecting Multiple Data Sets

Multiple collection methods draw data from the same subjects. These subjects interact with the researcher(s) in several ways over the course of data collection (as participants in interviews, as subjects of observation, and as respondents to surveys). This means that

the survey effort is also related to the interview effort in that they are typically done by the same researcher(s). Hence, researchers must consider how their *total* presence will affect subjects prior to entering the field.

A second issue concerns the manner in which the data will be collected when the observer is one of the instruments of data collection. Inherent to multi-method fieldwork is the disturbance caused by the (multiple) presence of the researcher(s). Approaches to reducing this disturbance lie on a continuum from unobtrusive observation to direct participation (i.e., action research) (Argyris, Putnam, and Smith,1985). Researchers can also strive to be unobtrusive and focus on constantly mitigating their role in the surroundings (Barley 1990). Barley writes: "with time, I believe I came to be seen as a harmless, but perhaps eccentric, individual without factional loyalties" (p. 243). Still, as he writes, his acceptance may have depended on a madcap drive through Boston with a technician from one of the hospitals to help them cover for a critical supply shortage.

Pettigrew (1990) takes a more participant-oriented approach. He writes of "an open and reciprocal relationship between the researchers and their host organizations," stating that "running a research in action workshop is not only a sound instrumental act ... it is also a clear sign of respect for your new partner" (p. 286). He goes on to detail the manner and substance of the reciprocity in activities such as status meetings, workshops, project reports, and deliverables.

Active participant/observers must also attend to ethical issues. Schein (1990, p. 204) says of intervention that "we should not do this lightly, and we should have a clear picture of what our motivation is when we do it." Regarding the role(s) of the researcher as a participant/observer, Schein (1990, p. 207) writes simply: "Be careful." Being involved in the outcomes of an organizational process is a tremendous responsibility for the researcher (e.g., Schön 1983).

Mintzberg (1979) left open the role of the observer, contending that each field researcher is forced to tune their use of participation and observation to sites in which they are involved. Given this advice, some contextual information helps to explain the variance in approaches. For example, Barley studied work-level changes brought about by a new imaging system while Pettigrew's emphasis was to understand organizational change from a managerial perspective. Schein's focus is on describing leadership's role in affecting change. Still, the role of the participant observer remains a research decision open to interpretation. The fieldworker is an interpreter both of the events seen and roles played. Each interaction between the researcher and the host site requires answering questions about the level of involvement such as: What is the appropriate role of the researcher? For what purpose? To what effect? How does this relate to the observations? The various levels of an organization can serve as insulation, allowing the researcher to have different roles at different levels.

Another concern with dependence in multi-method fieldwork involves determining when data collection begins and ends. Case research is often post hoc, making this a relevant but not critical question (Benbassat, Goldstein, and Mead 1987; Glick et al. 1990; Lee 1989; Yin 1989). However, this is a major consideration for research conducted in "real time." Since most organizational changes have many antecedents, no matter when data collection begins there is a history. This history may be relevant to the decision about when to begin data collection. Equally difficult is the decision to end data collection: when is something "over"? Dubinskas (1988) argues against work where "it

is assumed that we really can peg all events conveniently to that same time line" (p. 8). Barley (1988) suggests the researcher define these dates within the context of the study. Pacanowsky (1988) asserts the starting and ending points are arbitrary. If the researcher seeks to understand issues or events in an organizational setting, then the research is likely to start after the issue "began" and finish before the issue "ends."

4.3 Integration as Comparison or Contrast: Conducting Multi-method Analysis

Analyzing multiple data sets that are focused on a common phenomenon often leads to paradoxical results. That is, findings drawn from these different data sets may be contradictory (Jick 1979). These contradictions represent the potential for new learning or for exposing methodological flaws (Robey 1995). Developing such findings suggests the value of interim analyses to help define differences among data sets (Miles 1979).

In this integration, interviews and observations are often seen as a rich source of interesting data. However, the volume of data collected can make analysis seem overwhelming. This raises the question of how to characterize the interpretations that arise from the data. Mintzberg (1979) argues for an inductive approach. Miles (1979), drawing on his own work, suggests four points: intertwining analysis and data collection, formulating classes of phenomena, identifying themes, and provisional testing of hypotheses. This implies the importance of iteration as the basis to both formulating the classes of phenomena and identifying themes. This sets up the ongoing testing of interim hypotheses.

