Transforming Work Through Information Technology: A Comparative Case Study of Geographic Information Systems in County Government

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A comparative case study was designed to assess the consequences of implementing a particular geographic information system (GIS) in two neighboring county government organizations. Respondents reported radically different experiences with, and consequences of, the GIS technology. In North County, participants considered GIS to be responsible for transforming the way that work was accomplished and for changing patterns of communication among departments. In South County, the same GIS technology was implemented with little social consequence. These divergent outcomes are associated with differences in four specific processes related to the implementation of the GIS in the two organizations: initiation, transition, deployment, and spread of knowledge. In North County, implementation was initiated by an influential group of users (geographers) who positioned the technology as a shared resource that built upon existing competencies. A distributed configuration was deployed in North County, and conceptual knowledge about GIS was disseminated widely. By contrast, in South County GIS was initiated by a centralized data processing department as one of many revenue-producing services. Transition to GIS in South County required a departure from existing competencies, and it was deployed as a centralized system with limited procedural knowledge spread among the potential user community. Taken together, these findings suggest that implementation processes that advance users' learning about potentially transformational technologies are likely to result in perceived transformation. The theoretical perspective of organizational learning is, therefore, suggested as a guide for future research on the role of information technology in organizational transformation.
(*Organizational Impacts of Information Technology; IS Implementation; Organizational Learning*)

1. Introduction

It is commonly assumed that information technologies have the potential to transform social organizations. Through their capacity to gather, store, manipulate, and transmit information efficiently, information technologies may support more effective forms of organizational coordination and control and render traditional structures obsolete. Transforming organizations with information technologies is an important business objective because traditional structures are often ineffective in producing desired levels of productivity, customer service, employee welfare, and shareholder value. Scott Morton (1991) has argued

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that, in the future, all organizations will need to be transformed with computer-based technologies to be effective.

Yet, the literature on information systems contains many reports of unfulfilled potential, even where transformation is a formal organizational objective (e.g., Davenport and Stoddard 1994, Pinsonneault and Kraemer 1993, Robey, Wishart, and Rodriguez-Diaz 1995, Zuboff 1988). These recent studies are consistent with earlier reviews of the literature on the organizational impacts of information technology, which have consistently identified mixed and contradictory findings (Attewell and Rule 1984, Huber 1984, Kling 1980, Markus and Robey 1988, Nelson 1990, Robey 1977, Swanson 1987). From all such accounts, it is safe to conclude that organizational transformation is not accomplished through the mere installation of new systems with greater computational powers. Rather, the success of technology-enabled organizational change depends upon a combination of technical and social influences that are only partially controllable. New information systems must meet demanding technical requirements and high performance standards, and the existing social context must be receptive to attempts to change it. As technical and social influences interact, a diversity of consequences may be realized—intended transformations may occur, older forms may persist, or unanticipated combinations of new and old practices may emerge.

This research adopts an interpretive approach to examine the implementation of geographic information systems in two local county governments in the United States. Interpretive research assumes that social reality is subjectively understood, both by participants in the organization and by researchers (Burrell and Morgan 1979, Hirschheim and Klein 1989, Orlikowski and Baroudi 1991, Walsham 1993). Like all human artifacts, applications of information technology are open to interpretation by their developers, users, and other actors. We assume that the understandings and meanings which actors ascribe to information technology affect the technology's actual design, deployment, use, and consequences. Accordingly, we do not treat GIS as an object capable of effecting social change independently of actors' interpretations.

2. Geographic Information Systems

Among the applications of information technology with transformational potential are geographic information systems, or GIS. A GIS is a type of computer-based system that captures, stores, displays, analyzes, and models natural and artificial environments using data referenced to locations on the earth's surface. Spatial data are usually described in a GIS by geographic position and other attributes in computer readable form. Regulatory pressures, scarce resources, and public involvement in environmental decisions have led both public and private organizations to adopt GIS as a tool for modeling complex spatial problems. GIS technologies continue to advance with improvements in computer graphics, database management technologies, and the incorporation of satellite images. These advances have made more sophisticated, accurate, and cost-effective GIS applications available to support decisions and inform policies in areas such as environmental resource management, land-use planning, and law enforcement, among others.

GIS applications have transformational potential because they inform decisions about resources that are distributed across space. In the context of government organizations especially, GIS has the potential to consolidate the work of departments that deal with different resources within a defined geographic area. By providing a common technical base for spatial analysis, GIS has the potential to integrate tasks involving surveying, mapping, designing, planning, and other related activities normally performed in separate departments. Thus, GIS provides the capability for reducing structural differentiation by cutting across existing organizational boundaries and for creating new work procedures related to spatial analysis. GIS applications have become extremely popular, particularly in the public sector. Fletcher, Bretschneider and Marchand (1992) described GIS as the technology with the biggest impact on the thinking of county managers in local governments in the United States.

Despite their potential, information technologies have not been associated with transformations of government organizations in previous research. To the contrary, the weight of evidence favors the persistence of existing formal structures and political alignments when computers are introduced in local governments (Danziger, Dutton, Kling and Kraemer 1982, Danziger and Kraemer 1985, Kraemer 1991, Pinsonneault and Kraemer 1993). In summarizing the findings of an extensive research program on the effects of computers in government, Kraemer concluded that computing reinforced existing power structures and played little role in changing organizational structures:

> for the most part computing has had no discernible effect at all on organization structure Where it has had a discernible effect, it has led to slightly greater centralization of already centralized organizations. Thus, computing has clearly reinforced existing organizational arrangements. (Kraemer 1991, p 172)

While GISs were not common at the time of these studies, Kraemer expressed doubt that reforms in public administration would ever be directly associated with newer technologies. "Technology is not the driver; it is rarely even the catalyst; at most it is supportive of reform efforts decided on other grounds" (Kraemer 1991, p. 178).

In this paper, our objective is to advance understanding of the relationship between applications of information technology (GIS particularly) and organizational changes in the public agencies that use them. Our approach is to take a detailed empirical examination of how the technology is interpreted by social actors engaged in its development and use. By understanding the subjective sense that participants make of GIS, we believe that its role in organizational transformation can be better understood.

3. Social Interpretations of Information Technology

Recent approaches to research on the organizational consequences of information technologies emphasize the importance of the social context of implementation and the subjective meanings ascribed to information technologies. As actors propose, design, develop, implement, and use information systems, they endow them with social meanings, or interpretations. These interpretations help to shape the subsequent use of the technology, somewhat independently of technology's material properties (Hirschheim and Newman 1991, Prasad 1993, Robey and Azevedo 1994, Walsham 1993). The study of social interpretations can yield insight into the "social construction" of both information technology and organizations (Berger and Luckmann 1967, Bijker, Hughes, and Pinch 1987). Research that focuses on social interpretation can also potentially explain why similar or identical technologies often produce different social consequences even in comparable organizational settings (Barley 1986, Orlikowski 1993, Orlikowski and Gash 1994, Robey and Rodriguez-Diaz 1989). An interpretive study of information systems, for example, might reveal why users in one organization fail to exploit a technology with transformational potential while it is fully exploited in another. An interpretive study might also reveal why technologies with more modest transformational potential might occasion significant changes in a particular organization.

3.1. Key Assumptions

Two key assumptions underlie interpretive research on information technology. First, neither human actions nor technologies are assumed to exert direct causal "impacts" on organizations. Deterministic causal assumptions are replaced by the assumption of emergent causality, wherein consequences result from the interplay among computing infrastructures, conflicting objectives and preferences of different social groups, and the operation of chance (Markus and Robey 1988, Pfeffer 1982, Slack 1984). Emergent causality assumes that social consequences are not conditioned by any particular set of predictor variables. Rather, any number of influences may operate within a given social context to produce social interpretations and outcomes. The consequences of a technology like GIS, therefore, are assumed to be indeterminate. This assumption directs researchers' attention away from the multivariate contingency models designed to explain greater variance in the social consequences of information technology (e.g., Attewell and Rule 1984), while it draws attention to the complex social processes by which those consequences are enacted. Through detailed contextual analyses of the interactions between human actors and technology, social consequences can be traced, understood, and eventually managed. The interpretive approach eschews general "imperative" arguments about information technology and favors a particularistic, contextual orientation.

The second guiding assumption is that technology is conceived as a material artifact that embodies human purposes, but that it remains open to interpretation during implementation and use. Information technology is produced through human action; it does not and cannot occur naturally. The material properties of technology may be the result of social compromises and fallible knowledge during design and construction, so the exact purposes of its designers may not be faithfully rendered in the resulting product. Furthermore, information technologies are prone to adaptations of use, sometimes called reinventions or workarounds (Fulk 1993, Johnson and Rice 1987, Kraut, Dumais, and Koch 1989). They may be socially reconstructed through use, producing consequences different from those initially imagined. These assumptions of interpretive research reduce the temptation to regard information technology as capable of producing social results directly.

3.2. Explaining Technology-enabled Organizational Transformation

The results of a growing number of studies show the value of the assumptions used in interpretive research on information technologies. Several studies have focused upon the social context and processes that produce the meanings of technology, thereby offering potential explanations for the social outcomes. For example, Orlikowski's (1993) comparison between two organizations adopting computer aided software engineering (CASE) tools revealed a diversity of outcomes not explained by the characteristics of CASE alone. Differences in competitive conditions, corporate strategies and structures, and arrangements for managing information technologies were all linked to differences in the consequences of adopting and using CASE tools. Radical changes, or reorientations, in both the products and processes of system design were targeted (and partially achieved) in one organization, whereas incremental variations were targeted and achieved in the other, using essentially the same technology. From this study, the importance of specific aspects of context and process were established.

Other studies support the general conclusion that organizational context influences the consequences of information technology. Robey and Rodriguez-Diaz (1989) reported that differences in organizational cultures were partially responsible for the divergent experiences encountered by an implementation team installing the same information system in different offices of a multinational organization. In several case studies reported by Zuboff (1988), the political processes surrounding implementation were linked to failed attempts to transform organizations using information technology. Walsham (1993) employed a scheme based on structuration theory to examine the effects of context and process on interpretations of information technology in several organizations. In each of these studies, the researchers focused on the social meanings of information technology as a basis for explaining its organizational consequences. In turn, social interpretations of technologies were linked to the organizational context and social processes surrounding implementation.

While these studies amply demonstrate the source of social interpretations and their role in the implementation of information systems, they leave unanswered many questions about the processes through which information technology affects organizations. More recent studies illuminate some of the dynamics of organizational changes accompanying information technology. For example, it is clear that the implementation of technical changes can frequently deviate from a rational sequence designed to mesh technical and strategic objectives. Technologies may be acquired first, followed by changes in skill requirements, organizational structure, and, lastly, competitive strategy (Yetton, Johnston, and Craig 1994). Moreover, Sauer and Yetton (1994) explored the effects of simultaneous, contradictory changes in technical systems and concluded that multiple implementations (of a Kanban ordering system and a Material Requirements Planning system) in a single organization could impede one another. Additionally, the timing of social adaptations to technological change appear to affect subsequent use and consequences of a variety of technologies. Tyre and Orlikowski (1994) detected "windows of opportunity," occurring soon after new technologies were introduced, in which most successful adaptations were likely to occur. Adaptations after the initial window period were far less frequent or consequential than those occurring immediately after implementation. This finding suggests that, if the window of opportunity is missed, technologies with transformational potential may not be used to change existing organizational structures and patterns of work. Together, these studies have focused needed attention on the timing and sequence of events in the process of technical change.

Recent research has also begun to reveal the importance of different rates of technical changes in organizations. Although a distinction has been established in the organizational literature between radical (revolutionary) change and incremental (evolutionary) change (Dewar and Dutton 1986, Tushman and Romanelli 1984), empirical studies have produced contradictory findings regarding the relative effectiveness of radical and incremental change (e.g., March 1981, Miller 1982, Miller and Friesen 1982, Romanelli and Tushman 1994). In one of the first studies to examine the dynamics of radical changes involving information technology, Gallivan, Hoffman and Orlikowski (1994) proposed a distinction between the nature of change (radical versus incremental) and the pace of change (rapid versus gradual). Their report of one firm adopting CASE tools revealed a paradoxical pattern in which radical changes were effectively implemented at a gradual pace rather than rapidly, as might be expected. This finding suggests that both rapid and gradual rates of change may be associated with organizational transformation, although little is known about the relative effectiveness of implementation processes that proceed at these different rates.

Studies such as these stimulate further inquiry into the implementation processes for information technologies that purportedly enable organizational transformation. The present study is designed to contrast the experiences of two organizations with GIS technology and uses an interpretive approach to detect and explain differences in GIS's processes of implementation and the related organizational consequences.

4. Method

The research method employed in this study was to conduct interviews with a large number of respondents in two organizations. Analysis was aided by a comparative research design, which allowed contrasts between interpretations of the same GIS technology in the two organizations. By studying the same technology in comparable organizations, this design directed attention to the contrasts between implementation processes as potential explanations of divergent interpretations and social outcomes.

4.1. Research Design and Sampling

The research was conducted in two neighboring county government organizations that were in the process of implementing GIS. The two organizations used the same GIS software (called Arc/Info) for similar purposes. In one organization, given the pseudonym North County here, two user groups (Planning and Land Management Departments), one GIS coordinating group (Technical Services), and two persons outside of these three departments were studied. In the second county, given the pseudonym South County, two user groups (Planning and Environmental Management Departments) and one GIS coordinating group (Office of Computer Services) were studied. Within each organization, the sampling plan was flexible and evolved with the research needs. Key respondents were initially identified from the selected departments based on their involvement in GIS implementation. Discussions with these key people provided a deeper understanding of the social networks within and across departments, and additional respondents were selected from these networks.

A total of 32 interviews were conducted in North County with 31 different people. (One respondent was interviewed twice, the second interview serving to verify certain issues). Twenty-nine of the 31 respondents belonged to one of the selected departments, and two belonged to departments not previously identified (Legal and Regulation). In South County a total of 29 people provided 28 interviews (in one case two people were interviewed together). Table 1 shows the organizational locations of all respondents in the study.