Miles' four points are often modified to fit the particular needs of the researcher/ effort. For example, both Zuboff (1988) and Leonard-Barton (1990) do the interim analysis between cases, using an early case to establish the classes and themes that are modified by data obtained in later cases. Pacanowsky used ongoing reflection during his data collection. Then, following his stay at Gore-Tex, he rebuilt his analysis. Bogdan (1972, p. 59) argues for balancing participant observation with breaks from the field. Barley (1986, 1990) used a seven-week break from fieldwork to help make sense of what he was seeing. However, Glick et al. developed their research almost completely on post hoc analysis.

These examples illustrate the variations in the conduct of multi-method fieldwork. Being close to the data, as field work demands, often prevents the researcher from stepping back to see the, often quiet, evolutions of contemporary organizations and their computing infrastructures. Too much distance and the researcher is no longer able to view the flow of life—a central aspect of fieldwork (Geertz 1973).

This tension reflects a second issue: the multi-method researcher must be both close to and distant from the data. To make sense of mixed forms of field data, ongoing analysis is critical and deeply reflective analysis is demanded. Prescriptive analytic techniques—available in more traditional experimental and quasi-experimental data analysis (e.g., Pedhauzer and Schmelkin 1991)—are not as well developed for qualitative analysis (e.g., Miles and Huberman 1994). Still, there is some guidance. For example, using explanatory matrices—where issues form one axis, sources form the other, and supporting data fill the intersecting cells—is one flexible technique (Miles and Huberman

1994). Another technique is to build evidence chains, where an issue is stated and then the supporting evidence is laid out. Both of these imply immersion in the data to develop ways to categorize the corpus of data and to extract the relevant segments.

5. Assessing Multi-method Research Examples

The discussion in this part centers on three examples of multi-method studies on computing in organizations (see Table 2 for a summary).[4]

5.1 The Kaplan and Duchon Study of a Clinical Information System

Kaplan and Duchon (1988) report on the implementation of a clinical information system in nine laboratories of a large, urban, teaching hospital. The study team was comprised of information systems and organizational behavioral researchers. They pursued a set of questions concerning what happens when a new system is implemented and the effects of this implementation on work. The research team relied on interviews, participant observation, and surveys to collect data. However, the original theories guiding the research were so disparate that the first rounds of analysis revealed both a lack of clarity and the difficulty in triangulating among the sets of data. Theory generation emerged as the conceptual bond since the lack of coherence in the original approach led members of the team to build theory out of the data.

During data collection, the undiscovered differences with the *a priori* theoretic bases meant that the dependence among the data collection approaches varied. For example, some of the researchers did cursory interviewing with the goal of using the data solely to build surveys. Others supported their interviews with extensive note-taking and descriptive field notes. Furthermore, while the survey was developed by the team, drawing from both standard scales and context-specific questions generated from the data collected by interview and observation, all participant observation was done by one person

Two independent groups analyzed the data sets. The survey data were analyzed by part of the team, the rest by another part of the team. Findings from the survey were considered uninteresting relative to the *a priori* theory and this led to part of the team leaving the project. However, the qualitative data revealed several issues for the remaining two team members. After much discussion, Kaplan convinced Duchon to re-analyze the survey data in light of the findings from the interviews and observation. This re-analysis led to significant findings and the combination of analyses across several sets of data led to theory generation—the job orientation model. Thus, theory generation turned out to be the "conceptual glue" that provided the unifying tie between the disparate data sets. And the multi-method approach led to unexpected findings.

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[4]An author from each of these studies spoke during a panel on the use of multiple methods at the 1997 International Conference on Information Systems. That presentation and subsequent extended informal discussions with the authors of these studies form the basis of the presentation of their studies in this section.