The primary method for gathering data was through semi-structured personal interviews. Questions about the features and limitations of GIS were asked first, followed by questions about both the implementation of GIS and its consequences. Implementation questions asked whether the GIS was deployed as a distributed or centralized system, which department originated the technology, and how the organizational structure was established to oversee GIS implementation. Interview reports for this information were supplemented with documents and archival sources such as the organization's business plan. Questions about organizational consequences sought respondents' reactions to changes in their work and the organization as a result of GIS implementation. Information about each respondent's education, training and experience with technology was also obtained in the interviews.

Table 1 Research Design and Sampling Plan

	Departments and (numbers of respondents)·				
Research sites:	Technical support group	User department	User department	Others	Total respondents
North County	Technical Services (6)	Planning (12)	Land Management (11)	Legal (1) and Regulation (1)	31
South County	Office of Computer Services (14)	Planning (3)	Environmental Resource Management (12)	0	29
Total respondents	20	15	23	2	60

4.2. Data Analysis

Interview data were analyzed in four distinct steps: (1) coding and splitting the transcribed texts, (2) integrating the split data to form themes, (3) aligning themes with relevant social groups, and (4) contrasting the themes between the two sites.

4.2.1. Coding and Splitting. All interviews were transcribed and coded according to the scheme shown in Table 2. The coding scheme was developed through an iterative process whereby the two authors first established preliminary categories, then independently read sample transcripts and coded text into those categories, and then compared their classifications and discussed discrepancies. The preliminary categories were modified, and other sample texts were again coded independently. At each iteration the rules for assigning segments of text to each category were articulated and refined. The iterations eventually produced the coding categories shown in Table 2; the detailed rules used to assign text to these categories are available in Sahay (1993, Appendix 3.3). The iterative process ensured consistency in the method by which text was coded, which is comparable to the notion of interrater reliability as required in positivist research (Hirschman 1986). Using this scheme, all remaining interview texts were split into coded segments by one of the authors.

4.2.2. Formation of Themes. Themes were formed by defining a unifying idea that represented the interpretations found in multiple coded segments. Conceptual labels were assigned to describe the common thread among these ideas, and similarly labelled segments were combined into themes and assigned more general labels. A computer program was written to assist in the location and grouping of similarly coded segments of text. No specific number of themes was sought, although a conscious attempt was made to avoid the generation of too many themes with similar ideas underlying them.

4.2.3. Alignment of Themes with Relevant Social Groups. As used in research on the social construction of technology, the concept of relevant social group refers to the sets of people who are capable of influencing the implementation and use of technology (e.g., Bijker 1987, Fulk 1993, Mackenzie and Wajcman 1985). These groups were identified by detecting commonalities among the respondents connected with the coded segments that made up each theme. Thus, members of the relevant social groups were defined as those who subscribed to the same themes. Relevant groups formed around departments (e.g., the Planning Department in North County), organizational levels (e.g., managers), disciplines (e.g., geographers), and functions (e.g., initiators of GIS in North County).

4.2.4. Contrasting Themes Between Sites. To take advantage of the comparative research design, contrasts between sites were studied carefully to see how groups in the two organizations differed in their interpretations of GIS technology. Themes were compared directly and associated with differences in the reported consequences of technology.

5. Results

Using the method of analysis described above, 44 themes were generated and associated with nine relevant social groups in North County, and 39 themes as-

Table 2 Summary of Coding Schemes

Sites	North County	South County
Coding Schemes	1. Initiation 1.1 need 1.2 capability 1.3 software selection 2. Implementation 2.1 organization 2.2 technology 2. Impacts 3.1 current 3.2 future	1. Initiation 1.1 capability 1.2 software selection 2. Implementation 2.1 intraorganization 2.2 interorganization 2.3 technology, intraorganization 2.4 technology, interorganization 2. Impacts 3.1 current 3.2 future

sociated with eight groups were generated in South County. In the present analysis, only those themes directly relevant to explaining the organizational consequences of GIS are drawn upon; an exhaustive analysis of themes and groups derived from the study is reported elsewhere (Sahay 1993). Select themes were grouped into five categories representing four distinct processes of implementation (initiation, transition, deployment, and spread of knowledge) and the organizational consequences of GIS. These categories are related to the interview schedule insofar as they reflect the researchers' concern with capturing interpretations related to the implementation and consequences of GIS. However, the specific categories are derived from analysis of similarities among themes detected in the data. Categories were used to organize a narrative description of the implementation and consequences of GIS in each site. Representative excerpts from specific interviews were used to illustrate the consequences and processes. The results are organized to provide first an overview of GIS implementation and the consequences reported by respondents in each site. Then, the four specific processes are presented as a means of explaining the differences in consequences between sites.

5.1. North County

5.1.1. Overview of GIS Implementation. The implementation of Arc/Info in North County began in October 1989 with the preparation of a 72-page planning document that included a business case justifying the need for Arc/Info. A team of senior officials, drawn largely from the Geographic Sciences Department (GSD) and headed by a senior geographer, defined the overall implementation strategy. The planning document was prepared with the assistance of a well-known consultant who worked closely with the team. The selection process consumed three months, culminating in the choice of Arc/Info based on its technical and functional superiority over two competing packages. A distributed technical environment was chosen for implementation, with users holding primary responsibility for developing applications, maintaining different coverages, and controlling the quality of individual datasets. The functions of archiving and indexing were retained by the GSD, which had become a clearing house for the analysis and maintenance of spatial data in the years prior to the introduction of Arc/Info. GSD had previously included a core group of five technicians, primarily using earlier computer systems for spatial analysis (i.e., Computer Vision and PC Arc/Info). When Arc/Info was introduced (on Sun workstations), GSD was disbanded, and the technicians were redistributed over five user departments.

Implementation of GIS in North County was governed by a three-tier committee structure. At the top level was the GIS sponsor's group, which included representatives from top management. The second tier of the structure included GIS coordinators who were responsible for ensuring that their departmental GIS activities adhered to organizational procedures and data standards. The coordinators were closely linked to the GIS sponsor's group through some overlapping membership. A subcommittee of the second tier, the GIS Technical Advisory Committee (GTAC), included GIS professionals drawn from each department represented by the GIS coordinators. Most members of the GTAC were geographers, and the committee exercised considerable influence in shaping the technical future of GIS through such tasks as design of the data dictionary, repair of software bugs, and development of procedures for archiving data. The third tier of North County's governance structure was the users group, which existed to enhance user awareness and to provide feedback from users to top management. A group of GIS professionals, called the GIS Support Group, was responsible for operational matters such as keeping the system running, loading the software, configuring the workstations, maintaining the datasets, managing the archiving of data, assisting users with backups, solving user problems, and conducting training.

The geographers in GSD subscribed to an integrative and holistic philosophy of GIS technology's role and function, which seemed consistent with their academic discipline. They assumed users to be mature enough to appreciate a distributed system, and they favored a high degree of user training. The geographers' extensive experience with mapping programs equipped them with the capability to absorb new spatial technologies. Although most of the other groups (technicians, surveyors, and managers) were more familiar with data represented in digital form, they also understood spatial concepts and mapping systems in general. Consequently, it was easy for user groups to negotiate contracts for data conversion with GIS vendors. The implementation of GIS in North County had gathered a great deal of momentum, and by the second year of its three-year implementation program more than 50 workstations had been installed compared to the 12 originally budgeted.

5.1.2. Impacts of GIS in North County. Despite the fact that GIS was only partially implemented, it was widely expressed that Arc/Info had already produced changes in departmental structure and in the conduct of North County's business. Seven members of the social group identified as "managers" considered GIS to have redefined key aspects of work and organization. One commented that GIS had forced decision makers to restructure most systems because "it can't be a distributed system with centralized support." Another remarked that "people have had their responsibilities redirected to perform functions that involved GIS." These managers also concurred that individual departments interacted with each other to a greater extent than previously because they were required to maintain shared standards on common data. This produced new channels of communication between departments and forged links that had not existed before. With the redistribution of the five technicians from the GSD group within Technical Services to the user departments, users' control over GIS applications was further reinforced.

Interviews revealed that Arc/Info was regarded as the cause of these organizational changes. For example, a technical supervisor in the Planning Department, and one of the heaviest GIS users, reported that the technology "increases the trust between different departments and divisions . . . I think it has helped a lot with the environment here where everybody had put up walls around themselves. These walls have come down." Another manager in Technical Services supported this reasoning with the comment: "GIS basically forces a stronger union. [Departments] have to depend on each other. It is kind of like you all win together or fail together." Another GIS user in the Planning Department reported: "The resources are a lot better now because GIS relates all of the agencies together so you can get more information." The ability to "jump over on somebody else's computer," which referred to the sharing of applications and integrated data bases, was mentioned by a technician in Land Management as a great new capability.

Arc/Info was also seen to have changed the variety, efficiency, and accuracy of spatial analyses conducted in North County. A diverse range of applications had been made possible because of Arc/Info, from monitoring permit violations over time to examining socioeconomic shifts in the population. Individual spatial analyses also involved more detail than before. For example, while users might previously have developed and consulted one land-use map, Arc/Info now permitted various subclassifications within land use. A GIS planner reported: "I can sit and run several classifications of the area just like that. We used to take a day to do a classification on a small area." Several respondents supported the idea that GIS allowed much faster and superior analyses. This had already lead, in their view, to an escalation of the demand for GIS analyses, even when they were not always necessary. The same GIS planner mentioned that "overkill" sometimes occurred when, for example, an engineering model was performed with GIS when it did not have to be. A Director in the Technical Services Department noted that "the downside of all this technology is that sometimes we over-analyze things, and we don't use our experience and gut level feelings." The groups subscribing to these themes included seven technicians and six different managers, almost half of the respondents interviewed in North County.

Such changes were accompanied by differences of opinion on the matter of job security. A group of five technicians feared that managers, engineers, and other professionals would become self-sufficient users of GIS and that the jobs of any technicians reluctant to learn GIS-related skills were potentially threatened. Other respondents felt that jobs had become more secure and there was little danger that current skills would become obsolete. On the contrary, skills were being upgraded as Arc/Info provided the opportunity for users to learn the skills needed to meet the need for more geographical information. A technical supervisor reported that "jobs are very secure because the demand for information is going to be 100 times more than before."

5.2. South County

5.2.1. Overview of GIS Implementation. GIS was initiated in South County in 1987 through the efforts of a small group of people, including the Director and the Technical Support Supervisor, at the Office of Computer Services (OCS). South County's government was organized into independent agencies, and OCS was the central unit that provided data-processing services to all other agencies in the county. With the introduction of Arc/Info, GIS was added to the services provided by OCS. Funding to acquire GIS and other new systems was generated from contributions by the different departments to a common pool. In the first year, OCS obtained financial support from several larger user agencies, including Police, Zoning, Waste, and Elections.

As a centralized "DP shop" in a large governmental organization, OCS ran most of its applications for its client agencies on an IBM mainframe computer. OCS favored traditional controls and standards for system development and had resisted the deployment of distributed computer systems. OCS personnel generally lacked experience dealing with spatial information, and the transition to Arc/Info raised some important manpower issues for South County's OCS. In contrast with most of its data-processing applications, which were designed to run on the mainframe, OCS implemented Arc/Info on a Digital Vax computer system. A centralized technical configuration was adopted, with OCS maintaining the central databases, providing application development and support services, and conducting training programs for users. OCS's centralized Application Development and Technical Support groups were made responsible for developing specific GIS applications for users on a contractual basis.

GIS was introduced into two departments studied in this research: Environmental Resource Management (ERM) and the Planning Department (PD). Federal programs and agencies such as the Storm Water Utility and Federal Emergency Management Agency mandated that maps for storm water outfall and flood protection layers be prepared by GIS. ERM decided to develop a data management system prior to any real GIS applications. PD's interest in GIS took place through a chance encounter with members of North County's GIS group. This led to further meetings in which ideas were exchanged regarding the use of GIS to support different planning activities. As mandated by South County's governance mechanisms, each user department contracted with OCS to develop their respective GIS applications.

5.2.2. Impacts of GIS in South County. Among the respondents in the two agencies studied in South County, Arc/Info was reported to have made limited impact. A user in ERM, who had worked with the GIS applications being developed by OCS, reported bluntly, "I don't see any organizational change because we have GIS." The Planning Department had not made a firm commitment to GIS and the three users interviewed there had not experienced any consequences. Their position was to "wait and see" what effects GIS might have before proceeding with more serious financial commitments. In addition, there were few impacts on work and manpower requirements. A biologist noted that in ERM the extra work that had been generated due to GIS only involved data entry, and that was accomplished using temporary interns. Since most GIS work at ERM was conducted through the OCS analysts, the in-house development of GIS skills for the ERM analysts was limited. Three OCS staff members shared the belief that surveyors were apprehensive about losing their jobs, but the majority of users indicated that GIS technology would not displace anyone. Because new skill requirements were focused narrowly around data entry, impacts of GIS on job skills were seen as negligible in South County.

Overall, consequences were limited to GIS's use as a device to produce attractive maps, while supporting a small amount of spatial analysis and data base management. Some managers in the two user agencies feared that people might indulge in geographical analysis just because the tools were available, not because a project required it. These managers were pessimistic about the possible consequences of GIS, and they expected that any changes would come slowly, given budget and manpower restrictions and the functioning of South County's bureaucracy.

5.3. Explaining the Contrasts Between Counties

It is clear that the consequences of GIS in the two county organizations studied were very different. North County's experience was considered a "transformation" by the respondents, and the organizational and work changes that they perceived were readily attributed to the GIS technology. Thus, the respondents in one organization considered GIS to be responsible for transforming their work and organizational structure. GIS was also seen to have simultaneously elevated skill requirements and provided an opportunity for employees to improve their skills, thereby securing their jobs for the future. By contrast, none of these consequences was reported by respondents in South County. Although the GIS technology being used was the same as employed by North County, respondents in South County perceived little impact and forecast only moderate use of GIS, despite its admitted potential.

Explaining these divergent experiences can help to illuminate the more general question of information technology and organizational transformation. In the remainder of the results section, we examine specific contrasts between the *initiation* of GIS at each site, the *transition* from older technology to new, the manner in which GIS was *deployed* in each site, and the *spread* of *knowledge* about GIS. These processes were formed by organizing selected themes generated from the coding of text segments into larger categories. The labels used represent the common activities apparent (to the researchers) in the group of themes. These four aspects of the implementation process help to explain the differences in organizational consequences of the technology. Table 3 summarizes the differences between organizations on each of these four processes as well as the reported organizational consequences.