Table 2. Contemporary Multi-method Studies

	Kaplan and Duchon (1988)	Guinan, Cooprider, and Sawyer (1997)	The MSU Study[a]
Role of theory	Originally explicit, ended up as a grounded theory approach.	Extensive *a priori* integrative model.	Three interrelated *a priori* theories as interpretive framework.
Independence	Based on who conducted the data collection and by time.	Both theoretically-based chronology and using multiple researchers.	Multiple phases combined with separation of data collection by both levels of analysis and specific roles for each researcher.
Insulation	Time, the use of multiple researchers.	Time sequencing. The use of multiple researchers.	Time sequencing, the use of multiple researchers, and disparate data collection methods.
Interdependence	Theory-connected.	*A priori* links specified and incorporated into data collection instruments. This constrained adaptation over the course of the project.	Theory-connected. Seen as secondary to interdependence.
Integration	Ad hoc use based on role of grounded theory. Driven by qualitative data.	Theory driven. Problematic with the *a priori* theory did not hold up under the rigors of longitudinal research.	Both theory and data-driven approaches. Reliance on interim analyses. Current work suggests that this is difficult.
Comparability	Driven by use of grounded theory.	Driven by *a priori* linkages between theories.	Driven by on-going analysis of data. Using multiple analysis techniques.

[a]See Sawyer (forthcoming) and Sawyer and Southwick (1996, 1997).

5.2 The Guinan, Cooprider, and Sawyer Study of CASE Tool Use

Guinan, Cooprider, and Sawyer (1997) report on a four year study on the use of CASE tools by 100 software development teams at 22 sites of 15 companies. The study was conducted by 15 faculty and/or doctoral students. Like Kaplan and Duchon, they had multiple research objectives. Moreover, they built an extensive, normative, and multi-faceted *a priori* theoretical model that crossed levels of analysis and incorporated multiple theories. This conceptual structure framed both the survey designs and the interviews.

Data collection involved extensive surveying, done four times for each project team as it moved from initiation through implementation. This required using 28 instruments to gather data from more than 2,000 respondents. Survey data collection was supported by interviews of participants and other data collection efforts such as independently assessing development metrics and collecting documentation regarding the development effort. This led to amassing more than 500,000 data points. Because of the scope and level of effort, both academic and industrial advisory boards provided oversight and met frequently.

The *a priori* theoretical model served both as a means to organize data collection and as a time line that highlighted both the intended populations and the links between the data collection methods. The research team was both trained and managed to assure that this plan would be followed. However, the ability to adapt to issues that arose in the course of the data collection (where the time with each team spanned about 18 months) was constrained by the prescriptive nature of the *a priori* theory and the size of the data collection effort.

The extensive data sets, the large number of participants, the difficulty with incorporating adaptations along the data collection process and the multiplicity of interests, perspectives, and needs, made analysis difficult. That is, the large scope of the effort made it hard to provide concise explanations while a partial focus on sub-sets of the data often limited the discussion regarding important inter-relationships. For example, Guinan, Cooprider, and Faraj (1998) focus on the survey data and do not explicitly draw on the field work data.

5.3 The ERP Implementation at Medium Sized University

The third example draws from an ongoing study of the computing changes at one organization. From 1994 to 1999 a medium-sized university (MSU) installed both a client/server-based computing infrastructure and an enterprise resource package (ERP) to replace their mainframe computing infrastructure and proprietary, standalone administrative information systems. The goal of the research has been to identify how changes to MSU's computing infrastructure are manifested in the technical, social, and administrative structures of the organization. (See Sawyer forthcoming; Sawyer and Southwick 1996, 1997).

The research was designed to build on the factors listed in Table 1. For example three *a priori* theories formed the interpretive frame of the research (Sutton and Staw 1995). These theories overlap at various levels of analysis and provide a means both to

integrate various data sets and to analyze multiple data sets. To address independence and insulation issues, the research was planned in four phases. This allows for data collection to be separated by level of analysis and provides for some control over selection of participants. Further, this phased approach allowed for multiple researchers to have distinct roles in each phase. And, since the work is longitudinal, both levels of analysis and temporal distance insulate data collection. The research design also emphasized data interdependence over independence and insulation for two reasons. Thus, data collection methods were sequenced to help gather data first, then adjusted to deal with method independence and insulation issues.

6. Observations from Comparing the Examples

Several observations arise from comparing these examples. First, in all three examples, the research team included multiple researchers. Typically, each researcher had a particular method expertise (and perspective). This suggests that integrating the data sets collected using the various methods also meant integrating the various researcher's perspectives. Kaplan and Duchon intimate the intensity of the struggle to negotiate and integrate the various research perspectives and interests of the research team. In the MSU study, one researcher leads the effort and works with various collaborators within the research framework. Thus, each research team member has a predefined role.