5.3.1. Initial Positioning. In North County, Arc/Info GIS was positioned as a state-of-the-art technical response to the organizational need for new methods for conducting spatial analysis. The inefficiencies of previous systems and the organizational structure were mentioned expressly by five different respondents. According to a technician in Land Management, "Whenever you wanted maps or information, you requested it from [GSD], and they put it in their stack of priorities and gave it back to you whenever they could get to it." GSD was frequently referred to as a "closed shop," even in the formal implementation plan for Arc/Info where the closed shop was described as inefficient and an impediment to the spread of GIS knowledge.

The proposal to acquire Arc/Info represented it as a new order of spatial analysis and positioned the acquisition as a total organizational effort, rather than a departmental one. A manager in Land Management said, "We had to build a business case. What is the payoff of converting, establishing a GIS system, getting people to buy into it, especially the upper management?" A user in the Planning Department added, "We are not building any kingdoms. We want this to be an organizational initiative." To effect this organization-wide effort, the initiating group sought representation from different departments in the software selection process, prepared the 72-page document detailing objective criteria and benchmarks, selected the criterion of demonstrated

Table 3 Summary of Comparisons Between Sites

Basis for Comparison	North County	South County
Consequences of GIS	GIS was widely acknowledged as responsible for transforming the conduct of work and the relationships among departments Centralized GSD group within Technical Services was disbanded and technicians reassigned to user departments.	GIS was slowly implemented with little consequence for users Minor increases in staffing in Office of Computer Services were attributed to GIS.
Implementation Processes:		
Initial Positioning	GIS was positioned as an organization-wide response to shared needs. Initiating group was geographers with holistic view of organization and application systems.	GIS was positioned as revenue-adding service provided by Office of Computer Services. Initiating group was focused on marketing service to user departments
Transition to Arc/Info	Transition to GIS was smooth and continuous due to prior experience with spatial technologies.	Transition to GIS was abrupt and discontinuous due to lack of prior capability with mapping systems
Deployment of GIS	GIS was deployed in a distributed technical configuration supported by a central group. Users had primary responsibility for developing and maintaining applications	GIS was deployed in a centralized technical configuration, controlled by the Office of Computer Services. Data processing personnel had responsibility for developing applications for users
Spread of Knowledge	Conceptual knowledge about GIS was spread among users through training conducted by the initiating group of geographers.	Procedural knowledge was conveyed to users through training conducted by the Office of Computer Services.

functionality, and employed the consultant to develop the business case. All these factors supported the Arc/Info initiative in North County and helped to produce the shared understanding that the GIS was selected using objective criteria and that, indeed, "Arc/Info was the right choice."

By contrast, Arc/Info was introduced in South County with little explicit mention about the need for the software and the methods used for its selection. Arc/Info was primarily positioned as a revenue-generating product that OCS had added to its existing range of data processing services, to be marketed to the rest of South County. Acquiring Arc/Info was a relatively isolated effort by a small group of OCS staff, headed by the Technical Support Supervisor who had had no prior experience with mapping systems. The participation of users was limited to attendance at fund raising seminars. According to a technical supervisor in OCS, cost was the primary criterion for choosing Arc/Info over two competing systems. This perception was shared by at least seven OCS staff members and comprised a clear theme in the analysis.

A central pool of funds to support GIS development in South County was established. Some of the departments in the county, including Police and Elections, were regarded as "richer" because they had larger budgets, and they made substantial contributions to this fund. Other users had relatively limited budgets and did not make any significant contribution. The Director of the Planning Department, for example, commented: "Right now, we are hoping that the land use (contribution) will allow us to participate without having to make an out-of-pocket contribution." By waiting to see how GIS succeeded before they made significant financial commitments, such users admitted a disparity wherein GIS development did not correspond to the actual need for GIS products. While smaller departments had to refrain from developing applications, the funding formula used by OCS allowed the richer departments to "move ahead like gangbusters," according to one respondent. Other users supported this interpretation by referring to the funding of GIS by a "handful of departments," in contrast to the practice of taking county money "out of the general fund every year to fund this thing."

5.3.2. Transition to Arc/Info. Prior experience and demonstrated capability in working with spatial technology enabled a smooth transition to Arc/Info in North County. The interviews revealed that at least half of the respondents in North County had prior experience with spatial mapping programs like Computer Vision and Autocad or with image-processing software like ERDAS. A number of respondents also had academic training in disciplines that emphasized spatial analysis, such as geography, urban planning, and architecture. Also contributing to the smooth transition was the relatively long employment of people working with GIS in North County. Many had progressed through several transitions, from paper maps to various computer-based systems. As a technician remarked, "We already know about calibrating and geo-referencing and real world coordinates. Xs and Ys, lats and longs and all those things were already familiar to me." Another technician said, "Making use of digital mapping equipment was part of the culture of the district. Most people got used to the idea of digital maps instead of paper maps."

By contrast, the transition to Arc/Info in South County was regarded as abrupt because of the inexperience of OCS's personnel in working with spatial systems. South County had for 20 years functioned as a traditional "IBM shop" which served the data-processing needs of as many as 50 county agencies but which had never worked with any mapping programs. A GIS programmer in OCS described her situation as follows:

> I have been in IBM all my career. I've never dealt with graphics before. I was strictly a number cruncher. So there was that other stumbling block I had to overcome . . . I keep comparing it with a different universe in itself. You go through this black hole and you are in the Arc/Info world, and everything within Arc/Info is like a different galaxy

Six different members of the OCS staff shared this theme, reflective of their traditional data-processing backgrounds; few had any experience or training in GIS. Moreover, the Director of GIS had 16 years of data-processing experience, and the Technical Support Supervisor had worked more than 10 years in this area. Thus, the transition to spatial concepts in South County was considered by its initiators in OCS to be radical and discontinuous.

5.3.3. Deployment of GIS. In North County, geographers assumed responsibility for planning and executing the deployment of Arc/Info as a distributed system in which users shared data and applications. A senior geographer reflected the shared view of nine geographers, technicians and managers in using the analogy of a football game to describe the arrangement for GIS. The distributed deployment of the GIS was compatible, in their view, with this team-based, integrative approach in which the success of the team depends on the performance of its individual members. The preference of geographers for distributed deployment is also reflected in the comments of a respondent who had degrees in both geography and computer science:

> Maybe it is the geography part in me which says you need to distribute certain things, and then there is the computer science part in me that says that certain things need to be centralized. . . The smartest move we did was getting GSD disbanded It is not an IS or GSD thing. This is really . . . an unselfish posture

As stated in the business case, the distributed deployment of Arc/Info was to ensure user participation in development and to spread the responsibilities for database maintenance among those with the greatest interest in individual datasets.

By contrast, in South County OCS assumed centralized control over the development, support and training functions for GIS. Both the users and OCS analysts perceived certain technical advantages to centralization: the reduction of data redundancy, improved quality control and speedier access. However, opinions varied regarding the organizational benefits of centralizing responsibility for GIS. The OCS analysts believed that centralization would enable a rapid growth of GIS capabilities among users and preserve the enforcement of standards in developing new systems. For example, the OCS supervisor responsible for setting up the GIS users group in South County expressed the view that "There is a need to step back and get more into traditional data processing methodologies than we have in the past." Another OCS manager commented: "The problem arises when departments try to do things which are not part of their mission."

The users disagreed with this view and said that centralization inhibited the growth of GIS applications. A user in ERM remarked, "If anything, the centralized GIS has inhibited growth because of the problems in product development with people seeing it as more trouble than it is worth." Users suspected OCS of keeping them in a dependent relationship, restricting training, controlling purchases of all computer equipment in the county, and restricting users' access to the system. One user at ERM described OCS's "hardware lock," which prevented users from getting command-level access to their own systems, and another viewed much OCS time as wasted on unimportant mapping details, like "[spending 90 percent of their time] making the black line that goes around the border thicker." Another ERM manager questioned whether the centralized arrangement was conducive to supporting the work of the departments: "It contributes to the perception that their motivations were different from supporting our needs. Sometimes they make you feel that we exist in order to support them in the development of GIS."

5.3.4. Spread of Knowledge. North County's geographers emphasized the cultivation and spread of conceptual knowledge about GIS, Arc/Info in particular. Their training programs were designed to facilitate spatial thinking rather than getting people bogged down in detailed software procedures and commands. Training taught users to visualize problems in spatial terms and to translate the need for geographical products into workable GIS solutions. This involved understanding relatively advanced concepts such as topology, geo-referencing, and geo-coding. The trainers believed that the users should become self-reliant with the software because a distributed environment could be effective only when a mature user community understood how to meet its own needs. "We try to make the training more useful and make more sense to the users," said one geographer involved with training. Another commented, "I think the biggest issue in terms of human resources is to train the people."

Other means for spreading knowledge about GIS in North County were the efforts of the GTAC, a group dominated by geographers, and the GIS user group, which included at least 50 active users. The user group provided greater visibility to GIS technology, which further enabled the spread of knowledge. Informal learning also occurred and was reinforced by the widespread use of common geographical language among users, who comfortably spoke in terms of latitude, longitude, geo-coding, and other geographical concepts.

In contrast to the emphasis upon spreading conceptual knowledge in North County, the training conducted by OCS for South County agencies emphasized operational or procedural knowledge. For example, users were shown how digitizing was performed and how information about outfalls were entered into the database. While these users admitted that they learned to generate reports from a menu-driven system, they did not develop a conceptual understanding of the system. One user commented on her experience in training: "I have not worked with GIS before this project, and I have not learned a whole lot about it other than how to enter data into the system." Other users called the OCS stance a "closed-shop" attitude because OCS was not willing to transfer much knowledge about the system. The members of the OCS staff that were interviewed, however, shared the belief that the training provided to users was adequate. One OCS staff person commented, "Well, in most cases if we design a menu-driven system for a department which will maintain a map, we provide a level of training such that the user can pull up the menu." From the users' perspective, such operational training did not include building more general knowledge about spatial concepts or GIS technology.

6. Discussion

The findings of this study consist of interpretations provided by respondents in two organizations where the same basic applications of information technology were implemented. Intersite comparisons revealed distinct differences in interpretations about the consequences of GIS and the processes wherein the technology was introduced. North County's respondents regarded Arc/Info as a causal agent that both transformed their ways of conducting business and removed organizational barriers between departments. GIS expertise spread widely in North County, creating pressure on technicians and surveyors, among others, to upgrade their skills. By contrast, GIS was reported to have had little organizational impact in South County, where it was controlled and operated by a central data-processing department. South County's respondents acknowledged the potential of GIS to change their work processes and organization, but they had yet to experience such change at the time of this research.

These contrasts provide useful information for those interested in information technology's role in organizational transformation. Because the same technology (Arc/Info) was experienced differently during its introduction in the two counties, the results reported here strongly support the idea that information technology's consequences are socially constructed, i.e., that technology's social consequences depend upon its social meanings more than on its material properties. Beyond confirmation of this particular insight, the results reported here add to knowledge about the dynamics of implementation and contribute to a theoretical understanding of how implementation and transformation are related. Two points are raised in the remainder of the discussion. First, because the differences in outcomes were associated with reported differences in the initiation, transition, deployment, and spread of knowledge about GIS, these results provoke discussion about the *continuity of technical change and organizational transformation.* Second, our findings suggest that *organizational learning,* with its emphasis on spreading knowledge and empowering technology's users, be adopted as a theoretical perspective for future research on organizational transformation.

6.1. Continuity of Technical Change and Organizational Transformation

By most accounts, the concept of organizational transformation is associated with radical, discontinuous change in structures and processes. Whether part of a reengineering effort that begins with obliterating existing structures (Hammer and Champy 1993), or conceived as revolutionary, quantum change (Miller 1982, Miller and Friesen 1982, Romanelli and Tushman 1994), transformation is typically not seen as incremental, piecemeal and continuous. Nonetheless, our results identified a gradual and continuous process of change in North County, where earlier generations of computerized mapping products had been used for several years. The change process culminated in the acknowledged transformation of work even before Arc/Info was fully implemented. In South County, neither data-processing personnel nor users were familiar with technologies for spatial analysis, and the implementation of Arc/Info did little to provoke radical change. To the contrary, the discontinuity of technical change seemed to work against the technology's potential to affect work practice. On the basis of these results, we conclude that organizational transformations, paradoxically perhaps, may result from continuous experience with potentially transformational technologies. Discontinuous experience with technologies, while conceptually consistent with the idea of radical change, may not be conducive to organizational transformation.

On close examination, this conclusion is not as contradictory as it may first appear. Radical transformations in the way that work is performed and organized may be more easily accomplished by continuous, rather than discontinuous, changes in technology because changes that proceed gradually enhance the existing competencies of users. Therefore, these technologies have more chance of acceptance and use. Where information technologies, in particular, are counted upon to enable transformations, the acceptance and cooperation of those people who ultimately interact with the technology enhance the prospect that transformation will actually occur. Gradual transformational efforts that leverage existing user knowledge may succeed where rapid implementation of unfamiliar technologies may fail to attract support and acceptance. When unfamiliar technologies are employed as enablers of radical organizational change, we should expect users to resist the ensuing, competence-destroying disruptions to their worlds of work.

This reasoning is consistent with Tushman and Anderson's (1986) study of the introduction of new technology at the industry level of analysis. Where new technology is interpreted as a continuation of existing technological capabilities, as in North County, it is more likely to be seen as "competence-enhancing." Where new technology is interpreted as a departure from existing technological capabilities, as was evident from comments made by South County's OCS staff, it can be perceived as "competence-destroying" (Tushman and Anderson 1986). Competence-enhancing technologies build upon an established base of knowledge whereas competence-destroying technologies require the creation of new knowledge before the transformation can occur. The spread of new technology is easier in a competence-enhancing environment because social interpretations of technology are allowed to evolve slowly. By contrast, technological discontinuities disrupt the spread of new technology because new competencies must be developed.