A second observation is that all three studies use *a priori* theory—albeit each in a different way. The Kaplan and Duchon study struggled with *a priori* theory because it made it difficult for researchers to interpret the data. The empirical basis of the Guinan, Cooprider, and Sawyer study reflects the difficulty with adjusting the theoretical basis to accommodate emerging issues and findings. The MSU study was explicitly developed as an interpretive study so the *a priori* theory serves as a guide.

The third observation concerns the struggle with conducting the analysis that each study team faced. For instance, regarding the first example, this struggle reached the point where continuation relied on one author convincing the other to keep working (see Kaplan and Duchon 1988, p 580). The second example suggests an ongoing struggle to find a jointly agreed-upon view of the large set of findings as is suggested by the broad coverage of the summary paper (see Guinan, Cooprider, and Faraj 1998; Guinan, Cooprider, and Sawyer 1997). The emerging issues from the MSU study suggest that the interpretive approach allows for flexibility (see Sawyer forthcoming; Sawyer and Southwick 1997).

6.1 Additional Observations from the MSU Research Experience

The ongoing experiences with conducting multi-method research at MSU raise three additional issues. The first issue is establishing and maintaining the research. For instance, the research team took nearly 11 months to learn more about the prestudy period and to gain the confidence of the organization's members (its senior management, the technologists, the line workers, and their managers). This confidence-building was done using both a series of one-page outlines, each directed to specific audiences, and multiple

meetings with key stakeholders of each group. For example, the outline for senior managers included a promise to provide periodic feedback—where this feedback meant observation and not prescription. Line workers were promised that the research would document their issues and concerns in an open way—including sharing data with them on demand (as suggested by Barley 1990). Throughout the study, this relationship support has been a constant aspect of the fieldwork (see Pettigrew 1990).

A second observation from the MSU experience is the constant mixing of participation and observation In the field-based, participant/observer portions of data collection, the researcher becomes the central instrument of data collection. This is one factor in what Barley calls "becoming a research tool" (1990, p. 237). That means that conducting fieldwork makes the researcher inseparable from the data collection and analysis. This demands constant reflection and redefinition of the research team member's roles. For example, in the first phase of the MSU study, each research team member's role was to be unobtrusive and to focus on establishing the trust that is so important and difficult to define (see Barley 1990, p. 239; Bogdan 1972, p. 24). In the follow-on phases, research team member's roles differ. For the researcher observing the senior managers, a stance similar to Pettigrew is used. That is, the researcher is more active: interacting more with the participants. The researcher(s) observing the technologists approach the research more as Barley (1990) encourages: being distant but collegial, not taking sides, and being involved but not "going native." In the third phase, the researchers immersed themselves in several projects for the extent of that project. Finally, in the post-implementation phase, the members of the team doing the survey will have very little contact with the host site and the study's participants.

A third experience from the MSU study is the need to follow the implementation. For instance, the original plan for the MSU research was developed to focus on the levels of analysis across the period of implementation. It became clear almost immediately that this needed to be modified. The primary reason is that the computing infrastructure change at MSU is actually a series of projects (numbering nearly 40). Thus this is becoming a study of these projects, each of which can be viewed in the macro/micro way advocated by Wynekoop.

6.2 Multi-method Research on Organizational Computing Infrastructures

Since "what we know is always shaped by how we came to know it" (Brewer and Hunter 1989, p. 66), the purpose of using multiple data collection methods is to draw on the strengths of some to make up for the (often well-known) weaknesses of others (e.g., Campbell and Stanley 1966; Creswell 1994; Jackson 1987; Miller 1991; Miles and Huberman 1994).

Perhaps the limited discussion on the use of multi-method research for studying the roles of information technologies in organizations is due to the different sets of skills involved in presenting descriptive research (Van Maanen 1995a, 1995b). Perhaps it is due to the publication format, in which journals limit the length and, thus, the descriptive approach, of multi-method research (Yanow 1995). Perhaps this is also due to present expectations about the use of theory and the role of empirical data (Sutton and Staw 1995). Still, given the potential value of multi-method fieldwork-based research, it is important for such discussions to continue.

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