6.2. Organizational Transformation Through Organizational Learning

Quite frequently, researchers and practitioners have operated without the benefit of theory to understand the variables, conditions, and processes that enable organizational transformation (Scott Morton 1991). Where theory has informed research and practice, a wide variety of theoretical perspectives has been employed. As a result, there is no one orthodox theoretical perspective from which to view the phenomenon of organizational transformation as enabled with information technology. On the basis of the research reported in this paper, it is suggested that the theoretical perspective of organizational learning might profitably be exploited in future research on the transformation of organizations, especially where information technology is involved. Organizational learning places emphasis on the acquisition and use of shared knowledge and the need to overcome barriers to acquiring new knowledge (Attewell 1992, Huber 1991). It also utilizes the concept of "organizational memory" (Walsh and Ungson 1991) to convey the idea that older practices might be difficult to obliterate, even in the most radical change efforts. Organizational learning emphasizes controlled experimentation and the spread of knowledge throughout an organization rather than the impassive decomposition and reassembly of tasks suggested by advocates of reengineering (Robey et al. 1995). Acquiring and spreading knowledge about GIS emerged as a major process describing common themes in both counties. In North County, such knowledge acquisition was part of the implementation strategy of the initiating group; by contrast, the processes of deployment and spread of knowledge in South County effectively restricted users from learning what GIS might have been able to offer them. Moreover, the technicians in South County's OCS found it difficult to master the new skills of spatial analysis because GIS was such a great departure from their traditional, "data-processing" culture.

The interpretation of the experiences in North and South Counties as organizational learning is consistent with the recent evidence on implementing information technology reported by Gallivan et al. (1994). While they focused on no single body of theoretical work to support their analyses, their findings support an interpretation using organizational learning. They concluded that ". . . significant benefits in learning, participation, and flexibility may be afforded by a gradual pace, whereas such benefits may be forfeited in the rush to implement rapidly" (Gallivan et al. 1994, p. 336). The research results reported here support the claim that gradual changes benefit learning and lead potentially to significant transformations in work and organization that are both understood and accepted by organizational members.

Organizational learning may be facilitated by decentralized structures that promote initiative, experimentation, and spread of knowledge (Cohen and Levinthal 1990, Fiol and Lyles 1985, Levitt and March 1988). Clearly, the decentralization of many GIS functions in North County, following the breakup of the centralized GSD, enhanced organizational transformation by placing more initiative in the hands of the users. Information technologies like GIS can only become transformational if they are used to their potential, and decentralized management encourages more widespread knowledge and acceptance of technology. When users are involved with selecting hardware and software, developing applications, implementing them, and training each other in their use, overall knowledge increases. In North County, geographers promoted GIS's deployment as a distributed system that both empowered users and required them to become literate in the new spatial technology. Users also had the primary responsibility for developing and maintaining coverages and applications, and users comprised most of the coordinating unit, which provided technical and administrative support. South County's more centralized computing environment gave OCS the responsibility for maintaining data and building applications, and users expressed mistrust and apprehension towards the central unit. Thus, structural differences were associated with different degrees of organizational learning and different social consequences of the same technology.

7. Conclusion

This research applied interpretive methods within a comparative research design to examine the relationship between information technology and organizational transformation in two county government organizations. The results obtained reaffirm the value of an interpretive approach to research on technological change in organizations by showing how nearly identical technologies occasioned quite different social meanings and consequences in comparable organizational settings. This study contributes to the general argument that information technologies are socially constructed, and that shared meanings within a particular social context influence their organizational consequences. The material properties of GIS, and Arc/Info software in particular, appeared to be less influential in shaping those consequences than the social interpretations of GIS. Thus, we concur with Barley (1986) that technology is an *occasion for*, not a determinant of, organizational change. Similar technologies may be introduced in different organizations to support similar kinds of work, but the social processes and contexts surrounding their implementation may be so different as to occasion divergent outcomes. The assumption of emergent causality employed in this study increases the researcher's sensitivity to the social processes contributing to transformation.

Moreover, this research has provided evidence on the dynamics of organizational transformation. In North County, respondents reported their work and organization to be transformed by information technology, which was implemented by users with previous experience with related mapping and spatial systems, who deployed the technology as a distributed system, and who actively encouraged the spread of conceptual knowledge about the technology. The transformation, therefore, was associated with gradual and continuous technical change. In South County, where no transformation was reported, changes were introduced abruptly and controlled by a central data-processing department that restricted all but the necessary procedural knowledge to operate the system. These findings suggest that the pace of implementation is influential in effecting organizational transformation.

To help make sense of these findings, the theoretical perspective of organizational learning was proposed. While rarely applied to issues of information technology and organizational change, organizational learning focuses directly upon the processes of generating, distributing and accessing shared knowledge in an organization. Because the effective use of new information technologies often requires that substantial knowledge barriers be overcome (Attewell 1992), many efforts to transform organizations with new technologies may meet resistance or produce confusion. Although a relatively immature and imprecise theoretical approach (Huber 1991), organizational learning focuses directly on the issues revealed by the present study. In one site, barriers to understanding GIS were not substantial, and efforts were made to decentralize organizational structure and disseminate GIS knowledge widely. By contrast, users in the other site reported restrictions on their knowledge of and access to GIS. Organizational learning also provides a logical explanation for the observation that gradual technical changes were associated with organizational transformation. A gradual pace of technical change facilitates learning, which in turn dissolves potential resistance and encourages the development of useful applications. It can be argued that, unless applications of information technology are understood and used, they have little chance of transforming work.

Because they are drawn from a study of two organizations, these results should not be generalized to other contexts. Each context is different, so we should expect different contextual elements to interact with technical initiatives to produce different consequences. The findings should not even be extended to other settings where GIS, or even Arc/Info, is implemented. What is true for GIS in the two local county governments studied may be untrue for GIS in other governmental units or in private enterprises.

However, the conclusions of this study may have more general applicability to understanding information technology's role in the transformation of work and organizations. Any potential enabler of radical organizational change needs to be understood and accepted by those using it before it can be expected to play a transformational role. Accordingly, an implementation process that facilitates organizational learning may enhance the transformational potential of GIS and other information technologies.[1]

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References

Attewell, P., "Technology Diffusion and Organizational Learning· The Case of Business Computing," *Organization Sci* , 3 (1992), 1–19

—— and J Rule, "Computing and Organizations What We Know and What We Don't Know," *Comm. ACM*, 27 (1984), 1184–1192

Barley, S., "Technology as an Occasion for Structuring Evidence from Observations of CT Scanners and the Social Order of Radiology Departments," *Admin Sci Quarterly*, 31 (1986), 78–108

Berger, P L and L. Luckmann, *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, Doubleday, New York, 1967

Bijker, W E , "The Social Construction of Bakelite: Towards a Theory of Invention," in W E Bijker, T. P Hughes, and T Pinch (Eds), *The Social Construction of Technological Systems*, MIT Press, Cambridge, MA, 1987, 159–190

——, T P Hughes, and T. Pinch. (Eds), *The Social Construction of Technological Systems*, MIT Press, Cambridge, MA, 1987

Burrell, G. and G. Morgan, *Sociological Paradigms and Organization Analysis*, Heinemann Books, London, 1979

Cohen, W. M and D Levinthal, "Absorptive Capacity A New Perspective on Learning and Innovation," *Administrative Sci Quarterly*, 35 (1990), 128–152.

Danziger, J N , W H Dutton, R Kling, and K L. Kraemer, *Computers and Politics*, Columbia University Press, New York, 1982

—— and K L Kraemer, *Computers and People*, Columbia University Press, New York, 1985

Davenport, T H. and D B. Stoddard, "Reengineering· Business Change of Mythic Proportions?" *MIS Quarterly*, 18 (1994), 121–127.

Dewar, R. D. and J. E. Dutton, "The Adoption of Radical and Incremental Innovations. and Empirical Analysis," *Management Sci* , 32 (1986), 1422–1433.

Fiol, C M. and M. A. Lyles, "Organizational Learning," *Academy of Management Review*, 10 (1985), 803–813

Fletcher, P T , S. I. Bretschneider, and D. A. Marchand, *Managing Information Technology. Transforming County Governments in the 1990s*, Center for Science and Technology, School of Information Studies, Syracuse University, Syracuse, New York, 1992.

Fulk, J., "Social Construction of Communication Technology," *Acad Management J.*, 36 (1993), 921–950

Gallivan, M. J., J. D. Hofman, and W J. Orlikowski, "Implementing Radical Change· Gradual Versus Rapid Pace," in J I. DeGross, S L. Huff, and M. C Munro (Eds), *Proc Fifteenth International Conf on Information Systems*, 1994, 325–339.

Hammer, M and J Champy, *Reengineering the Corporation A Manifesto for Business Revolution*, Harper-Collins, New York, 1993

Hirschheim, R. and H K Klein, "Four Paradigms of Information Systems Development," *Comm. ACM*, 32 (1989), 1199–1216

—— and M Newman, "Symbolism and Information Systems Development Myth, Metaphor and Magic," *Information Systems Res* , 2 (1991), 29–62

Hirschman, E C , Humanistic Inquiry in Marketing Research: Philosophy, Method, and Criteria," *J Marketing Res* , 23 (1986), 237–249

Huber, G P , "The Nature and Design of Post-industrial Organizations," *Management Sci* , 30 (1984), 928–951

——, "Organizational Learning The Contributing Processes and the Literatures," *Organization Sci* , 2 (1991), 88–115

Johnson, B M and R E Rice, *Managing the Organizational Innovation: The Evolution from Word Processing to Office Information Systems*, Columbia University Press, New York, 1987

Kling, R , "Social Analyses of Computing Theoretical Perspectives in Recent Empirical Research," *Computing Surveys*, 12 (1980), 61–110.

Kraemer, K L , "Strategic Computing and Administrative Reform," in C. Dunlop and R Kling (Eds), *Computerization and Controversy*, Academic Press, New York, 1991, 167–180

Kraut, R , S. Dumais, and S Koch, "Computerization, Productivity, and Quality of Work-life," *Comm ACM*, 32 (1989), 220–238

Levitt, B and J G March, "Organizational Learning," *Annual Rev. Sociology*, 14 (1988), 319–340

Mackenzie, D and J Wajcman, *The Social Shaping of Technology*, Open University Press, Milton Keynes, UK, 1985

March, J G , "Footnotes to Organizational Change," *Admin Sci Quarterly*, 26 (1981), 563–577.

Markus, M. L and D Robey, "Information Technology and Organizational Change: Causal Structure in Theory and Research," *Management Sci* , 34 (1988), 583–598

Miller, D . "Evolution and Revolution: A Quantum View of Structural Change in Organizations," *J Management Studies*, 19 (1982), 131–151

—— and P M Friesen, "Structural Change and Performance Quantum versus Piecemeal-Incremental Approaches," *Acad. Management J* , 25 (1982), 867–892

Nelson, D L , "Individual Adjustment to Information-driven Technologies· A Critical Review," *MIS Quarterly*, 14 (1990), 79–98

Orlikowski, W J., "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly*, 17 (1993), 309–340

—— and J J. Baroudi, "Studying Information Technology in Organizations Research Approaches and Assumptions," *Information Systems Res* , 2 (1991), 1–28

—— and D C Gash, "Technological Frames Making Sense of Information Technology in Organizations," *ACM Trans. Information Systems*, 12 (1994), 174–207

Pfeffer, J , *Organizations and Organization Theory*, Pitman, Marshfield, MA, 1982

Pinsonneault, A and K L Kraemer, "The Impact of Information Technology on Middle Managers," *MIS Quarterly*, 17 (1993), 271–292

Prasad, P , "Symbolic Processes in the Implementation of Technological Change. A Symbolic Interactionist Study of Work Computerization," *Acad Management J* , 36 (1993), 1400–1429

Robey, D., "Computers and Management Structure: Some Empirical Findings Re-examined," *Human Relations*, 11 (1977), 963–976

—— and A Azevedo, "Cultural Analysis of the Organizational Consequences of Information Technology," *Accounting, Management and Information Technologies*, 4 (1994), 23–37

—— and A. G Rodriguez-Diaz, "The Organizational and Cultural Context of Systems Implementation. Case Experience from Latin America," *Information and Management*, 17 (1989), 229–239

——, N. A Wishart, and A. G. Rodriguez-Diaz, "Merging the Metaphors for Organizational Improvement. Business Process Reengineering as a Component of Organizational Learning," *Accounting, Management and Information Technologies*, 5 (1995), 23–39

Romanelli, E. and M L Tushman, "Organizational Transformation as Punctuated Equilibrium An Empirical Test," *Acad Management J.*, 37 (1994), 1141–1166.

Sahay, S., *Social Construction of Geographic Information Systems*, unpublished doctoral dissertation, Florida International University, Miami, FL, 1993

Sauer, C and P Yetton, "The Dynamics of Fit and the Fit of Dynamics. Aligning IT in a Dynamic Organization," in J I. DeGross, S L Huff, and M. C Munro (Eds), *Proc Fifteenth International Conf on Information Systems*, 1994, 41–50.

Scott Morton, M S (Ed.), *The Corporation of the 1990s· Information Technology and Organizational Transformation*, Basic Books, New York, 1991

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Slack, J. D., *Communication Technologies and Society. Conceptions of Causality and the Politics of Technological Intervention*, Ablex, Norwood, NJ, 1984

Swanson, E B., "Information Systems in Organization Theory: A Review," in R J Boland and R A Hirschheim (Eds), *Critical Issues in Information Systems Research*, Wiley, Chichester, UK, 1987, 181–204

Tushman, M L and P. Anderson, "Technological Discontinuities and Organizational Environments," *Admin Sci. Quarterly*, 31 (1986), 439–465

—— and E Romanelli, "Organizational Evolution. A Metamorphosis Model of Convergence and Reorientation," in L. L Cummings and B M. Staw (Eds.), *Research in Organizational Behavior*, JAI Press, Greenwich, CT, (1984), 171–222

Tyre, M J. and W J Orlikowski, "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Sci*, 5 (1984), 98–118.

Walsham, G, *Interpreting Information Systems in Organizations*, Wiley, Chichester, UK, 1993

Yetton, P., K D. Johnston, and J F. Craig, "Computer-Aided Architects: A Case Study of Strategic Change and IT," *Sloan Management Rev*, Summer (1994), 57–67

Zuboff, S, *In the Age of the Smart Machine: The Future of Work and Power*, Basic Books, New York, 1988.